PROTECTED CULTIVATION – A BOON TO INDIAN HORTICULTURE

By

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DECLARATION

I, Margaret Thomas, (2004 – 12 – 01) here by declare that this seminar report entitled **"PROTECTED CULTIVATION – A BOON TO INDIAN HORTICULTURE"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports

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(2004 – 12– 01)

CERTIFICATE

This is to certify that the seminar report titled **"PROTECTED CULTIVATION – A BOON TO INDIAN HORTICULTURE"** has been solely prepared by Ms. Margaret Thomas (2004 – 12 – 01), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

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Protected cultivation - A boon to Indian horticulture

Introduction

Agriculture is the backbone of Indian economy and there is a strong correlation between agricultural growth and economic prosperity. When we talk about globalization of Indian economy, we must think about globalising agriculture . If India has to emerge as an economic power of the world, our agriculture productivity must match with the productivity of those countries which are currently rated as economic powers. We need technology which can improve continuously the productivity, profitability and sustainability of our major farming systems. Protected cultivation is one such technology.

In our country although the situation with respect to food grain production is relatively comfortable , it is not respectable with other sectors including horticulture Agricultural planners are emphasizing more on the use of advanced biotechnologies to achieve breakthrough in the yield potentials and productivities of crops At the same time there is an emphasis to improve the efficiency of agricultural inputs in the farming systems . Improved and alternative technologies for intensive agriculture within the socio economic constraints of the nation have to be developed Every square meter of the cultivable land must grow manifolds with cropping or land use intensities much higher than the present . The extreme and unutilized agroclimatic regions have to be harvested as a part of this strategy Greenhouse cultivation of the crops meet the criteria set for the search of alternate technologies for commercial production of horticulture crops like fruits , flowers and vegetables

There are essentially two complimentary concepts for higher crop productivities.

1. Improvement in the genetic base

2. Maintenance of favourable environment

As the past, future may also belong to the approach of improving genetic base. However even for a given genetic material , the yield potential is fully exploited only when a favourable environment is provided. Greenhouse crop production take care of that issue in a nice way.

What is protected cultivation?

Protected cultivation is nothing but growing crops in protected structures for maximizing crop productivity and optimum growth. It is a total concept of modifying natural environment for optimum plant growth. Plant growth is severely limited in certain adverse climatic conditions either through out the year or during most of the year. This led to the idea of protected cultivation. which involves protection at production stages of crops from environmental conditions as high and low temperature, light, frost, hails, sno2 and rains where it is not possible to raise the crops in open fields.

Importance of protected cultivation

Different structures used in this technology protects plants from

I. Wind

II. Precipitations

III. Excessive radiations

IV. Temperature extremes

V. Insects and pests

It is also of vital importance to create an ideal microclimate around the plants It may be done by controlling or modifying the climate around the plants Growing environments can be altered to suit the specific requirements of plants and as a result the quality and productivity of crops is improved By controlling the

climate, we can raise crops in off season and can fetch good price. The environment control might include one or more of the following aspects.

a. Ventilation

b. Cooling / Heating

c. Humidification / Dehumidification

d. Carbon dioxide enrichment

e. Light control

The occurrence of small land holdings and short growing seasons in Holland and Japan and water scarcity in Israel and middle east countries persuade them to expand their area under greenhouse cultivation. India also can direct its path to that angle.

History

The history of protected cultivation dates back to 4th century BC when Plato had described about plants growing under protection. Roman emperor Tiberius Caesar who ruled between AD 14 and 37 was advised by his doctor to eat one cucumber daily. Arrangements were made for year round production by using frames glazed with transparent stone. Since time immemorial man has learnt to grow plants under natural conditions. To protect plants from excessive cold in earlier stages, wooden structures covered with glass and heated by oil burners were used. Continuous improvements in these structures have taken place over two to three centuries and now we have come to a stage where we can create ideal growing conditions for any plant in any place under the cover using glass, fibre glass, polycarbonate or polyethylene and other accessories.

In India protected cultivation is of recent origin and is in infancy. First greenhouse was made in Pune in 1991. Father of greenhouse technology in India is said to be Dr. Manmohan Attawar.

Present Scenario

In the context of shrinking land area but with the object of increasing crop production, both developed and developing countries are coming forward for protected cultivation. Among them Israel, Netherland, Holland, Japan are some of the important ones.

Table1

Greenhouse area in different countries (Jadhav et al, 2002)

COUNTRY	AREA
Japan	42,000
Spain	23,850
Italy	20,000
Holland	10,000
Turkey	9,800
France	5,540
USA	4,000
Germany	3,800
South Korea	3,725
USSR	2,166
UK	1,727
Israel	1,250
Bulgaria	1,000
Egypt	1,000
Canaries island	900
India	700
Canada	302
Cyperus	208
UAE	55
Philippines	12

India

Protected cultivation in India is still in infant stages but more farmers are showing interest in that. As per 1994-95 estimates approximately 100ha of land was under

protected cultivation in India. In a time span of two years, it almost doubled to reach 200-220 ha by 1997.It is reported that area under protected cultivation in India is increasing at the rate of 10%.In 2002, the area was 700ha and by the end of 2005, the area will be nearly 1000ha.(Jadhav et al,2002). Bangalore , Pune , Delhi, Hyderabad, Uttaranchal are the places in the front row. State governments encourage farmers to take up this technology. Maharashtra co-operative floriculture development Society Ltd try to raise funds from NCDC, NABARD, national banks, NHB and other government and financial agencies for creating modern structures of polyhouse techniques. Society arrange one day polyhouse training program within Maharashtra at various places with the help of Agricultural produce marketing committee. Till date 1600 people got benefited

Kerala

Farmers of Kerala is not much aware of protected cultivation. Vegetable production in Kerala is confronted with many limitations like scarcity of land and climatic factors like heavy rainfall and high humidity during rainy season and high temperature during summer. Hence protective structures against these adverse conditions should be encouraged. A low cost, rain shelter with ample natural ventilation has developed by Kerala Agricultural University and is yet to be familiarized. (Indira et al, 2004)

TYPES OF PROTECTED STRUCTURES

Different structures under protected cultivation can be classified as follows (Parmar and Choudhary, 2001)

1. Hot beds
2. Cold frames
3. Frame culture
4. Tunnel
5. Greenhouse

6. Rain shelter
7. Trenches
8. Plastic mulch
9. Seran cover

1. Hot beds

They are used in winter for vegetable production. It can be made of wood, cement or brick stone and prepared above ground. The pit is filled with the mixture of well rotten FYM, ash and soil. Artificial heating is employed. They are covered with a polythene lid during cold night and in early spring especially for tender plants like tomato, brinjal, melon and pepper. These beds provide an early start of crop. Initial cost is high. Crops like cucumber, okra, pepper, cabbage, muskmelon and watermelon are grown commercially in this structure.

2. Cold frame

They are wooden or concrete structures with plastic on top, which can trap heat from the sun, making the temperature several degrees higher. These are used for early crop and to harden plants like radish , lettuce and beet under the low temperature conditions.

3.Frame culture

These structures are used for early germination of summer crops like cucurbits Plastic tunnels can be used to protect midseason varieties of cucumber against rain Plastic tunnels are used extensively in the cold desert of Ladakh for raising vegetable nursery and to obtain early crops (Singh et al , 1997) Low tunnels of about 0.5cm height above beds are shown to give high yield from muskmelon (Singh et al, 2001) Low tunnels are utilized for watermelon and summer squash in Israel and can be practiced in India also.

Whenever plants are to be protected from cold and frost for very short periods, tunnels of about 6ft height can be made by bending steel tubes or bamboos and covering with polyethene sheets. The poly cover can be removed once the weather conditions become favorable (Attawar, 1993)

5. Greenhouse

Greenhouses are framed or inflated structures covered with transparent or transcluscent material large enough to grow crops under partially or fully controlled environmental conditions to get optimum growth and productivity. They trap thermal radiations inside. Photosynthetic rate is increased by the CO_2 released by the plants during night time. Evaporation from soil and plants also raise the humidity. Greenhouses are widely used now a days at a commercial level in metropolitan cities because of the facilities for partial or full climate control. We can install control mechanisms for temperature, humidity etc. Now a days CO_2 enrichment is possible which increases photosynthesis , vegetative growth and reproductive output to an extent of 13% and 31% respectively(De et al.,1998) Other benefits are

a. It reduces water consumption per unit leaf area

b. Protects plants from SO2 damages

c. Enables plants to overcome salinity stress

d. Suppresses weed growth

Computer controlled greenhouses are becoming more popular in cities like Bangalore and Delhi Computers provide a promising solution to automation of greenhouses and plant growth related activities. A modern greenhouse monitoring and control system developed by the CMC with SMART lab program for the plant tissue culture and greenhouse facility of National Chemical Laboratory, Pune is in operation (Parthasarathy, 1995)

Classification of greenhouses

Greenhouses can be classified based on cost, shape, covering material used etc. (Manohar and Igathinuthane, 2000)

I Based on cost

a) Low cost greenhouse

This is a zero energy chamber made of polythene sheet of 700gauge supported on bamboo or any locally available materials with sutli and nails. The temperature within poly house increases by 6 to 10 degree celcius more than outside. It has one opening kept open for one to two hours in the morning to reduce relative humidity.

b) Medium cost green house

It fetches a slightly higher cost and has generally Quonset shape, framed with GI pipe (class B) of 15 mm bore. This has single layer covering of UV stabilized polythene of 800 gauges. Thermostatically controlled exhaust fans for ventilation, cooling pad for humidifying air entering polyhouse are additional facilities. The poly house frame and glazing material have a life span of about 20 years and two years respectively (Sirohi et al., 2000)

c) High cost green house

It consists of fibre glass covering with full environmental control systems. The temperature, humidity and light inside are automatically controlled using computers. They are hi-tech green houses consisting of a sensor, a comparator and an operator. Microclimate changes are indicated through sensor or signal receiver. For example, temperature control systems consists of temperature sensor, heating or cooling mechanisms and thermostatically operated fan. Similarly relative humidity is sensed through optical tagging devises. Boiler operation, irrigation and misting systems are operated under pressure sensing systems. Anyhow this modern structure is

highly expensive requiring qualified operators, maintenance, care and precaution.

Type of greenhouse	Cost (Rs) per m^2
1 Low cost	125-200
2. Medium cost	500-100
3. High cost	1000–2000 and above

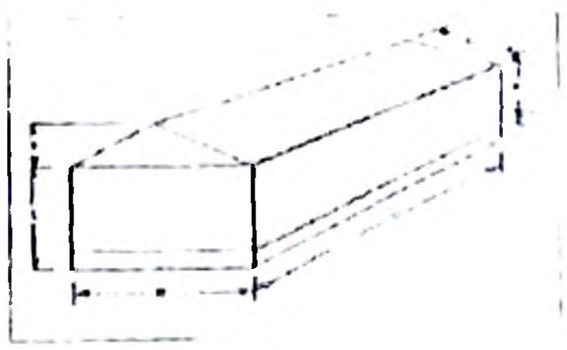
II **Based on shape**

Based on the shape of the structure, greenhouse can be classified considering the uniqueness of the cross section of greenhouse as a factor. Important ones are as follows

i) Lean to type

The design is used when a greenhouse is placed against the side of an existing building . Roof of building is extended with appropriate covering material and the area is properly enclosed

ii) Even span type or gable type



In this two roof slopes are of equal width The design is used for the greenhouse of small size and is constructed on leveled ground The posts will be 8-9 ft tall and height at the centre will be around 12 to 14 feet Ideal size of such greenhouse is with fibre glass covering is 29 ft width and 96 to120 ft length They can vary according to the situation. Several such greenhouses can be connected to

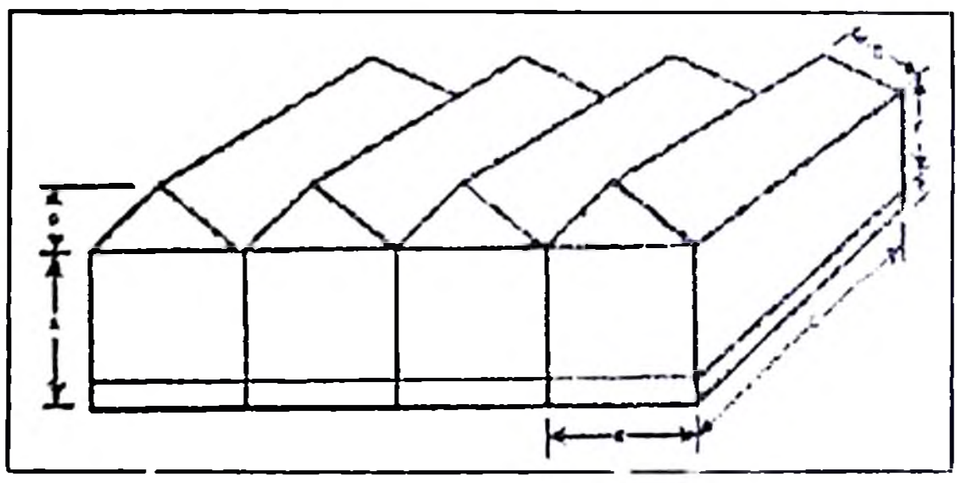
each other through gutter. They are most suitable for temperate region where the roof has to take a considerable amount of snow load (Attawar. 1993)

iii)Uneven span type

The type is constructed on hilly terrain. Roofs are of unequal width and makes the structure adaptable to the sides slopes of hill. This is seldom used and is not adaptable to automation

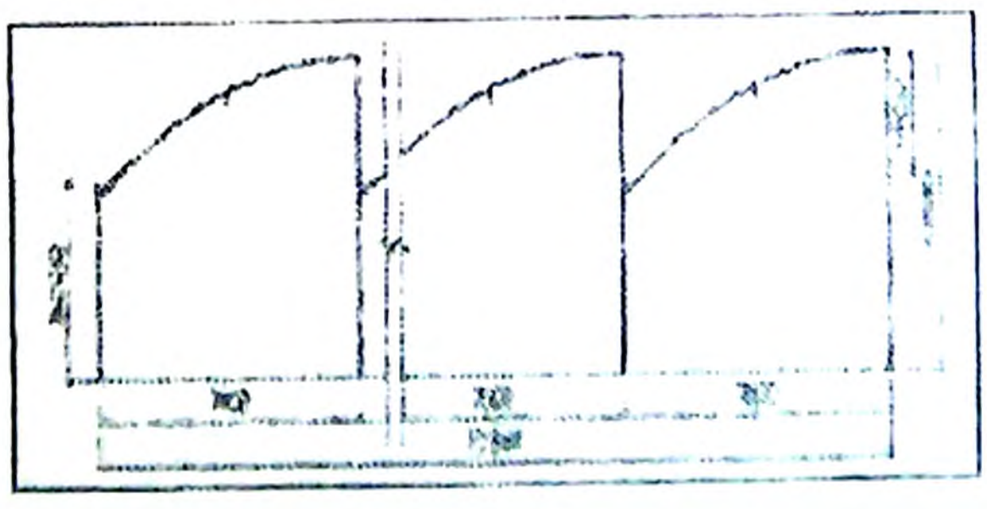
iv) Ridge and furrow type / Gutter connected greenhouse

Two or more greenhouses are connected to one another along the length of the eave which act like a furrow to carry rain or melted snow away. Sidewall is eliminated making a single large interior. Labour cost. Fuel consumption, automation cost etc are reduced. Snow load has to be taken care of. Even then ridge and furrow type greenhouses are well suited to the Indian conditions



v)Saw tooth type

They are similar to ridge and furrow type but with provision for natural ventilation



vi) Quonset type

The roof of this type will be semiround. Pipe arches or trusses are supported by pipe purlins running along the greenhouse. Polyethene fibreglass or polycarbonate sheets are used for roof. Generally poyethene sheets are used. Ideal size is 96-120ft in length, 29ft wide, 8ftsides and 12- 14 ft height at the center. They are less expensive than gutter connected and are useful when a small isolated area is required. They are either freestanding style or arranged in interlocking ridge and furrow. In interlocking type, truss members overlap sufficiently to allow a bed of plants to grow between overlapping portions of adjacent greenhouses. A single cultural space thus exists for a set of greenhouses in this type. Automation and movement of laborers are also easy

6.Rain shelter

It is a naturally ventilated low cost greenhouse. It possess only roof claddings and has open sides. It is made of GI pipes, wooden or bamboo poles. Cladding is provided with UV stabilized low density polyethylene (UVLPDE) film of 200μ thickness. It is economical, 70 to 80 percent transparent with 2-3 years usable life. (Indira et al., 2004). Improved performance and yield increase was observed for tomato.

7. Trench cultivation

It is also called as underground greenhouse technology. It is cheap and simple technology for growing vegetables during winter. The technology is being utilized by farmers of Ladakh and Leh region extending the vegetable production for three to eight months (Singh et al., 2002)

8 Plastic mulch

Mulching is a practice of covering the soil surface around the plant rootzone with straw, grass, stones, plastic etc. Plastic is used now a days by some farmers even though it will cause pollution. Mulching reduces evaporation, moderate diurnal soil temperature and keep down weeds. Plastic mulching increased yield in several vegetables like tomato, pepper, brinjal, watermelon

etc. It improves yield and quality of produce by modifying soil temperature and controlling soil moisture

9.Seran cover

Since most of the indoor foliage plants have originated in the tropical regions, they will have to be produced under partially protected conditions such as seran house or lath house. These structures ensure protection of the plants from excessive solar radiation, light intensity, precipitation, high winds and temperature extremities. They also reduce evapotranspiration and enable the grower to produce quality plants in shortest period. Seran cloth provides 25 to 80 percent shading (Attawar, 1993)

Applications of protected cultivation

This technology is mainly practiced for

a. Vegetables
b. Flower crops
c. Fruits
d. Spices, medicinal and aromatic plants

Protected cultivation of vegetable crops

Protected cultivation can be utilized mainly in three areas namely

1. Nursery raising of crops
2. Off season crop production
3. Seed production

I . Raising seedlings of vegetables

Use of protected structures for cultivation of crops including seedlings as a commercial venture is a recent phenomenon especially in the tropics. In India, plastic or net house are good enough to raise vegetable seedlings under partial controlled environment conditions. The most commonly used method to reduce radiation and temperature is by shade net covering and may be with fogging or misting facilities. These are ideal for the production of vegetable

seedlings as they are comparatively more economical; and feasible (Prabhakar, 2004)

Nursery raising in off-season is a blessing that it facilitates better germination and development of seedlings. The seedlings can be transplanted to main field or to protected condition when climatic conditions become favorable. Sirohi (1998) developed a polyhouse technology for raising an off-season nursery of cucurbits in winter. By this a cucurbit crop could be taken one and a half month in advance than the normal direct sowing in the field and fetches a good price. Increased duration of harvest also gives extra profit. Besides it is a low cost and zero energy technology. Temperature inside the polyhouse becomes 5 to 10 degree celcius higher than outside and provides a spring type climate to the seedlings in poly bags which helps in quick germination of seeds and fast growth in December- January. Ahluwaliya et al. (1996) found that yield and number of tomatoes per unit area was higher for the crop grown from greenhouse raised seedlings than open and are 53.4 and 48.7 percent respectively. At IARI, seedlings of cucumber, capsicum, tomato, brinjal, muskmelon, watermelon, lettuce, cabbage, cauliflower, broccoli, summer squash, bottle gourd and potato (True potato seeds) under covers are raised on a commercial scale for distribution to farmers (Singh and Sirohi, 2002)

Asparagus , sweet potato, pointed gourd and ivy gourd are sensitive to low temperature . The propagating materials of these vegetables can be well maintained under polyhouse in winter season before planting their cuttings in early spring –summer season for higher profit

Advantages

1. Seedling production can be done under adverse climatic condition
2. Time period is short
3. Reduction in mortality while transplanting
4. Early planting is accomplished
5. Suitable for both sexually and asexually propagated crops
6. Pest and diseases especially virus management is easy

7. It reduces the hybrid seed rate and hence the cost
8. It can be taken up as a commercial enterprise

II .Off season Vegetable crop production

Tomato, capsicum and cucumber are most important vegetables and their demand in Delhi and alike metropolitan cities is quiet alarming day by day. Prevailing low temperature and frost injury during winters are limiting factors. Chandra et al. (2000) reported higher yield of 110.5t/ha with Naveen and 98.6t with Pusa hybrid 2. Capsicum variety California wonder gave 87.2t/ha and cucumber variety Poinsette gave 73.2t/ha. Other factors like days to flowering, days to first picking, number of fruits per plant also were showed improvement under protected structures.

Cucumber

The cultivars selected should have certain special characters. It should be gynoecious with dark green parthenocarpic fruits and free of bitterness. Parthenocarpic, gynoecious, F_1 hybrids are preferred as they give high yield and good quality produce. If they are not available, Poinsette can be used which is an ideal variety for greenhouse cultivation. During winter, temperature regime of 25 and 10°C maximum and minimum are enough to get off season cucumber in greenhouse. Relative humidity in greenhouse should not go beyond 80%. Higher humidity increases foliar diseases (More and Chandra, 2000). In case of monoecious variety, hand pollination is required and should be performed between 8 and 10 AM.

Tomato

Tomato is the most popular vegetable crop grown under greenhouse through out the world. In addition to the quantum jump in the yield and superior quality, substantial reduction in the pesticide use makes it an ecofriendly proposition to grow tomato in naturally ventilated greenhouses.

Tomato hybrids with indeterminate growth habit are best suited to utilize both horizontal and vertical greenhouse space. Commercial hybrids like SH 771 are suitable with an yield potential upto 180 t/ha from a crop of six months duration

(Hebbar,2004). Pruning and training are essential operations. Lowering of plants and deleafing are otner operations. In rain shelter, it gave better yield, high lycopene and vitamin C content. A study conducted in TNAU in naturally ventilated polyhouse with insect proof net and open field showed that, S-41 under polyhouse was early in flowering and fruit set than open field yielding two fold as compared to open field .(Nagalakshmi et al.,2000). Off season cropping pattern under low cost plastic greenhouse cum rainshelter is more suitable for tomato crop (AAU,1997). Rain shelter cultivation of tomato at plastic culture development centre , Thavanur revealed that productivity of tomato inside the shelter was 5Kg per m^2 while in open condition it was only 1.3 Kg per m2(KAU,1999) Arya et al (2000) reported that plastic shelters increased tomato and capsicum production by 169 and 956 percent respectively without any use of pesticides

Capsicum

Capsicum is the most popular salad vegetable grown in greenhouse Capsicum hybrids with indeterminate growth habit are best suited for greenhouse cultivation Commercial hybrids like Indra, Green gold are suitable with an yield potential upto 120t/ha in six months. Pruning to four stems and training are to be done Capsicum yields in open field ranges between 20-40t/ha, where as in greenhouse the yield range is 100-120t/ha (Prabhakara et al ,2004)

Capsicum in rain shelter during Kharif season, gave larger fruits of mean weight of 35 57g and in open field it was 22 51 g In both Kharif and rabi seasons, crop gave higher yield under rain shelter than open field (Vezhavendran,2003) Capsicum variety greengold under naturally ventilated poly house recorded four fold increase in yield over that grown under open field condition Improved yield components like increased plant height including fruit weight has contributed for increased yield. Khan et al (2000) found that capsicum produced in low cost polyhouse was of excellent quality

Other crops

Offseason production of cucurbits, lettuce, cole crops etc are done in Pantnagar (Srivasthava, 2000) Off season production of muskmelon under plastic tunnels of

0.5 cm above the level of beds during winter at IARI showed good flowering and fruit setting (Singh and Sirohi, 2001)

Watermelon, muskmelon and summer squash are grown in low tunnels in Israel. Low tunnels are cheaper than greenhouses.

IARI has developed zero energy, low cost structure with bamboo frame and polythene sheet cover for production of summer vegetables like cucurbits in summer. Triploid watermelon under polyhouse along with provision of pollinizers and beehives gave better quality fruits. (Pitchaimuthu, 2001). Button mushroom cultivation besides its seasonal cultivation in northwestern region of country by small growers is currently being cultivated in climate controlled growing rooms. Temperature is around 24^0C and CO_2 concentration is less than 1000ppm while RH is around 85% (Verma,2001) Cauliflower variety Pusa Katki recorded highest yield of 153.82 Kg per $100m^2$ under low density polythene rain shelter in Jorhat (Saikia,1998). Cauliflower grown under naturally ventilated polyhouse showed reduction in duration by forming curds earlier by two weeks when compared to the crop in open condition The absence of diamond back moth under protected condition paved way for the production of quality curds which were free from residual toxicity (Nagalakshmi et al , 2000) Okra gave 2.5 to 3 fold increase in yield in greenhouse and winter brinjal gave 15 percent higher yield (Nimje and Shyam,1991) Broccoli gave 21 06tper ha at 30X50 cm spacing and 50g urea per plant under greenhouse (Kanthaswamy et al, 2000)

III. Vegetable seed production

Vegetables require specific temperature and climatic conditions for flowering and fruit setting Some vegetables are grown in one part of the country and their seed production is restricted to another part To reduce such microclimatic condition a protected environment is essential Summer squash require a mild climate for flowering, fruit set, fruit development and seed formation. Therefore its seed production is restricted to hilly regions of north India in summer season. But nowadays seed production of summer squash varieties like Australian Green and Pusa Alankar is also feasible in North Indian plains in a low and medium cost greenhouses.

Similarly seed production of highly remunerative crops like tomato, capsicum and cucumber is also performed under protected environment. The maintenance of purity of different varieties or lines can be achieved by growing them under greenhouse without giving isolation distance particularly in cross-pollinated vegetables like onion, cauliflower and cabbage. To get proper pollination and fruit set in onion, summer squash, cucumber and bitter gourd the beehives are kept inside during flowering (Sirohi and Behera, 2000) Trenches are used for seed production of cole crops in Leh region.(Singh et al., 1997)

Technology for protected cultivation of vegetables in high altitudes

Since cropping period is small in high altitude region , it is difficult to raise vegetables requiring transplanting such as cauliflower,cabbage,knol kohl, tomato, onion etc. Defense Research and Development Organization (DRDO) has standardized trench cultivation method for raising early nursery of vegetables Capsicum crop in solar greenhouses are grown by adopting polyhouse and trench cultivation techniques using polyethylene and local material affordable by farmers Winter leafy vegetables like spinach are also grown by using this technique. Vegetables like capsicum, brinjal and chillies during June - September and luttuce – sarson, turnip, onion, coriander and mint during October – December have been successfully grown under green houses in Leh (Thakur and Sphehia, 2004)

PROTECTED CULTIVATION OF FLOWERS AND ORNAMENTAL CROPS

Floriculture has emerged as most lucrative business due to much higher returns than other crops Flower consumers all over the world are becoming quality conscious The ornamental production units can be successful only if the produce are of excellent quality Regular production is also important to retain the position in the market To ensure consistency in quality and quantity of production required to limit the risk involved , it is necessary to grow these plants in greenhouse where growing environment can be altered to suit the specific requirements of plants

In India, efforts on promoting commercial floriculture have started due to liberalization of industry and trade policies Total area under floriculture is 88,600ha in India. Out of which more than 250 ha is under protected cultivation A significant

increase in the percapita consumption of floricultural products has been observed in the recent past in both developed and developing countries. So to meet the global demand, our production has to be increased manifolds. Protected cultivation is a solution for this. The main crops under protected cultivation are rose, chrysanthemum, carnation, gerbera, lilium hybrids, orchids and anthurium.

Rose

Growing roses under protected cultivation in India is of recent origin and is increasing rapidly with several corporate sectors and private people entering this sector. Roses grown for export should be popular varieties of that region and maintain high quality standards with respect to bud size, stem length, lush green leaves free of pests and diseases. These quality standards can be achieved and maintained only when grown under poly house, a greenhouse which gives protection against in element weather condition, pests and disease. Temperature should be maintained between 25 to 30°C during daytime and more than 15°C during nighttime. Good sunlight is must. Both high and low temperature cause bad effects. Increasing CO_2 concentration from 500 to 1000ppm increased flower yield (Sujatha, 2004). A relative humidity of 60-70% is to be maintained inside poly house. Most promising cultivars for greenhouse cultivation are Golden Gates, Grand Galla, First Red, Ravel, Noblesse, Vivaldi and Starlite (Misra and Pathania, 2000). The crop will give 150 to 300 stems per m^2 per year under protected condition.

Chrysanthemum

Chrysanthemum is one among the five important commercially potential flower crops. Chrysanthemum growing is not new to India. With the advancement of technology like using the greenhouse for climate control and with foreign collaborations, chrysanthemum cultivation is all set to go High-tech. Most of the hi-tech farmers are concentrated in Bangalore, Pune, Delhi, Calcutta and Ooty.

Chrysanthemum has it's own advantages like

1. Longer vase life than rose
2. It has greater chance of arriving in a better shape at the auction center after inadequate refrigeration and transportation infrastructure than the more delicate rose

3. In local Indian markets, the flower is well received with a better average price Light and temperature are important environmental factors influencing growth and development. It is typically a short day plant and normally cannot form flower buds when day length exceeds 14.5 hour. July – August is ideal time for planting in North India. However if controlled photoperiod facilities are available. planting can be done round the year. Black out and artificial lighting are followed to control day length (Raju et al , 2001) Pinching and disbudding are important operations to be followed in side the structure for quality bloom production

Poly house planting recorded significantly better growth and yield of 35 to 40 percent more than open condition. Spray stalk length , flower size , number of sprays per plot and number of flowers of spray were maximum under poly house condition (Gaikwad and Patil, 2001). Temperature of 16-18^{0}C is ideal for flower induction. High temperature increases stem length. Lime application on plastic or glass roof, frequent misting. adjusting timings of closing of black plastic cover. protection screen. fan and pad system etc will help to manage high temperature. (Janakiram and Rao . 2001)

Carnation

Perpetual carnations can be planted round the year under greenhouse environment if temperature is maintained at 20-25^{0}C. Master , Tanga. Laurella are some of the promising standard types. Plant density of 20 to 30 plants per m^2 is optimal. Pinching, disbudding and deshooting are important practices followed. Supplementary lighting from dusk to dawn with 10 watt incandescent bulbs hung at 1.5 m above the beds in winter produces early flowers of better quality. Growing of standard types requires specific environment and cultural practices and preferably protected cultivation. It is advisable to take up cultivation of several colors in a single polyhouse of carnation because the demand for color keeps changing (Thejaswini, 2004). Carnation under polyhouse gives 200 to 250 flowers per m^2 where as it is only 100 to 150 in open condition (Raju et al. 2001)

Gerbera

It is one among the top ten cut flowers which are in demand and traded in the world market. Gerbera was hitherto grown under open conditions. But as it requires partial

shade for optimum growth, it's cultivation under 50 percent shade net has become popular. However with the advent of new exotic and hybrid cultivars, which require more care in their management, it has become difficult to get high productivity of superior quality blooms even under partial shade. Hence to meet the quality standards of export or even upcoming domestic market one has to go in for it's cultivation under naturally ventilated low cost poly or greenhouse for making it's cultivation a profitable venture.

Plants under greenhouse requires a day temperature of 22 to 25^{0}C and a night temperature of 12 to 16^{0}C. Plant grows vigorous under polyhouse condition and starts flowering in about three months after planting. The average yield under greenhouse is around 175 to 250 flowers per m^2 per year of which 85 percent were of first grade quality while it was 130 to 160 flowers per m^2 per year only under open field with 15 to 20 percent of first grade (Sujatha, 2004)

Plasticulture Development Centre, Mahatma Phule Krishi Vignan Kendra, Rahuri has developed a low cost handy wooden frame structure ensuring high profit and successful cultivation. Casaurina posts can be used along with 800 gauges UV stabilized film. Benefit cost ratio found is Rs. 3.49(Ahmed et al., 2001) Pune, Nasik, Sangali, Satara districts of Maharashtra are well perpetuated with polyhouse industries of gerbera cultivation. Tissue cultured plants are best for polyhouse planting. Crop under plastic rainshelter in Assam condition showed early flowering, significantly higher flower size, stalk length and girth, number of flowers per plant, number of florets per flower, shelf life and vase life. (Mahantha and Paswan,2003)

Orchids

Orchids with their widest variety of genera and species are grown in all climatic conditions. In temperate regions, cymbidium is the most important genus of commerce. Other important gwnera are Paphipedilum, Miltonia, Phalaenopsis etc. A closed greenhouse with heating system is most common in the temperate region where heat generated due to greenhouse effect is sufficient to develop adequate temperature. Ventilators, evaporative coolers, fan and pad systems can be tried for temperature regulation and air exchange. Kerala is one of the few places in the world where sophisticated infrastructure is not required for

the cultivation of tropical orchids. However, the design of growing structures being adopted here require slight changes, in order to exploit the available climatic conditions. Light is the important single factor that controls healthy growth of orchid plants and their ability to reach flowering. Polypropylene nets can be used to provide optimum shade and light conditions

In Kerala, which receives high rainfall over a period of 5 to 6 montns, the direct effect of high rainfall and indirect effect of low light intensity due to cloudy weather are the major problems encountered in the commercial cultivation of orchids. As a trial in a growers field, Denurobium were grown in raised platforms provided with central channels. The channels were filled with water during summer to raise relative humidity. Two shade nets of 25 percent were given in the roof. While one in the sides. It was found that none of the shoots showed defoliation, indicating the highly congenial microclimate inside the geenhouse. Water in the channels took care of relative humidity and hence defoliation. During the rainy seasons, the polythene sheets improved light conditions and controlled the impact of heavy rains. Higher percentage of marketable spikes was obtained and the incidence of pest and diseases also was low. Based on the encouraging results, more cost effective systems are being tried for large scale production of orchids. In another design, the extra cost involved initially was compensated by growing fish on the floor of the orchid house

An indigenous low cost orchidarium was developed by Central Agricultural Institute, Port Blair. It is made up of bamboo poles and bamboo screen and covered with 50 percent agro shade nets. It has got following advantages

- It can be an alternative to fiberglass a or greenhouse owing to its low cost
- It is highly suitable for growing warm humid tropical orchids
- Besides ground space it has provisions to accommodate more plants by hanging them on the roof
- It is eco friendly and useful for small size holders for commercial cultivation. The cost per m^2 is only Rs. 243 (Shiva et al , 2003)

Anthurium

Depending upon the area of cultivation , the growing structures can be modified to suit the local climatic conditions. Commercial scale Anthurium cultivation can be taken up in low cost polyhouse or shade houses.

a. Low cost poly house

In areas where relative humidity levels are low and temperature levels are high, low cost polyhouses are more suitable UV stabilised polythene for covering and top or side ventilation can be provided. Inside the polyhouse, the top portion can be provided with layers of two shade nets (50% and 25%). If the light is very high, a thin film of calcium chloride or lime can be sprayed on the external surface of the polyhouse to reduce the incoming radiation.

b.Shade houses

In many of the commercial Anthurium growing areas, shade houses are the most popular are structures because of the simplicity of construction and low cost. The shade houses can be constructed by taking the support of tree trunk if the Anthuriums are grown in multistoried plantation cropping. Two shade nets of 75 percent and 25 percent and one layer in sides can be used to provide required shade. Such structures are more suitable in areas where the ambient relative humidity levels are already high and frequent air exchange through the porous side nets do not results in drastic reduction in the relative humidity levels (Sujatha and Sujatha, 2004)

A study conducted in Kerala Agricultural University by Valsalakumari et al (2001) for shade and nutrient management showed that highest values for vegetative characters like plant height , spread, number of leaves and Leaf Area Index were recorded under 80 percent shade. Days taken for flowering was significantly lower while spathe length and width were significantly higher in this treatment. Dry matter production and uptake of nitrogen, potassium and calcium was higher under 80 percent shade

Protected cultivation: The Indian advantages

- Abundant sunshine through out the year especially in autumn and winter for year round production without depending on artificial light and related cost escalation due to additional energy inputs.
- Many places in India especially Bangalore with Quito-Equador and Nairobi which are two best tropical production centers of the world. Bangalore and Pune with salubrious climate through out the year are more favorable destinations for floriculture hubs.
- India has wide variety of soils suitable for flower growing thereby, reducing the need to depend on costly artificial media.
- Relatively nearer to the new emerging markets like Japan . Australia and Middle East.
- Shorter production cycle 45 days from pruning to harvesting compared to 55 to 60 days in Kenya and Equador. Hence precise programming of flowering is possible in Indian conditions to meet the peek market demands
- The weather in India is very conducive for top quality flower production during the peak demand world wide during November – March (Christmas, New year day, valentine's day etc). Also unlike African countries, this period is free from adverse climatic disturbances like monsoon and rain storms

Other flower crops

Greenhouse grown gladiolus showed 20 percent reduction in time taken before sprouting of corms, spike emergence and flowering (10 17 days), compared to those in the field. Corm size and weight were 20 40 and 38 percent higher respectively in the greenhouse than in the open field (Shiva and Dadlani, 2002). Polyhouse planting gave of tulips gave higher plant height and early flowering compared to open field (Jhon and Khan, 2003)

PROTECTED CULTIVATION OF FRUITS

Protected cultivation of fruit crops is not that much advanced. Only a few crops are cultivated by using this technology. Straw berry is most important one.

Strawberry

Strawberry breeders world over have oriented their research programmes for breeding infra short day varieties, which are suitable for greenhouse condition. Dwarf varieties grow better under protected condition. Plastic tunnels, cloths, row covers and greenhouses arte widely used. This technology ensures better growth, lush green foliage, early development etc. Winter injury is great limiting factor in strawberry cultivation. But under protected structures there is no chance of winter injury due to rise in temperature. Perforated plastic tunnels never allow more than 35° C. Soil borne diseases are very less inside the structures. Enhanced runner production, flowering and fruiting are noticed. Besides flowering and fruiting were early by 20 to 25 days. Secondary and tertiary berries are more in number. Fruits showed better color development, high TSS, better flavour and low acidity. (Sharma, 2002)

Due to heavy and continuous rainfall, strawberry plants get decayed and died in open field. High tunnel polyhouses are recommended for high rainfall zones(Nevkar et al ,1998). Mitra et al (1990) found that the strawberry plants outside the polyhouse were completely decayed and died due to heavy rains where as average survival, percent inside the polyhouse was 92. The growth was better and consequently the plants multiplied to produce 285 percent more seedlings at the end of monsoon. Similar type of results regarding raising of nursery seedlings in low tunnel were reported by Behera et al. (1990). The cost of the structure is just Rs. 62 per m²

MEDICINAL AND AROMATIC PLANTS

Farmers of Chamoli district of Uttaranchal, earn more income by cultivating off season vegetables and medicinal plants. Mauriyal and Purohit

(2000) reported that cultivation of himalayan aconites could be well practiced in Srinagar in polyhouse tunnel. Tuber yield under polyethylene was eleven and eight times higher for *A.heterophyllum* and *A.balfouri* respectively compared with open grown plants. The contents of alkaloids aconitine and atisine were higher in tubers grown under polythene tunnel particularly for *A. heterophyllum* A trial of Chlarysage growing in polyhouse condition was conducted in Ladakh by Manojkumar and Sunil (2003). Herbage yield was 12.5 tonne per hectare inside the polyhouse where as it was 10 tonne in open field. And the essential oil yields were 87 and 30 Kg per ha respectively. An aromatic plant, rose scented geranium also reported to give higher oil yield from a trial in polyhouse. It gave 53 percent more herb and essential oil yield and 46.25 percent more net returns.(Tajuddin and Yaseen.1999).

SPICES

IISR(1998) standardised technologies for protected cultivation of bush pepper with high density of 350 pots per 140 per m2 An yield of 150g dry pepper per pot was recorded during first year and there was no Phytophthora incidence Cultivation of vanilla is practiced in shade houses in some places of Bangalore and Kerala.

PLANT PROPAGATION

Microbudding of *Citrus reticulata* cv Nagpur Mandarin inside greenhouse with desert cooler and glass house give encouraging results compared to open unprotected condition (Vijayakumari et al. 2000) Similar advantages are seen in vegetative propagation and multiplication of mango like fruit plants, plantation crops like cashew, cocoa and ornamental foliages like croton etc Low cost poly cum net tunnel with polyethylene sheet covering a shade net gave highest recovery of grafts (90.87%) and graftable rootstocks (95.02%). It also reduced growth period of the crop (Lingaiah and Vardhana,2000) Microtubers of various potato varieties are produced by tissue culture and being multiplied in net houses and in the field at Central Potato Research Institute(Shekhavat,1998)

SCOPE IN INDIA

The scope in Indian agriculture is tremendous if properly organized. Following are some promising fields.

1. Cultivation in problematic agro climates

There is about 75 m ha of an area in India comprising of such problematic conditions as of barren and uncultivable. culturable waste. fallow land and desert. Even a fraction of this area if brought under greenhouse, could produce substantial returns for the local inhabitants.

2. Greenhouse complexes around big cities

There is a large and substantiated demand of fresh vegetables, fruits and ornamental plants round the year in big cities. Demand for offseason and high value crops also exists in big cities. Greenhouse cultivation could therefore be promoted to meet the city requirements adequately.

3 Export of agricultural produce

Agriculture in India is being looked upon increasingly to reduce the foreign trade deficit. There is a good international market for horticultural produce. Promotion of greenhouse cultivation of export oriented crops near the convenient lifting points is a definite step towards the export promotion of India.

4. Greenhouse for plant propagation

Raising of seedlings and cuttings is a specialized job requiring control of growth environment. The existing nurseries with a greenhouse facility could increase their capacity and the quantity of their plant material. In temperate climatic conditions, plant propagation in greenhouses could mean a considertable reduction in the total time for preparation of saplings.

5. Greenhouse technology as base for other biotechnologies

Environment control in the form of greenhouse is desirable as in case of hydroponics or nutrient film technique. It is essential in case of tissue culture for raising crop productivity.

6. Greenhouse for cultivation of rare and medicinal plants

India has a variety of orchids and herbs, which have been identified for large scale cultivation. Greenhouse could provide the right type of environmental conditions for the intensive cultivation of these plants.

Greenhouse cultivation leads to higher rural development and a check on migration from rural to urban areas, higher income to small land holdings and dignified self employment opportunities for educated youths. In the final analysis, greenhouse technology has all positive attributes for wide spread application in the areas mentioned above.

SCOPE IN KERALA

Kerala with varied agroclimatic conditions is a unique place where horticulture can be boosted as an industry. The climate is not extreme here and both warm and cool season crops can be grown in different locations exploiting this favorable conditions. Generally the state comes under warm humid tropical zone with ample rains and high humidity. This limits the use of greenhouses in Kerala since the cost for reducing the temperature will be very high. Hence the normal fan and pad system of evaporative cooling cannot be employed here owing to the high humidity. The intense rainfall from June for about four to six months act as a limiting factor for commercial production of horticultural crops especially vegetables. About 80 percent of total vegetable production of state is concentrated during summer season. Hence the application of rainshelter is ideally suited to Kerala conditions.

It is a low cost structure with areca framework and roof claddings. The sides of the structure are kept open for ample ventilation. Sreelatha et al.(2002) studied the performance of tomato crop during rain season under rain shelter and observed a three fold increase in yield. The rain shelter crops excelled the open field crops in the organoleptic and nutritional quality. In tomato, vitamin C, β carotene and lycopene content were maximum in rain shelter crop. In capsicum also appearance, color and flavor were higher. In amaranth leaf spot incidence was very less or nil in rain shelter crop and hence appearance and flavor were maximum (NATP, 2004).

Multispan saw tooth type greenhouse and Quonset greenhouse are also suited to Kerala since these have provision for natural ventilation. Completely closed structures are not suitable for Kerala due to prevailing high humidity, which makes it impossible to reduce the temperature inside the structure.

CONCLUSION

Day by day the pressure of population is increasing at a fast rate. It is therefore necessary to supply required food for this population. Emergence of era of Hi-tech cultivation is becoming a boon to enhance the quality production. Hi-tech cultivation of fruits, vegetables and flowers is nothing but timely application of all basics of production including post harvest management and marketing. As the world scenario continues to change from plentiful to limited resources and with no respite in population , the pressure on the agriculture also continues to mount. It is therefore not surprising to expect radical changes in agricultural practices in near future.

Protected cultivation of crops under different structures like greenhouse meet the criteria set for the search for alternate technologies for commercial production horticultural crops within the socio economic constraints of the nation. Every square meter of the cultivable land will grow manifolds with cropping intensity much higher than the present. The extreme and unutilized agro climatic regions can be harvested as a part of this strategy.

The protected cultivation is still confined to the high-income group. In order to make it more popular, financially viable structures are to be designed considering the climatic conditions of each region.

DISCUSSION

1. Is there any disadvantage in carbon dioxide enrichment?

The practice can give rise to air pollutants like nitrogen oxides, SO_2, ethylene and Carbon monoxide. Nitrogen oxides are phytotoxic above 1ppm. Ethylene stimulates senescence in the plants, cause chlorosis, abscission, flower drop and reduced growth. SO_2 at injury level results in

tissue collapse and drying of leaves. The protein content in leaves becomes low.

2. Is this technology profitable?

Within one or two years of establishment, it cannot become a profit making venture but in the long run we can recover the cost and then profit can be incurred

3. What will be the incidence of viral diseases and temperature inside and outside rain shelter?

As the sides are open surely there is chances of virus incidence but it is very less compared to open field. Temperature will be more inside the structure.

4. Is fruit growing practiced in rain shelter?

No reports are obtained about that. High tunnel polyhouses are used as protective structures against rain in Maharashtra for strawberry. But it is not a typical rain shelter

5. What is the CO_2 conc. in the atmosphere?

350 ppm

6. What is greenhouse effect?

The greenhouse effect results from "the dirty of the atmospheric infrared window" by some atmospheric trace gases, permitting incoming solar radiation to reach th surface of the Earth unhindered but restricting the outward flow of infrared radiation. These atmospheric trace gases are referred as greenhouse gases. They absorb and reradiate this outgoing radiation, effectively storing some of the heat in the atmosphere, thus producing a net warming of the surface. The process is called the greenhouse effect

7. Why fan and pad system is not successful in Kerala?

Kerala itself is a greenhouse so fan and pad system is not required in Kerala.

8. What is the life span of greenhouse?

It depends on the materials used for the construction. Low cost greenhouses which are made of locally available materials will stand for a

maximum of 4 years. The polycover has a life span of 2 to 3 years where as the frame of middle and high cost greenhouses will stand for 15 to 20 years.

9. Cost of covering material?

For 100 m^2 UV stabilized sheet , it is Rs. 3000/-

10. What is your suggestion to a poor farmer, who has raised a tomato crop during July to protect the crop?

By using some wooden poles he can raise a structure above the crop and to cover the same he can use very cheap polyethene sheet, if his financial condition permits him

11. Whether we can raise bittergourd and yard long bean in protected structures in Kerala?

No As they are summer vegetables , in the hot and humid conditions of Kerala we cannot raise them in protected structures

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ABSTRACT

Agriculture is the backbone of Indian economy. To increase crop productivity and profitability and to achieve sustainability in agriculture we have to adapt novel and efficient technologies. Protected cultivation is one such technology. It is the concept of growing crops in protected structures for maximum crop growth and productivity by protecting them from adverse climatic condition and by modifying the microclimate around them. Different devices like fan and pad system, ventilators , heaters , coolers , artificial lighting etc are used for this purpose. Benefits of protected cultivation have been exploited in developing countries like Japan, US, Korea, Israel etc particularly in horticulture. Yield as high as 145 t/ha in tomato and 180t/ha in cucumber have obtained under protected cultivation.

Developing countries like India also have adapted this technology and has nearly 700ha are under protected cultivation.(Jadhav et al , 2002). In India computer controlled , high cost glasshouses are limited in number . Medium cost and low cost polyhouses are mainly used in the country for the production of hybrid seeds, quality vegetables and ornamentals for export, production of seedlings in the country. Polyhouses provide spring type climate for better germination of seeds and production of healthy seedlings (Prabhakar, 2004). Among the medium cost greenhouses quonset type is mostly used. Hot beds and cold frames are used to tide over the extreme temperature for raising crops like radish, beetroot, lettuce etc.

Protected structures have great scope for off-season production of fruits, vegetables and other horticultural crops. Plastic tunnels are largely used in the off season production of muskmelons during rainy season and raising cucurbit seedlings in extreme winter. Tomato and capsicum grown under naturally ventilated polyhouse produce an yield of 98.5 t/ha and 80.0t/ha compared to 42.3 and 20.2 t/ha in open field(Nagalakshmi et al , 2001) Cucumber variety grown under polyhouse condition yielded 190.1t/ha. Heavy rainfall particularly during June to August are limiting the production of vegetables like tomato, capsicum etc in Kerala. Rain shelter with good ventilation has been found ideal for growing above crops under Kerala condition. The incidence of leaf spot disease was found low in amaranth inside the rain shelter (Indira et al., 2004).

Consistency in quality and quantity of flower crops can be ensured by growing them in protected structures (Attawar, 1993). Anthurium under 80% shadenet gave quality produce in terms of spathe length and width(Valsalakumari et al.,2001).Carnation under polyhouse yielded 200-250 flowers/m^2/year and gerbera under low cost polyhouse gave B/C ratio of 3.49. Fruit crops like strawberry gave high yield and better quality produce of colour, flavor, high TSS and low acidity (Sharma, 2002).

The protected cultivation is still confined to the high income group. In order to make it more popular, financially viable structures are to be designed considering the climatic conditions of each region

Exploring cut greens for florist trade

By

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MSc Pomology and Floriculture

SEMINAR REPORT

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DECLARATION

I Smisha I·S (04 –12-17) here by declare that this seminar report entitled **"Exploring cut greens for florist trade"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports

Place: Vellanikkara
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CERTIFICATE

This is to certify that the seminar report titled **"Exploring cut greens for florist trade "** has been solely prepared by Smisha I S (04 12 17), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

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Exploring cut greens for florist trade

1. INTRODUCTION

Ornamental crop culture is fast emerging as an important and innovative dynamic global enterprise. Floriculture has become a potential money-spinner for the third world countries, since it is one of the most lucrative professions, having much higher potential return per unit area than most other horticultural crops. Floriculture industry worth US $ 60 billion, comprises florist trade of cut flowers and cut foliages, potted flowering and foliage plants, flower perfumes for production of essential oil, attar and concrete; dried flowers and plant parts; landscaping and turf grass industry.

There are a number of plant species whose magnificent, delightful and charming foliages find uses in floral designs, bouquets, wreaths and dried arrangements. These attractive plant parts are known by different names such as cut greens, cut foliages and florist greens. The main supplier of cut foliages are developed countries, but South American countries and other developing countries have entered this trade as suppliers of foliage plants (Kumar, V and Battacharjee, S. K, 2003)

Few areas in Agriculture have enjoyed rapid growth and expansion like that of foliage industry and modern foliage production and marketing firm bears little resemblance to its fore runners. The annual growth of cut foliage is around four percentages. The most important producers of cut foliage are Latin American countries (Costa Rica, Guatemala), USA, Spain, Kenya, Zimbabwe. Today foliage production is highly refined and additional research is a necessity for revealing mysteries in this area. With the people coming plant conscious, demand for cut foliage will hold on.

India with diverse agro-climatic conditions is a natural reserve of foliage plants. But research on these lines is very meagre in the country. Work on vase life studies conducted by

Roy (2001) on seventeen different foliage plant species at the National Botanical Research Institute, Lucknow.

2. What is cut foliage?

It refers to leaves or part of leaves along with stems, branches with or without decorative fruit or other part of plant (UN/ECE, 1994). Foliage of different herbs , shrubs and trees are attractive and are suitable for various arrangement in home office or other environment look lively with colours .

3. Relevance of cut foliage

Cut foliage is used as filler lining and background material in bouquets and various interior decorations. These aesthetic products have high demand during annual events and festival time (Naqvi, 1999).

Cut foliages when compared to popularly known cut flowers have the following advantages

1. Lesser cost of production because most of them can be grown in open condition and this eliminates the additional cost of production of green houses.
2. Year round production of a particular crop.
3. No strict time limit for storage.
4. Lesser risk of damage and quality while transport.
5. Longer shelf life

4.Characters we look for cut foliage

Crops selected for cut foliage production are those that are acceptable to the end user and provide an economic return to the grower. According to Elgar (1998). Consumer preference depend on certain characters like

1. Fresh appearance

2. Longer keeping quality
3. Attractive colours, shape, texture and stem length
4. Freedom from pest and diseases
5. Freedom from external damage
6. Strength to withstand transport and handling conditions
7. Good presentation

4.1. Plants chosen for cut foliage production should have

1. The capability of rapid regeneration after cutting
2. Lower susceptibility to pest and diseases
3. Greater leaf producing capacity

The final choice of commercial plantings are based on whether a particular variety when grown in a locality will produce foliage that has the capacity to withstand during transport and should posses good vase- life, colour, texture, stem length and presentation. It should be available at high demand period and should be a viable profitable investment

The annual growth of the market of cut foliage is around 4%. The most important producers of cut foliage are Latin American countries (Costa Rica, Guatimala), USA, Spain, Kenya, Zimbabwe and Sri Lanka and Europe would be a major target for cut foliage grower (Naqvi,1999). Main export of floriculture product from South Africa is cut foliage
(Kumar and Battacharjee,2003) Today foliage production is highly refined and additional research is a necessity for revealing mysteries in this area.

Makhijani(1975) explained the importance of cut foliage by highlighting the exquisite beauty in all foliage arrangement. Choudhary and Prasad (2000) highlighted the importance of protected cultivation of ornamental plants. Kumar and Battacharjee (2003) explored certain potential foliage plants which could be exploited as cut foliage.

Work on vase life studies conducted by Roy (2001) on seventeen foliage plants on National Botanical research Institute, Lucknow.

5. The scenario of cut foliage production and trade

The world export of cut foliage production was worth US$ 563 million during 1995.Austrlia is the major exporting giant of cut cultivated greens. In 1999, Australian export was around $2.6 million. Cut foliage is the major export commodity from South Africa and it forms the fastest moving floral export from China especially to Japan, USA and Europe. Import of foliage in the main world market during 1996 was worth US$ 536 million.

Table. 1 Major European countries importing cut foliages

Country	Worth in million US$
Germany	158
Netherlands	127
Switzerland	36
France	26
UK	24
Italy	12.2
Belgium	9.7
Denmark	5.8
Spain	3.9

(Kumar and Battacharjee, 2003)

5.1.Situation in India

According to 1998-99 statistics, among the exported floricultural products, foliage and other plant parts in different forms as fresh dried, dyed bleached etc., comprised of 17.16 per cent of the total which accounts to a foreign exchange of Rs. 18.18 crores. Endowed with diverse agro climatic conditions, cheap labour and good investment environment, India can plunge itself in to a global cut foliage trade with the backing of intensive location specific research and domestic market with in the country.

5.3.Scope in Kerala

Kerala lying in the humid tropics is the native of diverse foliage plant species, which remains to be explored. With this advantage presented by nature itself, systematic research for evaluation and large-scale production of cut foliage crops can be taken up in the state. Floriculture zonation of Kerala by Rajeevan (1999), presents plane land including coastal areas suitable for commercial production of foliage plants. Works on standardization of agro-techniques in foliage plants have already been conducted in the Department of Pomology and Floriculture (Geetha *et al*., 1997). Presently cut foliage production has made its entry in the domestic markets on a small scale and is yet to make its way into the export sector on a large scale

Foliage of many tropical ornamental plants potentially could be used is cut foliage industry, although with in a species many pre harvest and climatic factors can have significant effect in growth and quality

6 Production environment

Planting can be done either in pots or in field conditions. It requires investment if it is done on pots. In the open field condition compacted ground should be sub-soiled to break up any pan that could impede drainage. When annual weeds and grasses are a problem, spray herbicide. Containers are essential investment of cut foliage although the production in soil is cost effective.

6.1Containers

Containers reduce the application of chemical herbicides and plant protection chemicals. It also helps in judicial and individual plant care thus avoiding the carry over of poison into human locality through the cut grains.

Bunt (1998) compared plastic pots with mud pots and found plastic pot to be advantages. The drawbacks of clay pots were loss of water and nutrients due to flow of water from the medium to clay and reduction of the temperature of the media due to evaporation loss. Containers must have drainage holes at the bottom. Gopalaswamiengar (1991) reported plastic containers to be better than the mud pot under indoor conditions.

6.2Growing Media

Choice of the medium is a vital factor to produce export quality ornamental plants. Brown and Emino (1981) reported high variability in the growth response of phage plants in different media irrespective of their bulk density moisture holding capacity. Poole *et al.* (1981) suggested a blend of two or more components of different physical and chemical properties as the best growing media for plants. Bik and Straver (1982) suggested that tree bark could be used as a good medium for foliage plants. Bhalinge (2001) tested a commercial product Flora Bella (potting mixture in nursery) and found the product to be very effective media for various plants like herbs, vegetables and ornamental plants. Flora Bella was found to have high water holding, capacity, proper aeration and minimum leaching problem. Stamps (2002) reported mineral soils with very low organic matter content as the most widely used media for leather leaf palms.

6.3.Frtilizer application

Slow release of fertilizers has proved themselves to be a key to judicious and economic utilization of nutrients by plants. Increased water utilization effects and increased vegetative growth through increased fertilization effects (Poole and Conover, 1982). A study conducted at the Department of Horticultural Sciences, Texas (Campos and Reed, 1993)

showed that maximum growth of Spathophyllum and Dieffenbachia was obtained at 100-200 ppm N and 200-400 ppm N respectively on a constant feed basis of water soluble fertilizers in a 3:1:2 ratio of $N:P_2O_5:K_2O$.

Chase (1989) suggested a fertlizer rate of 9.9 gm/pot of osmocote for *Codiaeum variegatum* "Goldstar". Choose balanced fertilizer for foliage plants such as 10:10:10, and one that is higher in phosphorous for flowering plants, such as a 5:10:5.

6.4.Irrigation

Foliage plants require a constant supply of water for optimum growth, but utilize only small amount, which creates problems for commercial foliage growers in determining when, how much, and how to apply water to foliage plants. Do not allow drainage water to sweep back into the soil mix. Micro irrigation system, conserving energy water and nutrients are best for cut foliage production (Stamps, 2000).

6.4.1 Irrigation system chosen should be based on

1 Crops grown

2 Method of application

3 Area of production

4 Water qualities

5 Costs

Over watering a potted plant is perhaps the leading cause of death. Roots that are surrounded by water causes rotting and eventually the death of the plant. Strict watering schedule cannot be imposed on plant. Change depending on number of factors: the plant species, the type and size of pot, soil mix characteristics, variable weather conditions and how fast the plant is growing. Cacti and succulents can tolerate greater dryness, let the soil become crumbly dry for several days before watering. Do not allow the soil mix to dry excessively. Watering the plants by using softened water could be avoided which add sodium and chloride to the soil mix causing plant damage.

6.5.Soil mix

A proper soil mix is critical for good health. Most plants thrive in a mix containing one or two parts of potting soil, one part of moistened sphagnum moss and one part of coarse sand or perlite. If the soil is compacted or saturated with water, oxygen in the soil is reduced and roots suffer

7.Climate

Humid tropical and subtropical conditions are considered best for cut foliage production. Temperature is one of the most important factors in the production of cut foliage. Light and humidity are the other factors.

7.1.Temperature

Temperature needs of each foliage plant species should be determined. Ideal temperature for most of the foliage plants is between 25°C to 30°C during day and 20°C during night.

Symptoms of cold damage include leaf spot or blotches and downward curled foliage, slow growth and root rots. High temperature may cause yellowish green foliage with brown dry edges or tips and spindly growth.

7.2.Relative humidity

Relative humidity is an important aspect of foliage plant production because of its effect on plant water relations. For cut foliage production humidity should be maintained between 60-70% and humidity above 70% makes the crop susceptible to leaf diseases (Nagvi, 1999). Low humidity may cause brown or scorched leaf tips. Attempts to raise humidity in Indoors by grouping plants together, using room or surface humidifier

7.3.Light

Light is an important component for plant growth because it is the energy source for photosynthesis. Light often determines whether the plant will actively grow or simply survive. Characteristic of light to consider include intensity, quality and duration.

Intensity refers to the amount of light present and vary by season, shade etc. Quality of light refers to the spectrum or colours available; sunlight contain all colours in photosynthesis. Duration refers to the length of light of exposure. Plants with variegated foliage have less chlorophyll and hence require more light. If light is insufficient variegation may lost. Symptoms of insufficient light intensely include week growth, long spindle stems, poor colour in older leaves etc.

8.Other management practices done are:

8.1.Pinching

It refers to removing growing tip of stem to stimulate new growth from buds lower on the stem. Vining and bushy plants, such as grape ivy, peperomia and croton, are commonly pinched; do not pinch non-branching plants such as African violet. Mature plants can be pinched to produce dense bushy growth, especially on fast growing soft-stemmed plants with long lanky growth Once side shoots form, they can be pinched to promote even more new growth.

8.2 Repotting

Done only as needed during spring or summer when the plant is actively growing. Don't repot ailing or dormant plants or those with flower bud or open flowers A plant needs repotting if roots are growing out of drainage hole or surfacing in the pot, if the plant wilts shortly after watering or if it requires frequent watering As roots grow they compact the soil decreasing the pore space, which holds water and air for root system.

9. Table 2. Horticultural classification of cut foliages

Sl no.	Categories	Examples
1	Trees	Araucaria, Pinus, Thuja, Eucalyptus
2	Shrubs	Acalypha, Cordyline, Araba

3	Creepers	Asparagas, Monstera, Scindaspus, Philodendron
4	Annuals	Coleus, Cosmos
5	Grasses	Emu grass, Fountain grass, Bear grass, Pampas grass
6	Herbaceous perennials	Golden rod, Anthurium
7	Palms	Christmas palm, Chinese fan palm, Areca palm
8	Ferns	Leather leaf fern, Sharon fern, Asparagus fern
9	Others	Duranta,Callicarpa, Callistemon

9.1 Trees

Eucalyptus cineria and *E. stuartina* as the most productive species and along with *E. parvifolia, E. gunni* and *E. maidenii* they formed the best in quality for use as cut foliage. Farina *et al.* evaluated the growing conditions and post harvest treatments of Pteris tremula for its shrubs.

Pillay and Venkataratnam (1958) opined that *Codiaeum variegatum* counted for their colourful foliage, could be used for foliage decorations and described some of the outstanding varieties of crotons. The foliage of crotons is available year round and adds an exotic louch to floral designs (Stamps and Osborne, 2003).

Dracaenas can grow 2 to 10 feet tall, depending on cultivar. Scheffleras are grown for the attractive patterns formed by their leaves and for their tall shrubby form (Russ and Pertuit).

9.2 Herbaceous perennial

Dieffenbachia sp. and cultivars have been regarded as important tropical foliage plants because of their attractive foliage and case of production. Henny *et al*(1987) described the origin and production of new cultivar of Dieffenbachia 'victory'.

Aglaonema cultivars are important ornamental plants as they tolerate low humidity conditions. Two new hybrids of 'Diefferrbachia are 'Tropic Star' and 'Starry Nights' . A new hybrid of Aglaonema is 'Stripes'. one hybrid of Dieffenbentia is 'Starwhite'.

9.3 Ferns

Several species and cultivars of Asparagus like *Asparagus densiforus* Jessop 'Myers' (foxtail fern), *Asparagus densiflown* 'Sprengeri' (sprengeri fern). *Asparagus macowanii* Bak (Ming fern and *Nephrolepis exaltata*(Bosten fern) is grown for its foliage (Stamps, 2002)

9.4. Creepers

Philodendrons are among the most common and easy to grow houseplants. The veining types can be limited in height by the height of their support and by training and pruning. These often have dramatically large leaves in a variety of shapes (Russ and Pertuit, 2001).

10. Some of the potential foliage plants used as cut foliage are

10.1. *Araucuria* sp. F. Coniferae, Origin S. America

Tall plant resembling a Christmas tree has horizontal trees of symmetrically arranged branches. Leaves are needle like soft and dark green on the central stalk. It thrives in semi-shaded situations and prefers moderately moist soil. It is mainly propagated through seeds. The cultivated species are *A. araucana, A. heterophylla, A. exulsa*, etc. *A. araucana* is one of the hardiest species and tolerate temperature up to 15°C.

10.2. *Grevillia robusta* F. Proteaceae Origin: Australia

They are tall and graceful plants and have beautiful finely cut and fern like foliage. It requires partial shade or full sunshine and moist well-drained soil. The average vase life is about four weeks.

10.3. *Eucalyptus* sp. F. Myrtaceae Origin: Australia

High adaptability to diversified climatic and soil conditions. Simple leaves whose upper side shining and lower side dull. Occur in all types of soils and show tolerance to environmental conditions. Some species are known for their beautiful foliage and fragrance.

10.4. *Juniperus excelsa* Family Conifers

Known as Green juniper. Plant is a pyramidal dense conifer. Stems erect and leaves are alternate, bluish green and scale like. Female cones are purplish and berry like. Annual yield 40-50 leaves.

10.5. *Aglaonema commutatum* F. Araceae Origin: SW Asia

Graceful, glossy grey green lance shaped leaves. Grows about 60 cm tall. Grows best in partial light and at 18°C to 26°C.

10.6. *Dieffenbachia* sp. F. Araceae Origin: Central and S. America

Dieffenbachia sp are commonly called "Dumbcane". Tall plant with thick stem and lance shaped dark green leaves having irregular cream or white spots. It needs moderate light. "Picta", "Tropic snow", "Rudolph rocks "are popular varieties.

10.7. *Dracaena* sp. F. Liliaceae Origin: Central & S. America

They are popular houseplants due to their tolerance to light, low humidity, and erratic watering. They are also known as out door ornamentals in tropical regions of the world. All dracaenas are upright growing with a height of 90-120cm. Some of them attain a height to that of large trees. They have pendant, broad, soft, leathery green leaves. Silver gray colour is seen at center of the leaves with broad margins. Golden yellow or cream spots

can also be seen all along the leaves.. The most popular cultivar is *Dracaena fragrance*. Light is not needed for germination.

0.8. *Caladium* sp. Family . Araceae Origin: South and Central America

Caladiums are known for their fancy long stalked arrowhead leaves. Gorgeously oloured with red green, pink, purple and white variegations in attractive patterns. Need plenty f moisture and love shade and respond quickly to the application of liquid manure.

10.9. *Rheo discolor* Family . Commellinaceae

Herbaceous perennial. Leaves are alternate, simple and sessile. Colour metallic green with a vivid glossy purple beneath and glabrous and thick. Margin of the leaves are entire and apex is acute. Inflorescence cymose and cymes enclosed with in a spa the.

10.10. *Begonia* sp. F. Begoniacea Origin: India

Leaves are fan shaped and lop sided, hairy with toothed edges. Leaves are silvery white or deep green or crimson with attractive and intricate patterns. It has glistening and metallic appearance. Can be grown in semi shade and moist rich soil and with humid atmosphere.

10.11. *Sansevieria* sp. F. Liliaceae Origin: Europe & Asia Minor

Leaves are thick fleshy emerging erect from the ground. Leaves are sword shaped with dark green and gray green, horizontal bands, and yellow margin in the leaves. Need very little light and can grow in dark corner of the house.Other species are *S. liberica, S. parva, S. trifaciata, S. cylid rica*.

10.12. *Anthurium clarinervium* F. Araceae

Dwarf, compact plants, Dark green, velvet and heart shaped leaves with silver gray veins. They prefer warm humid conditions with well-drained soil. Frequent watering and shaded situation are required for good growth.

10.13. *Scirpus cernuus* F. Liliaceae

Plant is an herb. These plants are known for their triangular and solid stem. Leaves are medium long linear and simple. Colour dark green margin entire, venation parallel and apex acute.

10.14. *Philoderdron* sp. F. Araceae Origin: Tropical America

Large sized glossy green and decorative foliage. They are well adaptable to environment and relatively easy for production. Require moderate watering and well-drained soil. Grow best in partial shade and moist conditions. Royal king, Red duchess, Red princess, Emerald duke are some hybrids.

10.15. *Monstera deliciosa* F. Araceae

Monsteras are beautiful plants with cylindrical stem. Alternate, large cordate leaves are present. They are glabrous, pinnatified with deeply cut margin. Annual yield - 10-15 leaves.

10.16. *Scindapus aureus* F. Araceae Origin: Solomon islands

Trailing habit with small heart shaped light green leaves marbled or freckled with yellow Stems are thin and fleshy and produce aerial shoots. Grows well in semi shade, warm moist and humid conditions.

10.17. *Zebrina pendula* F. Commelinaceae Origin: Mexico

Leaves are ovate succulent deep green or purple with two silver bands and purple beneath. The plant root at the nodes and can be propagated by cuttings Flowers are rosy purple.

10. 18. *Hedera* sp. F. Araliaceae

Leaves are alternate simple and evergreen. They have Shiny dark green with pale veins and lighter green below. Stem is tender light green but later turning to light brown. It is a low spreading ground cover and some times climb on buildings.

10.19. *Tradescantia* sp. F. Commelinaceae Origin: Argentina and Brazil

A small trailing plant with glossy green leaves. Can grow in semi shade for best growth. Requires a moist condition. Commonly used species are *T. purpureae*, *T. reginae* and *T. fluminensis.*

10. 20. *Alocasia* sp. F. Araceae Origin: Tropical Asia

They are attractive foliage plans with. dark green leaves marked with irregular areas of coloured blotches. It should provide shade, copious water and good drainage during summer. Propagated by seeds, stem cuttings, removal of suckers or division of rhizomes.

10. 21. *Calathea* sp. F. Marantaceae Origin: Brazil

Plants are medium tall having long lance shaped, light green markings along midrib, purple beneath. It loves shade and moist humid conditions. *Calathea zebrine*, *Calathea ornate*, *Calathea makoyana*, *Calathea insignis* are important species.

10. 22. *Cordyline* sp. F. Liliaceae Origin: California

These beautiful plants are also known as Ti plant and Hawaiian good luck plant. Cream or bronze leaves splashed with shades of red or brown. Requires bright light and humid conditions for best growth. Amabilis, baby doll, big doll are important varieties.

10. 23. *Schefflera* sp. F. Araliaceae Origin: Tropics

In *schefflera sp* leaves divided in to fine leaflets. They are upright plants with thick spreading stem. Hardy plant grown in partially shaded places. Rooting BA 200 ppm/NAA 50 ppm.

10. 24. *Codiaeum variegatum*

They have tall shrubby growth and grow well in pots. Gorgeously coloured leaves with red, maroon, pink orange, yellow green and various other patterns. Leaf shape varies with long narrow, curling or twisted like a corkscrew, ribbon like broad oval and elongated with large variation in shape.

10.25 *Aralia* sp. F. Araliaceae Origin: N. America and Australia

Aralias are attractive cultivars with large leathery, cordate oval leaves. Leave are variegated and tented with creamy white or pale green. Multiplied by stem cuttings, air layering and from seeds. Quite hardy species and can be grown in open condition.

10.26. *Asparagus* sp. F. Liliaceae Origin: S. Africa

The ornamental asparagus are grown for their fine, feathery foliage often used as bouquets and floral arrangements. Cultivated species are *A.saparagoides*, *A.plumoses*, *Aspringeri and A.officinale*. Dark green and plume like leaves on smooth wiry trailing stems. Require humus rich soil and plenty of water. Occasional application of liquid manure is helpful for their growth. Thrive well in partial shade and at 15°C to 26°C.

10. 27. *Sellaginella* sp. F. Sellaginellaceae

Commonly they are called as club moss. Small scale like leaves. Colour of leaves in various shaded of green and some times bronze or bluish. Like shade and moisture for growth. Fronds can be used for preparing bouquets in combination with flowers.

10.28. *Adiantum* sp. F. Polypodiaceae

The cultivated green house species are A caudatum,A. cuneatum A cuneatum var. 'dissectum' They are commonly known as "Maiden hair fern". The light and air are two main components of climate influencing growth. They enjoy light but not direct sunlight. Usually born at the end of relatively long slender polished black or purple stalks. Fresh leaves used in preparing buttonholes and bouquets along with flowers and dried leaves in greeting cards. The cut foliage can be treated with $AgNO_3$ (25mg/litre) to increase post harvest life

10. 29. *Cycas* sp. F. Cycadaceae

The cultivated species are *C.circinnalis* and *C.revoluta*.Favour a temperature range of 7- 8 ^{0}C. Leaves are attractive and branched and pinnate. hey are shade loving plants and requires well drained soil. Plants are propagated either by seeds or suckers.

Some potential cut foliages

Juniperus excelsa

Eucalyptus spp

Grevillia robusta

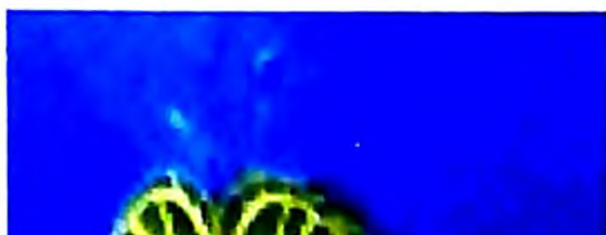
glaonema commutatum

Dieffenbachia spp

Rheo discolor

Dracaena spp

Begonia spp



Anthurium clarinervum

11.Harvest and post handling of cut foliages

Even though pre harvest production environment has a considerable effect on the vase life of cut foliage, the time of harvest and mode of harvest have a crucial effect on the vase life of the foliage. Temperature of flowers and foliage at harvest is normally close to that of ambient air. At this temperature respiratory activity is very high. Therefore it is best to harvest on cooler part of day, either early morning or late afternoon (Elgar, 1996).

12.Post harvest handling

A significant factor concern for the consumers is the post harvest life of act foliage. Shelf life is a characteristic feature of each species and cultivar and is strongly dependent on the cultural conditions and handling after harvest. A number of post harvest treatment like pre-cooling, conditioning, pulsing, storage, packing etc. affect the vase life of cut foliage in holding solution.

12.1 Pre-cooling

Pre-cooling is a practice done for quick reduction of the temperature of packed natural to keep them fresh in storage and transport. Rapid cooling of packaged cut flowers and foliage reduces the time they would otherwise pickup higher temperatures and therefore help prolong the quality and vase life.

Elgar (1998) reported that a low temperature treatment of cut flowers and foliage after harvest reduced the rate of ethylene production and depleted stored carbohydrates from leaves. Plant material should be cooled as soon as possible after harvest to minimize deterioration.

12.1.1 Different cooling methods for cut foliages are

1 Room cooling,

2 Vacuum cooling

3 Pressurized cooling

4 Enhanced rapid cooling

Pre-cooling of cut flowers maintained a low temperature level inside package during the entire cold storage or shipping period.

12.2Conditioning

It involves preparation of plant material prior to its arrangement to ensure that its life is not unduly shortened once it is sieved from plant part or tree.

Conditioning or hardening of flowers and foliage sectors the turgor of flower wilted after cutting. This is achieved by treating flowers with dematerialized H_2O supplemented with germicides and acidified with citric acid to pH 4.5 - 5.0. Water solution should be supplemented with a wilting agent such as Tween 20 at a concentration of 0.01-0.1% (Nowak and Rudnicki, 1990). Plant materials are conditioned according to its stem types and conditioning may be warm water conditioning or conditioning with water or flower pod or tepid water.

12.3 Pulsing

Pulsing refers to short duration pre-harvest treatment or pre-storage treatments. The effect of such a treatment lasts throughout the entire vase life of a flower or a foliages. Swapna (2000) compared different pulsing solutions and reported a 6 hr pulse with a solution containing 500 ppm HQ and 5% sucrose as the best to increase vase life of Dendrobium.

In the present study pulsing was done with different combinations of sucrose 5%), HQC (200 ppm, 400 ppm) and $AgNO_3$ (50 ppm, 100 ppm) together with distilled water, acidified H_2O and hot H_2O dip treatments at 50°C and 60°C for 5 seconds. Pulsing with distilled water was on par with other treatments, including those with chemicals, is indicative of a very cheap method, making it cost effective and pollution free. Forest (1991) also reported that pulsing cut *Eucalyptus gunni* with STS or 8-HQC did not long then the vase life. It was on par with keeping in distilled H_2O or tap H_2O.

Work conducted by Sindu M. Eapen in COH, Vellanikkara shows that:

Plant height recorded in different species varied accordingly. Maximum height was recorded for *Asparagus sitaccous* which is a twiner. Shrubs like codiacum varrigatum and Polyseias guilfoylei followed this .Out of 27 species plant spread was maximum in the firm *Nephrolipis cordifolia* for the first few months after which *Schefflua arboricola* recorded maximum spread.

Leaf length considered to be most important features was maximum for funs *Nephrolipis exeltata* and *N. cordifolia* followed by *Ophiopogon jaburn* 'Nariegatus'. It was minimum for *Juniperus excelsa, Aglaonema costatum, Polyscias guilfoylei*. The width was maximum in *Monstera diliciosa* and *Cyperus alternifolius* and minimum in *Scirpus cernuus*.

In the commercial production of cut grains, the leaf yield or the number of leaves produced per plant per unit lime is the most important concern surpus cumus recorded maximum leaf production per month. Longivity of leaves under normal conditions of growth foliage of schefflora arboricola was found to have maximum longevity.

12.4 Storage

A study on the effect of post harvest treatment of cut foliage (Forrest, 1991) showed that higher temperatures shorten the vase life of cut foliage. A study on the effect of cold storage on the vase life of cut foliage showed that *Eucalyptus parvifolia* showed longest practical storage time (Ferrante *et al.*, 2003). Cut foliages are stored in wound corrugated fiberboards or plastic sleeves. Floral preservatives are used during storage. Floral preservatives include carbohydrate usually in the form of sucrose plus bactericide and a wetting agent.

12.5 Grading

12.5.1Parameters considered for grading are

1. Size and shape of the produce
2. Texture of the foliage
3. Strength straightness and length of foliage
4. Free from put and disease attack

5 Development condition of foliage

12.6. Packaging

Akamine (1976) in a study on the post harvest handling of tropical ornamental cut crops in Hawaii reported that foliages are shipped in corrugated cations with moisture provided by wrappers of moistened newspapers. Thin polyethylene foils of 0.04-0.06 mm thickness permits only partial gas exchange their maintaining lower respiration rates (Batacharjee, 1997). Packaging is done based on the uniformity of produce. Each unit of presentation should have fairly uniform quality. High quality packing materials avoid internal damage.

13.Foliage arrangements

By using foliages also we can make good arrangements. Foliage arrangements are now become more popular Makhijani(1975) explained the importance of cut foliage by highlighting the exquisite beauty of all-foliage arrangement.

Roy (2001) suggested colour, texture shape and suitability of the leaves on the major selection of foliage plants used as cut foliage. Selection of containers is also depending on the type of foliage. Long necked flower vases were ideal for having the desirable effect.

14.Criteria for economic production

Economic production of cut foliage affect many factors. Resource based production. In India especially in Kerala so many indigenous plants grown in homesteads can be used as cut foliage. By growing in protected condition and giving proper cultural operations we can develop quality foliage plants. Higher proportion of crops meeting exports criteria should be developed. Export oriented production is lacking in Kerala. Plants with longer productive life and quality should be selected. Value addition is another important criteria.

Government of India and various governmental organizations are providing support to develop commercial floriculture in India. With the liberalization of Industrial and trade policies, export oriented production of floriculture products have boosted up. The ministry of APEDA is implementing a project, which provides setting up of Infrastructure for promoting export. Model markets with cold storage facilities are proposed to be established in various centers like Delhi, Mumbai, Chennai, Calcutta, Hyderabad, Pune and Bangalore by APEDA in collaboration with central and state government agencies.

15. Conclusion

A vacuum exists in export-oriented production of cut foliage in India. In order to fill this certain strategies are to be employed. India is lacking high-tech post harvest handling technologies. Therefore should envisage the following basic strategies.

A high tech export oriented post harvest production technologies such as pre cooling or cold storage/ refrigerated transport facilities should be developed. Development of domestic market in the country. Diversification of crop for export oriented production. Intensive location specific research is a must for on production of quality foliages.

We can expect from one or two years Indian will become a good exporting giant of cut foliage.

Discussion

1. What is cut greens?

According to UN/ECE standards for cut foliage it refers to leaves or part of leaves along with stem branches with or wit out decorative fruit or other part of plant.

2. Can we use all foliage plants as cut foliage?

No, we can't use. It should posses certain post harvest qualities like good vase life and longer keeping quality. Greater no of leaf producing capacity, attractive shape, colour and pattern of leaf are the other qualities.

3. Is there any firm in India for exporting cut foliage?

In India Delhi, Bombay and Calcutta there are firms for exporting cut foliages

4. Function of warm water and flower foods?

Cut foliages after harvest should dip in warm water and some flower foods. Flower foods provide some nutrients and give a feeling that its life is not unduly shortened after it is harvested from the plant. It also acts as a protection against some antimicrobial agents.

5. Among the cut greens which has maximum vase life?

According to the study conducted by Sindhu in our college by using seventeen important foliage plants *Schefflera arboricola* was found to have maximum vase life.

6. Function of drainage holes in a container?

Drainage holes are necessary because if water is not properly drawn out from the container it cause excess water in the pot that may cause rotting of the root and eventually death of the plant.

7. What is a pressurized cooling?

It is the method of cooling technique in which stream of forced air is drawn in to the room and the plant material is cooled.

8 Which is the important Asian country exporting cut greens?

Sri Lanka

9. How many years from now will India take to export cut foliage?

We can expect from one or two years India will become a good exporting giant.

10. Is packaging practices are similar to that of cut flowers?

Packaging practices are similar to that of cut flowers. The advantage over cut flowers is that foliage can be packed in greater numbers than flowers and there is less possibility of loss of quality and texture in case of cut foliages.

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ABSTRACT

Ornamental crop culture is fast emerging as an important and innovative dynamic global enterprise. It is one of the most lucrative professions having much higher potential return per unit area than most field crops, plantations and other horticultural crops. Floriculture industry is worth US$60 billion. The industry comprises florist trade of cut flowers, foliages, potted flowering plants, flower perfumes etc. Cut foliage is an important part of florist industry. It is used as filler in bouquets, flower arrangements etc.

The world export trade of cut foliage is now worth US$563 million and the demand is increasing every year. The most important producers of cut foliages are Latin American countries (Costa Rica, Guatemala). Spain, USA, Kenya, Zimbabwe, Sri Lanka and Europe would be the major target for cut foliage growers (Naqvi, 1999). Cut foliage contributes a major share in the export of floriculture products from South Africa (Kumar and Bhattacharjee, 2003). Some of potential foliage plants used as cut greens are *Aglaonema commutatum, Alocasia sp ,Alpinia sp, Araucaria sp, Asparagus, Calathea etc*

Cut foliage is used as filler lining and background material in various flower arrangements Fresh appearance, longer keeping quality, attractive shape and good presentation are the most preferred characters for cut foliage (Elgar, 1998)

Temperature, humidity and light are the factors influencing the growth of the foliage plants. Good management practices are essential for production of quality cut greens. Optimum temperature range is from 25^0C to 28^0C during day and 18^0C during night for tropical foliage plants. The light requirement is different for different foliage plants and most of cut foliage crops grow well in 50-75 per cent shade condition. Containers also play an important role in cut foliage production. Choice of growing media is also important. A blend of two or more components of different physical and chemical properties is the best as growing media for foliage plants (Poole *et al*., 1981)

Harvesting and post harvest management are the important practices to be taken care of when foliage plants are used as cut foliage. Pre cooling, conditioning, pulsing, storage, grading and packing are the important post harvest management practices. Vase life of cut foliages can be increased by dipping in solutions like sucrose (5%), HQC (200ppm –400ppm), $AgNO_3$ (50ppm-100ppm) and acidified water pH 3.5) for 3 to 6hrs and hot water dip at 50^0C to 60^0 C for 5 seconds.

A vacuum exists in export-oriented production of cut foliage in India. India is lacking high- tech post harvest handling technology and should develop it. Diversification of crop for export, intensive location specific research on production aspects and developing domestic market with in the country are the basic strategies to be employed.

10

FOOD FROM FLOWER CROPS

By

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SEMINAR REPORT

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COLLEGE OF HORTICULTURE

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DECLARATION

I, Meghna Davis, (2004 – 12 – 15) here by declare that this seminar report entitled "**FOOD FROM FLOWER CROPS**" have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports.

Vellanikkara

Date: 2/12/2005

Meghna Davis

(2004 – 12–15)

CERTIFICATE

This is to certify that the seminar report titled **"FOOD FROM FLOWER CROPS"** has been solely prepared by Ms. Meghna Davis, (2004 – 12 – 15), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

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FOOD FROM FLOWER CROPS

INTRODUCTION

Flowers are associated with mankind from the dawn of civilization. It is said that, man is born with flowers, lives with flowers and finally dies with flowers. Flowers provide an allure that has been used by man to transcend the season and evoke emotion. Flowers are used for various purposes in our day-to-day life like worshipping, religious and social functions, wedding, interior decoration and self-adornment.

Flowers are used to convey human feelings also. Flowers commonly used for this purposes are: Rose for love; Pansy for thoughts; Carnation for women's love; French marigold for jealousy/sorrow; African marigold for vulgar minds; Narcissus for self esteem; Daffodil for regard; Amaryllis for pride; Iris for message; snap dragon for presumption, Jasmine for amiability, Lily for purity; Stock for luxury; Sweet pea for departure, etc

Besides beauty and aesthetic values of flowers, they are important for their economic value as sale of flowers (loose as well as cut blooms), extraction of essential oils and making of economic products like gulkand

"Eating flowers is actually very glamorous. It gives food a summer glow and another dimension for cooking", explains Patricia Michelson. Cooking with flowers may sound quaint, charming possibly bizarre, but perhaps not exciting enough to satisfy cotemporary palates. Used in right way, however flowers make a delicious and exotic addition to all sorts of dishes

During the days of Shakespeare plays, audiences snacked on delicacies like, stewed primroses and drank rise water and cordials made from carnations. During Elizabethan times, flowers were a staple in kitchen and major events. One written account of the dishes served at a medieval feast mentions that 'marigolds seasoned the venison, roses graced the stew and violets mingled with wild onion in the salad." In short, edible flowers are the feathers in a desert maker's cap.

In America, edible flowers played a role in the kitchen since colonial times and were used to make teas as well as flavouring for punch, cakes, preserves, jams and jellies

and a colourful garnish on salads. Actually, almost all of the world's cuisines use edible flowers.

Flowers are used for making different dishes, like salads, syrups, jams, jellies, candied flowers, floral honey. Floral liqueur, etc. Flowers are used as flavours also.

FLOWER FLAVOURS

Flowers appeal to far more than the eye; they get your taste buds going, too. Edible flowers all have unique flavours. The most commonly available edible flower, nasturtiums, has a bright peppery flavour. Johny-jump-ups have a wintergreen-mint flavour. Roses and violets have a sweet taste that is perfect for desserts. Carnation has spicy flavour.Daylily has a crisp and sweet flavour, English daisy has grassy and tangy flavour, marigold has a spicy flavour, and orchids have a warm and peppery flavour. Primrose has a sweet flavour. Tulips have crisp and cucumber like flavour, violet have a very sweet flavour, chrysanthemum have a bitter to very bitter flavour etc.

CANDIED FLOWERS

To candy edible flower petals, select clean petals that have sufficient size to be candied, such as rose petals. Moisten the petals with a wash of beaten egg whites. The petals can then be dipped into, wiped, and/or sprinkled with super fine sugar and allow it to dry. The candied petals can now be used with desserts, sorbets, beverages, toppings, butters, spreads, and other foods. Flowers generally we used for making candied flowers are rose, violets, pansies, Johny-jump-ups, lilac, scented geraniums, etc

FLORAL LIQUOR

Petals of flowers are used for making floral liquor. Petals are put in a jar and required quantity of vodka or brandy is added to that. Steep it for two days. Then, add sugar and steep for two weeks, shaking vigorously once or twice a day to let sugar dissolve. Strain after two weeks and then filter it into a clean decanter.

Flowers used for making floral liqueur are rose, carnation, lavender, etc.

FLOWER BUTTER

Finely chopped flower petals are mixed with softened butter. Refrigerate it for several days to bring out the flavour. Then it is ready for use. This is used with breads or used in sugar cookies or pound cake recipes.

FLOWER HONEY

Chopped or crushed flowers are added to honey and boiling water. Then remove it from heat after sometime and let cool to room temperature. Allow jar of honey with flowers to sit for one week. Flowers can be strained out if desired.

FLOWER JELLY

Apple juice or white wine	2-3 cups
Flower petals	1 cup
Sugar	4cups
Lemon juice	1/4 cups
Food colouring (optional)	1-2 drops
Liquid pectin	3 ounces
Fresh flower petals	optional

Directions -

Juice or wine pour over petals and boiled Cover and steep until liquid has cooled, then strain out flowers, leaving only liquid Sugar, lemon juice and food colouring is added Bring to a boil over high heat and as soon as the sugar has dissolved, stir in the pectin Remove the jelly from the heat and skim off any foam. Let jelly cool slightly and add more flower petals if desired.

LOTUS

Lotus is the flower of antiquity. From ancient times, it is considered to be a sacred flower. During the prehistoric period, the Dravidian in South India used lotus

flowers as their food, much earlier than the people of the Indus Valley civilization (3000-2000 BC). The earliest literary reference of lotus was made by the Aryans in the Rig - Veda (2000-1500BC) wherein there is a mention of lotus being used as food.

Besides its aesthetic value, lotus is used as a food. Its flowers are offered to gods and goddess in temples. Almost all parts of the lotus plant are edible. The rhizomes are consumed as vegetable either roasted or in curry form. Dried rhizomes slices are used in making curry or fried chips. Rhizomes are also frozen and pickled. The rhizomes are used in preparing a kind of arrowroot, which is aromatic, sweet and nutritious. The fresh rhizomes contain water 83.80%, crude protein 2.70%, fat 0.11%, reducing sugars 1.10%, Ca 0.06% and vitamins (mg/100g).

The carpels or nuts embedded in the fruiting receptacle are edible and nutritious. These are eaten after removing the outer covering and the embryo, which is bitter. The nuts, which are sweet and delicious, are eaten in different ways, like raw, roasted, boiled, or candied. These are also grounded into flour. The nuts are rich in protein (17.2%) and total carbohydrates mainly starch (66.6%). They also contain sucrose, (4.1%) and iron (2.3%) besides small quantities of fat, fibre, Ca, P and ascorbic acid.

The tender leaves, petioles and flowers are eaten as vegetables. Yellowish-white fibre is produced from petioles. The lotus flowers are used for extraction of perfumes. The stamens of the flowers infused with water make a fragrant tea (India), while the seeds off-white and crisp textured are removed from flower pods (that look like some life form from another planet), peeled of their downy skins and eaten raw, or dried and puffed like popcorn (India)

Fresh seeds, both mature and immature, can be eaten raw. Dried seeds, sometimes called "lotus nuts" must be boiled until soft. Crystallized with sugar as part of Chinese New Year sweet offerings, cooked into a sweet soup, and made into sweetened lotus nut paste, which is mostly sold in cans and used as a filling for Chinese moon cake.

In Thailand, young tender leaves are eaten with a savoury source. Dried mature leaves are softened first by soaking in boinig water, then drained and used to wrap sticky- rice parcels and other foods to be steemed. During the steaming process, they impart a delicate flavour.

Enfolding a chicken in lotus leaves, then encasing it in pond mud or clay before cooking it, is the famous beggar 's chicken which has now become and esteemed restaurant dish, with various refinements, such as filling the cavity of the chicked with soaked dried mushrooms, soy and wine with swelling along its length it resemble links of sweet potatoes. Salads (Thailand) more mature roots are stir- fried, stuffed and deep fried or simmered in soups (China and Japan).

ROSE

Rose is one of the nature's beautiful creations and is universally acclaimed the Queen of flowers. Rose is an ornamental shrub with upright or climbing stems, usually prickly. The leaves are alternate, compound, and oddly pinnate with stipules adherent to the leaf stalks. Flowers are solitary or compound, and inserted at the top of a roundish or pear – shaped fleshy tube Petals and sepals are generally five. Rose has perfumed taste.

Rose water

Rose water is an important commercial product obtained from rose petals It is used as a perfume and in medicines and confectionary It has the property of cooling the body and is often used in eye locations and eye drops for its soothing qualities It is also used in drinking water and sprinkled on the guests at wedding feast and other social functions Species used for making rose water are *Rosa damascena, R. borbonana, R. alba* acts as digestive and people believed it gave happy thoughts Rose water used in almost all our syrups and pastries of all kinds Adding a drop of rose water to a glass of cold water

Rose petal conserve

Dried rose petals are put in syrup made with sugar and very little water, cook until the conserve is very think, the product is known as rose petal conserve

Rose wine

Rose wine is made up of with rose petals by ordinary wine making method.

Rose Hips

Ripe fruits, berries of rose are known as rose hips. They are abundant on the western prairies, when water is anywhere nearby. Rose hips have been an important food

for all native tribes, where any kind of roses can be found. They are extremely high in Vitamin C.

Tea

Dried rose lips are boiled with water to make tea in Czechoslovakia. The resulting tea may be pinkish, depending on the type of roses, whose berries are used.

Jam

Ripe rose hips are boiled in a pan. The pulp obtained is strained and mixed with honey. Both are heated gently till consistency of jam is reached. They aid digestion and have certain curative properties.

Rose honey

Rose lips combined with honey to prepare rose honey. Rose hips are good sources of ascorbic acid. Pal (1972) reported that every 100g rose hip syrup contains 150 mg of ascorbic acid, compared with 50 mg present in fresh orange juice.

Rose hips contain some beta-carotenes, bioflavonoid, which helps to prevent intestinal cancers and helps to control blood pressure and good for heart. It contain ascorbic acid – 1,000-10,000 ppm, carotenoids - 100-500 ppm, pectins - 34,000-46,000 ppm and flavenoids - 100-3500 ppm

Gulkand

Rose petals are also preserved for direct consumption by making gulkand, which is prepared by pounding equal proportion of petals and white sugar. It is considered both a tonic and laxative. *Rosa damascena, R. Chinensis, R. gallica, R. pomifera* and some other scented roses, e g. Edoucard are used for preparing gulkand.

Pankhuri

Dried rose petals are known as pankhuri, which is occasionally used for preparing sweetened cold drinks

Rose petal soup

A surprisingly refreshing and delicious cold soup. Pluck the rose petals from the head. Cut away the white basal (heels) portions and discard. Put aside some petals for a garnish. Put sugar, water and cinnamon in a medium saucepan, bring to a boil. Add the cherries and reduce heat to simmer for 10 minutes. Add the wine and rose petals. Remove from the heat and allow to sit until cool. Put this mixture in the blender or food processor,

liquefy it. Stir in 8 ounces of the sour cream. Refrigerate to chill thoroughly serve in a large glass bowl serving the rest of sour cream on top. Scatter with rose petals and a sprinkling of cinnamon looking petals and stalks, removing the bitter pistils, stamens and white section at the base of petal. If flowers are to be stored, keep them refrigerated or placed in water prior to reserving. Flowers can be tightly wrapped and stored refrigerated for up to a week however; it is always best if, to serve shortly after picking.

ORCHIDS

Orchids are the most fascinating and beautiful of all flowers. Orchids constituent an order of royalty in the world of ornamental plants.

Orchids are perennial herbs of varying habit, which is generally influenced by different environmental factors

Several orchids have been used as food in different parts of the world. *Anectochilus* leaves are used in Indonesia and Malaysia as vegetable. Dried leaves of *Dendrobium salaccense* cooked with rice add delicate and exotic flavour. On the Islands of Cyprus, the villagers make a milk custard bunk with dried ground tubers of *Orchis anatolica* (Withner, 1959). Pseudo bulbs of *Cymbidium madidum* and *Dendrobium speciosum* are used as food. In western Australia, tubers of *Microtis unifloral*, *Caladenia carnea* and *Eriochilus cucullatus* are eaten by the native inhabitants of South Australia. Natives of this country also use the tubers of *Acianthus*, *Dipodium*, *and Pterostylis* as their food (Bose and Battacharjee, 1980).

The tubers and pseudo bulbs of several orchids like *Orchis latifolia*, *Cymbidium aloifolium*, Some species of *Dendrobium* and *Habenaria* are used for preparing salep which is valued as a restorative and is used in the treatment of various diseases. Many of the orchid species contain alkaloids. The most important alkaloids dendrobine from *Dendrobium nobile*, then laburnine from *Lipairs bicallosa*, malaxine from *Malaxis congesta* and phalaenopsine from *Phalaenopsis mannii*.

HIBISCUS

Flowers, leaves and roots of hibiscus are edible. Young leaf buds – are good either raw or cooked. Flowers are cooked with other food also. They have a very mild

flavour and very mucilaginous. They make a very acceptable and beautiful addition to the salad. Leaf buds are mild and quite mucilaginous. Roots are also edible, but very fibrously, mucilaginous without very much flavour.

The leaves, stems, flowers and seeds of *Hibiscus sabdariffa* are edible, and they have been used in foods and drinks for thousands of years. Nutritionally they are characterized by high contents of protein, argentine, aspartic and glutamic acids, and dietary fibre. The most common use of this plant is the infusion of dried sepals of hibiscus flowers to produce a tea, the so-called "drink of the Pharaohs" (Bulatov and Haddah, 2002). Hibiscus is also used in the food and pharmaceuticals industry. Sepals of hibiscus flowers are used to make a floral fruit tea or mixed with other herbal teas; aqueous extracts of hibiscus are also used in the preparation of drinks, syrups, gels, jams, ice cream, food flavourings and colourings. The health-promoting properties attributed to the flavonoid and anthocyanin contents of infusions of hibiscus sepals are outlined. Hibiscus flowers contains flavonoid aglycones also e.g. quercetin and cyanidin (Puckhaber *et al.*, 2002).

Javanican Hibiscus Drink

Hibiscus blossom and ginger is added to boiled water. Turn off heat and cover and steep for 4 hours. Then strain and sweeten with sugar to taste. Chill them and it is ready to serve

Hibiscus Aride

Washed hibiscus blossoms are added to a source pan containing one quart of water along with grated ginger. Then allow it to boil for 10 minutes and remove it from heat and allow cooling. When cooled, strain liquid into a pot. Add 2 quarts water and juice from lime and sugar of required quantity to taste it. Chill and serve cold over cracked ice. Garnish with fresh lime wedge, if desired. This drink is good for rooting sore throats.

Hibiscus preserve

Petals are covered with lemon juice and microwave on high for four minutes. Add boiling water and sugar and stir it well. Cook two minutes then stir. Further cook it for two minutes and allow mixture to cool for about one hour. Once cool, cook it for four minutes, then stir. Let cool slightly and pour into a sterilized jar.

Hibiscus contains antioxidant that helps to control Cholesterol levels and reduce heart diseases. Hibiscus is used in folk medicine to treat hypertension and liver disorders, and is used to make popular soft drinks in various countries around the world.

Hibiscus syrup

Hibiscus petals are covered with lemon juice in a deep glass bowl. Microwave for two minutes on high. Mix sugar and boiling water in a saucer, heat it. Add the petals and lemon juice mixture to the sugar water. Stir it well and heat it to reduce the volume 1/3. Strain it to remove petals and store in a covered jar in the refrigerator. This syrup is delicious over fresh fruit, ice creams, custard etc.

Hibiscus vodka

Add hibiscus syrup, lemon rind and a few drops of rose water to the bottle of vodka. Close bottle tightly shake gently and allow standing at room temperature for one week or more Strain the mixture and chilled over ice.

JASMINE

Jasminum spp. is one of the oldest fragrant flowers cultivated by man. Plants are grown as both shrubs and climbers. Flowers and buds are used for making garlands bouquets, veni, used for decorating hair of women and for religious offering. They are also used for the production of perfumed hair oil and attars.

The flowers of the Arabian jasmine (*J. sambac*) are reported to be used in China for flavouring tea. Historic evidences show that even two or five hundred years ago, the women in China extensively used the jasmines for hair ornamentation. Flowers are also used in food preparation for scenting them, food, wine and drinks (Anon, 1972)

Jasmine Tea

Jasmine tea is made from green tea leaves and mixed with fresh jasmine flowers. Jasmine tea is the most popular drink of the elders of Okinawa, who rarely drink plain Japanese green tea. It is believed that the health benefits of jasmine tea may surpass those of green tea. Several situations have found that jasmine tea lowers cholesterol levels.

DAYLILY

Plants are monocotyledonous, herbaceous perennial species. Plants are tall (60-90 cm or more) and erect having tuberose and flushing roots. The leaves are numerous both radical and yellowish green. Flowers are like lily. Tepal tubes are short enclosing the ovary.

For hundreds of years it has been an important food material in China and Japan. In many of Chinese markets the dried buds and flowers are sold in large quantity. They are used in soups and stews to provide gelatinous quality and delicious flowers. Before the flowering scapes appear, the central tender leaves are sliced for salads and eaten like asparagus, which is quite palatable. In Europe, tuber – like roots are eaten raw, which are sweet in taste and has not like flavour (Bose and Yadav, 1998). Daylily is a potential source of alkaloid and also contains some metals like Cu, Pb and Zn (Lee et al., 1983).

Some people prefer the flavour of the dried flowers to the fresh but fresh appeals more to western gardeners. Fresh flowers and buds have a sweet flavour with no bitter aftertaste. Day lily compliments a wide variety of hot and cold savory foods, including soups and stews. Fresh flower buds and petals are usually reserved as a special topping or garnish for dishes.

Fresh flower buds, petals and whole flowers can be eaten cooked or raw. Whole blossoms are used to adorn cakes, or stuffed with special in gradients and placed on serving patterns or individual plants.

Dried day lilies are used as a thickener and flavouring for soups and stews. Day lilies compliment a wide variety of hot and cold savory foods, including dishes of contrasting colour, where their beauty stand out. Fruit pods are used to make pickles. Petals are used for salad preparation. It is also good for dyeing.

Daylily petal salad

Daylily petal along with lettuce flower is served into a bowl. Drizzle the oil over it, toss it well. Drizzle lemon juice over it and salt is sprinkled. Add basil grind a bit of pepper over the top. Garnish with daylily petals.

GLADIOLUS

It is very popular flowering plant. The native used the corms of *Gladiolus edulis* by roasting them in Bassa (Africa). *G. quartinianus* corms are used as food when founded in water with guinea – corm flour and into a cooking beverage. The flowers of *G. saundersii*, *G. ecklonii*, *G. papilio*, *G. cruentus* and *G. natalensis* are used as uncooked salad by nipping of the anthers. The culinary virtues of many flowers, including gladiolus, dipping it in butter and fried until crispy or stuffing with a savory hamburger and vegetable filling and fried, and also the preparations like Gladiolus Hors D'oeuvres' or 'gladiolus cake' with pixiola flowers and recommended recipes. It has been found that the corms of Psittacinus hybrids contain high amount of carbohydrates mostly as starch (65.4-78.61%) and protein (12.6-18.5%)

Through an analysis pentosan (2.91%), fat (0.58%), saponin (present only before alcoholic extraction) and ash (sulphated, 3.48%) and after through extraction glucose, xylose and arabinose were found whereas the amino acid analysis revealed the presence of lysine, glycine, glutamic acid, alanine, praline, tyrosine, isolucien and some unidentified ones (Khan *et al*, 1980). Ancient Greeks used the roasted corms of *Gladiolus italicus* as food

Gladiolus acid is produced by corms affected with *Penicillium gladioli*. The leaves of this genus are also rich in Vitamin C, ranging from 1 to 1.7% depending on the species and cultivars. Inhibitors are also found in sheath leaves and at leaf bases but not on the tip of the leaves (Konoshima, 1980). Cytokinin – like substances like X1, X2, X3, X4a, X4b, X5a, X6, X7 and X8 from the corms of the cv. Friendship. Anthocyanin pigment (Malvin) also present in gladiolus corms

CHRYSANTHEMUM

Chrysanthemum is a popular flower crop of commercial importance. Leaves alternate, inflorescence heads many flowered. Certain species like *Chrysanthemum cinerariifolium* and *C. coccineum* are cultivated as sources of pyrethrum, an important insecticide. Ryori Giku is a yellow flowering culinary type, which is eaten as delicacy in Japan after frying. Chrysanthemum has also figured prominently in China and Japan. The

antibacterial activity of the methylene chloride and methanol extracts of *Chrysanthemum coronarium* fresh flower heads was also reported (Urzua and Mendoza, 2003).

Chrysanthemum tea

Flowers are boiled to make a sweet drink with green tea leaves, resulting beverage is known as chrysanthemum tea. It has many medicinal uses, including an aid in recovery from influenza.

Chrysanthemum wine

Add flower petals, grape juice concentrate, yeast, sugar etc to boiled water and stir it well. Remove heat and keep it for 24 hours and strain. When vigorous formation subsides, transfer to secondary and fit airlock. After 60 days, rack, stabilize, top up and refit air lock allow three months before tasting.

Flowers contain anti HIV compound. Leaves of certain species are edible, particularly *C. coronarium*. It is used as vegetable in East Asia, under the name Tung ho (China) or Shungiku (Japan). In China, greens are often stir fried simply with garlic and dried Chile peppers.

VIOLET

Violets are hardy perennial. They have a sweet, winter grew or perfumed flavour. They have sweet taste. Flowers are generally violet in colour. Petals are used to colour butter. Flowers are used in fruit salad. Violet flowers are used to make champagne cocktail or violet Martine. Violets are used for decorating cakes and pies. Violet tea is also prepared. It acts as a digestive.

NASTURTIUM

Nasturtium flowers have peppery flavour. It is suit to prepare salad, pickles. Flowers are always a colour addition to any food.

Nasturtium salad

Flowers, leaves and green seeds are delicious in salad, vinegar, pickles and flavoured oils. Nasturtium petals and violet leaves are put in bowl garlic and clone is also added. Sprinkle with lemon juice and oil.

CALENDULA

Also known as pot marigold, this annual produce pale yellow to deep orange flowers. Plants bloom from late spring to mid summer. Calendula flowers have a slightly bitter flavour and are valued mostly for their colour. Petals are used in salads, soups, butter, rice, stews or in tea. It is some time used as a saffron substitute. *Calendula officinalis* contain crude ethanolic and aqueous extracts (Ahmed *et al.*, 2003).

In addition to that, some flower crops like lilac, geranium, etc are also used in food preparation. Scented geranium, having a mint like flavour is used in preparation of salads, desserts and chilled summer soups. Lilac also used in salad preparation and it has a lemon flavour. Miniature roses are added to jellies or syrup for a mildly sweet flavour and also for decorating cakes and other disserts. Squash blossom are used in stir-fries, steamed foods or served flesh in salads and cold foods. The blossom provides a mild flavour.

MARIGOLD

Petals of marigold are used for extracting pigment, lutein, which is used as food additive. Lutein has yellow colour and it is used as a colouring agent (yellow) in food industry. African marigold (*Tagetes erecta* L.) flower pigments can be extracted and used as a natural food additive to colour egg yolks orange and poultry skin yellow (Bosma *et al.*, 2003).

TEN RULES OF EDIBLE FLOWERS

The culinary use of flowers dates back thousands of years to the Chinese, Greek and Romans. Today there is a resurgence of interest in edible flowers. All flowers are not poisonous. But we should follow some rules before sampling flowers.

Eat flowers only when you are positive they are edible in uncertain, consult a good reference book on edible flowers prior to consumption. If we are not interested to eat them we can't enjoy its flowers and sometimes it may cause some side effects also.

1. Just because flowers are served with food does not mean they are edible. It's easy and very attractive to use flowers for garnish on plates or don decoration, but avoid using non-edible flowers this way. Many people believe that anything

on the plate can be eaten. They may not known if the flower is edible or not and may be afraid to ask.

2. If pesticides are necessary, use only those products labeled for use on edible crops. Generally we don't apply more chemical fertilizers to those crops, which we are used for consumption. More chemicals may give more yields, sometimes, but it may create problems for consumption and they are injurious to health.
3. Do not eat flowers from florists, nurseries or garden centres. In many cases these flowers have been treated with pesticides not labeled for food crops, as their ultimate aim is to get more yield.
4. Do not eat flowers picked from the side of the road. Once again, possible herbicide use eliminates these flowers as a possibility for use.
5. Remove pistils and stamens from flowers, before eating. Eat only the flower petals for most flowers. Pistils and stamens may add some bitterness to the dish, so that they are not used for edible purposes.
6. Different flowers occur in plants when grown in different locations because of soil types, fertilization and culture. Environmental conditions play a big role as well. What has excellent flavour at one time may taste different at the end of the season or the next year.
7. Introduce flowers into your diet in small quantities one species at a time. Too much of good thing may cause problems for your digestive system.
8. If you have allergies, introduce edible flowers gradually, as they may aggravate some allergies.
9. Enjoy the different flavour and colour that edibles.

Collect the flowers at the optimum time, pick fully open flowers in the cool of the day. Flowers that are not fully open or those starting to wilt should be avoided. Sample a flower or two for flavour before harvesting. Remove the pistils and stamens because the pollen can detract from the flavour of the flower as well as cause allergic reactions in susceptible individuals.

Place long stemmed flowers in water and than in a cool location. Short-stemmed flowers should be placed between layers of damp paper toweling or in a plastic bag in the refrigerator. Immediately before using, gently wash the flowers to remove dirt

and check for insects. Before washing, test one flower for colorfastness. Some tend to discolour in water.

Only the petals of some flowers such as rose, tulip, yucca and lavender are edible. Separate the flower petals from the rest of the flower just prior to use to keep wilting to minimum. Roses, dianthus, English daisies and marigolds have a bitter with are at the base of the petal where it was attached to the flavour. Break or cut off this portion before using.

A group of flowering plants that are most often used to garnish or enhance the appearance and flavour of various foods. The petals or the entire flower can be placed into, around or on foods for the desired results. As another alternative, the petals can be candied and served as a sweet addition with different types of food. When the flower petals are to be consumed, make sure they are cleaned thoroughly and have not been exposed to or contain chemicals and pesticides.

Since some flowers may be poisonous or contain strong allergies identify the flowers type before assuming it can be consumed. Do not attempt to consume petals that are from unknown varieties of plants. Make sure the identification is correct to be confident it is an edible variety, or if not edible, make sure it has not been used simply as a decoration that comes in contest with the food being consumed. It is always wise to consider buying flowers from food stores or specially stores, where the variety is identified and classified as edible

Edible flowers grown from the seeds should be picked early or late in the day to assure they contain as much moisture as possible. Select flowers with healthy

CONCLUSION

Man uses flowers for various purposes like veni, garland making, bouquet making, self-adornment, for religious purposes etc. Flowers provide an allure that has been used by man to transcend the seasons and evoke emotion.

Dried or fresh, certain specialty flowers can stimulate and only the eyes but also the sense of taste or smell, empowering new marketing opportunities for small-scale enterprise. Such flowers can be marketed fresh, dried, sugar coated, in bulk, as single or sometimes grain. The exciting market, although subject to whims of designers, chefs, or

fashion, continues to grow to mat demand. For small-scale operation, recognizing unique marketing opportunities provides entry to this competitive market place. Growers of specialty flowers service specific needs in the flower industry. These spin offs includes rare cut flowers, edible flowers for garnishes or salads and medicines. The popularity of edible flowers has increased nowadays.

These is an instant evolution of diversified edible flowers products to meet the changing wants of consumers. As edible flowers become more popular, defining the preference of consumers and chefs will become more important to producers and marketers.

DISCUSSION

1. Why should we remove pistils and stamens, before using the flower for cooking?

A) Pistils and stamens add some bitter taste to the food and in some cases it may produce allergies to the consumer. So it is better to remove pistils and stamens, before cooking.

2. Common crops used as edible flower in Kerala?

A) Lotus, Rose, Marigold

3. What are the allergies caused by edible flowers?

A) Skin blotches, itching, red lesions, asthma

4. Patricia Michelson – Who is that?

A) She is a chef

5. Are there any branded products, which we can use for edible purposes?

A) Yes Roohafza It is a syrup made from hibiscus flowers

6. Bee bread – what you mean by that?

A) Partially digested pollen mixed with honey is known as beebread It is used to nourish honeybee grubs

7 Name of companies, marketing these food products?

A) Gulland - Ramdev Food Pvt Ltd, Gujarat, Salmax Export Pvt Ltd, Mumbai

8 Is there any companies in Kerala?

A) Yes Synthetic Industrial Chemicals – Kolanchery for marigold pigment, lutein extraction

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KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF HORTICULTURE
Department of Pomology and Floriculture
Hort.651-Seminar
Topic: Food from flower crops

Name of the Student : Meghna Davis
Admission No. : 2004-12-15

Venue: Seminar Hall
Date: 5-11-2005
Time: 2.00pm

ABSTRACT

Flowers are associated with mankind from the dawn of civilization. It is said that man is born with flowers, live with flowers and finally dies with flowers. Flowers are used for various purposes in our day-to-day life like worshipping, religious and social functions, wedding and interior decoration and self-adornment.

According to Patricia Michelson, eating flowers is actually very glamorous. It gives food a summer glow and adds another dimension to cooking. Many flowering plants are used to garnish, enhance the appearance and flavour of various foods. The petals or the entire flower can be placed into, around or on the foods for the desired results.

In America edible flowers played a role in the kitchen since the colonial times and were used to make tea as well as for flavouring cakes, jams and a colourful garnish on salads. Rose, gladiolus, orchid, jasmine, daylily, etc. are some of the important flowers used for preparing foods.

Rose is used for making salad, floral liquor, flower honey, gulkand (Pal, 1972), pankhuri, rose jams, etc. Rose hips are also used in various recipes. In Southern part of Australia, the natives use the tubers of Orchid species, *Acianthus*, *Dipodium* as their food (Bose and Bhattacharjee, 1980). The natives of Africa used the roasted corms of *Gladiolus edulis* as food. The flowers of Arabian Jasmine are reported to be used in China for flavouring tea and it is also used for scenting foods, wine and drinks (Anon, 1972).

Daylily flowers are used to make soup and stews. Tender leaves are used for making salad. In Europe, tuber like roots are eaten raw which are sweet in taste and has nut like flavour. (Bose and Yadav, 1998).

Fresh rhizomes of lotus are consumed as vegetable either in roasted or in curry form. Dried seeds, also called as 'lotus nuts' is boiled, crystallized with sugar, cooked into a sweet soup and made into sweetened lotus nut paste which is used as a filling for Chinese moon cake.

Calendula flowers are used for making salads, stews, soup, butter, tea, etc. and are valued mostly for their colour. Chive flowers with mild onion flavour are used to prepare salads and curries. Violet flowers have a sweet taste and they are used in fruit salad and for preparing tea.

The popularity of edible flowers has increased nowadays. There is a constant evolution of diversified edible flower products to suit the changing wants of consumers. As edible flowers become more popular, defining the preferences of consumers and chefs will become more important to producers and marketers.

NEW AVENUES IN FLORI-BUSINESS

KAVERIAMMA. M.M.
2004-12-02
M.Sc.(Hort.) (Pomology and Floriculture)

SEMINAR REPORT

Submitted in partial fulfillment for the requirement of the
Course No. Hort.651 - Seminar

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DECLARATION

I, Kaveriamma, M.M. (2004-12-02) hereby declare that this seminar entitled "New Avenues in Flori-business" has been prepared by me independently after going through the various references cited here. I have not copied from any of my fellow students or other seminar reports.

Vellanikkara

22-11-2005

KAVERIAMMA. M.M.

(2004-12-02)

CERTIFICATE

This is to certify that the seminar report titled "NEW AVENUES IN FLORI-BUSINESS" has been solely prepared by Ms. Kaveriamma.M.M (2004-12-02), under my guidance, and has not been copied from any seniors, juniors or fellow students seminar reports.

Vellanikkara
Date

Major advisor
Associate professor
Department of pomology and floriculture

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NEW AVENUES IN FLORI-BUSINESS

Introduction

Floriculture, mere gardeners' activity once upon a time has become a lucrative agri-business enterprise today.

Commercial potential of floriculture as a viable agri-business enterprises received attention by the Govt. of India during the eight plan. Liberalisation of economic policies encouraged corporate houses and entrepreneurs to invest in setting up export oriented units.

The Indian floriculture industry witnessed quantum leap in floriculture with the introduction of roses in the year 1991. Thereafter, the cut flower industry grew into a massive scale spreading further to other crops like Gerbara and Carnation. However, the present statistics about cut flower production is not very much envouraging though there was about twelve fold increase in the production of cut flowers during the period between 1993-94 to 1997-98; the trend thereafter is not quite encouraging.

The Indian cut flower industry assumes an insignificant position among the various branches of Horticulture like fruit and vegetable production.

The components of floriculture industry in the country are production of loose flowers, cut flowers, dry plants and flowers as well as oils and pigments. As we look at the area under flower production, our country has an envious share of 25% of the total world area. However our export share is an abysmally low level of less than 0.5%.

Weapons for competition are:

1. Quality improvement of quality by pre and post harvest management
2. Environmentally sound production
3. Wider assortment
4. Better presentation
5. Cost affective methods
6. Faster and regular service

The floriculture industry comprises of

- Florist trade of traditional and contemporary cut flowers and cut foliage
- Value added products like bouquets, garlands, floral baskets and flower arrangement
- Plant nursery for propagation and supply of plant materials including tissue culture plants, seeds, bulbs, corms and other propagation material
- Bioaesthetic planning
- Plant rental service for supply of house plants on annual rent for a specific period
- Flower perfumes and Gulkand
- Oils and edible product
- Dry flowers and potpourris
- Pigments, pharmaceuticals and insecticide

Diversification in floriculture

The following broad areas seem to be relevant in this context.

(i) Identification of crop specific zones

More than a decade back certain zones were identified and designated as ideal for growing certain cut flowers. These were termed intensive floriculture zones.

Accordingly, areas around Delhi, Pune, Nasik, Hyderabad and Bangalore emerged as most potential areas for the production of cut roses under cover.

During the period orchid and anthurium industry took a new turn in Kerala.

Temperate orchids were identified to be most potential in North eastern states.

On the other hand, traditional flower industry proposed in states like Karnataka, Tamil Nadu, West Bengal, Maharastra, Andra Pradesh and Orissa.

In order to exploit the diversity in landforms and agro-ecology, the state can be divided into the following zones depending on the commercial flowers suited.

Sl. No.	Zone	Features	Suitable crops
1	Palakkad district and similar areas	Low rainfall, low humidity and cheap labour	Jasmine, crossandra, marigold, tuberose

2	Hll zone I	Upto 1500 m above MSL	Anthurium, Rose, Carnation, Gerbera, Gladiolus
3	Hill zone II	More than 1500 m MSL polyhouses will be necessary for certain crops	Cymbidium orchid, lilies, bird of paradis, alstroemaera
4	Other areas	Plain land including coastal areas	Orchid, anthurium, foliage plants

The agro-ecological situation prevalent in the state provides great potential for flourishing of a strong floriculture industry in the state. Agro-climatic zonation would also be helpful in identifying relevant crops and in preparing projects accordingly, thus helping in chanseling developmental activities.

Resource based development

- Water (availability and quality)
- Altitude and terrain
- Soil types and fertility
- Wind, rainfall
- Humidity, temperature, day length etc.
- Nearness to the airport

Top 10 cut flowers

1. Rose
2. Tulip
3. Chrysanthemum
4. Gerbera
5. Carnation
6. Freesia
7. Lily
8. Alstoemeria
9. Iria
10. Gyprophila

Location specific growing system

The relevance of location specific systems is not adequately understood in floriculture. A slight modification of the system to suit the resource availability would drastically improve the production and quality. In Kerala, which receives high rainfall of more than 5-6 months, the direct impact of high rainfall and the indirect effect of low light intensities are the major problems encountered in the commercial cultivation of orchids. In the design developed by the University, where shade was provided at two levels. High percentage of marketable spikes were obtained and the incidence of pest and disease also loss. The system is widely adapted in the state and outside. Similar approaches could be ventured anywhere to improve production and quality.

Exploitation of cut flowers

ROSE

Rose is without doubt the most beloved and popular of all garden shrubs. No other shrub or plant can provide a continuous display of colours.

Rose has been held in esteem and cultivated since the early days of gardening.

Roses have the largest share in global flower market to the tune of 17%.

CARNATION

Carnation flowers are valued for its excellent keeping quality, wide array of colours and forms and ability to rehydrate after continuous transportation.

Due to high cost of production inside green house in Europe and USA, its cultivation is shifting to more naturally growing area. India can tap this potential.

GLADIOLUS

Gladiolus is very much liked for its majestic spikes containing attractive, elegant and delicate florets.

These florets open in sequence over a longer duration and has a good keeping quality of cut spikes.

Our flower markets are flooded with gladiolus spikes during winter but in summer it is available in a limited scale due to supply from the hills only.

ANTHURIUM

Anthurium assumes significant position on account of its beauty. It is grown for showing cut flower and attractive foliage.

These are very popular with flower arrangers because of its bold effect and lasting qualities of flower when cut. The long shelf life of anthurium symbolizes a long, healthy life.

The demand for anthurium cut flowers in the domestic and world market is so high that there is tremendous potential for India to tap this market. Between 1999-2002 demand for anthurium is up by 38%. The demand on the other hand for flowers such as rose and carnation has increased by 18% in the same period.

Anthurium is an excellent crop for commercial projects and farmer can earn minimum of Rs.5 lakhs/annum from an acre of anthurium and demand is increasing.

ORCHIDS

Orchids are a group of attractive flowers having a wide range of diversity in their form, shape, colour and texture of flowers.

Its constitution is a most sophisticated piece of floral engineering.

Some orchid flowers last for one or 3 months if they remain attached to the plant and as cut flowers they remain fresh for 1-4 weeks.

Important orchids as cut flowers are

- Phalaenopsis
- Cymbidium
- Dendrobium
- Aranda
- Oncidium
- Mokara
- Cattleya

Other plants used as cut flowers are

- Bird of Paradise
- Gerbera
- Lily
- Leliconia

As loose flowers are

- Jasmine
- Chrysanthemum
- Aster
- Crossandra
- Zinnia
- Rose etc.

Landscape gardening

Its an aesthetic branch of horticulture dealing with planting of ornamental plants in such a way that it created a picturesque effect.

Lawn forms an important component of a landscape. Various lawn grasses are used. To name a few

- Bermuda grass
- Korean grass
- St. Augustine grass
- Mexican kushion grass

Ornamentals grow could be annuals, creepers, perennials like shrubs and trees etc.

Annuals or seasonals are a group of plants with complete their life cycle is in one season.

Annuals are grown for

- Bedding purpose : Phlox, Petunia, Verbana
- Cut flowers : Carnation, aster
- Loose flowers : Marigold, Chrysanthemum
- Hanging basket : Daisy, Verbana, Phlox
- Shady situation : Salvia, Cinerria
- Screening purpose : Hollyhock, Sweet pea

Shrub grasses are

- Ixora
- *Pentas lanceolate*
- Musserde

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- Acalypha
- Clenodurations

Creepers are : Coral creeper, Railway creeper, Thumbergia, Rangoon creeper, Monstera, Clitoria, Phillodendron, Purple wreak

Ornamental trees that can be grown are:

- *Plumeria*
- *Callistemon lanceolate*
- *Polyalthia*
- *Bauhinia*
- *Palms* etc.

Consultancy service in landscaping

Landscaping is an attractive branch where trained personal can get into. It would be landscaping houses, resorts, factories, airports etc.

Interior plantscaping

Growing of either foliage or flower plants indoors is termed interior planting. It includes growing of shade loving plants, Bonsai, terrarium etc.

Shading loving plants include: Asparagus, Aglaonema, Caladium, Pothos, Phyllodendron, Syngornium, etc., Monstia, Maranta.

Nursery and seed industry

The biggest suag in India is nonavilability of quality planting material. Nurseries of repute, selling genium planting material can be established.

Bonsai

The art of growing plants in shallow containers is termed Bonsai.

Numerous tree species can be used to make Bonsai. Common ones are Ficus species.

The various styles of Bonsai are

- Upright style
- Winding style
- Gnarled style
- Cascading style

Terrarium

Growing of plants in clear transparent glass bowls is termed terrarium.

Commonly grown plants are - Peperonia, Chlorophytum, Cacli etc.

Exploitation of various resources

Exploitation of cut foliage and pot plants

Tropical cut foliage is an important part of florist industry, cut foliage is used as fillers, bouquets, flower arrangements etc. in combination with cut flowers.

Unlike with flowers, there is year round demand for cut foliage.

During October-November to April-May production in the colder regions is very low whereas demand is high. Advantage is that production in India will be practically year round because of the varied agroclimatic conditions.

- The investment cost is also low compared to cut flowers
- Risk of damage during transport is also low.

The concept to be considered here is the use of cost effective and easily manageable structures, which provide quality foliage that can compete in domestic and foreign markets

- Locally available materials can be used for the construction of greenhouse against costly materials that are imported.
- Only quality planting materials should be used.

Selection of foliage is most important because the beauty and display of the arrangement is entirely dependent upon the foliage.

They have enough potential as an alternative of flowers, particularly during the lean period.

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Foliage plants are often used to create an interior landscape that would serve as screen and also soften the interior design.

25% of the floriculture market has been captured by foliage plants.

In India, cut foliage are: Dieffenbacia, Caladium, Calathra, Ficus, Cycon, Areca, Dracaena, Maranta, Peperonia are some of the common potted foliage plants.

Dry flowers

. . . . . a way to enjoy their beauty for a long period. Since fresh flowers are beautiful and delicate as well, it becomes stupendous job to maintain their crown for a long time.

So by drying flowers by different techniques these can be used for pot-pourri, flower arrangement and to add flavour to cooking.

Even with increased popularity of plastic and fibre, many people still prefer "The real thing" preserved in a lifelike manner.

Being a low cost high demand industry, new generation of professional driers are coming forward with great razzle. High income generating power of flower can be utilized elegantly in this manner also.

In a field of diversity and novelty, abundant scope awaits for dry flower. Dry flower industry was brought to India by British. It prospered in Calcutta because of its nearness to north eastern region. The plant diversity in Kerala can also be seen in that perspective.

Reasons are many for considering the dry flower field attractive

Dry flower are :

- They are cheaper
- Production is not dependent on weather or season
- They are ecofriendly and biodegradable
- Agricultural waste can be used as raw material
- Field problems like pest and disease are seldom encountered
- Shelf life is much high compared to fresh flowers
- Can be transported by surface, reducing the transport cost

- Phyto-sanitary certificate, quarantine measures are not required.

Exploitation of native flowers

- In the mad run for procuring exotic plants and exotic technology for cut flower production we have rather asand--- several traditional shrubs and trees
- Specialisation becomes the tool for survival. India has to explore its rich native flora. In global floriculture such attempts are made in Australia and even in a small country like Sri Lanka.
- Since majority of our floriculture production is in the tropical zone, the rich flora of the tropics has to be judiciously exploited.

Even the ornamental plant species, which are pushed to the back line could find a better place in commercial floriculture.

The may also call for a systematic breeding programme in order to improve productivity, vase life etc.

General bottlenecks associated with the development of floriculture industry in India are as follows:

- At present cultivation of flowers in greenhouse is dependent on foreign technology, as we are yet to establish on indigenous technology. The initial investment is therefore, very high. Even the equipments are required to be imported.
- Flowers are highly perishable in nature and therefore when grown in a controlled environment, they need to be transported in similar conditions to maintain their quality and freshness. For this, refrigerated vans for road transport and adequate warehousing space at airport till they are loaded in the aircraft are required. There is dearth of warehousing space at the airports.
- Certification procedures related to phytosanitary and custom formalities are tedious.
- There is no direct air service from India to flower marketing areas like Amsterdam, Copenhagen etc.

- High air freight in our country and inadequate cargo space for flowers are the twin problems to be sorted out wish air India.
- Growers do not get sufficient information about export market trends, demands, prices, consumer preference etc.
- Production units are small and scattered and there is no proper linkage between produces, processors and exporters.
- Floriculture is a capital intensive industry with long gestation period. Availability of adequate finance is a problem.

Steps taken by the Govt. to increase flower export

- Import duty on floriculture planting material has been reduced from 55% to 10%.
- To further promote floriculture, the commerce ministry is contemplating duty exemption on the import material for green house and tissue culture labs considering the huge capital inputs.
- For export of tissue culture plants, and cut flowers by air, subsidy on air freight has been allowed up to a maximum of 25% of the international freight rate.
- Setting up of cold storage unit at international airports.
- APEDA is planning to step up flower exports to West Asia, Australia and Newzealand.
- Import duty on precooling units and refrigerated transport units reduced to 25%.
- Plans to set up model floriculture regional centre at Chennai, Bangalore, Trivandrum, Pune, Lucknow, Calcutta, Mohet, Srinagar and Gangtok.
  - for conservation of important varieties of flower crops of the region.
  - large scale multiplication.

CONCLUSION

Standing at this point and in the light of various opportunities we have, the only way to make a dent in the floriculture industry, both in the domestic and export market is to think in terms of our own strength and opportunities.

Discussion

1) Name the plants used as Bonsai

Many plant species can be used to make Bonsai. Commonly plants belonging to genus *Ficus* are used.

2) What is the character of plant suitable to make Bonsai?

Plants should be hardy when Bonsai has to be made.

3) What is tinting?

Imparting colour to flowers is turned tinting.

4) What is potpourri made up of?

Potpourri is made up of dry flowers. Commonly Rose petals are used.

5) If given a chance, which avenue would you choose?

I'd go for anthurium crop cultivation as its is a lucrative field. A farmer can earn upto Rs.5 lakhs/annum from an acre of anthurium.

6) Which country tops in flori-business?

The Netherlands.

ABSTRACT

Floriculture consisting of cultivation and trade of cut flowers, cut foliage, dry plants and flowers, oils and pigments, potted plants, garden-bedding plants, planting materials, services, etc. has become an important sector, experiencing rapid change the world over. Consumption of flower in most countries is rising, associated with income development (Satya and Maitra, 2004).

Commercial potential of floriculture as a viable agri-business enterprise received attention by the Government of India during the eighth plan. Liberalization of economic policies encouraged corporate houses and first generation entrepreneurs to invest in setting up export oriented units.

The weapons for competition in the international market includes quality flowers, environmentally sound production, wide assortment, better presentation, cost factor and faster and regular service.

The Indian floriculture industry witnessed quantum leap with the introduction of roses in the year 1991 (Bose and Yadav, 1998). Thereafter, the cut flower industry grew into a massive scale spreading further to other crops like gerbera and carnation. However, the present statistics about cut flower production is not very much encouraging though there was about twelve fold increase in the production of cut flowers during the period between 1993-94 to 1997-98; the trend thereafter is not quite encouraging (Rajeevan *et al.*, 2003).

The components of floriculture industry in the country are production of loose flowers, cut flowers, dry plants and flowers, landscaping, oil and pigment extraction etc. Plants are widely used in urban environments, both outdoor and indoor (Fjeld and Bonnevie, 2004). Though our country has an envious share in area, it has an export share of less than 0.5%.

Diversification in floriculture includes identification of crop specific zones, location specific growing systems, sustainable production system, exploitation of cut foliage, native flowers, oil and pigment extraction, dry flowers and plants.

Standing at this point and in light of various opportunities we have, the only way to make a dent in the floriculture industry, both in domestic and export market is to think in terms of our own strength and opportunities.

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ROLE OF NATURAL ANTI MICROBIAL COMPOUNDS IN FOOD PRESERVATION

By

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(2004-12-10)

SEMINAR REPORT

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COLLEGE OF HORTICULTURE
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DECLARATION

I, Shibi Varghese, (2004 – 12 – 10) here by declare that this seminar report entitled **"ROLE OF NATURAL ANTI MICROBIAL COMPOUNDS IN FOOD PRESERVATION"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports.

Vellanikkara
Date 26/11/05

Shibi Varghese
(2004 – 12–10)

CERTIFICATE

This is to certify that the seminar report titled **"ROLE OF NATURAL ANTI MICROBIAL COMPOUNDS IN FOOD PRESERVATION"** has been solely prepared by Ms. Shibi Varghese(2004 – 12 – 10), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

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ROLE OF NATURAL ANTI MICROBILAS IN FOD PRESERVATION

Introduction

Man need adequate food and balanced nutrition for growth and development and to lead an active and healthy life. The food whether raw or processed should be safe and should not be injurious to health. Fresh food is mainly spoiled by various microorganisms and by inherent enzymes. Various methods are used to check contamination and to increase their storage life. Raw materials are however processed in to various value added products by innovative and programic approach.

The various preservation methods based on the application of heat, cold, removal of water, application of radiation of all have the common objective of retarding the number of living organisms in food. Or at least holding them in check from further multiplication. Preservatives are used in food to solve this problem. Preservatives come under the group food additives.

FOOD ADDITIVES

An expert committee of FAO and WHO has defined foods additives are non nutritive substances added intentionally to food, generally in small quantities to improve it's appearance, flavour, texture or storage properties. Food additives are substances, which are intentionally added to foods during processing to improve the shelf life or for improving colour, flavour and texture of food or as processing aides (PFA, 1954)

Important classes of food additive are preservatives, colours, antioxidants and stabilizing agents, anticacking agents, flavoring agents, sequestering and buffering agents

PRESERVATIVES

Preservatives, which help in keeping food wholesome and appealing they are essential tools in today's processing industry. They inhibit the growth of molds and bacteria and extend the shelf life of processed foods (Grundy, 1996).

Preservatives mean a substance which when added to food is capable of inhibiting, retarding or arresting the process of fermentation, acidification, or other decomposition of food. Preservatives are substances that are intentionally added to food product to

prevent spoilage caused by mold yeast or bacteria. Preservative may be single or mixed forms. Preservative further classified in to Class-I (natural preservatives) and Class-II (chemical preservatives).

Characteristics for a good food preservative.

A good chemical or natural preservatives should pocess the following characters to maximize the efficiency; coast benefit ratio and ease of handling while minimize adverse effect on the products in which they are used. (Meenakshi and Bhavana, 2004)

1. Broad anti microbial spectrum.
2. Non toxic to human.
3. Effective at small doses.
4. Free of odour, colour and flavour.
5. Cost-effective and should available in dry forms.
6. Water soluble and non corrosssive.
7. Stable during storage.
8. Should not have any adverse effect on fermentation or loaf characters.

Factors affecting the antimicrobial activity of preservatives

1. Physical and chemical properties of food.
2. Characters and number of microorganisms
3. Composition of food, pH, acidity, nutrition value
4. Initial contamination prior to the use of preservatives
5. Type of preservative used
6. Time and temperature of storage
7. Cost and toxicity of antimicrobial agents (preservatives)

CHEMICAL PRESERVATIVES

Also called Class II preservative. It is defined by food and Drug administration as any chemical that when added to food tend t prevent or retard microbial growth, food deterioration and thus increase the shelf life.

Commonly used chemical preservatives are:

i) Benzoic acids including its sodium and potassium salt

ii) Sulphurous acid including its salt

iii) Sorbic acid sodium, potassium & calcium salts

iv) Sodium diacetate

v) Sodium and Calcium propionates

vi) Methyl and Propel Para hydroxyl benzoate

vii) Nitrites and Nitrates of Sodium and Potassium

(Swaminathan, 1989)

Disadvantages of chemical preservatives

Sl.no:	Chemical preservative	Potential changes
1.	Benzoic acid	Cause asthma and neurological disorder
2.	Sodium benzoate	Nettle rash and asthma
3.	Potassium benzoate	Allergic reactions
4	Methyl p-hydroxyl acetic acid	Cause skin allergies
5.	Sulferdioxide, sodium sulfate	Toxic provides asthma, attack and difficulty to matabolise Vit B_1
6.	Potassium nitrate	Shortness of breath, dizziness, head ache, potential carcinogen
7.	Sodium nitrate	Provoke hyper activity
8.	Sodium propionate and calcium propionate	Linked to migraines

NATURAL PRESERVATIVES

In today's food industry chemical preservatives are commonly used to maintain natural quality to ensure safety and stability of the products during their extended shelf life. But consumers now prefer food products that are natural, additive free, non thermal processed and have and accepted shelf life with assured quality and safety.

Use of natural antimicrobial system especially from plants may help to over come the problems associated with the chemical preservatives (Bhavabhuthi *et al*. 2003)

Natural preservatives defined as any substance from plant, animals and microorganisms that when added to food tend to prevent or retard the microbial growth, food deterioration and thus increase the shelf life. (Arya, 2004)

Commonly used natural preservatives are:

I. Salt
II. Sugar
III. Vinegar
IV. Honey
V. Dextrose
VI Vegetable oil
VII Organic acids
VIII Spices
IX Bacteriosins

Functions of natural preservatives:

Natural anti microbials mainly perform three functions (Sethy *et. al*., 2003)

1 They have the capacity to inhibit microbial growth
2 They inactivate the microorganisms in food
3 Promote the growth of desirable microorganisms with out affecting the organoleptic properties of food.

Advantages of natural preservatives:

Heinemann *et al* (1965) listed the following advantages of natural anti microbial agents

1. Non toxic
2. Easily available
3. They are having less deleterious effect, on the organoleptic properties of food.

4. Economical to produce
5. Effective at low doses
6. Stable during storage
7. Extend the shelf life of processed foods either alone or in combination with other systems

Consumers now demeaned food products with fewer synthetic additives but increased safety, quality, and shelf life. These demands have lead renewed interest in the use of natural anti microbial to preserve t6he foods. How ever despite the wide range of potential anti microbials relatively few are suitable to use in particular food products.

1. SALT

Salt is used as a flavoring and taste enhancing compound, in combination with other preservatives .It is also widely employed in foods for enhancing their shelf life .As a common dietary source no country is restricted its use. However in foods labeled as low salt food it's concentration is restricted (Manay, 2000)

Mechanism of anti microbial action

Common salt is known to have decreases the water activity of the food product which restrict the growth of microorganisms .the water activity of saturated salt solution is only the range of 0 75 Some of the microorganisms continue to grow below 0 75 aW.

Common salt also decreases the solubility of O2 in water. This may reduce the minimum inhibitory concentration of other preservatives. Eg: Salt reduces the minimum concentration of sorbic acid against yeast and mold when used along with sorbic acid. Salt also improve the effective ness of physical. methods of processing like drying, refrigerstion and microwave heating when used along with these operations.

APPLICATION

Vegetable products

In India highest concentration of salt is used to process pickles from unripe fruits like mangos, kerondas and vegetables along with spices and vegetable oils. Vegetables pickled in week solution of salt are again subjected to lactic acid fermentation. Eg:

Saurkrat, pickled gherkins and olives. The main preservative is not common salt but organic acid either added or formed from vegetable during fermentation.

Dairy products

Emulsifying fats are highly susceptible to microbial attack so they require salt application depending up on their moisture content. in butter 0.3%-2.0% of salt is applied after butter grains are washed .In margarines also 2.5%-3.0% salt is employed. In cheese the salt is either added in the form of salt powder or salt solution. But salt is hardily preventing the mold attack in cheese during the ageing process.

Effect on salt on food quality

Salt has flavour enhancing action but this is at much lower level of use. At higher concentration salt is employed as preservative .It increase the shelf life of the food product. Application of salt also remove watersoluble ingredient such as salt soluble vitam9ins and minerals from food due to osmosis. So biological value of salt preserved food is accepted to lower. But this is of minor significance compared to it s preservative action.

Experiments have also been conducted using different concentrations of spices powders and salt to find out the relative effectiveness of these food additives in inhibiting the growth of yeast, mould and bacteria along with 16 and 18 % salt concentration in culture meadia. It was observed that in the presdsence of salt, the concentration of spices powders was reduced for checking the growth of micro orgfanisms. The effect of spices varied with the amount of salt added in the test medium. However, coriander powder was ineffective even at 20% concentration both with 8 and 16% salt in the test medium (Meena, 1992). Among the spices used, clove was the most effective (0 2%) and cumin was the least (12%) effective against all the microorganisms

2. SUGAR

Sugar is a sweetening agent, is widely used as a preservative either alone or in combination with other preservatives. Sugar is mainly produced from sugar cane juice or beetroot by extraction of juice, concentration, discoloration and by crystallization. Sugar is readily soluble in water and slightly soluble in alcohol.

Health aspects

Sugar is utilized in the body to produce energy. But if it is consumed in large quantities it cause obesity, dental caries and may lead to cardiovascular disease.

Regulatory status

Since sugar is a major ingredient sin many food products its use is not restricted by law in any countries. However the person suffering from diabetics are advised not to use products containing high concentration of salt.

Mechanism of Anti microbial action

Sucrose lowers the water activity of food and there by it inhibits the growth and survival of microorganisms. In lower quantities microorganisms utilize sugar nutrients. Among the microorganisms which can tolerate high concentration of sugars are *Aspergillus glucose* and osmo tolerant yeasts Eg: *Sccharomices roxii* and yeasts of the genus *Torulopsis* (Fraice, 1995). In addition sugar lowers the solubility of O_2 in water. Hence the product containing higher sugar concentration, the O_2 available to aerobic microorganism only a fraction of that found in products of low sugar content.

APPLICATION

Fruit products:

Addition of sugars to fruit products is an extremely old method of preservation. Sugar is highly compactable with fruit products in taste because such products are already naturally sweet flavourd. The fruit products are preserved by sugar alone should have about minimum 65%total soluble solids. These include jam, jelly, and marmalades. The products, which are preserved with high concentration of sugar, include fruit syrup, which require around 70%sugar with out any other preservative.

Fruit preserves are prepared by gradual increase in the consistency of sugar syrup. By the process of osmosis, water from the fruit leached in to the solution and sugar enters the fruit. Sugar concentration in the murabbas and canned fruits also around 65% -75%. The can be stored at room temperature with o0ut any spoilage.

Dairy products

In India sweetened condensed milk is prepared by evaporating whole milk to 30-32% total solids and mixing 40% powdered sugar, thus increase the total solids to 70-75%. This evaporated and sweetened milk is preserved well at room temperature with out any mold spoilage if protected from the environment by suitable packaging. There are large numbers of sweets like "rasagulas" which are kept well in hard syrups. In addition there is large number of sweets, which are prepared from "khoa"and sugar syrup. These also keep well for short duration due to high concentration of sugar.

3. HONEY

Preservative action of honey was known t ancient Egyptians. Honey is listed in PFA as Class I preservatives. Honey is a solution of fructose and glucose and to a lesser extends of sucrose. Its preservative action is mainly due to lowering of water activity of the system. However, some minor constituents present in plant exudates collected by honey bees may also serve as a preservative and supplement the preservative action of inverted sugar.

4. DEXTROSE

Preservative action is also due to water activity lowering mechanism In fact 180g of dextrose equal to 342.8 g of sucrose in decreasing the water activity and there fore, it's preservative action should be higher. However high cost it is not utilized at industrial scale for food preservation Secondly during thermal processing of foods, sucrose is partially converted in to fructose and glucose Thirdly dextrose is more prone to cause browning in foods than sucrose So it is not encouraged especially in protenatious products such as milk products

5. VINEGAR

As per PFA vinegar should contain a minimum of 3.75%acetic acid. This should be derivate from fermentation of naturally available materials such as sugar cane juice, coconut water etc. with the help of acetic acid bacteria. Alternatively it is also prepared by dilution of synthetic acetic acid to the level of 3.75%. But this should be labeled as

synthetic prepared from acetic acid. However, vinegar derived from fermentation and that derived from synthetic acetic acid do not differ in their toxicological and antimicrobial properties.

Mechanism of anti microbial action

The action of vinegar and acetic acid in food based on essentially by lowering the pH value of the food product only at concentration of above 0.5%, preservative action by penetrating cell wall of bacteria and denaturing the proteins of cell plasma. If the ph of the product is brought down to 3.0 the anti microbial effect of acetic acid is 10 –200 times more powerful as that of any other acids. This deference may be due to the fact that only the un- dissociated acetic acid is more readily penetrate into the interior of the cell wall. Acetic acid increases the heat sensitivity of the bacteria, but to that of yeast and mold. (Crusess, 1969)

The bacteria, which are inhibited by bacteria are,

1 *Salmonella aertryke* (0.04%)

2 *Staphylococcus aureus* (0.03%)

3 *Phytomonas phasioli* (0.02%)

4 *Bacillus cereus* (0.04%)

5 *Bacillus mosentricus* (0.04%)

6 *Saccaromyces cervisea* (0.59%)

7 *Aspergillus niger* (0.27%)

Although acetic acid is more effective against bacteria than film forming yeasts and mold, its action is still weak as compared to other preservative.

Application within the tolerable flavor range acetic acid has only a slight effect on microorganisms. It is there fore used along with other physical methods especially high or low temperature or in combination with other preservatives.

Vegetable products

Preservation of vegetable in vinegar is an ageold non-fermentative process. Raw vegetables can be immersed in 0.5%-3.0%acetic acid, which contain spices, salt or sugar or sweeteners according to the product concerned. The main vegetables,

which are preserved in acetic acid are gherkins, beet root and mixed vegetables. How ever vinegar alone is sufficient to provide long time storage since film forming yeast and number of mold can well develop in vinegar preserving liquids. Hence pickled vegetables are pasteurized in sealed packages. To prevent mold attack after the packages are opened.

Fruit products

In many countries plums, cherries, pears, vine grapes and other fruits are pickled in vinegar. The process involves covering of the fruit with hot liquids containing 2- 2.5% acetic acid and ad large amount of sugar, after which both their fruit and liquid are sterilized.

Bakery products

In bakery products, sodium diacetate is added to a maximum of 0.5%on flour weight basis to protect against ropiness. Acetic acid not only inhibits the bacteria themselves but also reduces their heat resistances during baking, so that their death rate is higher in dough acidified with acetic acid.

6. VEGEGTABLE OIL

Vegetable oil mainly consist of triglycerides and to a lesser extend of diglysarides and mono glycosides and free fatty acids, while tryglysarides hardily have any preservative action but mono and diglycerides and free fatty acids have mild preservative action Minor constituents such as allyl isothiocainate in mustard have some preservative action

The preservative action of vegetable oils in vegetable pickle is to avoid entry of microorganism by forming an impervious layer it also does not allow entry of O2thus creating anaerobic condition which favor anaerobic fermentation thus producing more acids.

7. ORGANIC ACIDS

Organic acids whether naturally present in food, accumulating as a result of fermentation or intentionally added during formulation have been utilized for years to control microbial spoilage (Vijay and Sruthy, 2002). Mode of action of organic acid s is

attributed to direction of the substrate, depression of the internal cellular pH by ionization of the undissociated acid molecule, or disruption if the substrate transport by alteration of cell membrane permeability. The organic acids may include lactic acid, prop ionic acid, citric acid etc.

Commonly used organic acids as food preservative.

ACID	OCCURENCE	ACTION
Benzoic acid	Raspberries, Canberries, Plum	Antifungl,prevent amino acid uptake by microbial cells.
Citric acid	Citrus fruits	Lowers pH, chelate metal ions, interfere with glucose utilization in cells.
Malic acid	Apple, Tamarind	Multifunctional additive
Propionic acid	Swiss cheese	Mold inhibitor
Lactic acid	Lactic acid bacteria	Spore inhibitor lowers pH of the system

Syed *et al.* (1996) reported that meat cuts (beef, mutton) and chicken carcasses, when sprayed with organic acid singly or in combination with sodium chloride, extended the shelf life of meats at ambient temperature ($28+ 2^0C$).

8. SPICES

Herbs and spices are used widely in the food industry as flavours and fragrance. How ever they also exhibit useful anti microbial property. Many plant derived anti microbial compound have a wide spectrum of activity against bacteria, fungi and mycobacterium and this has lead to suggestions that they could used as natural preservatives in foods (Farag *et al.* 1989,Ramadan, 1972,Conner and Beuchat, 1984). Although more than 1300 plants have been reported as potential sources of anti microhial agents (Wilkins and Board, 1989), such alternative compounds have not been successfully exploited in foods to date. Active ingredient of spices constitutes an alternative approach to chemical preservatives (Peter, 1994).

Spices are not homogeneous group of substances obtained from various plants. These may be fruits, leaves, stem or roots .All spices have some active principles, which are active against microorganisms which are responsible for their preservative action. For example, curcumin, euginol, cuminaldehide are the active principles of turmeric, cloves, and cumin respectively. Piperin is the active principles of black pepper. Thymol is the active principle of thyme. These provide sufficient anti microbial action against some of the food spoiling bacteria. However, many of the active principles have pungent flavour. So spices cannot be utilized as universal preservative. These are used in pickles and chutneys.

Essential oils of spices are related to aroma and flavoring properties of spices. They are also having preservative action due to the anti microbial component present in them. Essential oils are the volatile oils extracted from plant or plant parts by distillation and enzymatic action (Pruthy, 1980)

Mechanism of anti microbial action

Active ingredient present in spices inhibits the enzyme associated with energy production in microorganisms. They also damage the membrane integrity of the microorganisms. It cause leakage of iones, ATP, nuclic acids and amino acids from microorganisms. At a high concentration of spices it affect the pH of the microorganisms. (Soliman, 2002)

Essential oils commonly used in food and their active constituents.

SPICES	ACTIVE COMPOUND
All spice	Euginol, methyl euginol, carvone
Caraway	Caravone
Cinnamon	Cinnamaldehide, euginol
Clove	Euginol, euginol acetate
Coriander	QD-linalool,
Cumin	Cuminaldehide
Garlic	Diallyl disulphide, diallyl trisuphide,
Mint	Limonene, 1,8-lineole

Oregano	Thymol, Carvacrole
Pepper	Piperin, monotarpenes
Sage	Borneol, thujone

Natural spices are widely used in a variety of food products. It is important to know the effect they have on the keeping qualities of food products. A number of studies have been made on the bactericidal and bacteriostatic properties of spices to evaluate their effectiveness in preventing are retarding spoilage caused by microorganisms. Some of the spices do exert a definite inhibitory action against microorganisms many of them without significant action. Anand and Johar (1 957) mentioned that mustard; cinnamon and clove are the potent spices in checking the microbial growth. Cinnamon and clove in small doses had an inhibitory action and did not permit the germination of mould (*Aspergillus niger*) spores.

Meena and Sethi (1996) studies antimicrobial activity of some common spices towards *Aspergillus niger*, *Bacilllus cereus*, *Lactobacillus acidophilus*, *Saccharomyces cerevisiae* and *Mycoderma spp*. Clove was most effective followed by cinnamon, mustard, *ajowain* and cumin at lower concentration than coriander.

Conner and Beachut (1984) studied the effect of essential oils of spices including cinnamon, clove, garlic, onion, savory and thyme. Out of these, garlic oil was a potent inhibitor of yeast growth at a concentration as low as 25ppm.They also reported that cinnamon and clove oils were stimulatory to pseudomycilium production by *saccharomyces cerevisiae*. Tadon and Lal (1960) found that the preservative effect of mustard oil was due to its volatile component known as allyl-isothiocyanate. All these mustard varieties containing greater proportion of allyl-isothiocyante helped to promote the development of acidity when used in large concentrations. The seeds of deferent species of mustard yielded varying percentage of pungent volatile oil containing allyl-isothiocynate. Sethi and Anand (1975) reported anti microbial property like other spices essential oils from clove and cinnamon .the bactericidal property of this compound that is responsible for the preservative action of mustard in pickles and fermented vegetables.

Antimicrobial Effectiveness of Spices:

Sl: no.	Spices and herd	Inhibitory
1	Cinnamon, clove, mustard	Strong
2	Allspice, coriander, cumin, sage, thyme, oregano	Medium
3	Blackpepper, chilllipower, ginger	Weak

Rees *et al.* (1993) studied antimicrobial activity of aqueous extract of freeze-dried garlic towards bacteria, yeast, fungi and virus. All the microorganisms tested were susceptible to garlic. For checking the growth of bacteria and yeast, 0.8-40mg garlic extract/ml of the growth media was inhibited by at least 25% at 2.0mg of garlic extract/ml of the growth medium. Lactic acid bacteria were least sensitive to the inhibitory effect of garlic. In mixed culture studies of Lactobacillus acidophilus and *E.coli*, garlic prevented the establishment of *E.coli*. Fresh garlic extract showed maximum germicidal activity against Bacillus cereus and *Bacillus brevis*.

Shukla and Tripathi, (1987) they identified anethole as the active constituent of aniseed oil having fungi static action to all the species at 600ppm. Results indicated the potential use of aniseed oil to protect food against fungal decay during storage. Karapnar and Aktug (1987) tested various spice components namely thymol, eugenol, menthol and anithole for the inhibition of food borne pathogens. Among these eugenol was most effective followed by thymol, anithol and menthol.

Hitokoto *et al.* (1980) reported that eugenol extracted from cloves and thymol from thyme caused complete inhibition of the growth of *Aspergillus flavus* and *A. versicolor* at 0.4 mg/ml or less. Shetty *et al.* (1994) tested antimicrobial activity of cumin, volatile oil and its major active constituent (cuminaldehyde) against various microorganisms that frequently occur in foods. Fungal and yeast cultures were more sensitive to cumin volatile oil and cuninaldehyde than bacteria. Among Gram negative bacteria, E.coli was the most sensitive to the volatile oil while *Pseudomonas aeruginosa* was the most resistant. *Staphylococuus aureus* had a minimum inhibitory concentration almost double that of all the other gram-positive spp. Tested, while the fungi had minimum inhibitory concentration value of 10-20 times lower than those of the bacteria. Minimum

inhibitory concentrations were in the range of 10-30, 0.1-5.0 and 0.025 to 3.25 mg/ml for cumin, cumin volatile oil and cuminaldehyde respectively.

Although majority of essential oils from herbs and spices are classified as Generally Recognized As safe (GARS) (Kabara, 1991), their use in food as preservative is limited because of flavour consideration, since effective antimicrobial dose may exceed organolepticaly acceptable level.

9. NATURAL ANTI MICROBIALS FROM MICROORGANISMS

Starter culture ensures a high degree of safety in the course of production in modern dairies and milk processing plants. The starter culture of bacteria age protective to human health and are capable of forming substances like bacteriosins, H_2O_2, by metabolism they inhibit their own species and other microorganisms.

Bactiriosins are low molecular weight proteins bacteriosins are low molecular weight proteins produced by many starter bacteria. They are bactericidal to closely related strains and species.

Many genera of starter bacteria namely

1 Lactococcus

2 Leucanostoc

3 Bifedibacterium

4 Pediococcus

5 Lactobacillus

6 Propaonibactirium etc

have been identified as bacteriocisns producing strains Over the years a large number of bacteriocins has been researched

Eg. Nisin, Natamicin, Subtilin, and Pediocin.

By selecting the proper culture, substrate and process conditions, many such shelf-life-extending ingredients have been created. They already have been used in processed meats, salad dressings, certain types of cooking sauces, and prepared salads. In dairy products, cultured natural preservatives have successfully extended the refrigerator life of cottage cheese when added to the dressing, and have controlled yeast and mold in yogurt.

Researchers first to identify food-grade bacterial culture that produce bacteriosins. These are then grown on a food ingredient substrate such as corn syrup solids, skim milk or whey. The resulting culture is concentrated and spray-dried to yield a bacteriosin containing food ingredient that may be labeled as simply "cultured corn syrup solids," etc. Such food ingredients also may contain organic acids and other substances that contribute to preservation. In some instances, the culture may even modify proteins in the substrate so the ingredient can offer moisture-binding properties. The bacteriosin containing whey protein (BCWP) is very effective as an inhibitor and inhibits gram-positive spoilage organisms such as Lactobacillus

In addition to spoilage organisms, the BCWP inhibits the growth of *Clostridium botulinum, Listeria* and *Staphylococcus aureus*

NISIN

Nisin is a natural antimicrobial agent used worldwide, since 1953 to control bacterial spoilage in both heat-processed and low-pH foods. Nisin, the active ingredient in Nisaplin®, is effective against a wide range of Gram-positive bacteria, both as vegetative cells and as spores. It is a small peptide produced by Lactococcus lactis, a bacterium which occurs naturally in milk. Nisin is a polypeptide and ismost stable in acid conditions. Nisin is soluble in aqueous environments. Some loss of activity is expected when nisin is used in heat-processed foods. At normal levels of use, it does not affect the colour, odour or flavour of the finished product. Nisin is manufactured by controlled fermentation of Lactococcus lactis in a milk-based medium. The nisin produced is concentrated, separated and spray-dried before milling into fine particles and standardised by the

SUBTILIN

It is an antibiotic peptide obtained from the bacterium *Bacillus subtilis* that is active against gram-positive bacteria and various pathogenic fungi. Subtilin mainly used in preservation of Asparagus, corn and peas. It reduces the heat sensitivity of the bacteria and ultimately results in the death of microorganisms.

PEDIOCIN

Pediocin is a thermostatic proteins and function under a wide range of pH. It is commonly used in fermented sausage. Pediocin inhibits the food born pathogens like *Listeria monocytogens*, *Clostridium perfringens* etc. It has a wide activity when used in conjugation with other physical methods like heating, freezing and acid treatments

NATAMICIN

Natamicin produced by strain of *Streptomyces chattanoogensis* it act as mould inhibitor in cheese and wine

FUTURE OF NATURAL ANTI MICROBIAL COMPOUNDS

1) Natural antimicrobial system is set to become an increasingly important component in food preservation methodology.
2) Many plant and plant products contain antimicrobial compounds that could be utilized in food preservation
3) The use of natural preservatives from plant system in food preservation has still to enter a period of exponential growth.
4) More research needs to be done on their antimicrobial effects in food.
5) The challenge is to isolate, purify and stabilize and incorporate these natural anti microbials in to food without adversely affecting sensory, nutritional and safety characteristics
6) Their main role in the future there for to develop a combination system of natural preservatives to reduce the amount of chemical preservative in food processing

CONCLUSION

The practice of food preservation mankind has been in vogue since ti immemorial to solve the problem of food spoilage. Currently as a result of novel research in food preservation has offered more natural foods to the consumers. Natural anti microbials can contribute greatly towards extended shelf life of food either alone or in combination with other systems There is a great potential for more extensive use of natural antimicrobial agents (Biopreservative) from animals, plants and microorganisms. In light of the consumers preference for natural foods.

Longer shelf life attained by use of natural preservatives will be ecofriendly beneficial to both producers and consumers. The use of natural preservative has still to enter a period of exponential growth. The challenge is to develop and incorporate these biopreservative in to food with out adversely affecting their quality characteristics

DISCUSSION

1) Are bacteriosins available in the market?
    a. Yes. Bacteriosins are available in the market. Such as nisin and pediocin
2) Where is bacteriosins commonly used?
    a. Bacteriosins are commonly used in dairy industry
3) Bacteria readily spoil non-acid foods. Why?
    a. Bacteria readily spoil acid fewer foods because; bacteria can't tolerate a high acidic condition. So food, which is having less acidity, is highly susceptible to bacterial attack.
4) The use of spices is limited as a biopreservative. Why?
    a. The use of spices in food is limited as preservative because of flavour consideration, since effective antimicrobial dose may exceed organoleptically acceptable level.
5) Use of turmeric other than preservative?
    a. A natural colour is extracted from turmeric. It is also having anti carcinogenic property.

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ABSTRACT

Man need adequate nutrition and balanced food for growth and development and to lead an active and healthy life. The food, whether raw or processed should be safe and should not be injurious to health. Chemical preservatives are commonly used to maintain raw material quality and to ensure safety and stability of the product during their extended shelf life. But consumers now prefer food products that are natural, additive free; nonthermal processed and has an acceptable shelf life with assured quality and safety. Use of natural antimicrobials especially from those of plants may help to overcome the drawbacks associated with the use of chemical preservatives.

Natural preservatives also known as Class-I preservatives or biopeserva-tives, include salt, sugar, honey, dextrose, vegetable oil ,organic acids, spices and bacteriosin (Arya, 2004).

Natural preservatives have the capacity to inhibit microbial growth, inactivate microorganisms in foods and promote the growth of desirable microorganisms without adversely affecting most of their organoleptic properties (Sethi *et al.*, 2003).Natural preservatives are nontoxic ,easily available, economical to produce, effective at low doses and stable during storage. Organic acids are naturally present in food, accumulating as a result of fermentation or intentionally added during food processing which can be utilised to control microbial spoilage (Vijay and Sruthi, 2002).

Herbal spices are important source of antimicrobials and the use of spices, their essential oil or active ingredients for controlling microbial growth in food material constitute an alternative approach to chemical preservative (Peter,1994). Cinnamon, clove and mustard have strong inhibitory effect on microorganisms. Bacteriosins are low molecular weight proteins produced by many strains of bacteria and are bactericidal to closely related strains and species. Mainly used bacteriosins are Natamicin and Nisin (Heinemann *et al.*, 1965).

Natural antimicrobial agents can contribute greatly towards extended shelf life of food either alone or in combination with other systems. There is a great potential for more extensive use of natural antimicrobial agents from animals, plants and microorganisms in light of consumer preference for natural foods.

AN OVERVIEW OF GLOBAL GRAIN AMARANTH

By

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(2004-12-03)

SEMINAR REPORT

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DEPARTMENT OF VEGETABLE CROPS
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DECLARATION

I, Smitha.K.S, (2004 – 12 – 03) here by declare that this seminar report entitled **"AN OVERVIEW OF GLOBAL GRAIN AMARANTH"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports.

Vellanikkara
Date 02-12-2005

Smitha K.S
(2004 – 12– 03)

CERTIFICATE

This is to certify that the seminar report titled **"AN OVERVIEW OF GLOBAL GRAIN AMARANTH"** has been solely prepared by Ms. Smitha.K.S. (2004 – 12 – 03), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

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CONTENTS

Introduction

In the developing world, the painful fact is that around 192 million children and 2000 million others experience micronutrient deficiencies, particularly the pregnant women, leading to infant mortality (Gaddagamath, 2002). Food based strategy to combat malnutrition prevalent among vulnerable segments of the population involves identification of optimal good sources of nutrients and ensuring their availability. Grain amaranth is a unique, nutritionally rich non-cereal crop capable of combating malnutrition. It is a multipurpose crop when both leaf and grains are utilized. Grain amaranth types normally tall with in three promising species viz. *A. hypochondriacus*, *A. caudatus and A. cruentus*.

Grain amaranth was selected as one of the four cereal crops from among 400 selected by a National Academy of sciences select panel as an underexploited tropical plant with promising economic value (NAS,1980). A survey which was conducted by Theisen *et al.* (1980) identified amaranth as one of five crops, which should receive immediate further study as a food crop better adapted to environmental stress. Both of these studies represent concern for identifying a broader variety of plant species, which have potential as major food sources, and for developing these for more efficient food production in our world economy.

An important nutritional quality at grain is its protein (15%) with perfect amino acid balance (Lysine 5%) which is higher than in cereals (Raju, 1990). It is also rich in minerals like iron, calcium and phosphorus and can be used for supplementing the diet to obtain a nutritionally rich food.

HISTORY

Existence of grain amaranth was at least 6000 years ago in Central America. The oldest seeds found are those of Amaranthus cruentus. Another species,*A hypochondriacus*, was in use by at least 1500 years ago, and later became the species used by the Aztecs. Although the earliest seeds of *A.cruentus* and *A.hypochondriacus* were both found in caves at Tehuacan, Mexico. Sauer observes they could easily have been domesticated far away, and possibly much earlier than those finds indicate. The origin of the grain-type species, *A.caudatus*,is not well understood, but Sauer believes the species was first grown as a grain in the Andean mountain valleys of South America. Amaranth was used as a grain over a wide region, from at least the southwestern U.S., down through Central and South America to Argentina. Amaranth may have had some use as a grain by Native Americans in other parts of the U.S. Although there is no recorded history of its

use, *A.hypochondriacus* seeds found in the Ozarks of the south central U.S. have been dated to 1100AD.

The most significant historical use of amaranth as a grain crop was in central Mexico during the Aztec civilization (the Aztec name for amaranth was huahtli).Amaranth was both an important food grain for the Aztecs, and a part of their religious practices. Annual grain tributes of amaranth to the Aztec emperor were roughly equal to corn tributes .The reasons for decline in amaranth production following Spanish conquest of the Aztecs in the 1500s are not well understood. Amaranth was significantly used in Aztec religious ceremonies, and some have speculated that the Spanish conquistadors discouraged production of amaranth as part of their overall efforts to suppress the Aztec culture and religion.

Although the production of amaranth in Latin America diminished dramatically subsequent to Spanish rule, the positive attributes of the crop led its adoption in other areas of the world. By the 1700s, amaranth had spread throughout Europe for use as a herb and ornamental. In the late 1800s, amaranth was reportedly being grown in mountain valleys of Nepal and parts of east Africa. During the 20th century it has been grown in China, India, Africa, and Europe, as well as North and South America.

Although the U.S. has been the leading producer of grain amaranth used in retail food products, the largest production area in the last decade is believed to have been in China (the Chinese amaranth production is reportedly based on cultivars developed by the Rodale Research Center in Pennsylvania). The main Chinese use of amaranth is reportedly to feed the forage to hogs, rather than harvesting the grain.

CROP MANAGEMENT

CULTIVATION

Grain amaranths are broad leaf plants with small seeds. The plant is branched to unbranched, leaf and stem colour range from red to green, with multitude of intermediate, and seed colour range from black to white. It is observed that amaranth plants have the highest plasticity for morphological traits. Branching of stem and inflorescence are highly affected by plant density.

GRAIN SPECIES

There are three species of amaranth cultivated in India. They are A.hypochondriacus, *A. caudatus* and rarely *A. cruentus*. In the hills *A. hypochondriacus* is more productive than the other two species.

ENVIRONMENTAL ADAPTATION OF THE CROP

Amaranths are cultivated in environments ranging from the two semi arid lands from sea levels to high Himalayas. Generally cultivated with in 30° latitude of the equator. Most grain amaranths have been concentrated in high land valleys, such as Sierra Madre, Andes and Himalayas. Ecotypes also evolved to that tolerate alkaline sandy soils with pH as high as 8.5 as well as the acidic clays of the hills

PHYSIOLOGY

Grain amaranth assumes special significance like Sorghum, maize and sugar cane. The C4 pathway is particularly efficient at high temperature, in bright sunlight and under dry conditions. Sutarno (1984) reported that the *A. cruantus* plants were grown at NaCl concentrations of 0-3000ppm. Plant height , the number of leaves /plant dry weight were significantly increased at 500-1500ppm, NaCl but at 3000ppm high mortality occurred. Flowering date was unaffected by the treatments. Harley and Ehleringer (1987) reported that the three species of the C_4 genus Amaranthus , *i.e. A.cruentus*, *A hypochondriacus* , *A caudatus* showed same response of CO_2 assimilation to leaf temperature, measured at high quantum flux, each exhibiting a temperature optimum of approximate 37°C. All three species had net photosynthesis C_i responses typical of C_4 species , with a steep initial linear response to C_i followed by a fairly abrupt transition to saturation in the region of 100-150/litre.

DAY LENGTH

Some of the grain species of amaranth are sensitive to day length. Some strains of *A.hypochondriacus* will not set flower in summer, however, they do mature in the green house during short day conditions of winter. *A.cruentus* remain vegetative for a long period in equatorial house. However it goes to seed very early when introduced into the long -day conditions. A.caudatus thrives well in high hills and is known to be a short -day species. The leaf area, number of branches, chlorophyll content increases with increase in light (Eze,1987).

ALTITUDE

For cultivation of grain amaranth elevation is not a severe limitation. Amaranth grows satisfactorily from sea level to above 3000m, but only *A.caudatus* is known to thrive at altitude 3000m in Andean region and Himalayas.

TEMPARATURE

It grows best when the daily temperature is at least 21^0C.Various accessions have shown optimal germination at temperature varying between 16^0C and 35^0C.The speed of emergence increased at upper end of the range. The grain species *A.hypochondriacus* and *A.cruentus* tolerate high temperature and they are not frost hardy. *A.caudatus* being a native to Andes and high Himalayas is more resistant to chilling than the other two grain species. Growth of the plant cease at about 8^0C and the plants are injured below 4^0C Field emergence may satisfactory with soil temperature between 18.5 ^{0} C and 24 ^{0}C (Weil and Belmont,1987)

SOIL AND FERTILIZER

Field observations indicate that amaranth grows well on soil containing widely varying levels of nutrients. Initial studies in Pennsylvania shows that young grain amaranth plants grow taller with fertilizer, but these grain yields has thus shown far little improvement. Grain amaranth require well drained sites and appears to prefer neutral or basic soils. A modified mass selection programme was used by Campbell and Foy(1987) to screen four grain amaranth population for tolerance to Al in pH 4.8 Tatum soil. Result indicated that all four populations were quite intolerant of high levels of Al and that further breeding is required before adequate levels of Al tolerance can be reached

An experiment was conducted in Sangla, Kinnaur, and Himachal Pradesh, India during the summer seasons of 2000 and 2001 to study the effects of phosphorus and potassium fertilizer rate (20, 40 or 60 kg/ha each) on the performance of amaranth (*A. hypochondriacus* cv. Annapurna). Plant height, inflorescence length, rachis per inflorescence, and yield increased significantly with the increase in the rate o f P_2O_5 up to 40 kg/ha.

Yield and yield attributes decreased significantly at 60 kg P_2O_5 /ha over 40 kg P_2O_5 /ha. Amaranth responded to K_2O application up to 40 kg/ha. Maximum grain yield (2414.8 kg/ha), net returns (29091 rupees/ha) and benefit cost ratio (1.73 rupees) were obtained with 40 kg/ha each of P_2O_5 and K_2O. The optimum rates of P_2O_5 and K_2O

were 42.8 and 39.7 kg/ha, respectively.(Rana and Ramaswar,2003).Under hilly condition in India NPK at the rate of 20:30:20 kg /ha meet the full requirements of the crop.

RAINFALL

For seeds to germinate and establish roots, amaranths require well moistened soil, but once seedlings are established, grain amaranths do well with limited water: infact, they grow best under dry , warm conditions. Grain amaranths have been grown in dry land agriculture in areas receiving as little as 200mm of annual precipitation, and, at the other extreme, vegetable amaranths are routinely grown in areas receiving 3,000mm of annual rainfall.

PREPARATION OF FIELDS

The field must be well leveled and two to three ploughing are sufficient for sowing of amaranth seed Before sowing application of 50 quintals of farmyard manure per hectare has given very good result in yield.

SOWING TIME AND SEED RATE

The crop is generally sown in the first or second week of June just after the first monsoon shower Traditionally, the seeds are broadcasted but better crop stand is achieved if seeding is done in rows The depth of sowing should be less than 2cm in view of very small grains, with 50cm spacing between rows and 20cm between plants A seed rate of 1-1 5 kg/ha is used for good grain yield. In order to standardize the optimum time for sowing of seed in the hills for obtaining highest seed yield, a randomized block design trial with four sowing dates with an interval of 15 days was conducted.

Highest grain yield of 16 1 q/ha obtained when sowing was done on the first date of sowing and least was recorded on the last date of sowing. The reason for low yield levels in this trial was due to heavy lodging and seed shattering. The delayed sowing reduced the plant height, inflorescence length and spikelet number per plant. It also induced tenderness to the plants Early caused a big stem borer problem as compared to late sown plants which were completely free from this disease (Joshi,1986)

INTERCULTURE

Seed germinates within 4 to 5 days after sowing and needs maximum care till it attains a height of about 25-30cm.In fact this is the most critical stage for obtaining maximum yield potential of the crop. During this phase, it must be properly spaced, made free from weeds and must receive adequate moisture. One more weeding is necessary after 30 days of sowing. At the seedling stage one spray of fungicides to check the attack of damping off is necessary at the seedling stage. Once the stand is established , maintenance is relatively easy. The broad leaves and erect habit quickly create a close canopy, making under strong weeds only a minor problem.

Mixed cropping with legumes was found to increase the yield of amaranth. Under mixed cropping legumes not only supplied the nitrogenous fertilizer to the amaranth plants but also held them by twining and avoiding lodging which is a serious problems in the hills.

HARVESTING AND CLEANING OF SEEDS

Amaranth grains mature much earlier and the plant dries up quite late. If the heads are allowed to remain till the plant dry up, heavy shattering of grains is noticed which leads to heavy grain loss. The heads are cut when the plant is still somewhat green and start weathering and kept for sun drying for 6-7 days in the threshing yard. Threshing is done by beating. The produce is threshed and winnowed like other cereals. Usually the harvesting is done early in the morning when the plants are somewhat wet due to night dew to avoid grain shattering in cutting heads.

CROP PROTECTION

Hymenia recurvalis and other catter pillars are serious pests of amaranth. *Cletus sp Lygus lineolaris* bug, *Trichoplusiani* ,a weevil *Conotrachelus seniculus* . Spinach flea beetle ,Lygus bug . Tarnished plant bug, are presently considered to be the most important insect pests of grain amaranth .Lygus bugs are cosmopolitan pests. They feed on hundreds of plant species .Lygus bug damage grain amaranth by feeding on the meristamatic tissue, developing floral buds, immature blossoms, and developing embryos. This feeding causes localized wilting and tissue necrosis, abscission of fruits, morphological deformation of fruit and seed, and altered vegetative growth have severely damaged grain amaranth yields by piercing the developing plant parts and sucking out the juices. Stem borer is another problems in Africa and in Asia in early

sown plants, which causes high degree of lodging in plants. Seedbeds should be guarded against ants and termites. Root knot nematodes, a serious pest of Celosia also slightly affects Amaranthus species.

Soil fungus, damping off, leaf blight, white rust and mycoplasma and virus have been identified as the serious diseases of grain amaranth in India. Reddy *etal.*(1980)reported causal organism *Xanthomonas amaranthicola* a bacterial leaf spot disease of Amaranths in India. A severe mosaic disease caused by a strain of cucumber mosaic virus in *Amaranthus caudatus* was reported in Himachal Pradesh by Chowfla and Sharma (1987) damaging the crop. The other virus affecting the crop are Ivy Vein clearing virus, alfalfa mosaic virus and beet western yellow virus.

This station *S. kumaoensis* was recorded during 2001 and 2002 on grain amaranth (Amaranthus sp.) in an experimental farm in Kinnaur (Himachal Pradesh, India) and adjoining fields. The pest appeared on the second and third week of June on beans then shifted to the grain amaranth crop. Infestation on grain amaranth ranged from 25 to 40% in both years. The adult weevils caused damage on emerging seedlings, young and tender leaves, and growing points, thus, hindering plant growth. The larvae fed on internal root tissues and underground stem portions. Complete defoliation of seedlings was observed in the case of severe infestation. (Pankaj.2004)

CROP IMPROVEMENT

GERMPLASM COLLECTION , BREEDING AND RESEARCH CENTERS

There are presently three points for amaranth germplasm collection, breeding and research centers.

1 USA Rodale organic gardening and farming research center, Kutztown and the National Seed Storage Laboratory, Fort Collins Colorado, USA.

2 Nigeria National Horticultural Research Institute and other institutions at Ibadon.

3 India National bureau of Plant Genetic Resources, New Delhi and TamilNadu Agricultural University, Coimbatore, Kerala Agricultural University, Thrissur.

In India ,where both grain and vegetable amaranths are of great importance, a large collection has been gathered by the National Bureau of Plant Genetic Resources(NBPGR).The collection is kept at the hill station at Shimla and at Akola. It comprises about 1,400 accessions, 1000 of which are grain amaranths

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PLANT IMPROVEMENT

The high genetic diversity in the amaranth family offers opportunities for increasing desirable characteristics, such as yield, protein content, height, and resistant to pests and disease. The fact that most of the seed volume is occupied by the embryo might account for the unusually high lysine content, this provides a good opportunity for the development of varieties of even higher nutritional quality. Selection of plant varieties with large and non shattering seeds, as well as the development of harvesting and processing methods adapted to the seeds characteristics, would improve processing of grain amaranth

TAXONOMY

Amaranth belongs to the genus amaranthus and family *amaranthaceae* The genus amaranthus has got two section i.e .Amaranthus and Blitopsis. Most of the grain amaranth type comes under amaranthus with dibasic chromosome number, terminal panicles and pentamerous flowers.

Grain amaranth types normally fall with in three promising species viz. *Amaranthus caudatus, Amaranthus hypochondriacus, Amaranthus cruentus*.(Devadas and Mallika 1987) developed a simplified key for the identification of the different species Inflorescence of *A hypochondriacus* is stiff, *A.cruentus* is moderately stiff and *A caudatus* is smooth & drooping type

VARIETIES

A high yielding variety of grain amaranth named "Annapurna" has been developed by the NBPGR Regional Station Shimla after screening germplasm of 2700 collections studied at this station (Joshi,1985) This variety has been recommended for cultivation in the mountain regions of Himalayas. It's average grain yield is 22q/ha.The distinguishing characters of this variety are given as under. The plant is tall, medium late maturing with dark green broad leaves.

The inflorescence colour is yellowish green with long compact terminal and lateral spikelets. The seed shape is medium bold , round bulging at center and tapering at periphery. Seed colour is creamish white. The popping quality of seed is excellent and the grains pop about 6 times to its seed size. The varieties of grain amaranths are R104, 20 USA, Jumla, VL-21 and S.K. Nagar , Plainsman recently developed for cultivation in different parts of the World.

In order to standardize the optimum time for sowing of seed in the hills for obtaining highest yield, randomized block design was used. All the species exhibited high rate of CO_2 assimilation. Leaf conductance to water vapour declined with decreasing quantum flux in all species, but less rapidly than assimilation, resulting in increasing values of internal co_2 concentration. Under near optimum measurement conditions and high quantum flux, all species maintained C1 values close to the region at which saturation was reached.

ECONOMIC USAGES

DOMESTIC USES

The nutritive value of grain amaranth with regard to protein , amino acid, mineral contents, vitamin and food energy is superior to other conventional cereal crops. It is a multipurpose crop.The tender green leaves used as vegetables. The tender stem of amaranth is used as drum stick in making curry. In the hills grains are used in different culinary preparations, white grains are popped and mixed with milk and sugar, popped grains in the form of sweet puddings, white grains mixed with maize and finger millet flour for making chapattis

Popped grains are mixed with sugar syrup to make sweet balls, in North India popped grains mixed with honey to make flat round breadings, soaked and grinded seeds mixed with wheat and finger millet flour and salt and spices to make delicious paratha and very crisp pakoras are also made of amaranth flour. The black seed is used as cattle feed The green vegetable is considered as purgative.

ETHNOBOTANY

The grain amaranths are grown on the border of maize fields in Solan and Bilaspur districts of Himachal Pradesh to ward off bird damaging maize cob. The dried stems are used as fuel and considered to break rock boulders easily with its smoke when burnt In Kumaon hills local people consider that the grains help in curing measles in children when they sleep over the spreaded grains of amaranths on the bed. It is also considered as an effective cure for snake bite.

In Himachal Pradesh it is considered that the decoction of grains is very useful and effective in treatment of foot and mouth diseases of animals , it's excessive feeding causes some mouth ailments to cattle. Natives of the Americas dried the flowers for tea and used them for contraception and excessive menses. The leaves are boiled and used as a compress for swellings and sprains. The leaves were steeped to make a tea for

stomach upset. Local applications of infusion used as gargle for mouth and throat irritations, lowers blood pressure, aids in elimination. Tincture is applied externally to sores and ulcers. Decoction used for leucorrhea as a douche, and as an enema for rectal bleeding .In certain areas of Himachal Pradesh the grain stocks are used for meat and apple fruit preservation for 4-6 months and they say that meat remain fresh for one and half month and become more tasty whereas apple remain farm fresh for 4-6 months when merged in grain bins of amaranths. In the ancient times the tribal mountain dwellers used grain amaranth stock as a reserve food and they are still farmers in these areas who have 50 year seeds with them. The seed quality and popping do not deteriorate with aging and no pests has been in the seed under such prolonged storing. In Tamilnadu and Kerala hills , the tribe use stem and leave juices of grain amaranths in the treatment of kidney stones (Parker, 1986).

AGROINDUSTRIAL USES

Grain amaranth assumes more nutritional significance as a fancy food crop for elaborating different industrial products like bread , pastry, biscuits , flakes , crackers, ice-cream and in elaborating lysine rich baby foods. The toasted seed flour mixed with wheat in a 1:9 ratio gave bread of food quality as compared to one of 100% wheat Amaranth meal or flour must be blended with wheat meal or meat flour because it lacks functional gluten Sanchez (1983) has given detail agro-industrial uses of gram amaranth

The new food products , Amarlac and Amarameal of high nutritional quality were recently released in Guatemala by the Amaranth food company represent the first output of several years of research to processing and utilization of amaranth grains and converted into high quality human food particularly for young children and pregnant women. Grain amaranth germ and bran contain 20% oil which can be exploited as edible oil The starch that make up the bulk of amaranth flour has extremely small granules a unique dodecahedral structure, and high water absorption capacity. It is likely to prove useful for application in the food , high quality plastics, cosmetics and other industries.

The other new uses of amaranth are natural dyes, pharmaceuticals and squalene ,a high priced material found in amaranth grain but normally obtained from shark livers and used in cosmetics. The amaranths which has got ornamental value may be due to the presence of showy inflorescence and variegated leaves. The amaranth foliage

is edible with biological value comparable and even superior to common vegetables of popular consumption, consisting of less oxalates and nitrates. Therefore it can be recommended as an important food for human nutrition. In mineral content iron, calcium , phosphorus, amaranth green rank at the top. Eighty two percent of India's population live in rural areas. These are primarily engaged in agricultural pursuits, low cost cereals and vegetables form the major constituents of their diet. Dark green leaves , which are in-expensive, are rich sources of several nutrients calcium, iron, carotene, riboflavin ,folic acid, and ascorbic acid , all of which are essential for growth and maintenance of normal health.

The availability studies of iron and β-carotene from amaranth indicate that these are excellent sources of iron and β-carotene. Daily inclusion of amaranth in the diet of children can helps to alleviate their iron and vitamin A deficiencies which cause blindness in thousands of children each year. Besides , it is an excellent source of folic acid which helps to increase the blood hemoglobin level .The hypocholesterolaemic effect of amaranth grain, oil and squalene are examined. In experiment 1, rats are given a semi-purified diet containing 1% (w/w) cholesterol for four weeks and either amaranth grain (AG; 300 g/kg) or amaranth oil (AO; 90 g/kg) substituted in experimental groups. Both AG and AO lowered serum and hepatic cholesterol and triglyceride levels

Faecal excretion of cholesterol and bile acid in the AO group increased, while AG affected only bile acid excretion. In experiment 2, rats were fed the cholesterol diet for four weeks and injected (i.p.) with saline (control), amaranth squalene (AS) or shark liver squalene (SS, 200 mg/kg) for seven days. The hypolipidaemic effects of AS were evident in both serum and liver

In addition, AS markedly increased faecal excretions of cholesterol and bile acid, and slightly inhibited 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase activity. In contrast, none of these effects were observed in the SS group. This preliminary study suggests that the cholesterol-lowering effect of AS may be mediated by increased faecal elimination of steroids through interference with cholesterol absorption, and that different sources of squalene (plant versus animal) may affect cholesterol metabolism differently. (Shin et al,2004)

The wheat and maize flour mills in India can enrich the flour quality of both the cereals by mixing 20% amaranth grains to increase the lysine content in

chapattis and other food products. A future promise of amaranth is the development of leaf protein concentrates. These will be specially useful for young children. Weaning foods (24 mixtures) were prepared in India with 3 main ingredients: the cereal (malted wheat, raw milled rice, puffed rice or rice flakes); grain amaranth (roasted, malted or puffed); dried green leafy vegetable (spinach or drumstick leaves (*Moringa oleifera*)). Mixtures based on malted wheat provided most energy, protein and retinol. The rice-based mixtures provided less protein, although addition of powdered milk improved protein content. Mixtures with spinach provided more iron and retinol than did those with drumstick leaves. Intake and acceptability trials were made with 25 children 6 to 18 months old of the mixtures from each of the 4 cereal groups which were found to be most acceptable in sensory evaluation trials. Of the mothers 76 to 85% reported that the mixtures were accepted by their children. There were significant increases ($P<0.01$) in all nutrient intakes during the trial with the increase in energy, Fe and retinol greater than that for protein and calcium Mean intake of mixtures was from 58 to 78 g daily. Amaranth leaves contain high amount of protein. The fibrous pulp left after extracting the amaranth green is suitable food for animals.

One control and 13 experimental diets were prepared with different levels of raw and popped amaranth and red palm oil (India). Feed intake increased by 43.46% in the control group, as against an increase of only 5.17-30.74% in all experimental groups. Hatchability in experimental eggs was 94.3% (average of all experimental groups) compared to 88.4% in the control eggs. Though best results were obtained by feeding 50% popped amaranth, singly and in combination with 4 and 6% red palm oil (RPO), and with 6% RPO alone, the use of 6% RPO alone was the most practical in obtaining value added eggs (Anurag et al,2004)

BIOCHEMICAL EVALUATION

Grain amaranth began attracting increased research attention in 1973 when John Dowten an Australian plant physiologist found that the seed contain protein of unusual quality. It is high in the amino acid lysine with a protein content of about 16%.The seeds contain higher levels of protein ,lysine and oil than the cereal grains but less leucine. Levels of protein and lysine are high in leaves suggesting that it may be valuable as a forage crop.

The protein content of different varieties ranged from 14.5 to 19% on dry weight basis. One variety of *A.hypochondriacus* NGLKO/OP-1 and one from IARI, IC-35380

had the highest protein value of 17.5 and 17.9% respectively. Amaranth germ , for example contain as much as 30% protein. It also contain about 20% edible oil but no attempts have made to extract this oil. The fat content of all varieties , except TLKO-15, was relatively more than that of commonly consumed cereals. Because of this energy content of the grains was also relatively higher. The calcium content ranged from 193-389 mg/100g *A.cruentus* had the highest calcium content (389mg /100g).These values were significantly more than those usually found for cereal grains. On the other hand , the nicotinic acid values of all samples tested were significantly lower than that of most cereal grains. Despite such low content of niacin equivalents were, however, satisfactory. In phosphorus and iron content grain amaranths are superior to others common cereals.

Crops	Protein	Fat	Carbohydrate	Calcium	Phosphorus	Iron
Amaranth	16.0	3.1	60.0	0.49	0.60	17.5
Rye	12 1	1 7	73.4	0.38	0.37	10.5
Buckwheat	11 7	2 4	72.9	0.12	0.28	15.5
Chenopodium	12 0	5 0	68.0	0.20	0.50	12.6
Wheat	13 3	2 0	71 0	0.41	0.37	10.5
Maize	9 2	3 9	73 7	0.20	0.25	3 5
Rice	7 0	1 0	78 0	0.20	0.18	3 5

Cereals are considered unbalanced in terms of amino acid composition because generally they lack sufficient amounts of lysine for optimum health. Amaranth protein, however, has nearly twice the lysine content than that of wheat protein , three times that of maize, and in fact as much as found in milk the standard nutritional excellence. The protein of maize , wheat and rice are deficient in the essential amino acids. Amaranth is rich in both lysine and sulphur containing amino acids.

In addition, the amino acid composition of amaranth protein corresponds more closely to that of the FAO/WHO recommended proteins standard and for optimum nutrition. The essential amino acids viz threonine, isoleucine, valine and leucine are found in amaranth grains at levels less than those in the FAO/WHO standard , but these are found in adequate amounts in the more conventional grain.

When amaranth grains combined with the more common grains can provide a protein, which very closely approximates the FAO/WHO standard protein. Protein efficiency ratio have ranged from 1.5 to 2.0 for cooked grain, and it's total digestibility is about 90 per cent. Amaranth protein, at a biological value of 75, comes closer than any other grain protein to the perfect balance of essential amino acids, which theoretically would score 100 on the nutritionists scale of protein quality based on amino acid composition.

The antinutritive factors, such as saponine, trypsine inhibitors, and tannins, do occur in grain amaranths but at levels similar to those in legumes or in some other grains viz Sorghum.

Varieties of amaranth species, which have white, brown and black seed coats were studied by (Sauer. 1980). The tannin contents of white seeds were similar, whatever the colour, though tannins were present in brown and black seed coats, but not in white ones. The tannins in the seed coat occurred mainly in the "stalactiti" structures of the parenchyma of the exotesta. White and brown testae were thinner than black ones and the stalactities in them were smaller.

In two wild and four cultivated forms of A hypochondriacus no relationship was found between cultivated or wild status and protein or amino acid contents of the seeds. The black seeded forms AG 16 contained the most protein followed by cultivated AG 21.AG 21 and cultivated AG 24 contained the most lysine. Lysine content of protein was correlated positively with contents of six other amino acids and negatively with contents of seven. AG 16 and AG 21 appears promising for use in improving protein and essential amino acid contents (Misra *et al.*1983).

Amaranth seeds are very small (1000 seed weight 0.42 to 1.21 grams).The starch that makes up the bulk of amaranth flour has extremely small granules, a unique do decahedral structure , and high water absorption capacity. It is likely to prove useful for applications in the food, plastics, cosmetics, and other industries.

NUTRITIONAL QUALITY OF AMARANTH LEAVES

Grain amaranths are dual-purpose crops. The foliage is edible with biological value comparable even superior to common vegetables of popular consumption, consisting of less nitrate and oxalates (Der Marderosian et al., 1980). Therefore it can be recommended as an important food for human, nutrition. Devadas and Saroja (1979) reported that in mineral content, notably iron and calcium, amaranth green rank at the

top as against other pot herbs. Eighty two per cent of India's population lives in rural areas. These are primarily engaged in agricultural pursuits. Low cost of cereals and vegetables form the major constituents of their diet. Dark green leaves, which are in expensive, are rich sourse of several nutrients; calcium. Iron, carotene, riboflavin, folic acid and ascorbic acid, all of which are essential for growth and maintenance of normal health.

The availability studies of iron and ß carotene from amaranth indicate that Amaranthus species are excellent sources of iron and ß carotene. Daily inclusion of amaranth in the diet of children each year. Besides it is an excellent source of folic acid which helps to increase the blood haemoglobin level.

Amaranth leaf protein highly extractable as compared to other species. Heating or treating the extract with acid precipitates the nutrients as leaf protein concentrates. In the process, most of the harmful compounds are eliminated, as they remain in soluble phase. The fibrous pulp left after extracting these amaranth greens is suitable food for animals (Carlasson, 1982)

The nutritional value of amaranth green is similar to that of other leafy vegetables. High level of protein and critical amino acids lysine and methionine have found in green amaranth leaves. Amaranth leaves are important source of vitamin, especially vitamin A, the lack of which results in a most serious nutritional deficiency in tropics and leads to blindness in thousand of children each year. The high amount of protein in the leaves is a most profitable proposition for developing leaf protein isolates. Oxalic acid and other anti nutritional factors like saponins are found in amaranths nontoxic, because the oxalic acid dissolves in the water. Amaranth green vegetable is excellent in organoleptic taste

FUTURE RESEARCH NEEDS

A comprehensive germplasm collection of these under-utilized food plants is the only adequate way of maintaining genes for future breeding needs. In order to buildup and broaden the existing genetic base, it is important to extensively explore as much of the known areas of cultivation as possible. So far we have collected 3000 accessions in grain amaranths and our ultimate target is 6000 collections, which will represent the entire range of variability in the crop on global perspective. There is need to have finer grid collection for locating genes for early maturity, dwarf types, bold seeded and non-shattering and non-lodging types from Himachal Pradesh, Jammu and

Kashmir, Uttarkhand, North eastern region, Gujarat, Maharashtra, Madhya pradesh, North Bihar and Southern Indian hills which are our high priorities areas for collection in India.

Since exotic material of grain amaranths, in our germplasm is poorly represented, there is need to enrich representative variability from Peru, Bolivia, Ecuador, Guatemala, Mexico, Argentina, Ethiopia, Nigeria, Sierra Leone, China, Nepal and Bhutan. There is also need to buildup all the 50 known species of the genus *Amaranthus* from different sources because our germplasm represents only 10 species of the genus, at present.

Grain amaranths are highly nutritious, studies on the quality parameters such as spectrum of essential amino acids are very important. Till regular breeding work in this crop is initiated, selection and standardization of uniform high yielding lines for multilocation yield evaluation is essential to select types having wider adaptability in the hills. Correlation, genetic divergence, adaptability, inheritance and combining ability studies are other essential areas where due attention could be paid for varietal improvement in grain amaranths.

There is need to increase grain size which is a major productivity constraint, by increasing the ploidy levels through colchicines treatment to have auto-tetraploids. Apart from the morphological evaluation, which has been extensively carried out, there is a need to study and screen the germplasm for protein electrophoresis to determine the real genetic variability by way of isoenzyme analysis as a potential genetic markers to discard the redundants in the germplasm holdings.

Since the crop is highly drought resistant and cold tolerant, there is also a need to study all the three mechanisms involved in drought resistance i.e., drought avoidance, water conservation and tolerance of dehydration.

There is need to develop an international cooperative net work to test the elite lines and germplasm of amaranth in as many locations as possible under different agro-climatic conditions.

The varieties selected for adaptability trials should include a range of species and morphological types that have agronomic potential. This would be an excellent way to obtain indications of the geographical areas where given types will grow best. It would be the first step towards developing 'zones' for amaranth adaptability, similar to those used for cereal crops.

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Studies of the way the people grow and use grain amaranths in Central and South America and the Himalayas, as well as those methods employed to grow and use vegetable amaranths elsewhere, could prove informative and fruitful for further improving this crop. Data could not gathered about the most favorable environments under which various species can be grown profitably. Still more useful information could be collected by documenting the rainfall, temperature, day length, soil conditions of these areas. This would help in permitting better targeting to new areas. Lesser known uses, soil requirements, crop ecology and soil aspects need further exploitation. Although such studies would benefit those wanting to grow amaranth for the first time, it will also assist people, who traditionally cultivate the crops.

Collection of weedy related species will be still more important which will be useful to the amaranth breeders in transferring desirable genes in the cultivated forms. Grain amaranth has luxuriant growth under natural conditions because it requires least chemical fertilizers spray schedules and water as compared to cereal and other crops. Therefore, it is most appropriate crop for sustainable agriculture. It could also serve as a plant of soil and water conservation because of its enormous root system. It is characterized by its high nutritive value, drought and saline alkali tolerance as well as heat and cold tolerance. The major attributes of grain include: high protein (13-19%), high levels of lysine, complementary amino acid profiles as it raised the amino acid scores of sorghum, maize, rice and wheat, unique microcrystalline starch granules (1-3 microns in diameter). Suggested applications are: a talc replacement, an aerosol carrier for cosmetics, and a dusting compound for baking breads, tiny starch granules may be useful in biodegradable plastics. 5-8% of its seed oil is a component called squalene which is otherwise extracted from whale and shark liver oil, squalene is an important ingredient in skill cosmetics and penetrants (like Preparation H) as well as computer disc lubricants, high levels of non-fermentable fibers suggest that amaranth grain may lower serum cholesterol without increasing the risk of colon cancer, the discovery in amaranth of vitamin E isomers, which are known to inhibit cholesterol biosynthesis, may be related to its hypocholesterolemic properties and is a multidimensional crop for the producer as a potential forage, silage, green manure, and animal feed. Thus grain amaranth is a crop for both food and forage. The protein, lysine, unsaturated fatty acids, and amylopectin could be extracted from grain amaranth. The pigments (such as amaranthin) could be extracted from it and used in the beverage industry. Many important genes such as genes responsible for high nutritive value, the pest resistance

genes, drought resistance gene, herbicide (atrazine) resistance gene, gene controlling high photosynthesis rate, etc. could be extracted, cloned and transformed from grain amaranth to common crops such as wheat, rice, corn etc.

It is important to develop farm machinery for planting implements, thresher, winnowers and grain cleaners etc.

The germ and bran of grain amaranth contains about 20% oil, there is need to study and screening the germplasm for exploiting it for edible oil use.

The growers of these crops in the remote mountain areas need to be encouraged to cultivate these crops by giving subsidy for *in situ* conservation so that further evolution may take place at the real centre of cultivation and diversity apart from *ex situ* conservation.

It is essential to ensure that intensive production programmes, similar to those in cereals, also required to be organized for grain amaranth, too, so that the mountain agriculture of the Himalayas shows a balanced growth and the food needs of the mountain people can be supplemented in terms of balanced nutrition.

It is essential to develop short duration varieties required for double cropping and to fit in crop rotation in largely rainfed terrains of the hills to increase crop production

It will be of paramount significance if the wheat and maize flour mills in India can enrich the flour quality of both the cereals by mixing 20% amaranth grains to increase lysine content in the *chapattes* and other food products.

In the scentific gathering on grain amaranths, the participation of Government/private organizations involved in standardization and production of various agro-industrial food products is essential to take advantage of these under-utilized but nutritionally rich food plants in elaboration of different food products like bread, pastry, cake, biscuit, flake, cracker, ice-cream and lysine rich baby foods to raise the standard of living.

In order to diversify the present narrow food base, there is a burning need to create greater awareness about the high nutritive value, excellent organoleptic taste of both grain and green leaf of amaranthus among consumers and its increased use, in general, diet can make a significant contribution to the nation's physical and mental health. The crop needs a back up from the media people for its quick dessimination and adoption for the sustained well-being of the mountain people.

CONCLUSION

The current status of amaranth is a crop which has great potential , a variety of possible uses, and a decade –plus of research behind it. However, as with most alternative crops, cultivar improvements are needed, production and utilization research challenges remain, and major barriers exit in market development. More specifically, further breeding should improve seedling vigor, reduce lodging and seed shatter, improve ease of harvesting, and improve yield. Insect pest need to be better understood, and control methods developed. Likewise, disease symptoms and preventions are poorly understood with amaranth. Although information on amaranth response to basic management practices had been developed. From a utilization stand point, a fair amount has been learned about general amaranth grain characteristics .However, the response of factors such as grain protein to management and environment is only partially understood

Also, specific high value uses of amaranth, such as the starch fraction, merit additional investigation. Markets remain relatively small and underdeveloped, in part because there is a general lack of familiarity with amaranth in the public and private sector. To achieve a higher level of market penetration , amaranth will have to become more publicized, prices will have to fall, and availability will have to be increased

On the positive side, amaranth is widely adapted, tolerant of dry conditions, and diverse germplasm is available for breeding to improve the crop. Amaranth has relatively good yield potential for a high protein grain crop, especially considering lack of breeding with the crop

It can be grown successfully with conventional grain crop equipment, usually with only minor modifications, and has a production cost comparable to other grain crops. The colourful appearance of the crop and its colourful history continue to generate interest in this crop, and its good nutritional characteristics combined with its variety of potential uses illustrates the importance of continued work with this "rediscovered" crop

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DISCUSSION

1) Which is more palatable - vegetable or grain amaranth leaves?

   Grain amaranth leaves are less palatable than vegetable type because it is having hairs on leaves and it is fibrous in nature.

2) What is the NPV ratio of grain amaranth?

   NPV ratio is more than one because it has got low cost of production per unit area.

3) Is there any disadvantage in leaf harvest in grain amaranth?

   Grain yield will reduce but it can be compensated by additional income that is getting from leaf harvest.

4) Why there is no pests and disease in grain type compared to vegetable type?

   The plant is robust, fibrous and hairy in nature, which resists the pest attack.

5) Which country is the leading producer of grain amaranth?

   China

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ABSTRACT

In the developing world, the painful fact is that around 192 million children and 2000 million others experience micronutrient deficiencies, particularly the pregnant women, leading to infant mortality.

Food based strategy to combat malnutrition prevalent among the volunerable segments of the population involves identification of optimal good sources of nutrients and ensuring their availability. Grain amaranth is a unique, nutritionally rich non cereal crop capable of combating malnutrition. Amaranth grains are reported to be a good source of high quality protein (15%) with perfect aminoacid balance (lysine - 5%) which is higher than in cereals. It is also rich in minerals like iron, calcium and phosphorus and can be used for supplementing the diet to obtain a nutritionally rich food

In Kerala, grain amaranth is seen mainly in it's natural habitat with wide range of genetic diversity. It is a multipurpose crop where both leaf and grains are utilized. Grain amaranth types normally fall within three promising species viz. *A. hypochondriacus*, *A. caudatus* and *A. cruentus*. Mallika developed a simplified key for the identification of the different species. This crop has got wide applications in nutraceuticals, culinary preparations, therapeutic use etc. Processed grains can be utilized in breakfast items, bakeries and confectionaries.

Grain amaranth can be considered as a promising crop of the future from the nutritional point of view. Value addition in grain amaranth naturally increase it's consumption rate and popularity.

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EXPLOITATION OF HETEROSIS IN CUCURBITS

By
SMITHA SARA ABRAHAM
(2004-12-16)

SEMINAR REPORT

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requirement of the course
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DEPARTMENT OF VEGETABLE CROPS
COLLEGE OF HORTICULTURE
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CERTIFICATE

This is to certify that the seminar report titled **"EXPLOITATION OF HETEROSIS IN CUCURBITS"** has been solely prepared by Ms. Smitha Sara Abraham *(2004 – 12 – 16)*, under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

Vellanikkara
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DECLARATION

I, Smitha Sara Abraham, (2004 – 12 – 16) here by declare that this seminar report entitled **"EXPLOITATION OF HETEROSIS IN CUCURBITS"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports

Vellanikkara
Date

Smitha Sara Abraham
(2004 – 12– 16)

Introduction

Vegetables are defined as, those herbaceous plants of which some portion is eaten, either cooked or raw during the principal part of the meal, constitute an important part of our agricultural system. They are rich source of carbohydrates, proteins and fibres. Vegetables play an important role in our daily food intake from time immemorial. Among different vegetables, those belonging to cucurbitae family constitute largest number of cultivated vegetable crops. Even though they are more adapted to tropical conditions, their performance is fairly good in temperate conditions also. They assume importance not only as a source of food but their medicinal values are now greatly acknowledged in India and abroad. Both tender and mature fruits are consumed and relished equally.

Cucurubitae family consists of 90 genera and 750 species. These crops are cultivated throughout the world and most of them are Asiatic in origin. Cucurbits form an important group of vegetables grown during summer season in Kerala. They are used in culinary purpose in making sweets like petha. They are used as salads and juices. The outer rind of bottle gourd is used as utensil.

Some species of cucumis genus are among fast example of domesticated plants and evolution was greatly influenced by man (Whitaker, 1956). Allard (1960) in his classical book on plant breeding wrote that cucurbits although monoecious, do not suffer from inbreeding depression. So better F_1 can be produced. They have comparatively large flowers. They are of diverse sex forms. They may be monoecious, androecious, gynoecious etc. The male to female sex ratio is 15:1 - 30:1. So there is no need of emasculation by removal of pollen grains. The female flower is with slightly swollen pedicel and male flowers can be easily identified and removed by pinching. The cucurbit fruit is many seeded pepo. So by single fertilization many seedlings can be obtained. Several cases of heterosis for characters selected to yield and earliness have been reported in cucurbit family, especially in genus cucumis. In 1939, Curtis suggested production of hybrid squash by growing pollinator and female parents in violation and removing male flowers of seed parent by hand prior to anthesis.

In Kerala the productivity of vegetables in general is low which is considered as one of the reasons for shortages of vegetables in the state, which is far from requirement. About 40 different vegetable crops are grown in the state. However

high yielding varieties are very limited which can be attributed for the low productivity of vegetables. Cucurbits are no exception in which high yielding varieties can be developed very easily. We are also blessed with an appreciable variability existing in this crop in terms of fruit size, colour & yield.

Comparison of yield potential of hybrids

Yield of hybrids is almost double of that of high yielding variety. Even if we give better management, open pollinated variety cannot yield more than 25-35 t/ha (Kalloo and Panday, 2002).

Statistics of hybrid cultivation in India

India has an area of 6.09 million hectares under vegetable cultivation and a production of 84.81 million tones. During last decade there was an increase in cultivable area by 0.42%. But the increase in production was 79.0%(Rai and Pandey, 2004). This tremendous increase in production with meagre increase in area was achieved by development of hybrids. The area under F_1 hybrids was 5.9 lakh hectares. 42 hybrids were recommended under multilocation trials by AICVIP (All India Coordinated Vegetable Improvement Project).

The area of hybrid melons under cultivation is 0.2068 lakh hectares (4.02 %) and hybrid gourds is 0.1066 lakh hectares (2.44 %)

Definition

Heterosis is a phenomenon of increased or decreased vigour than both the parents due to the crossing of dissimilar gametes

History

The term heterosis was coined by Shull in 1914. The first hybrid was produced in cucurbits by Jones. Power (1944) suggested that the term heterosis should be used only when the hybrid

Bases of heterosis

There are mainly 4 bases of heterosis. They are.

1 **Genetic basis**. Dominance hypothesis and over dominance hypothesis are two important hypotheses of genetic basis

Dominance hypothesis: The Dominance hypothesis was proposed by Davenport in 1908. According to this hypothesis, the genes governing vigour are dominant and beneficial in nature. No epitasis is observed i.e. there is complete additivity of gene effects between loci. No linkage i.e. complete recombination between various loci

Over dominance hypothesis: The hypothesis was proposed by Shull and East in 1908. According to him, heterosis is a result of superiority of the heterozygous off springs over the homozygous parents. Superiority of offspring may be due to production of superior hybrid substance different from either of homozygous products. Greater buffering capacity in the heterozygous resulting from cumulative action of divergent alleles.

Physiological basis: The hypothesis was proposed by Ashlay in 1930. According to him the hybrid embryos would be able to mobilize stored food materials earlier than those of inbred due to a more efficient enzyme system. So heterotic hybrids usually have better initial embryo weight, seedling vigour and have greater capacity to synthesis growth promoting substances, utilize and assimilate more nutrients.

Molecular basis The hypothesis was proposed by Srivastava, 1983 states that the hybrids show increased DNA replication, translation, transcription and formation of surplus genetic information

Biochemical basis: According to this hypothesis, the growth of a plant may be limited by the genes that regulate certain metabolic pathways down to lower levels than maximum possible (Milborrow, 1998). Heterozygotes may partially escape this regulation because they have two slightly different alleles of these genes, allowing greater flow on these pathways

Types of heterosis

There are mainly three types of heterosis (Singh , 2004) They are,

1) **Relative heterosis** Relative heterosis is a condition in which the hybrid is superior over the mid-parent It is determined as,

$$\text{Relative heterosis} = \frac{F_1 - \text{mid parent}}{\text{mid parent}}$$

2) **Heterobeltiosis**: Heterobeltiosis is a condition in which the hybrid is superior over the better parent. It is determined as,

$$\text{Heterobeltiosis} = \frac{F_1 - \text{better parents}}{\text{better parent}}$$

3) **Standard heterosis** The Standard heterosis is a condition in which the hybrid is superior over the standard check variety It is determined as.

$$\text{Standard heterosis} = \frac{F_1 - \text{standard check}}{\text{standard check}}$$

Estimation of heterosis

The heterosis can be estimated in two ways (Singh and Choudhary,1976)

Diallel analysis The method is used for estimating general combining ability of parents and specific combining ability of hybrids. The parent plants are crossed in all possible combinations

Line x Tester analysis The method is used to estimate general combining ability by top cross method A tester plant with wide genetic base is selected. The method provides information about GCA and SCA of parents and crosses respectively. It estimates various types of gene effects. The method is superior over other methods.

Fixation of hybrid vigour

To ensure that heterotic gene combinations produced in heterotic hybrids remain intact in subsequent generations. Fixation of heterosis is done in three ways;

1) **Vegetative propagation**: The method is based on the effect of mitosis. Genotype of parent plant is transmitted to all its vegetative progeny. Vegetative propagation of F_1 and clonal progeny maintains heterotic gene combinations intact.
2) **Apomixis:** If F_1 produces only apomictic seeds with an embryo, F_2 and subsequent generation identified to F_2 genotype. Parental inbred should reproduce asexually to enable production of hybrid seed, while F_1 and subsequent generation produce only apomictic seeds. To achieve this discover apomixis controlled by two complementary genes. In such case each parent will contain dominant allele of a single complementary gene.
3) **Balanced lethal system**: Two recessive lethal genes are tightly in repulsion phase Eg l_1l_2 $4l_2$. In such situation only heterozygotes can survive. In several species balanced lethal system is associated with complex reciprocal translocation. So these species remain permanent hybrids even though they reproduce asexually. But balanced lethal system leads to ovule sterility. In such crops, vegetative propagation and apomixis are best methods. Now considerable effects are made to utilize heterosis.

Hybrid seed production

A good number of F_1 hybrids have been released in the country in cucurbitaceous vegetables and these have become popular among farmers. For the popularization of new variety, especially a hybrid cultivar, production of quality seeds and its extensive distribution at a reasonable price are prime importance. For this it is necessary to estimate the time taken for emasculation, pollination etc. So as to compute the cost of production of F_1 hybrid seeds, various aspects of this topic are reviewed here under.

Haften and Stewenson (1956) reported that in tomato plants, the time required for pollination to produce 400 seeds was 12 minutes for male sterile plants and 51 minutes for fertile plants. They also noted that number of successful crosses was

greater, the time required to emasculate and pollinate was less and the number of seeds per fruit was more when sterile plants were used.

The report of F.A.O (1961) says that in cucumber two women can bag & pollinate 100 flowers/hr in tomato it was only 80 flowers/hr. In brinjal, the time required to complete emasculation and pollination of one flower was reported to be 50-60 sec.

Lal (1977) conducted a detailed study on hybrid seed production in long fruited and round fruited brinjal variety and it was revealed that 500 flowers in long fruited brinjal and 400 flowers in round fruited varieties were sufficient to gave one kg of hybrid seed and the emasculation and pollination for this took 10-12.5 man hours.

Devdas & Ramadas (1993) carried out studies on the cost of production of F_1 hybrid seeds in bitter gourd They gathered information from an 18 x 18 diallel experiment Hand pollination was started from 51 days after sowing and seed extracted was started from 73 days after sowing A total of 3,629 flowers were pollinated and 53,499 seeds were obtained Further it was observed that 313 women hours were required for the whole operation starting from preparatory work for pollination to packing of seeds extracted Out of the total flowers pollinated, 66.19% developed into ripe fruits fit for seed extraction Approximately 36 flowers were pollinated per women hour of pollination When the entire process starting from preparatory work to bagging of flowers to packing of seeds was considered, about 171 seeds were produced per women hour The labour required to produce 1 kg hybrid seed was worked out to be 29 25 women are approximately

Steps in hybrid production

The method of hybrid production mainly involves mainly three steps

i) **Production of inbred line** For the production of hybrids the parents should be homozygous and uniform to make them uniform and avoid segregation 2-3 selfing is to be done Hayes and Johnson indicated that inbred isolated from parents of high genetic diversity yielded better hybrid than those originated from same or related parents

ii) **Testing combining ability** This method identifies parents by GCA and SCA General combining ability (GCA) is used to produce large number of hybrids whereas specific combining ability (SCA) is used to produce hybrids superior than the parents.

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iii) Production of F_1 hybrid seed

Breeding of cucurbits

A x B

F_1 — Source population

F_2 — Improved population

F_3 — I_1

F_4 — I_2 Selection for yield, horticultural characters, resistant to bitterness high femaleness

F_5 — I_3

F_6 — I_4

Production of initial hybrids

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Test of initial hybrids with harvest only once as soon as the first over sized fruit can be observed record number of fruits also, 25 plants /3.6 m2 plot sufficient

↓

Multilocation tests of hybrids and superior inbred followed by identification, release and notification

(Tatlioglu,1993)

Methods of hybrid seed production

The hybrid seed can be produced by several methods:

i) **Pinching of staminate flowers and natural cross-pollination**: In almost all cucurbits the method is followed. One row of male plant and two rows of female plants are planted alternatively. The staminate flowers are pinched off from female plant and allowed for insect pollination. This method is also called "crossing block method"

ii) **Use of male sterile lines** Genetic male sterility has been reported in small amounts in crops like muskmelon, winter squash, pumpkin etc. (Mc Creight *etal*, 1993) The particular character can be utilized in the production of hybrids The male sterility gene is recessive and may be due to pollen abortion, failure of anther dehiscence, anther abortion, pistillody of the anthers The superior F_1 cultivar 'Punjab Hybrid' is a result of work using ms-1 In the seed production block, the 50% of fertile segregates (Ms_1ms_1) will have to be removed from female row For this purpose, in early hours of morning, anthesis of three anthesised flowers from each plant of female parent are pierced with needle Male plants are identified and tagged everyday All male plants are subjected to confirmation on last day of rouging period The pollinator (Hara Madhu) is homozygous fertile (Ms_1Ms_1) to ensure that all F_1 hybrid plants are fertile

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iii) Use of gynoecious lines

Gynoecious lines are used for the production of hybrids in cucurbits especially in cucumber and muskmelon at commercial scale. In cucumber, the planting ratio of female to male parent is kept 4:1, by adjusting in such a way those four hills of female plant surrounds one hill with male parent and is being situated at the centre of each three hills. In this way, the pollination is easier and there are chances to visit all the female flowers of the female plant by the pollinating insects. Daily field observations are done and the staminate flower appearing in the female line are to be removed before it flowers. Maintenance of parental lines is also necessary. The male parent can be maintained by selfing and rouging out undesirable plants before they come into flowering. The gynoecious female parent is maintained by inducing staminate flowers by spray of silver nitrate @ 50-100 ppm or silver thiosulphate @ 25-50 ppm at two-3 true leaf stage and selfing is carried out. Fruits are harvested when they starts turning brown.

For hand pollination, the mature male buds on male or pollen parent and female buds on seed parent are bagged in the afternoon and next morning these female flowers are pollinated with bagged pollen and re-bagged and labeled. The pollen can be collected between 5.00-6.00 am and pollination completed between 6.00-9.30 am. Since each plant is allowed to have two main branches and three fruits on each branch developing to seed maturity, the pollination is completed in around two weeks time.

Gynoecious sex expression is linked with parthenocarpic genes. Hybrids developed by utilizing gynoecious lines are having parthenocarpic gene and do not require pollination for fruit set. Gynoecious lines are suggested to be grown at high plant density, high temperature and long days to promote male tendencies so that stable gynoecious lines could be selected.

iv) Artificial pollination

Method used in watermelon and pumpkin for the production of hybrid seeds. In watermelon, pinching the growing tip at 5^{th} - 6^{th} node allows laterals to grow a main vines and removing secondary branches. This training helps in locating female buds and their production on all plants at 10^{th} to 15^{th} node to help in completing whole

pollination within 10 days time. Monoecious sex forms alleviates the emasculation process. Isolation plantings of male and female plants helps their maintenance while cross pollination is done by bagging mature buds in the evening or seed parent and male buds on pollen parent and collecting covered pollen to pollinate bagged female flower on the seed parent in the morning (6.30 - 9.30 am) and covering the pollinated female flower again.

v) Use of growth regulators

Robinson *et al.* (1970) carried out an experiment using 2-chloroethylphosphonic acid (ethephon) as a sex regulator in cucurbits and this provided a basis for economical production of hybrid seed. Production of male flowers on monoecious plants of *Cucumis pepo* can be temporarily suppressed for 2-3 weeks by repeated sprays of ethephon at 250 ppm on young pits at the first three leaf stage. The application of 250 ppm of ethephon prevents development of staminate flowers. Thus by arranging seed field into alternate rows of treated and untreated plants, and harvesting fruits only from treated rows, hybrid seed can be produced in abundance with little hand labour. Shannon and Robinson (1979) used two applications of ethephon at 600 ppm at 2 and 4 leaf stage and reported complete male suppression during the fruiting stage. Ethephon is being used for commercial production of hybrids seeds in squash (Swarup, 1991)

This method is utilized for commercial hybrid seed production in summer squash. Here, ethrel is applied at the rate of 200-300 ppm at two true leaf stages and four true leaf stages. Another application is useful at flowering time. Ethrel helps in suppressing the staminate flowers and initiating pistillate flowers successively in the first few flowering nodes on the female parent. The row of male parent is grown by the side of female parent and allows natural cross-pollination. In the absence of insect pollinators, hand pollination is possible because the two sexes are separate. The female flowers of the female parent and male flowers of the male parent have to be bagged separately prior to opening and hand pollination brought about later. Four to five fruits set at initial nodes containing hybrid seed would be a sufficient seed yield

vii) Chemical agents for suppression of male flowers

Kohli *et al.* (1981) used GA_3 at 10,000 ppm as an androcide in bell pepper their, at the onset of flowering and another after 10 days, causing complete male sterility, which lasted throughout the season.

Wittaver and Hillyer (1954) observed that spraying dilute solution of Maleic hydrazide (MH) or β-naphthalene acetic acid (100 ppm) in early stages of development of plants of squash (*Cucumis pepo*) suppressed the formation of staminate flowers without interfering with the production of pistillate flowers. More (1993) reported that the chemical growth regulator sodium-alpha-beta dichloroisobutyrate (FW-450) prevented the opening of the mature staminate buds of watermelon. No deleterious effects on female fertility were associated with the application of FW-450.

Breeding for pest and disease resistance

Vegetables particularly cucurbits are infested by a number of pests like fruit fly, aphids, jassids, epilachna beetle etc. Soil inhabiting fungus, invades the roots of plants and causes diseases like fusarium wilt. The cucurbits are also infested by diseases like mosaic, powdery mildew, downey mildew etc. The pesticides and fungicides are effective only to a limited extend Cultivation of resistant varieties and hybrids are the easiest way to overcome the problems For the development of a resistant hybrid both the parents should be resistant, in case the resistance is a recessive character. If the resistance is a dominant character either one or of the parent should be resistant.

Cucumber has been subjected to multiple disease resistance An attempt was made to utilize multiple disease resistant gynoecious lines and pollen parents There was resistance to powdery mildew, Downey mildew, anthracnose, angular leaf spot, cucumber mosaic and scab A hybrid Rodnichok was developed which was resistant to pseudomonas, *Alternaria* spp, *Colletotricum lagenarium* and *Cladosporium cucumerinum*

Extend of heterosis in cucurbits

The extend of heterosis on yield of certain cucurbits are tested. The extend of heterosis showed by certain cucurbits on yield are;

Crop	Yield percentage
Cucumber	54.1 - 187.80
Pumpkin	104.80%
Water melon	36.0 - 87.0%
Ridge gourd	75.81%
Sr ike gourd	129.80%
Bottle gourd	84.7%

Hybrids in cucurbits

There are several hybrids produced by public and private seed companies are popularized in India. Some of them are followed;

Cucumber hybrids

Pusa Sanyog F_1 hybrid below a Japanese gynoecious line and green long Naples. It matures in 50 days. Fruits are 28-30 cm long, cylindrical and have dark green skin with yellow spines. It has been released by IARI Research Station, Katrain

A few newly developed tropical gynoecious hybrids as OCH-1 and DCH-2 at IARI have shown greater promise for cultivation in plastic green house recording 220.0 tonnes and 192.6 tonnes fruit yield/ha respectively (6-9 fold increase in yield) There are being tested in multi location trials of project Directorate of Vegetable Research (More, 1993) Others are Phule Champa, Phule Prachi (MPKV, Rahuri), Pant Sankar Khira-1 (Pant nagar)

Bitter gourd

Indam 1124 (IAHS, Bangalore) Early hybrid with long green fruits

Shubra (Golden seeds) White bitter gourd hybrid, with long fruits

Other hybrids are

Indam-49, Indam -625 (IAHS, Bangalore)

MBTH-101, MBTH-102, MHBI-1, MHBI-13 (Mahyco), Vishesh, Vinay (Golden seeds).

Water melon

1) Arka Manik (IIHR, Bangalore): This has been bred at IIHR, Bangalore from a cross of IIHR 21 x Crimson sweet. Fruit are round to oval with green rind, dark green stripes and weight is about 6 kg. The flesh is deep crimson, with granular texture. It is very sweet with 12-15% TSS. It has multiple resistant to powdery mildew, downey mildew and anthracnose. Yield potential is 500 q/ha.

2) Arka Jyothi Mid-season F_1 hybrid cultivar evolved at IIHR, Bangalore by crossing a local water melon of Rajasthan (IIHR 20) with crimson sweet. Fruit are oval with deep blue angular stripes. Average fruit weight is 5-6 kg. Flesh is bright crimson, sweet with 11-13% TSS. Yield pot is 600 q/ha.

Pusa Bedana Seedless triploid variety of water melon developed at IARI, from a cross of Tetra-2 (4x) x Pusa Rasal (2x). The fruits have dark green skin with faint stripes. Fruits are triangular on shape with tough rind, red flesh and white remnants of false seeds. TSS is 12-13%. Average fruit weight is 5-6 kg. The number of fruits/vine varies from 3-6. It takes 115-120 days for first fruit harvest. It could not become popular due to irregular fruit shape and increased cost of seed.

Private sector

Madhu, Milan, Mohini (HAIS)

MHW - 4, MHW - 5, MHW - 6, MHW - 285 (Mahyco)

Nath - 101, Nath 102 (Nath seeds)

GC 285 (Golden seeds)

Bottle gourd

Pusa Meghdoot This is an F_1 hybrid cultivar between Pusa summer prolific long and sel-2 developed and released by IARI, New Delhi in 1971. Fruits are long light green and attractive. It is relatively early and suitable for cultivation in spring-summer season. It has shown considerable yield heterosis over Pusa Summer Prolific Long.

Pusa Manjari This is a round fruited F_1 hybrid cultivar developed and released at IARI, New Delhi in 1971 from a cross of Pusa Summer Prolific Round and Sel-11. It

has given 48% higher early yield and 106% total yield over Pusa Summer Prolific round.

Private sector

INDAM-204, INDAM-320 (IAHR)

Warad, MHBG-8, MHBG-10 (Mahyco)

GSH-1 (Golden seeds)

Indam-204 IAHS, Bangalore is early prolific bearer with medium, long, pale green, cylindrical fruits.

Ridge gourd

Indam-98126 (IAHS)

Surekha, MRGH-3, MHRG-C (Mahyco)

Golden-50 (Golden seeds)

Indam 98126 is early prolific bearer with long uniformly ridged, dark green fruits

Sponge gourd

Priya (golden seeds)

Haritha, MSGH-1, MHSP-8, MHSP-10 (Mahyco)

Ash gourd

MAH-1 (Mahyco) - Round fruited and high yields

Pumpkin

Pusa Hybrid (IARI, New Delhi)

MPH-1, MHPK-2, MHPK-4 (Mahyco)

Summer squash

Pusa Alankar It is an F_1 hybrid between EC 27050 and Selection IP1-9 early maturing, uniform dark green fruits with light coloured stripes, slightly tapering towards stem end tender delicious and matures in 45-60 days. It has been bred at IARI regional station Katrain

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Musk melon

Punjab Hybrid: F_1 hybrid developed at PAU, Ludhiana having parentage as male sterile MS-1 x Hara Madhu. Identified in 1985 for zones IV and VIII, Punjab Hybrid has 2-2.5 m long vines, vigorous luxuriant growth, globular fruits with distinct statures, weighing about 800 g. Flesh are creamy yellow. Rind is netted. TSS is about 12%. It is early in maturity has good post harvest life and transportability. It is moderately resistant, to powdery mildew.

Hybrid combinations

Hybrid combinations	Specific advantage	Reported by
Bitter gourd MC 66 x MC 49 MC49 x MC 34 Arka Harit x MC 82	Early yield	Vahab (1985)
Priya x MC 34 MC 49 x MC 66	Percentage female flowers	Vahab (1985)
Arka Harit x MC 79 MC 78 x MC 66 MC 78 x MC 84 Priya x MC 66	Yield	Vahab(1985)
Cucumber CS 12 x Poona Khira CS 9 x ARC 1 BSS 169 x ARC 1	Yield	(Gayathri,1982)
Poona Khira x ARC 1 CS 9 x Poona Khira	Early Yield	(Gayathri,1982)

Ridge gourd LA 81 x LA 44	Yield, Weight and No. of fruits/plant	(Juliemole,2000)
LA 87 x LA 86	Fruit length	(Juliemole,2000)
LA 81 x LA 44 LA 87 x LA 86 LA 43 x LA 44	Superior in yield	(Juliemole,2000)
Snakegourd P 12 x P5 P 12 x P 8	Yield	(Varghese,1991)
P 4 x P3 DFH 15 x DFH 58 P13 x P 4	Yield	(Sudhevkumar,1995)
Nedumangad Local x Kaumudi	Yield	(Radhika,1999)

Disadvantages

The cost of F_1 hybrids is unaffordable to farmers. As the heterotic effect diminishes gradually, the farmer has to change the seed every year. Due to high demand of hybrids there is chances of losing local seed materials, which may lead to genetic erosion. Besides this there are several other constraints prevailing which act as barriers in rapid spreading of hybrid vegetable technology in this country. Some of these constraints are

- Lack of awareness among growers about hybrid crop production
- Unorganized marketing system for fresh vegetables
- Lack of post harvest management techniques
- Non-availability of quality seeds
- Non-availability of other inputs at proper time
- Non-availability of biotic stress resistant hybrids

Future strategy

Considerable research on the development of heterotic combinations in different vegetable crops has been done in the State Agricultural Universities and National Institutes in the past. However, the results are confined to the publications

since further research and refinement were not continued. Hence the already identified hybrids/hybrid combinations may be progressed and tested in the farms for understanding their adaptability. In addition, research on hybrids may be strengthened to develop high yielding as well as multiple pest and disease resistant varieties suitable to specific locations and seasons.

- Since a large number of hybrids were developed, further stress should be on development of hybrids having pes and disease resistance as well as high quality.
- Haploidy breeding may be utilized for the development of true to type inbred since it saves lot of time for making inbred than the conventional selfing methods
- The biotechnological research for the development of inbred and invitro hybridization may be strengthened for getting quick result.
- Agro techniques specific to each F_1 hybrid should be standardized and recommended along with release of hybrids.

Conclusion

In spite of fact that the hybrid seeds are very costly and farmer has to depend on research organization or private seed companies for the seeds every time, the demand of hybrid seed increasing day by day. To meet the increasing demand of population there is need for mass effect for popularizing hybrids and hybrid seed production technology. Let us hope that the next decade will be that of hybrids for sustainable development of horticulture as well as for higher economic returns to the vegetable farmers

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Discussion

1. Why more seed companies is oriented in places like Banglore?

   Because of low labour costs. Easy for marketing facilities

2. Why the farmer has to change the seeds year after year?

   The seeds will have maximum heterosis in F_1 generation. As the generation changes homozygozity will increase and heterozygozity decreases. As a result the hybrid vigour will get diminished

3. Why private seed companies are producing more hybrid seeds?

   The private seed companies are more profit and result oriented. So they will produce more hybrid seeds and sell them at high rates.

4. What can be done to reduce cost of hybrid seeds?

   Public sectors should take initiative to produce hybrid seeds and sell them at moderate costs. In stead they are selling seeds of open pollinated varieties.

5. Why marker genes are used in hybrid seed production?

Marker genes are used to detect hybrid seedlings from selfed ones. Mainly used to identify lobed leaf character in watermelons.

6. Is it possible to achieve all superior character in a single hybrid?

No it is not possible. A hybrid superior in a particular character may not be superior in another character due to negative correlation between characters.

ABSTRACT

Heterosis is a phenomenon of increased or decreased vigour of F_1 hybrid over the parents by the crossing of two dissimilar gamates or individuals. The term heterosis was coined by Shull (1914) and is used only when the hybrid is superior or inferior to both the parents (Power, 1944). The phenomenon of hybrid vigour is explained mainly by 'Dominance hypothesis' (Davenport, 1908) and 'Over dominance hypothesis' (East and Shull, 1908) Heterosis is usually assessed by Diallel analysis and Line x Tester analysis (Singh and Choudhary, 1976) and the extent of heterosis is estimated as Relative heterosis, Heterobeltiosis and Standard heterosis (Singh, 2004)

During the last decade, India witnessed a quantum jump in the production of vegetables Inspite of a meagre increase of area by 0.42% in area the increase in production is manifold (79%). This is achieved mainly by the development and adoption of improved varieties and hybrids, standardization of agrotechniques etc. During 2002-03 India produced 84.8 million tons of vegetables from an area of 6.90 million hectares It is estimated that 10% of total area under vegetables is occupied by F_1 hybrids (Rai and Pandey, 2004) Cucurbitaceous vegetables are the choice of breeders, next to Solanaceous vegetables, for exploitation of hybrid vigour. Highly cross pollinated nature, lack of inbreeding depression, large number of seeds in a fruit, and comparatively large size of flower offers scope for exploitation of hybrid vigour in cucurbits (Singh and Swaroop, 1971) Existance of different sex forms like monoecious and dioecious forms avoids the costs of labourious hand emasculation process. Among cucurbits heterosis is mainly exploted in water melon, cucumber, bottle gourd etc and the method generally followed is pinching and removal of staminate flowers followed by hand pollination or allowing free insect pollination

Heterosis for yield has been reported up to 187.80% in cucumber, 129.80% in snake gourd (Sudhevkumar, 1995), 75.81% in ridge gourd (Juliemole, 2000), 104.80% in pumpkin. Plant growth regulators like ethrel, maleic hydrazide etc have been utilized in suppression of maleness and to increase femaleness.

A number of heterotic combinations have been identified in public sector undertakings like National Institutes and State Agricultural Universities. However, private seeds companies like IAHS , Mahyco., Namdari seeds, Ankur seeds, Nath seeds etc. have made significant contributions in popularization of hybrids in the country. Phule Chamba. Pant Sankar Khira-1 (cucumber)
Indam-49. Visesh. Vinay, Shubra (bitter gourd), Arka Jyothi (water melon) etc. are a few of the F_1 hybrids popular in India.

Inspite of the fact that the hybrid seeds are very costly and farmer has to depend on research organizations or private companies for the seeds every time. the demand of hybrid seed is increasing day by day. To meet increasing demand of population. there is need for massive efforts for popularizing hybrids and hybrid seed production technology. Let us hope that next decade will be the decade of hybrids for sustainable development of horticulture as well as for higher economic returns to the vegetable farmers

CURRENT STATUS ON PRODUCTION AND UTILIZATION OF MEDICINAL PLANTS IN INDIA

By
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(2004-12-06)

SEMINAR REPORT

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COLLEGE OF HORTICULTURE
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DECLARATION

I, Sreerekha M.V (2004 – 12 – 06) here by declare that this seminar report entitled **"Current status on production and utilization of medicinal plants in India"** have been prepared by me independently, after going through the various references cited herein and has not been copied or adopted from any of the fellow students or previous seminar reports

Sreerekha M.V
(2004 – 12– 06)

Vellanikkara
Date: 06-12-05

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CERTIFICATE

This is to certify that the seminar report titled **"CURRENT STATUS ON PRODUCTION AND UTILIZATION OF MEDICINAL PLANTS IN INDIA"** has been solely prepared by Ms. Sreerekha M.V(2004 – 12 – 06), under my guidance, and has not been copied from any seniors, juniors or fellow student's seminar reports.

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1. INTRODUCTION

India has one of the oldest, richest and diverse cultural traditions associated with the use of medicinal plants and herbs for human, livestock and plant health, also in textiles, perfumery and cosmetics (Kamboj. 2000).

Developing countries are the major source of medicinal plants and plant parts in the world market. Among them India is a traditional exporter of medicinal plants for the past several decades. The world health organisation estimated that 80% of the population of developing countries relies on traditional medicines, mostly plant drugs for their primary health care needs. The demand for medicinal plants is increasing in both developing and developed countries due to growing recognition of natural products, being non-narcotic, having no side effects, easily available at affordable costs (WHO, 2004).

1.1 Wealth of Medicinal flora in India

Indian gene centre is extremely rich in plant genetic wealth occupies a unique position with respect to genetic resources of medicinal plants apportioning 11% flora. The country stands 10th among the plant genetic resource which encompassing 15 agroclimatic zones. India is one of the top mega diversity centres of the world with a unique wealth of 15000-20000 medicinal plant species. The diverse climatic conditions of India is more suitable for the cultivation of important medicinal plants. Around 70% of the plant spread across the tropical forests of Western Ghats, Himalayas, Vindhyas, NE region etc. There are 10 biogeographical zones in India. It harbours two of the 25 hotspots of the world i.e., Eastern Himalaya and Western Ghats. Kerala is situated on the hottest of hotspots of endemism.

Table 1. Members of plant kingdom with medicinal properties

Group	Species total	No. of sp with medicinal value
Flowering plants	17,000	8,000
Lichens	1,600	650
Algae	2,500	650
Pteridophytes	1,022	200
Bryophytes	2,564	150

2. Availability and distribution of Major Medicinal plants

The diverse climatic conditions of India is suitable for cultivation of medicinal plants in india. Around 70% of the medicinal plants in the country spread across the tropical forests of the Western Ghats, the Vindhyas, the Nagpur Plateaus, Aravalli, the Terai region and the wide areas of the Himalayas and the North-East.

India's surface land has been grouped into 10 distinct zones and there are further divided into 25 biotic provinces and 426 biomes. The forest areas of these biogeographic zones or provinces we classified into 16 major forest types and more than 200 subtypes. Some of the important medicinal plants occurring in such biogeographic zones are listed here

Table 2. Availability of medicinal plants in different biogeographical zones of India

Biogeographical zones	No. of known medicinal plants	Occurrence of some important medicinal plants
1) Trans Himalayan zone	700	*Ephedra gerardiana*
2) Himalayan zones		
a) NW Himalaya	1700	*Aconitum, Saussurea costus, Picrorhiza, Podophyllum hexandrum, Swertia chirata, Taxus wallichiana*
b) Western Himalaya		
c) Central Himalaya	1200	*Nardostachys, Taxus, Panax, Swertia, Picrorhiza, podophyllum* etc.
d) Eastern Himalaya		
e) Desert zones (Kutch and Thar)	500	*Convolvulus microphyllus, Citrullus* sp.
4) Semi arid zone	1000	*Commiphora wightii, Salvadora*
5) W. Ghats	2000	*Myristica, Coscinium fenestratum, Garcinia indica.*
a) W. Ghat mountain		
b) Malabar coasts		
6) Deccan Peninsula	3000	*Pterocarpus santalinus, Mesua ferrea, Aristolochia* sp., *Terminalia* sp.
a) Deccan plateau south		
b) Central plateau		
c) Eastern plateau		
d) Chota Nagpur		
e) Central highlands		
7) Gangetic plains	1000	*Holarrhena pubescens, Chlorophytum* sp., *R. serpentina, Saraca indica*
a) Upper gangetic plain		
b) Lower gangetic plain		
8) NE India	2000	*Smilax, Abroma sp*
a) Brahmaputra valley		
b) Assam hills		
9) Islands	1000	*Calophyllum inophyllum*
a) Andaman islands		
b) Nicobar islands		
c) Lakshadweep islands		
10) Coasts	500	*Rhizophora sp. Acanthus*
a) West cost		
b) East cost		

According to Principe (1989) the domestic market of Indian system of medicine and homoeopathy (ISMH) is of the order of Rs 4000 crores (US dollar 800 million) of which Ayurveda drug market alone is about Rs 3,500 crores (US dollar 700 million). India's total export earnings from the crude drug, herbal extracts and finished products stands at Rs 800 crores (US dollar 160 million). But India's share is only 2.5-3%. While China contributes about 50% followed by Japan 20%.

Table 3. Export status of important medicinal plants in India

Plants	Export share (%)
Psyllium husk	63
Senna leaves and pods	6
Ginseng roots	4
Saps and extracts of Opium	3
Psyllium seeds	2
Belladonna roots	1
Others	3

Table 4. Plant parts exported from India

Plant parts	Quantity (t)	Value
Psyllium husk	192776.67	200 crores
Senna leaves and pods	7430	20 crores
Belladonna leaves	16.5	85 lakhs
Ginseng roots	3000	130 crores
Ipecac (dried rhizome and fruits)	14	5 l
Liquorice roots	54	70 l
Nuxvomica seeds	18	18 l
Poppy flowers and unripe head of dried poppy	9.4	18 l
Isabgol seeds	1000	7 crores
Periwinkle	522	crores
Neem seeds	106	38 l
Neem leaf powder	13	68,000
Gymnema powder	19	1 crore
Saps and extracts of poppy	22	8 crores
Extracts of neem	29	1 crore
Betel leaves	1200	4 crores

Table 5. Herbal extracts exported from India

Extracts	Quantity (kg)	Value (Rs.)
Amla	10	9608
Aswagandha	12	19197
Boswelli	3238	363341
Brahmi	260	721050
Gulgulu	900	1061850
Thulsi	1110	2004813
Gymnema sp.	275	227672

Importing countries

Isabgol is imported by USA, Indonesia, UK, Mexico and Japan. Senna mainly exported to Japan, China, USA and France. UK, USA and Canada are the major importing countries of Belladonna roots. Ginsing roots are exported to USA, Italy, Germany and UK. *Gymnema sylvestre* is imported by Japan, UK, USA and South Africa. *Catharanthus roseus* is exported to France, Hungary, Italy, Japan and USA. Opium poppy to UK, USA and Japan. UK, USA, Israel and Japan are the importing countries of neem leaves and Sarpagandha by Turkey.

Table 6. Major medicinal plants (in quantity terms) procured by the sample pharmacies

Sl No.	Scientific name	Common name in English	Common name in Malayalam	Parts used	Major preparations
1	*Sida* spp	Country mallow	Kurunthotty	Roots, leaves	*Balaristam, Dhanwantharam kuzhambu*
2	*Tinospora cordifolia*	Amruth balli	Chittamruth	Stem	*Amrutharishtam*
3	*Terminalia chibula*	Alalekaayil	Kadukka	Fruits, fruit rind	*Abhayaristam*
4	*Withania somnifera*	Ashwaganda	Amukkuram	Roots	*Ashwagandaristam*
5	*Adhatoda sp*	Malabar nut	Adalodakam	Roots, leaves	*Kasharistam*
6	*Cedrus deodera*	Deoder	Devatharam	Bark	*Varunadhi kashayam*
7	*Cyperus rotundus*	Nut grass	Muthanga	Roots	*Mustharistam*
8	*Wodfordia fruticosa*	Dhatki	Thathiri	Dried flowers	*Abhayaristam, kutajaristam*
9	*Boerhavia diffusa*	Punarnava	Thazuthama	Leaves, whole plant	*Punarnavasam*
10	*Aegle marmelos*	Bael fruit	Koovalam	Roots	*Dasamoolaristam*

Table 7. Major medicinal plants (in value terms) procured by sample pharmacies in 2000-2001 (Rs./kg)

Sl. No.	Scientific name	Common name in Malayalam	Quantity purchased (kg)	Price/kg	Parts used	Value in million Rs.
1	*Aconitum heterophylum*	Athividayam	2000	3800	Roots	0.76
2	*Lodolcea seychellarum*	Aklarithenga	60	3500	Fruits	0.021
3	*Crocus sativus*	Kunkumappov	105	30000	Flowers	0.31
4	*Anacyclus pyretheum*	Akki karuka	100	1200	Leaves, roots	0.012
5	*Holostemma ada-kodien*	Adapathiyan	17000	280	Roots	0.48
6	*Kaempfera galanga*	Kachoory	16000	235	Rhizome	0.38
7	*Piper longum*	Thippali	18000	200	Fruits	0.36
8	*Cinnamomum kamphora*	Pacha karpooram	17500	200	Camphor	0.35
9	*Commiphora mukul*	Gulgulu	22000	180	Resin	0.40
10	*Trichosanthus cucumerina*	Kattupadavalam	26000	115	Stem	0.30

3. Medicinal plant based utility sectors (Singh *et al.*, 2000)

a) Folklore medicines - In this system about 5137 species of medicinal plants are used

b) Ayurveda - 2351 species are used

c) Siddha - 1785 medicinal plants are used

d) Unani - 979 medicinal plants are used

e) Homoeopathy - 506 medicinal plant species

f) Tibetan system - 350 medicinal plant species

g) Modern medicine - 204 species are used

3.1 Folklore medicine

Certain folk uses are interlinked with our custom. Adorning hair with 10 auspicious herbs known as Dasapushpam nurtures a belief among Hindus that this practice is beneficial for attaining prosperity. Similarly taking bath in water boiled with Nalpamaram i.e., bark of four latex bearing trees (*Ficus religiosa*, *Ficus bengalensis*, *Ficus racemosa* and *Ficus microcarpa*) is said to be effective against skin diseases. Also using Thriphala, fruits of *Terminalia chebula*, *Terminalia bellerica* and *Phyllanthus emblica* is popular as an ophthalmic and rejuvanative.

3.2 Ayurveda

Over the centuries, Ayurveda has developed into a time tested science of life. This system has flourished here on account of floristic diversity present here (Valiathan, 1998)

Table 8. Ayurvedic plants

Antirheumatic plants	*Sida rhombifolia* *Commiphora mukul* *Justicia gendarussa*
Antiasthmatic plants	*Adhatoda vasica* *Datura metel* *Tylophora asthmatica*
Diuretics	*Boerhaavia diffusa* *Scoparia dulcis*
Antidiabetics	*Gymnema sylvestre* *Aegle marmelos*
Carminatives	*Acorus calamus* *Kaempferia galanga*
Skin diseases	*Plumbago zeylanica* *Aloe vera*
Hypotensive	*Rauvolfia serpentina* *Andrographis paniculata*

Some ayurvedic formulations commercially available in the market are aqueous extract, powders, medicated wines, incinerated products, distilled medicaments, jams, tablets, ointments, medicated oils and medicated ghee.

3.2.1Emerging areas of utilization of medicinal plant species

Some of the indigenous plants with significant research lead and which are likely to emerge as promising plant drugs in Ayurvedic systems of medicines (Pal, 2002).

Antiprotozal plants	- *Allium sativum*
	Ricinus communis
Antiulcer plants	- *Calophyllum inophyllum*
	Asparagus racemosus
Cardiovascular plants	- *Thevetia neriifolia*
Anticancerous plants	- *Catharanthus roseus*
Hepatoprotective	- *Phyllanthus amarus*
	Andrographis paniculata
Antiinflammatory plants	- *Vitex negundo*
	Curcuma longa

3.2.1.1 Immuno modulators / Adaptogens

Ocimum sanctum, Withania somnifera, Sida cordifolia, Desmodium sp., *Asparagus racemosus, Boerhaavia diffusa* etc. are the plants used as immuno modulators

3.2.1.2 Health foods / Neutraceuticals

Holostemma adakodien, Asparagus racemosus, Centella asiatica, Curculigo sp., Ipomoea mauritiana and Ginkgo biloba are used for preparing health foods (Hub and Staba, 1992)

3.2.1.3 Over the counter products

It includes mainly plant parts, extracts and Galenicals (Shah, 1982).

Important plant part used are rhizome of *Curcuma longa* and *Zingiber officinalis*, Bark of *Pterocarpus santalinum* and *Santalum album*, leaves of *Ocimum sanctum* and *Coleus aromaticus* and leaves and flowers of *Hibiscus rosa-sinensis*

Amla, Aswagandha, Boswelli, Guggul, Tulsi, etc are the important plant extracts, available in the market

Galenicals are the processed products which are consumed without the prescription of a doctor *Aloe vera* is present in many cosmetics preparation In vicks,

peppermint is the major ingredient and in Pudin hara, Pudina is used. Kudangal and Brahmi are the major constituents of a memory booster.

3.2.1.4 Phytopharmaceuticals

According to Dev (1997) phytopharmaceuticals are the active ingredients present in the medicinal plants and used to prepare drugs in modern medicine.

Papaver somniferum - Morphine, Codeine, Thebaine and Papaverine. These are used as sedative or as analgesic

Cinchona spp. - Quinine, Quinidine, Cinchonine and Cinchonidine, which are used against Malaria

Gloriosa superba - Colchicine, Gloriosine, as antirheumatic

Catharanthus roseus - Vincristin, Vinblastin, Ajmalicine. Effective against cancer

Rauvolfia serpentina - Reserpine, Serpentine, Ajmaline and some other alkaloids which are commonly used against hypertension

Strychnos nuxvomica - Strychnine, Brucine

Atropa belladonna - Atropine, Belladonnine, which are used as Mydriatic, Analgesic and antispasmodic

Podophyllum hexandrum - Podophyllotoxins. Effective against cancer

Taxus baccata - Taxol is extracted, it is used against ovarian and breast cancer.

Camptotheca acuminata - Camptothecin, effective against breast cancer

4. Multipurpose medicinal plants

Medicinal plants are used not only as health care products but also as source of dye, fuels, botanicals etc (Dubey *et al*., 2004)

- Cosmetics
- Dyes
- Petrocrops
- Botanicals
  - a) Pesticides
  - b) Herbicides

4.1 Dyes

Natural dyes are extracted from the parts of some medicinal plants having a prominent place in food and textile industries.

Ceasalpinia sappan is a medicinally valuable tree effective against dysentry. . red dye is extracted from its heart wood is used to colour liquor and silk.

Lawsonia inermis which is effective against skin diseases. A dye is extracted from the leaves are used in textiles and cosmetics.

Other species are *Bixa orellana*, *Cucurma longa*, *Indigofera tinctoria*, *Pterocarpus marsupium* and *Hibiscus rosa-sinensis*.

4.2 Cosmetics

Important ingredients of cosmetics are *Aloe vera*, *Curcuma longa*, *Crocus sativus*, *Rubia cordifolia*.

4.3 Petrocrops

Producing liquid fuels from medicinal plants has been identified as a promising option. Crops used for extracting fuels are commonly called Pterocrops. Examples *Jatropha curcas*, *Pongamia pinnata* and *Calophyllum inophyllum*.

4.4 Medicinal plants as pesticides and Herbicides

The active ingredients or alkaloids present in the plant parts have the capacity to repel or kill the insect pests and also to suppress the growth of some weed species

The components of *Azadirachta indica*, *Pongama glabra*, *Hyptis suaveolens*, *Hydnocarpus* sp. *Acorus calamus* and *Andrographis paniculata* are effective insecticides

Eucalyptus globulis contains a component called 1,8-cineole is having the capacity to suppress the weed growth (Chattopadhyay, 1996)

5. Unani

Plants like Banyan tree (*Ficus bengalensis*), Peepal tree (*Ficus religiosa*), Neem (*Azadirachta indica*), Sal (*Shorea robusta*) and teak (*Tectona grandis*) are used in Unani system of medicine

6. Homoeopathy

In this system, *Hypericum* sp., *Withania somnifera*, *Achyranthus aspera*, *Aegle marmelos*, *Boerhaavia diffusa*, *Calotropis gigantium*, *Carcia papaya*, *Ocimum sanctum*, *Vitex negundo* etc. are used against different diseases.

7. Types of threats

In India about more than 8000 species of medicinal plants are facing extinction. The reasons for extinction being

- Human interference (7.8%)
- Fragmentation (5.0%)
- Loss of habitat (18.7%)
- Over exploitation (17%)
- Destructive harvest (19.8%)
- Trade (24.6%)
- Others

Plants listed below are coming under endangered group and export of these medicinal plants is prohibited now

- *Saussurea costus*
- *Dioscorea deltoidea*
- *Rauvolfia serpentina*
- *Podophyllum hexandrum*
- *Pterocarpus santalinus*
- *Nartostachys jatamansi*
- *Picrorhiza kurroa*
- *Taxus baccata*

(Fransworth and Soejarto, 1985)

8. Substitution and Adulteration of Medicinal Plants

Since increase in demand of herbal drugs concerned medicinal plants have been indiscriminately overexploited, leading to scarcity of many valuable species. In India more than 90% of plant species used by the industry are collected from the wild and over 70% of the collection involve destructive harvesting because of the use of parts like roots, stems, bark, wood and even whole plants (Pal and Shukla, 2003). Over half a

million tonnes of the raw materials are indiscriminately collected from the wild mostly followed destructive harvesting procedures and thus about 1,65,700 ha of forest being cleared each year. The alarming situations have resulted into short supply, high prices and forced substitution and adulteration of crude drugs entering into formulations of many medicines (Tirtha, 1998).

Table 9. Substitution of medicinal plants

Medicinal plant	Substituted plant
Acorus calamus	*Alpinia galanga*
Atropa belladonna	*Atropa accuminata*
Curcuma aromatica	*Curcuma domestica*
Nardostachys jatamansi	*Valeriana* sp.
Picrorhiza kurroa	*Gentia kurroo*
Rauvolfia serpentina	*R. densiflora, R. tetraphylla*
Saussurea costus	*S. hypoleuca*

Table 10. Adulteration of medicinal plants

Medicinal plant	Substituted plant
Saraca asoka	*Polyathia longifolia*
Cinchona spp.	*Swietenia mahogany*
Centella asiatica	*Richardia scabra*
Nardostachys jatamansi	*Selinum* sp.
Taxus buccata	*Cephalotaxus* sp.
Hemidesmus indicus	*Cryptolepis buchanani*
Cassia angustifolia	*Cassia obtusa*

Paramesh (2004) reported that based on a study conducted by Convention on International Trade in Endangered Species of wild fauna and flora. Some suggestions are recommended to sustain the herbal industry. Recommendations are

- Enforce rules for using proper botanical names and regulating collection from wild
- Impart training programmes to tribal to identify medicinal plants

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- Ensure access of medicinal plants to village communities for their primary health care needs and involve them in conserving natural resources
- Declare a minimum price for major medicinal plants and a fair price to primary collectors
- Enforce *in situ* conservation by forest dwellers and tribals
- To support *ex situ* conservation as a supplementary and complementary to the above
- To pass legislation to regulate internal and external trading
- Active exploration of emerging intellectual property issues related to access to biological diversity of medicinal plants
- To encourage large scale cultivation to meet needs of user industry

9. Cultivation of medicinal plants

Keeping in tune with the above recommendations, attempts to popularize the cultivation of medicinal plants have been initiated in our country. Important medicinal plants being cultivated in India are listed here.

Table 11. Area of cultivation

Plant	States	Area (Ha)
Psyllium	Rajastan and Gujarat	55,000
Opium poppy	MP, UP and Rajastan	20,000
Senna	TN, Rajastan and UP	20,000
Cinchona	WB and TN	8,000
Aswagandha	MP, Rajastan and UP	5,000
Safed Musli	MP, Gujarat and UP	5,000
Periwinkle	AP, Karnataka and Maharashtra	4,000
Solanum sp	Maharashtra	4,000
Sarpagandha	MP	2,500
Ipecac	WB	100

9.1 Production of some important medicinal plants

1. Isabgol (*Plantago ovata*)

It is an annual stem less herb, native of Persia, now grows as a cash crop on about 16,000 ha in the Mehsana, Palampur and Banaskantha districts of N. Gujarat, Rajasthan and Madhyapradesh. The crop matures within 110-120 days. An average seed yield is 800-1,000 kg ha^{-1}.

Psyllium husk is used as a laxative and also against irritation in gastrointestinal tract.

2. Senna (*Cassia angustifolia*)

It is commercially cultivated in Tirunelveli, Ramanathapuram districts of TN, in Gujarat and in Rajasthan. India is the main producer of this crop in the world and exports senna leaves and pods. The crop yields 1-1.4 t of leaves and about 1.5 g of pods per hectare. The produce should contain about 2.5% of alkaloids.

3. Aswagandha (*Withania somnifera*)

Indian ginseng is cultivated in parts of MP, Gujarat and Rajasthan. Crop is ready for harvesting 150-170 DAS. Entire plant is uprooted and roots are cut, dried and used. An average yield of about 600-700 kg ha^{-1} dry root is obtained.

4. Aloe (*Aloe barbadensis*)

It is a dry land crop, requiring low input. Crop is ready for harvesting after about 18 m. An average yield of 100 t/ha of fresh leaves can be expected.

5. Safed Musli (*Chlorophytum borivillianum*)

It is a major Indian med. plant used for the preparation of vital tonics. Saponins present in the fleshy roots are active ingredient. Dried fleshy root powder is medicinally important. The crop is ready for harvesting within 120-150 days. Average fresh root yield is about 3,000-5,000 kg ha^{-1}.

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6. Satavari (*Asparagus racemosus*)

It is also well known for its use, in vital tonics. The fleshy roots contains saponins, which have aphrodisiac property. It is harvested after about 12 months. An average of about 12-14 t/ha of fleshy roots is obtained.

7. Green chirata - kiriyat (*Andrographis paniculata*)

Commonly known as king of bitters. Its herbage contains andrographoloids as hepatoprotective, immuno modulant, antimalarial and antipyretic actions. An average dry herbage yield of 3,500 kg/ha obtained.

8. Sarpagandha (*Rauvolfia serpentina*)

It is a well known medicinal plant. The alkaloid present in the roots is used against hypertension. It is an evergreen, perennial indigenous herb found widely distributed in the Himalayan foot hills and Peninsular India. Plants are ready for harvesting 18 m after planting. Average root yield varies from 1,500-2,500 kg ha^{-1}.

9. Glory Lily (*Gloriosa superba*)

Glory lily is mainly cultivated for the production of colchicines, which are present in its seeds and rhizome. It is cultivated in limited areas of TN and HP. India exported about 1.75 t of colchicines worth about Rs.524 l.

10. Belladonna (*Atropa belladonna*)

Presently grown on a small scale in Kashmir. The leaves and roots of belladonna constitute the common drug to contains atropine, hyoscyamine and hyoscine as mydriatic, analgesic and antispasmodic properties. The average crop yield in the first year is 300 kg of leaves and thereafter 750 kg of leaves/ha annually. An additional root crop 2-3 q/ha is obtained when the plants are finally uprooted.

11. Galanga (*Kaempferia galanga*)

Galanga is used for both medicinal and aromatic purpose. Its rhizome contains essential oils which are used in flavouring and perfumery. They are also diuretic, expectorant and carminative. The rhizomes are ready for harvesting after 6 m. Rhizome yield may vary from 3,000-4,000 kg ha^{-1}.

12. Periwinkle (*Catharanthus roseus*)

It is highly reputed for its alkaloids vincristin and venblastin, which are used for treatment of Leukemia. The plant also contains antihypertensive alkaloids. Plants are ready for harvesting 240 DAP. An average yield of 750 kg ha^{-1} of dry roots and 1,500 kg ha^{-1} leaves are obtained.

13. Kauch (*Mucuna pruriens*)

Its seeds contains L-DOPA which is active ingredient used for the treatment of Parkinson's disease and hypertension. It is also well known for its aphrodisiac property. Seed yield may vary from 1,750-5,000 kg ha^{-1}.

14. Cinchona (*Cinchona ledgeriana*)

Cinchona bark yields Quinine which is used as a treatment against Malaria. Quinidine SO_4 is used in the treatment of heart troubles. Cinchona plantations cover about 1,600 ha in the Nilgiris, Annamalais hills of TN.

15. Opium poppy (*Papaver somniferum*)

Its cultivation is restricted to about 24,000 ha in the districts of Neemuch, Mandsaur and Ratlam in MP, in Faizabad, Bara Banki, Bareilly, and Shahjahanpur in UP, and in Chittoor, Jhalawar and Kota in Rajasthan. The average yield of raw opium varies from 13-33 kg ha^{-1} and also yield 3-4 g of seeds/ha. 25 opium alkaloids are reported in which morphine, thebaine, codeine, narcotine and papaverine are important. Indian popy constitutes codeine and narcotine mainly.

16. Ipecac (*Cephaelis ipecacuanha*)

India is cultivating this crop commercially. Its cultivation is done by the West Bengal Cinchona department and to a smaller scale in Sikkim and parts of Assam. The annual production ranges from 25 to 30 t of dry roots and parts of the produce, including emetine salts, is exported earning a foreign exchange 1 million rupees annually. The yield varies from 600-1000 kg of roots per hectare. The roots contain emetine, caphaeline and psychotrine.

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17. Foxglove (*Digitalis lanata*)

Leaves contain glycosides used for heart disorders. India imports a major parts of its segments of this drugs. The average yield recorded in India is 600 kg/ha, higher yield upto 1,500 kg are reported from elsewhere. *Digitalis* leaves should contain 0.1% glycoside (digoxin, digitoxin etc.).

18. Dill or Sowa (*Anethum graveolens*)

Sowa is mainly utilized for its aromatic leaves and fruits as condiment. The fruits contain an essential oil, rich in carvone and is used in pharmacy for the preparation of dill water and similar preparations to treat flatulence, abdominal and colic pain.

19. Liquorice (*Glycyrrhiza glabra*)

Its extract containing glycyrrhizin (2.14%) has a healing effect on peptic ulcers. Underground stem and root constitutes the drug. It also used as demulcent, laxative, expectorant etc. The crop yield ranges from 1-3 t/ha.

20. Dioscorea (*Dioscorea* spp)

An average yield of 1 kg of fresh tubers containing 70% moisture. The calculated tuber yield as reported is 7.5 t/ha (dry).

21. Sweet flag (*Acorus calamus*)

500 hectare confined to the Koratgere Taluk of Tumkar district in Karnataka. The crop yield ranges from 2.5-4 t of dry rhizome per ha.

In Kerala, many medicinal plants are used in domestic market. Twelve plants are most important (Kurian *et al.*, 2005).

a) Atalotakam (*Adhatoda beddomei*)

Whole plant or root is used for medicine preparations. Harvest after 6 months of planting if it is used as whole plant. For root extraction, harvest 2 years after planting. About 25-30 t/ha of yield is given by whole plant and the root yield is 6-7 t.

b) Iruveli (*Coleus zeylanicus*)

Stem is the commercial part. It yields about 3-4 t/ha. Harvesting should be done 6-8 months after planting.

c) Neelamari (*Indigofera tinctoria*)

2.5-3 t of leaves are harvested after 2½ months of planting. Harvest the leaves at an interval of 2 months.

d) Thippali (*Piper longum*)

Spike and roots are used in medicines. Harvesting is done after 6 months of planting onwards. Roots should be extracted after 1½ years of planting. Average yield is 750 kg/ha.

e) Chethikoduveli (*Plumbago zeylanica*)

Tubers are used as medicinal part. Harvest the tubers after 1½ years. December-January months are better for harvesting the tubers. It yields about 10 t of tubers per ha.

f) Satavari (*Asparagus racemosus*)

Tubers are the commercial part. Harvest after 2 years of planting. Average yield is about 60 t/ha.

g) Adapathiyan (*Holostemma adakodien*)

Part of commerce is roots. January or February months is the suitable months for harvesting. It should be done 1½-2 years after planting. Average yield is 1.5 t/ha.

h) Palmuthakku (*Ipomoea mauritiana*)

Tubers are used. It is used against many diseases. Harvest the tubers after 2 years of planting.

i) Chappangam (*Caesalpinia sappan*)

Commercial part is the heartwood. So harvest the heartwood after 6 years of planting. Average yield is about 8 kg/plant.

j) Chittaratha (*Alpinia calcarata*)

Rhizomes are used in medicines. Harvest should be done after 1½ years of planting onwards. Average yield is about 20-25 t/ha

k) Kacholam (*Kaempferia galanga*)

In this also rhizomes are used. After 7-8 months of planting, when leaves showing drying, harvest the rhizomes. Average yield is 7-10 t ha^{-1}.

l) Kattar vazha (*Aloe vera*)

Succulent leaves are used. From six months to 3 years we can harvest the leaves. 22 t/ha is the average yield. It is the major ingredients in hair tonic and skin ointments

9.2 Tree Medicinal species

Tree species occupied a prominent place both in commercial point of view and for preserving ecosystem.

Table 12.Tree medicinal species

Name	Uses
Azadirachta indica	Antiseptic, dentrifice, antidiabetic, insecticides
Saraca indica	Uterine diseases, skin diseases
Caesalpinia sappan	Antidysentric, skin diseases, natural dye
Bixa orellana	Febrifuge, against jaundice, food colourant
Oroxylum indicum	Anti-inflammatory, in dasamoola
Gmelina arborea	Cardiotonic, digestive
Aegle marmelos	Antidiabetic, antidysentric, antipyretic, in dasamoola

10. Supply base of medicinal plants

Supply base of 80% of raw drugs coming from wild. From forest area the supply is about 45%, 15% from non-forest area and 20% from forest alike areas. Another 20% is coming from cultivated fields or obtained from other states

10.1 Marketing channel

Many types of marketing channels are present in India. The most commonly seen system is Tribals → Commission agents → Traders/Dealers → Ayurvedic drug manufacturing units. In this system Tribals collect the raw drugs from the wild. From tribals, commission agents buy the raw drugs and sell to traders or dealers. Finally it reaches to Ayurvedic drug manufacturing units.

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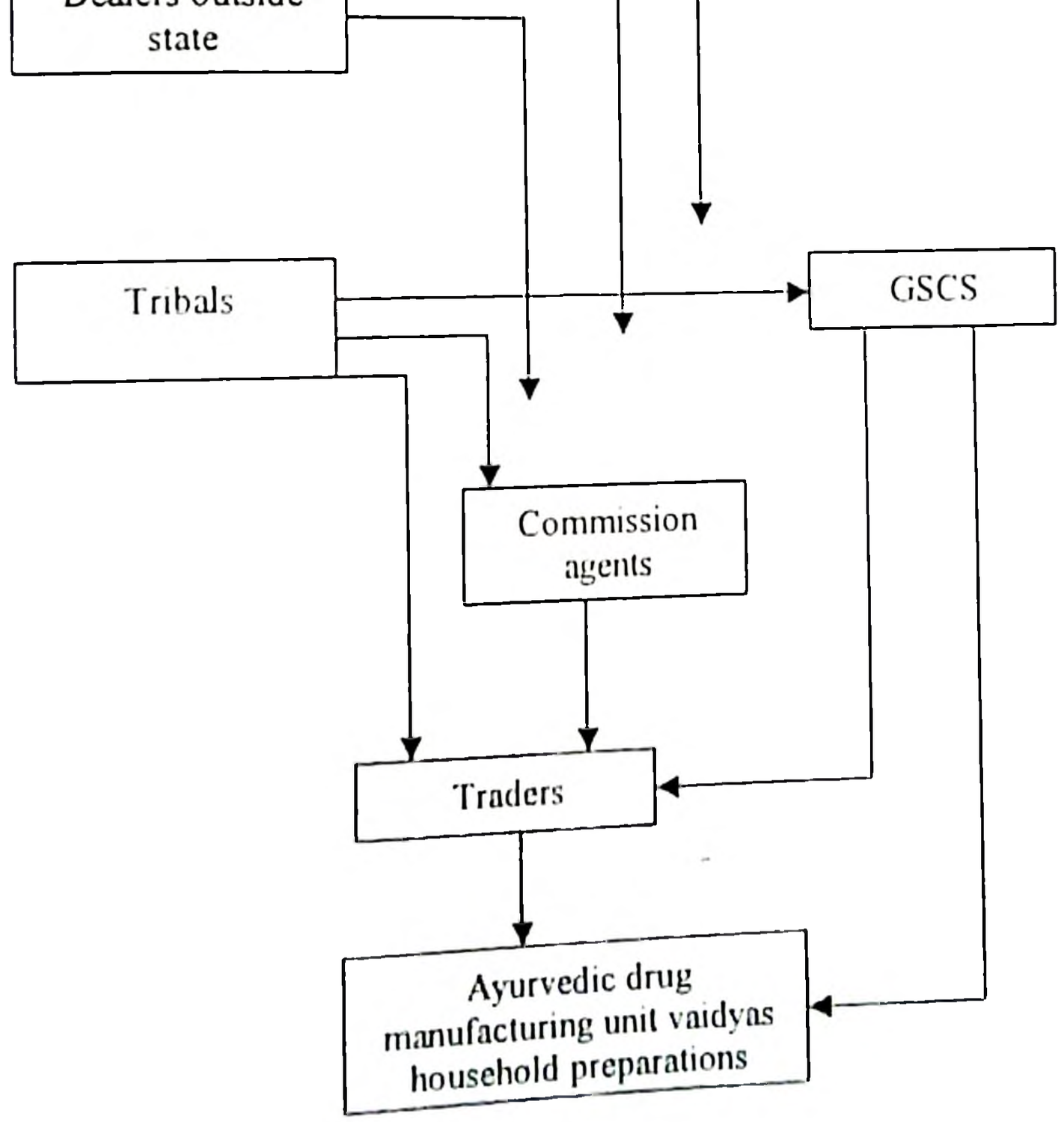
Marketing channels



In India, many companies are involved in the manufacturing of ayurveda products. Such companies are Dabur India Ltd., Ghaziahad, Vicco Laboratories, Mumbai and Himalaya Drug Company, Bangalore.

Important Ayurvedic drug manufacturing units in Kerala are Kottakkal Arya Vaidyasala, Malappuram, Vaidyaratnam Oushadhasala, Thrissur, Nagarjuna Herbal Concentrates, Thodupuzha, Arya Vaidya Pharmacy Coimbatore Ltd., Palakkad, Kerala Ayurvedic Pharmacy Ltd., Alwaye, Sitaram Ayurveda Pharmacy, Thrissur, SD Pharmacy, Alappuzha, Santhose Pharmacy, Kadalundinagaram etc. (Rawal, 2003)

11. National Medicinal Plant Board

NMPB was set up under a Govt resolution on 24th November 2000 under the chairmanship of Union Health and Family welfare minister.

Objectives of NMPB are the co-ordination of all matters related to medicinal plants including drawing up policies and strategies for conservation, proper harvesting, cost effective cultivation, research and development, processing and marketing of raw materials to protect, sustain and develop this sector.

NMPB has identified 32 species of medicinal plants, which are recommended to India Out of these 32 medicinal plant species only 13 are recommended into different agroclimatic areas of Kerala These are

Acorus calamus	-	Vayambu
Adhatoda beddommei	-	Chittatalotakam
Celastrus paniculatus	-	Jothishmathi
Citrullus colocynthis	-	Kattuvellari
Coscinium fenestratum	-	Maramanjal
Caesalpinia sappan	-	Pathimukham
Baliospermum montanum	-	Nagadanti
Mucuna pruriens	-	Naikorana
Plumbago indica	-	Koduveli
Salacea oblonga	-	Ponkarandi
Solanum anguivi	-	Cheruvazhuthina
Trichosanthes cucumerina	-	Kattupatavalam
Woordifordia fruticosa	-	Thathiri

12. Conclusion

Though tremendous advances have been made in modern medicine, there are still a large number of conditions for which suitable drugs are not available. Hence utilization of indigenous knowledge of plants and plant products should be in public domain and creation of public awareness on the need of medicinal plant conservation policy has to be promoted. Also safeguarding the medicinal plants from unjust commercial exploitation has to be evolved as a national policy for sustaining medicinal plant based industries.

13. DISCUSSION

1) Is there any agency or firm for testing the quality of medicinal plants?

In India, many laboratories and institutes are conducting the quality evaluation tests of medicinal plants. Some of them are Central Institute of Medicinal and Aromatic Plant, Lucknow, Quality evaluation Laboratory, Spices Board, Cochin, Nagarjuna Herbal Concentrates, Thodupuzha and Central Drug Research Institute, Lucknow.

2) How can the quality be assessed?

Quality can be assessed by chemical and anatomical tests.

3) What are the components or colouring agents present in Anatto?

Colouring agents in the Anatto are Bixin and nor-bixin.

4) What about the antidiabetic property of Stevia and Insulin plant?

Antidiabetic property of stewia and insulin plant has scientifically not proved

5) What are the basic criteria for cultivation of medicinal plants in Kerala?

Cultivation of medicinal plants in Kerala mainly depends upon the demand by user industry

6) Whether all the medicinal plants are cultivated in Kerala?

No, some of them are cultivated here. Examples are Chettikoduveli, Kacholam, Neelamari etc.

7) What are the methods for conserving the endangered species?

In situ conservation of medicinal plants by forest dwellers and tribals. Also *ex situ* conservation as complementary and supplementary to *in situ* conservation.

8) Mention about biotechnological developments in conserving medicinal plants?

Conserving the medicinal plants in gene banks, cryopreservation etc.

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ABSTRACT

India has one of the oldest, richest and diverse cultural traditions associated with the use of medicinal plants and herbs for human, livestock and plant health, also in textiles, perfumery and cosmetics. About 80 % of the population of developing countries relies on traditional medicines for their primary health care needs.

Medicinal plant as a group comprise approximately 15000 species and accounts for around 50 % of all the higher flowering plant species of India. Five hundred species are mostly used in the preparation of drugs. India's total export earnings from the crude drug, herbal extracts and finished products stands at Rs 1210 crores. But India's share is only 2.5-3 % while China contributes about 50 % followed by Japan is 20 %. Around 70 % of the medicinal plants in the country spread across tropical forests of the Western Ghats, the Vindhyas, Nagpur Plateaus, Aravalli, Terai region and the wild areas of the Himalayas. Mainly the cultivation of medicinal plants are confined to states of Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Tamil Nadu, West Bengal, Andhra Pradesh, Karnataka, Maharashtra and Kerala.

Medicinal plants are extensively utilized throughout the world in distinct areas of health management like folk medicines, Ayurveda, Siddha, Unani, Homoeopathy, Tibetan system and Modern medicine.

Many medicinal flora with significant research leads, are likely to emerge as promising plant drugs like antiprotozoal, antidiabetic, cardiovascular, anti-inflammatory, adaptogens, anticancerous, hepatoprotective, antiasthmatic and neutraceuticals. Another utility sector is over the counter products which include non-prescription medicines involving plant parts, extracts and galenicals.

In spite of enormous diversity of medicinal flora several species are threatened with extinction. The reasons being loss and degradation of wild habitat, unsustainable harvest and increased demand of various sources. The alarming situations have resulted in to short supply, high prices and forced substitution and adulteration.

Roots, barks, leaves and flower parts of medicinal plants of high value can be adulterated with less valuable plant parts.

Convention on International Trade in Endangered Species of wild fauna and flora(CITES) regulates the international trade of species threatened with extinction. In India the first official step to regulate the trade in endangered medicinal plant species by Govt of India was taken in the year 1994, by which around 56 medicinal plant entities were banned from export purpose. So creating public awareness on the need of conservation of medicinal plants and safeguarding them from unjust commercial exploitation have to be evolved as a natural policy.

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CHANGING SCENARIO OF ANTHURIUM PRODUCTION IN INDIA

By

GAYATHRI.M.N
(2004-12-08)

SEMINAR REPORT

Submitted in partial fulfillment for the
requirement of the course
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DEPARTMENT OF POMOLOGY & FLORICULTURE
COLLEGE OF HORTICULTURE
KERALA AGRICULTURAL UNIVERSITY
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DECLARATION

I, Gayathri.M.N, (2004 – 12 – 08) here by declare that this seminar report entitled **"CHANGING SCENARIO OF ANTHURIUM PRODUCTION IN INDIA"** has been prepared by me independently, after going through the various references cited here in and has not been copied or adopted from any of the fellow students or previous seminar reports.

Gayathri

Vellanikkara

Date 02-12-2005

Gayathri.M.N

(2004-12-08)

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CERTIFICATE

This is to certify that the seminar report titled **"CHANGING SCENARIO OF ANTHURIUM PRODUCTION IN INDIA"** has been solely prepared by Gayathri.M.N (2004-12-08) under my guidance, and has not been copied from any seniors, juniors or fellow students' seminar reports.

Vellanikkara

Date 02-12-2005

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INDIAN FLORICULTURE: AN OVERVIEW

Flowers speak millions of unspoken words. No wonder they are there in almost every occasion. Since time immemorial the importance of such a delicate creation of nature has always been appreciated.

India has a long tradition of cultivating flowers. Festivals in India are not complete without flowers. In the yesteryears, every house in Kerala had a little yard where traditional flowers were grown. But today concrete has engulfed the natural beauty. Kerala now gets its flowers from neighboring states. The situation has become so grim that if flowers from Karnataka or Tamil nadu stops coming no pooja or wedding can take place in Kerala.

In most part of the country flower growing is carried out on small holdings. Commercial floriculture has gained importance in the recent past. The foreign exchange earning ability of the industry also compels India to enter international trade (Sharma *et al*., 1999). It is estimated that over one lakh hectare is covered under flower crops in India. Two third area is under traditional flower crops. Following are the major components of Indian floriculture industry.

1) Cut flowers

2) Loose flowers

3) Dry plants and flowers

4) Oils and perfumes

5) Pot plants

6) Landscaping

7) Cut foliage

Production of flowers in India is estimated to be three lakh tonnes. The major states involved in flower production are Karnataka, Tamil nadu, West Bengal, Andhra Pradesh and Maharashtra. Flower consumers in India are now becoming quality conscious demanding flowers grown under protected environment

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Climatically controlled greenhouses were launched in India in 1991 and at present about 500 hectare is available for growing quality flowers for export purpose (Ghosh, 1998). A number of such export oriented units (EOU's) with green house production have been set up in cluster around Pune, Nasik, Bangalore, Delhi and Hyderabad. The flowers exported from these units are receiving high consumer acceptance and high quality.

Table: 1 Top ten destinations of Indian floriculture produce

Country	1997-98
USA	19.97
Netherlands	17.73
Germany	10.44
Japan	8.31
UK	6.57
Italy	3.56
France	2.12
Australia	1.75
Singapore	1.72
Spain	1.55

USA is the single largest exporter of Indian floriculture produce and dry flowers and pot pourries contribute the lion share. Other major markets are Europe, Japan and Gulf countries. Thus we can testimonise that the floricultural produce from India has already made a mark in the global floriculture business meeting the stringent quality standards.

Considering the significant growth of this industry since then, which is evidenced by mushrooming of flower shops all over the country and increased purchase of flowers as gift items, one can put the current trade at several times the earlier estimate. A recent study of the Delhi market alone put the value of flowers traded whole sale at Rs 50 crores a year.

WORLD FLORICULTURE INDUSTRY

Floriculture has evolved as most lucrative business due to much higher returns than other crops. Flowers are emerging as potential money-spinners for many a third world country. According to estimates the global trade in cut flowers alone is worth Rs.30, 000 crore (Dharmarajan, 2004). The global floriculture trade is expanding at the rate of 15per cent per annum.

The Netherlands world's leading flower producer and exporter, controls the world export and auctioning of flowers (65%). The other countries with a major share in international export market are Columbia, Israel and Italy (13%, 8% and 7%, respectively). The major exporting countries are Germany, USA, France, UK, Italy, Belgium and Japan.

Table: 2 Global Trends in floriculture

Top 10 Cut flowers	(Unit: Million)
Rose	1618
Tulip	522
Chrysanthemum	399
Gerbera	241
Carnation	193
Freesia	149
Lily	143
Alstroemeria	126
Iris	89
Gypsophila	83

(Source Floriculture, Asiapacific)

The flower that occupy important position in international cut flower trade are rose, tulip, chrysanthemum, gerbera, carnation, freesia, lily, alstroemeria, orchid, anthurium, gladiolus, liliatris etc

RELEVANCE OF ANTHURIUM

If rose and orchids are the king of flowers, aroids are the king of foliage. With a vast array of colours and incredible vase life, the anthurium is most popular and long lasting of all tropical flowers. They are valued for their handsome colorful long-lasting flowers and attractive foliage. They are very popular with flower arrangers because of the bold effect, bright colour and long keeping quality.

Ranked 11th in the global trade, anthurium is next only to orchids among tropical flowers (Laws and Galinsky, 1996). The popularity of Anthurium as a flowering pot plant has increased dramatically and has become a popular addition to many foliage growers' product lines. Nowadays pot plants are also gaining importance as that of cut flowers. Export value of anthurium pot plants in Dutch auctions increased by 23 per cent in 2003 (Molfino, 2003). It's also grown for its attractive foliage.

Almost all the flowers ranking top among global cut flowers trade belong to either temperate or subtropical climate. The superiority of anthurium is that it can be grown in high altitude and places of tropical region. They are relatively easy to grow, have attractive foliage and under proper environment produce long lasting flowers year around. Currently, numerous cultivars with different size, shape, colours and some with delicate fragrance are available for the consumer.

MAJOR PRODUCERS AND IMPORTERS

Anthurium cultivation takes place in many of the countries between 60 degrees northern latitude and 40 degrees Southern latitude. Anthuriums are currently being cultivated in hundred countries around the world where the surface area has been increasing over last few years (Fijk, 2005).

A large number of varieties are extensively cultivated throughout the world with the heaviest concentration in the United States, Netherlands, Mauritius, Philippines and Hawaii. The Hawaii anthurium industry is responsible foe registration of flowers. Every year, considerable numbers of varieties are being released as a result of hybridization. Germany, Italy and France have long been the major markets for anthurium. The cut flowers supplied from the exporting countries goes mainly to the largest flower auction in the world i e Aalsmeer flower auction at Amsterdam, Netherlands.

Table: 3 Top ten anthurium varieties supplied to Dutch auctions in 2003

Sl no.	Varieties	Market share (%)
1	Tropical	37.8
2	Midori	7.2
3	Acropolis	6.3
4	Pistache	4.0
5	Choco	3.2
6	Fantasia	2.6
7	Cheers	2.2
8	Champagne	1.8
9	Casino	1.7
10	Terra	1.7

(Source: Anthur Info, 2004)

Because of its long shelf life anthurium is an excellent export product. Cut flowers were assorted based on colours in the Dutch auctions. In 1980s orange was the dominant colour. Now Red colour shares 40 per cent of market share. Colour preference varies according to country.

Table: 4 Colour distribution of anthurium in the Dutch auctions in 1997

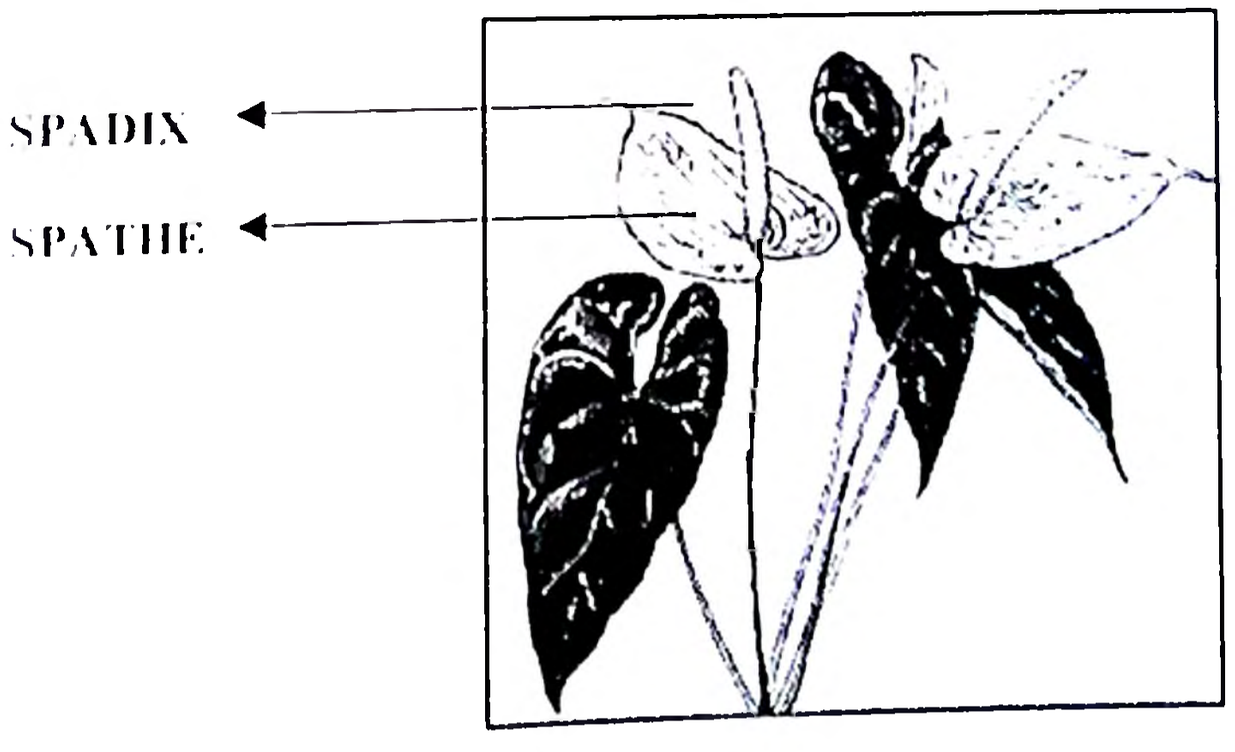
Sl no	colour	Market share
1	Red	40
2	Pink	13
3	Green edged	11
4	Mixed	8
5	White	8
6	Cream	8
7	Green	6
8	Orange	3
9	Miscellaneous	2

HISTORY

Anthuriums, a group of tropical aroids, constitute the largest genus of family Araceae. The elegant blooms of this tropical aroid are produced and sold throughout the world. *A. andreanum* is native to the wet forests on the Western Slopes of the Andes, in Southern Columbia and northern Ecuador where it grows as epiphyte. Edouard André discovered *A.andreanum* in Columbia in 1876. André sent it to Jean Linden in Belgium. From there it made its way to the royal botanical gardens at Kew, England (Madison, 1980)

A doctor Karl Van Scherzer introduced the first *Anthurium scherzerianum* in Europe in1857. This variety originated in Costa Rica. Through cross breeding and selection the most important cultivated varieties emerged from these two varieties, the A. andreanum cut flower and pot plant varieties and the *A.scherzereanum* pot culture varieties. Birdsey (1951) proposed that the cultivated anthurium be referred to as *Anthurium cultorum*. The reason being that the cultivated anthurium bears little resemblance to the wild species. This proposal has merit, but the name is not often used.

FLORAL CHARACTERS



The 'flower' consists of a colorful modified leaf called the spathe and hundreds of small spirally arranged bisexual flowers on a pencil-like structure called the spadix, arising from the base of the spathe. It is commonly known as 'candle'. Anthurium blooms throughout the year, one bloom arising from the axil of every leaf. The longevity of the spathe on the plant varies from 60 to 90 days, depending on the variety.

The genus name Anthurium came from the Greek words 'anthos' and 'oura', which mean 'flower' and 'tail' respectively. The literal translation of the name anthurium, "Tail Flower" clearly befits this plant with its spike shaped inflorescence. The name of anthurium differs locally, usually with reference to the shape of the flower. In South America, for example, it is called Cresto de Gallo (cocks comb); in China, Bull's Head, in the United States, Tail Flower and in other countries, Flamingo flower. In the Netherlands, the *Anthurium andreanum* is also called the lak-anthurium (Lacquer flower).

MAJOR BREEDERS AT INTERNATIONAL LEVEL

Earlier AVO (Anthurium Vogels) was one of the giants in anthurium breeding. Their varieties were prefixed Avo. For example, Avo Aneke, Avo Isis etc. Afterwards another breeder ANTHURA came into existence. In India great majority belongs to Anthura.Their plants are marketed in India by Florence Flora, Bangalore. Now a days plants from another breeding company FLORIST is becoming much popular. Their varieties are cheaper compared to Anthura. In India their plants are marketed by KF Bioplants, Pune

ANTHURIUM PRODUCTION IN INDIA

India is endowed with various agro climatic conditions suitable for growing anthuriums. There is a relative nearness to emerging markets like Japan, Australia, and Middle East and to even Maldives During the peak demand period in November-March, the weather in India is very conducive for top quality production The tropical conditions prevailing in the coastal belt is very congenial for the cultivation of anthuriums

As it is a tropical flower, it cannot be grown in extremes of climates In India, it is grown in areas where temperature ranges from 15 to 35°C and having a relative humidity percentage of 65 to 75, such as Coorg in Karnataka, Nilgiris and Palani hills in Tamilnadu, Wayanad, Idukki and Palghat districts of Kerala, Northeastern states like Meghalaya, Mizoram, Sikkim etc. More than 70 percent of anthurium produced in India is cultivated in Coorg (Vinayak, 2005). In spite of the potential for higher returns, the production of anthuriums has not taken off to that extent because of the high cost of

planting material, prolonged juvenile phase prior to flowering, poor access to location specific technology, lack of good marketing network etc.

OPPORTUNITIES IN KERALA

There is tremendous potential for cultivation of anthurium as cut flower in Kerala.The natural climatic condition existing in Kerala is highly ideal for growing anthurium, heliconia, ginger lily etc that are popularly known as 'tropical exotics'. With an atmospheric humidity of 80 per cent and above temperature ranging from 20-30^{0}C and abundant sun light, Kerala itself act as a natural green house.

Anthuriums reached Kerala as an ornamental plant in the British bungalows (during 18th century). During the late 1980's Kerala has developed a newfound love for two groups of flowering plants-the orchids and anthuriums. Both produce exquisite and delicately hued flowers. First it was an orchid bloom in Kerala.Then it slowly gave way to anthurium for the customers found anthurium more lasting up to 20 days. Considering the prospects, several nurseries, tissue culture labs have mushroomed in the state during the last decade. The government of Kerala has established a model floriculture center and tissue culture unit at the capital city.

Kerala cut flower producer's society gave an impetus to anthurium cultivation by organizing 'SPECTRUM 90'flower show in Thiruvananthapuram.Since 1992,the Tropical Botanical Garden Research Institute (TBPGRI) Palode, Thiruvananthapuram under different schemes partially funded by the department of biotechnology, GOI has trained over 1500 individuals in Kerala in orchid and anthurium production (Sudha, 2001))

Indian floriculture industry standing on the verge of commercialization has identified Kerala as a potential place for anthurium industry. The zonation of Kerala with respect to commercial floriculture also gives due importance for anthurium cultivation (Rajeevan, 1999). Kerala appears to be in a better situation with regards to commercial anthurium production compared to countries like Mauritius. It was observed that anthurium production in Mauritius has deteriorated in the recent years and they do not have a major share of the global market as before. Most farms use old varieties and many of the new varieties popular in global markets and easily available in Kerala, are not available in Mauritius due to stringent phyto sanitary regulations.

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Table : 5 Floriculture zonation in Kerala

Sl.no	Zone	Features	Suitable crops
1	Palakkad district	Low rainfall,low humidity areas with cheap labour	Jasmine,Crossandra, Marigold,Tuberose
2	Hill zone I	Up to >1500m above MSL	Anthurium,Rose, Carnation,Gerbera, Gladiolus
3	Hill zone II	>1500m above MSL.Polyhouse condition is necessary for certain crops	Cymbidium orchids,BOP, Alstroemeria, lilies
4	Other areas	Plain land including coastal areas	Orchid, Anthurium, Foliage plants

(Rajeevan. 1999)

SPECIES AND VARIETIES

Major species

Though 500-600 known species are included under the genus Anthurium, not more than 50 are in cultivation (Bailey, 1963). Major species under the flowering and foliage group are given below

A. Flowering group

a) ***Anthurium andreanum*** is an epiphyte with somewhat creeping habit of growth using aerial roots for anchorage. The species is a native of S.W. Colombia. It is believed to be a naturally evolved secondary polyploid (Sheffer and Kamemoto, 1976). The plant is erect with oblong heart shaped green leaves. The spathe is heart shaped, reddish orange or scarlet, 10-15 cm long with a yellow and white prudent spadix. It is suitable for green house and is widely grown for its handsome foliage and coloured spathes.

b) ***A. scherzerianum*** known as the Flamingo flower or Flame plant. The better known and more compact plant with narrow leaves, 15-20 cm long and 4-6 cm wide. The ovate

spathe is brilliant scarlet, while the spirally twisted spadix is golden yellow. It flowers chiefly from February to July and needs keeping moist.

c) *A. bakeri* short stem, strap like leathery, elliptic, lanceolate leaves, deep green with stout mid rib, spathe and spadix green.

d) *A. x ferrierense* (andreanum x ornatum) "Oil cloth flower", robust climber with lobed, heart shaped leaves, ovate cordate, rosy spathe waxy smooth, carried upright, and erect spadix white to rose, willing bloomer.

e) *A. ornatum* Native of Venezuela, noble leaf ovate - cordate, bright green, cupped spathe with turning purplish - rose toward tip, upright spadix red purple.

f) *A. regale* "Royal anthurium" with large, oblong heart shaped leaves and narrow sinus, dark olive - green with silver green veins, pale beneath.

g) *A robustum* a regal hybrid with larger, satiny leaf iridescent, olive green, heart shaped with open sinus and pale veining, narrow green spathe.

B. Foliage Group

a) *A. clarinervium*

Native of Mexico A dwarf ornamental species, dark green velvety heart shaped leave with clear, silver-grey veins, similar to *A. crystallinum* but more diminutive, with leaves 12-20 cm long, spathe reddish green

b) *A. crystallinum*

Native of Columbia and Peru Known as "crystal anthurium", strikingly beautiful tropical foliage plant From the central crown with thick fleshy roots arise wiry petioles, circular in cross section, carrying large decorative, velvety, heart shaped leaves of stiff-leathery texture, glistening emerald green with contrasting network of white veins, 25-45 cm long, with basal lobes overlapping, acutely angled at the thickened juncture, long-stalked inflorescence with slender yellowish green spadix and linear green spathe, followed by red purple berries.

c) ***A. holtonianum***

Native of Panama and Colombia. Striking plant with large; palmately compound, glossy green leaves, the long segments pinnately lobed and undulate.

d) ***A magnificum***

Native of Colombia. Large and showy heart shaped, velvety olive green leaves 25-40 cm long, having prominent white veins, the petioles 4-angled, spathe and spadix green.

e) ***A. veitchii***

Native of Colombia. Known as "King Anthurium". Unusual plant with pendant, showy leaves up to 1 m long, cordate and base, rich metallic green; curved lateral veins sunken, giving a quilted look pale midrib. Inflorescence with narrow green spathe.

g) ***A. warocqueanum***

Native of Colombia. Known as "Queen Anthurium". Climbing species with showy, long tapering, velvety leaves up to 1 m long, deep green with ivory veins, small spathe green to yellowish

VARIETIES

When anthuriums are grown commercially, it is always advisable to limit the number of varieties to a few. A good anthurium variety should have

- Compact plants with short inter nodes, producing suckers profusely.
- Bright, clear coloured, showy, heart shaped spathe, with plenty of blisters and symmetrical overlapping of basal lobes
- Spadix shorter in length than the spathe, reclining to the spathe, oriented at an angle less than 30°
- An erect and long flower stem, about five times the length of the spathe.
- Resistance to common diseases and pests.

The assortment of cut flower varieties is annually expanding. Red colour was preferred most and there were nine colour groups in which the varieties fell.

Anthurium flowers are classified into three basic groups based on the character of the spathe. They are 'Standard' with heart shaped spathe (the most common type), 'Obake' with bicoloured spathe and 'Tulip' with cup shaped spathe.

Based on the colour of the spathe, some of the important anthurium varieties are listed below:

1. Red spathe

Tropical (most popular variety), Flame, CanCan, Carre, Mauritius Red, Tinora, Liver Red, Agnihotri

II. Orange spathe

Nitta, Sunburst, Sunset Orange, Mauritius Orange,Gino Orange

III. White spathe

Uniwan, Acropolis, Uranus, Cuba, Titicaca, Mauritius White, Meringue White

IV. Pink spathe

Marian Seefurth, Cheers, Aymara, Salasaga, Magic Pink Agnihotri, Lady Jane (Miniature)

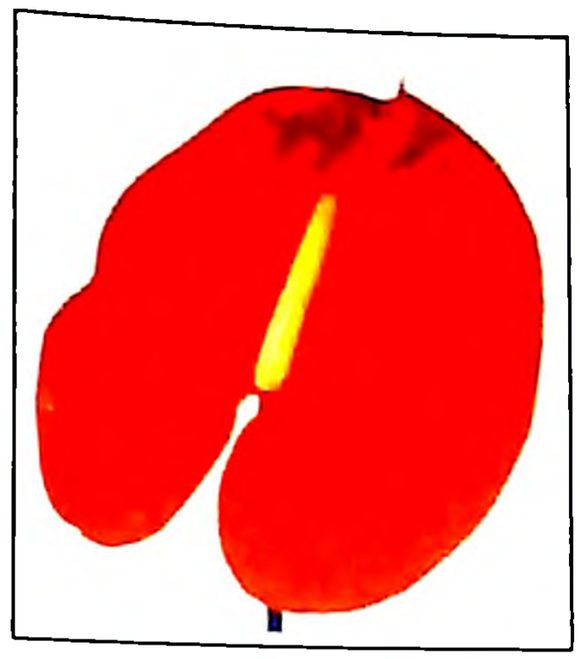
V. Obake & other novelties

Red Dragon (red obake) Fantasia (Cream spathe with pink vein), Madonna (cream obake), President (Pink obake), Fla Rose (Peach), Sultan (Pink obake), Lambada (White obake), Choco (chocolate brown), Midori, Pistache (green), Carnival (white spathe with pink margin), Amigo (red obake)

GERM PLASM COLLECTION

Collection of anthurium was being maintained viz., Heissarghatta (9), Yercaud (16), Coimbatore (15), Kalyani (5) and Vellanikkara (65). Interspecific hybrids were

TROPICAL



CAN CAN

ACROPOLIS

CHEERS

PISTACHE

LINDA-DE MOL

evolved between *Anthurium andreanum* and *A.veitchii*, *A.magnificum* and *A.hoffmani* and *A.magnificum* and *A.crystallinum* at IIHR,Heissarghatta.

ANTHURIUM BREEDING

Hybridization and selection are the most important methods for improving anthuriums. Two cultivars, Uniwai (an exceptionally high yielding white) and Marian Seefurth (with a rose opal spathe) were evolved by clonal selection (Kamemoto and Nakasone, 1963)

Formerly anthurium breeding consisted primarily of so called mixed culture. Since anthurium is a cross-pollinated crop, it is very heterogenous. Using cultures for propagation homogenous populations were built up. But they took more time. More over the cuttings carried infestations (nematodes) and infections (bacteria, virus).

The development of *in-vitro* propagation by prof. Pierik in the 1970's provided an enormous stimulus for the anthurium cultivation. It is now possible to propagate select disease-free plants quickly in the laboratory. The offspring's of these selected plants are identical. These are called clones. New varieties are developed by cross breeding and by selecting and propagating the best plants from this offspring

GROWING STRUCTURES

Regulation of shade

In commercial practice, anthurium is grown under shade. The intensity of light affects the morphological characters, flower production and quality of flowers. A study conducted in Kerala Agricultural University by Valsalakumari *et al* (2001) for shade and nutrient management showed that highest values for vegetative characters like plant height, spread, number of leaves and Leaf Area Index were recorded under 80 percent shade. Days taken for flowering was significantly lower while spathe length and width were significantly higher in this treatment. Dry matter production and uptake of nitrogen, potassium and calcium was higher under 80 percent shade. High temperature coupled with poor aeration is an important problem for growing anthuriums during summer season, particularly in the plains (Rajeevan *et. al.*, 2002).

The anthurium grows naturally in a shade environment, well protected from extreme weather conditions. During the entire cultivation, the plant must be protected against excess sunlight, heavy rains and wind. Too much light will cause the flower colour to fade.

The common growing structures are:

a) Green house

b) Low cost poly houses

c) Shade houses

d) Rain shelter

Green houses

Green house culture leads to 10-15 times higher yield than out door cultivation. Modern green houses are equipped with a climate control computer that regulates temperature, light humidity and carbon dioxide level. Cooling in green house is very essential where the outside temperature goes above 30 ^{0}C.

Evaporative cooled green houses consists of a fan and pad system with running water stream over the pad and consequent with drawal of air through it by means of fans on the opposite side

Fog cooling is also practiced now a days. In certain places, the high energy consuming fan and pad system is being replaced by roof-ventilator system or the retractable-roof with or with out roll-up side curtains (Misra and Pathania, 2000)

Cuatro option green houses

It is constructed of heavy galvanized steel It provides protection against high air humidity, rainstorms and many other problems in the tropics. A combination of a permanent shade curtain of shading percentage of 40 per cent with a movable shading curtain with a percentage of 60.

Low cost polyhouse

In areas where relative humidity levels are low and temperature levels are high, low cost polyhouses are more suitable. UV stabilized polythene is used as the cladding

material and top or side ventilation can be provided. Inside the polyhouse, the top portion can be provided with layers of two shade nets (50% and 25%). If there is high light intensity, shade paints like Redusol or Variclear or lime can be applied

Moveable screen for optimum light level

Shade hall in the tropics

Shade houses

Shade houses are the most popular are structures in many of the commercial anthurium growing areas, because of the simplicity of construction and low cost. The shade houses can be constructed by taking the support of tree trunk if the anthuriums are grown in multistoried plantation cropping. Two shade nets of 75 percent and 25 percent and one layer in sides can be used to provide required shade. Such structures are more suitable in areas where the ambient relative humidity levels are already high and frequent air exchange through the porous side nets do not results in drastic reduction in the relative humidity levels. (Sujatha and Sujatha, 2004)

Rain shelter

It is a naturally ventilated low cost greenhouse. It possess only roof claddings and has open sides. It is made of GI pipes, wooden or bamboo poles. Cladding is provided with UV stabilized low-density polyethylene (UVLPDE) film of 200μ thickness. The film is economical, 70 to 80 per cent transparent with 2-3 years usable life.

PROPAGATION

I. Conventional methods

Seed propagation

Developing new varieties necessitates crossing and subsequent propagation through seed. The seeds germinate within 10 days and can be transplanted within 4 to 6 months. It may take about 11/2 to 2 years for the seedlings to bloom. The plants developed from seeds also show variability. The seeds are germinated *in vitro* too.

Stem cuttings

Propagation using stem cuttings is the most common method. Top portion of the stem with a few roots is removed (top cutting) and planted. The remaining part of the stem develops side shoots. By repeating this, more number of plants can be obtained

Suckers

Anthurium plants produce suckers from the base of the plant. These suckers, when they grow to 4-5 leaf stage with 2-3 good roots, can be separated and planted. It is better to separate the suckers from the mother plant before they grow into large size.

Leaf axillary bud

Anthurium can be propagated from the axillary buds arising from the leaves. A single leaf with a dormant axillary bud and root is separated from the plant. It is then planted in a pot containing sand and organic matter (3:1).

Root stock cutting

After top cutting, the rootstock is removed from the pot and cut into small pieces, each containing a single node. These pieces are treated with a fungicide and kept in trays of pots containing sand and organic matter (3:1). Adequate drainage should be provided and each node develops into a new plant

II. Improved methods

Tissue culture

Methods have been standardized for the quick multiplication of anthurium hybrids through tissue culture. The substrate (from agar) contains carbon (black) to improve root taking (but without antibiotics). Deflasked rooted plants can be planted out in net pots held in egg trays. Washed fine sand or mixture of coarse sand and leaf mould (1:1) can be used as the medium. Fertilizer mixture containing NPK (3:1:1) at a concentration of 0.2 per cent can be sprayed on the plants at weekly interval. Application of Indofil M 45 (0.2%) is recommended against fungal diseases. Meristem and leaves can be used as the starting points for propagating the anthurium. A major advantage of propagation via meristem is that there are virtually no genetic deviations (mutations).

Artificial seeds or syneeds, consisting of tissue culture derived somatic embryos encased in a protective coating have been suggested as a powerful tool for mass production of elite plant species. Advantages of artificial seeds over somatic embryogenesis for propagation include ease of handling and potential long-term storage. This method holds tremendous potential in the anthurium production industry, because of the feasibility of rapid, large scale propagation of desired genotypes at a reduced cost of production (Redenbaugh *et al*., 1991).

Micro cuttings

Micro cuttings refer to the tops of tissue culture plants transported without agar in plastic containers. These plants are identical to tissue culture, but they are often somewhat larger and stronger.

The cultivation of both tissue culture plants and micro-cuttings requires much experience. Hardening and growing them till bigger plants is very difficult. Without sufficient experience, the chance of loss is very large. This material is always supplied in the form of single plant.

Plugs

Plugs are made by cultivating two tissue culture plants on a plug of oasis (polyphenol foam). to plants with a height of between 8 and 10 cm. The plants are then about four months older than the tissue cultured ones. Plugs cannot be directly processed in beds or final pots (of approximately 17 cm). They should first undergo further growth. under reasonably protective conditions, preferably in a cultivating greenhouse.

Tissue culture (2-3 cm) Plugs (6-10 cm) 7 cm. Pots (10-15 cm)

Plant the plugs in these pots without splitting them (which products much root damage) and put the pots against each other. preferably on a table. Water them regularly with an EC-level of 1.0; making sure that no water can remain under the pots. Keep the temperature at around 23°C (73°F) and maintain a light level of no more than 10,000 lux.

Ensure good relative air humidity of approximately 70 per cent. The small plants must be protected against rain and wind. After the plants have grown for around two months, the pots can be set twice as fair part (spaced). Then, they can be cultivated for another two months until the plant has reached a height of between 20 and 25 cm. To grow plants of 30 to 40 cm. they must be spaced again. The harvest will take about four months longer.

MEDIA AND MEDIA MANAGEMENT

Anthurium cultivation lasts between five and six years. In choosing the substrate it is therefore important to select a material with a stable structure. The substrate must meet the following requirements.

1. It must be able to store water and fertilizers

2. It must easily drain (rainwater)

3. It may not rot

4. It may not fall apart or collapse

5. It may not contain any poisonous substances

6. It must offer the plant sufficient support

7. It must have a course fraction (2-5 cm), so that there is air between these pieces

Most important, the substrate must provide sufficient room for the roots to grow and to store oxygen. In the jungle, Anthurium roots hang in the air or grown on stems covered by moss. They absorb water and oxygen from the moist air and from the surface of the stems. Since there is no transport of oxygen from the leaves to the roots in the plant, the substrate must contain sufficient oxygen.

Highly organic, well aerated, medium with good water retention capacity and drainage is used for growing anthurium. The growing media can be divided into two groups, the so-called inert media (a medium that is unchangeable and does not react with other substances) and non-inert media. Examples of inert media are polyphenol foam (oasis), lava stones, carbon (charcoal, coconut carbon), rockwool, broken clay stones and other types of foam Non-inert media include course peat, coconut shells, sugarcane pulp (bagasse). . rice husks, leaf mould,tree bark, coir pith compost ,wood shavings,etc

A 1:1 mixture of coarse sand and dried cow dung was found to be the cheapest and the best for growing anthuriums in Kerala. Application of *Trichoderma viridae* in the growing medium @ 5 g per pot controls fungal diseases.

Inert media

The advantage of inert media is that they hardly change, not even after several years. Only a fraction becomes smaller. Inert media sometimes retain less water and fertilizers, requiring a good irrigation system for regular irrigation and fertilization. The buffer capacity of these media is lower than those of non-inert media. One should therefore be careful in using chemicals and fertilizers. Oasis is a favorite and is the most widely used in the Netherlands. There are various reasons for this: it retains water very well, it is not too wet and stays extremely airy. If oasis is not available rockwool, or charcoal are very good alternative.

A disadvantage of a synthetic substrate is that there is much refuse at the end of cultivation. This is not good for the environment. Steaming the material for re-use can provide a solution for some substrates

Non-inert media

Non-inert media are usually readily available and therefore inexpensive. However, they have the disadvantage that they change over time. Usually this involves decomposition, requiring the addition of a new layer of medium to the bed. That brings with it a small advantage, incidentally, the buffer capacity is increased as a result. The roots on the bottom of the bed will rot however, since the medium is to compact there and too wet. This is very disadvantageous production drops, problems arise and the plants can even die off. Non-inert media must be regularly supplemented. This stimulates rejuvenation of the plant. Since the plant forms new roots, this will result in a temporary drop in production. Peat and coconut shells are the best types of non-inert media. They will retain their structures for several years. Coconut shells contain much Na and Cl. This can be rinsed out with clean water. At the start of cultivation it contains more than enough K.

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SUBSTRATES

Polyphenol foam (oasis)

Approximately 80 per cent of Dutch anthurium growers use oasis. The products are made from petroleum products. Because of the many small pores, it retains much water. For anthurium cultivation, oasis is in the shape of a course granulate, with much air between the chunks.

The products have a density of 22 kg/m^3. Oasis must first be aired to allow any poisonous gases (formaldehyde) to escape. Oasis is not flexible. When it is depressed, it breaks apart and loses its structure.

Oasis has no buffer capacity for nutrient elements. It is therefore essential to have a good irrigation and fertilizing system. After fabrication, the pH is very low. As a consequence, it must first be lime washed to get the pH to a level that is acceptable for the plant. Per m^3 oasis 1.5 kg of Dolokal (±90% $CaCO_2$) is sufficient. Oasis retains its properties during cultivation, since it is an inorganic material. Once oasis dried out, it absorbs water poorly. This is also the case after steaming the material.

If the substrate is supplemented during cultivation with oasis, a great deal of attention should be paid to wetting down the oasis. With rain pipes that do not work well, dry spots could exist. For this reason, peat is sometimes added to new oasis. It will then take longer to dry out. The amount of polyphenol foam to use will depend on the cultivation system.

1) Beds 840 m^3/ha

2) V-gutter 560 m^3/ha

3) W-gutter 460 m^3/ha

4) Pots 420 m^3/ha

When buying oasis, pay attention to the quality (oasis granulate is a waste product of oasis chunks or flower-pricking foam). It should not become too dusty.

Rockwool

Rockwool is made by melting basalt, limestone and cokes at 1600°C (6100°F), following which it is sprayed on and thrown off a revolving disk. Since solidification takes place during this process, long fibres are produced. Afterwards, binders are added to improve water absorption. For Anthurium cultivation, rock wool in the shape of granulates is used.

The pH of this material is relatively high. When nutrient water with a low pH is used, the granulate depresses. The structure is then fairly stable. This can be partially resolved by growing in pots or in small gutters. Rock wool has no buffer capacity for fertilizers.

Peat

Course, slightly decomposed peat is normally chosen as substrates. They have a high percentage of air and are very stable. Peat has a naturally low pH and must therefore be lime washed. The quantity of Dolokal for lime washing will depend on the type of peat. Over time peat is biodegradable. The extent to which this happens will depend on particle size. Course peat retains it structure better over the years and remains moist

Coconut or coconut shells

Coconut is used as substrate in the shape of chunks (coconut husk). Problems that could occur with this type of substrate are high salt content and high pH factors. Especially coconut shells from coastal trees could contain high concentrations of salts. It would be advisable, therefore, to use shells from trees far removed from the coast

Despite the addition of fertilizers without Na and K, the concentrations could rise in the substrate, if the Na, K and Cl absorbed by the substrate should be released. Regularly rinsing with clean water is therefore advisable

Finally, some substrates cause many problems. These include soil, bagasse (sugarcane pulp), pine needles, sawdust and stones with few pores. We do not recommend the use of these substrates.

Management of the media

Based on a trial conducted in the Kerala Agricultural University, the following recommendation is made with respect to managing the media after planting in pots. Initially the potting mixture is filled to about one-fourth to one-third. Subsequently, with the growth of the plant, fresh medium is added, which will not only encourage the growth of the plant but will also provide good drainage. The repotting time can also be extended. Give a slight raking of the surface of the media once in five to six weeks.

GROWING SYSTEMS

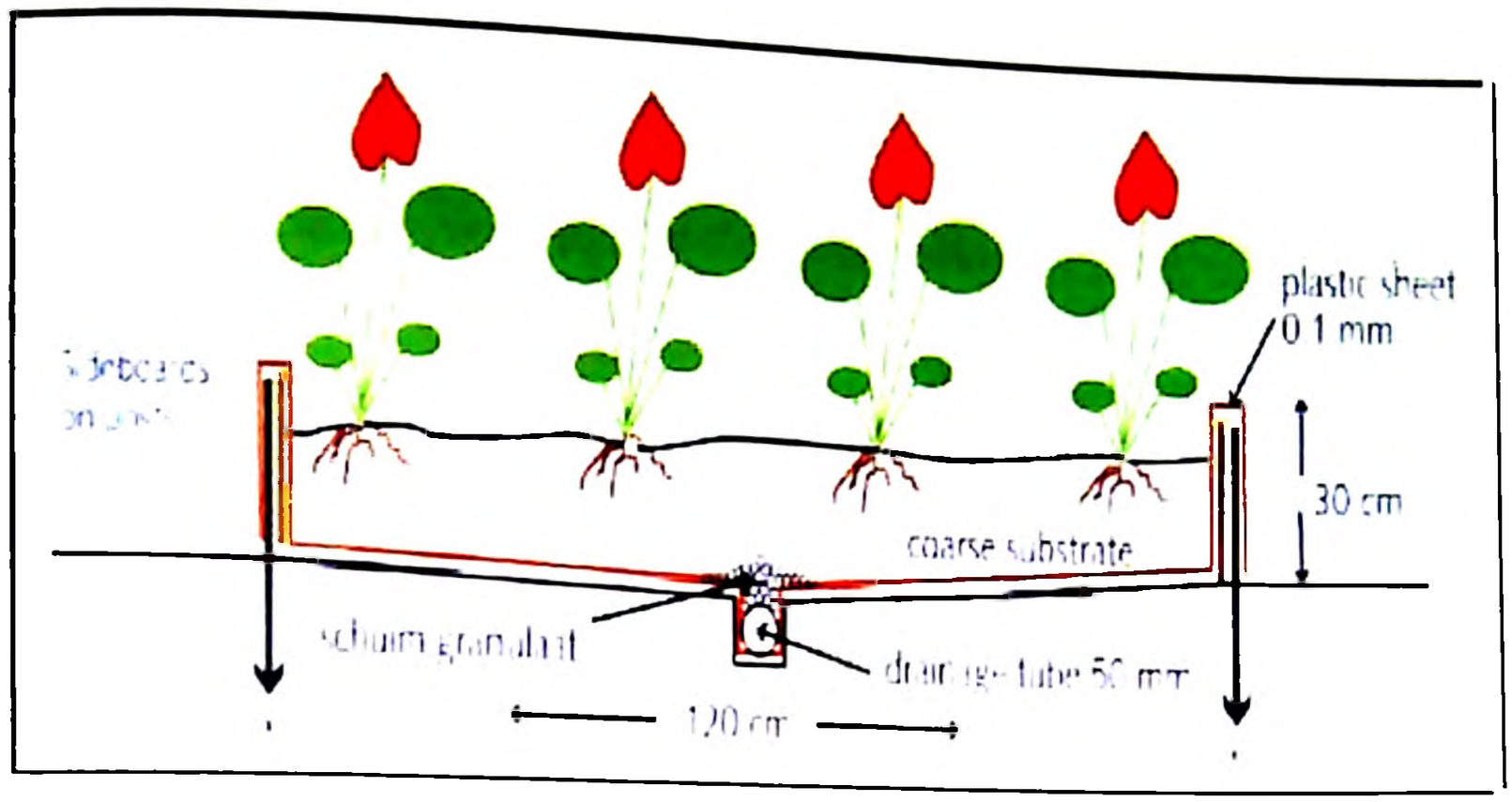
Various growing systems and substrates can be used in anthurium cultivation. The first is the cultivation on the ground. This type of growing system is rarely used in tropical countries. Use is made of beds with natural substrates (such as coconut and bagasse), which is placed directly on the underground. Cultivation on lava cinders, as used in Hawaii (lava "in a field"), is also a type of cultivation on the soil.

All other growing systems are separate from the underground the substrate is separated from the soil to prevent diseases and pests from the soil (such as nematodes) reaching and damaging the roots of the plants. Moreover, by cultivating separately from the soil, the drainage water is captured and water dosage can take place more accurately.

Bed cultivation

The most common type of growing system is cultivation in beds. The bed consists of plastic foil (0.1 mm thick), with a drainage tube for removing excess water located at the lowest point. The side of the bed can consist of a strong polystyrene sheet or other strong material (wood). A wire on posts covered with plastic sheet can also be used to create the bed shape. The bed has a width of 1.20 to 1.40 metres, depending on the distance between the posts of the greenhouse. With a post distance of four metres, one can make two beds of 1.20 meters each with two paths 0.80 metres each. When post

distances are 6.40 metres, three beds of 1.20 metres each can be placed and the paths can be 0.93 metres wide.



In general, beds that are too wide will hamper work on the crop. If the beds are too narrow, on the other hand, there will be relatively much path surface. Narrower paths can be used, however, in the cultivation of miniature anthurium flowers, since this crop does not grow as much in or across the paths.

Land having gentle slope (3.0 cm for every 100 m) is more suitable so that water stagnation could be avoided. If the slope is too steep, the head of the bed could dry out. Planting is done on the beds preferably in four rows in the same potting media as mentioned above. Dense planting prevents proper air circulation and hinders spray penetration. Therefore rigid leaf pruning and spray schedule should be followed to take care of the diseases. Bed cultivation is popular in Karnataka where as pot cultivation is being practiced more in Kerala (Gajanana and Subrahmanyam, 2003)

Pot cultivation

Pots can also be used for Anthurium cultivation. In small scale planting, anthuriums are generally planted in earthen pots. In the tropical planes having high rainfall, as experienced in Kerala, it is advisable to grow anthuriums in pots. A pot size of 23 cm to 30 cm, with a minimum of two holes, is usually preferred. For filling the pots, a crock piece is placed on the hole of the pot at the bottom; above that 2 cm layer of coarse sand is spread. Over this, pieces of bricks or charcoal are arranged in such a way that the plant, along with the root ball, can be placed easily.

Water doses can cause problems in pot. In principle, each dripper spike provides the same amount of water. Differences in plant size can cause the supply of water to deviate from the needs of the plant. Dripper spikes can also become blocked. For cultivation in pots, one must make sure there is good ventilation or drainage under the pots. Good drainage is difficult with cultivation in plastic bags.

Lightweight pots made of different materials like plastic, coir etc are also used now a adays. Lightweight pots can fall over. It is best to make use of racks (for example, wire netting on supports), so that the pots are hanging. Good drainage is also possible then. If the crop is lying flat, it will not come into contact with the growing medium.

As a result, the re-growth of roots higher on the stem is hindered, so that there is no automatic rejuvenation of the crop. The file expectancy of the plants is shorter then in bed cultivation, as a result. An advantage of this pot system is that the spread of disease via the substrate is restricted. Work can take place with a relatively small substrate volume, so that rapid control of nourishment becomes possible.

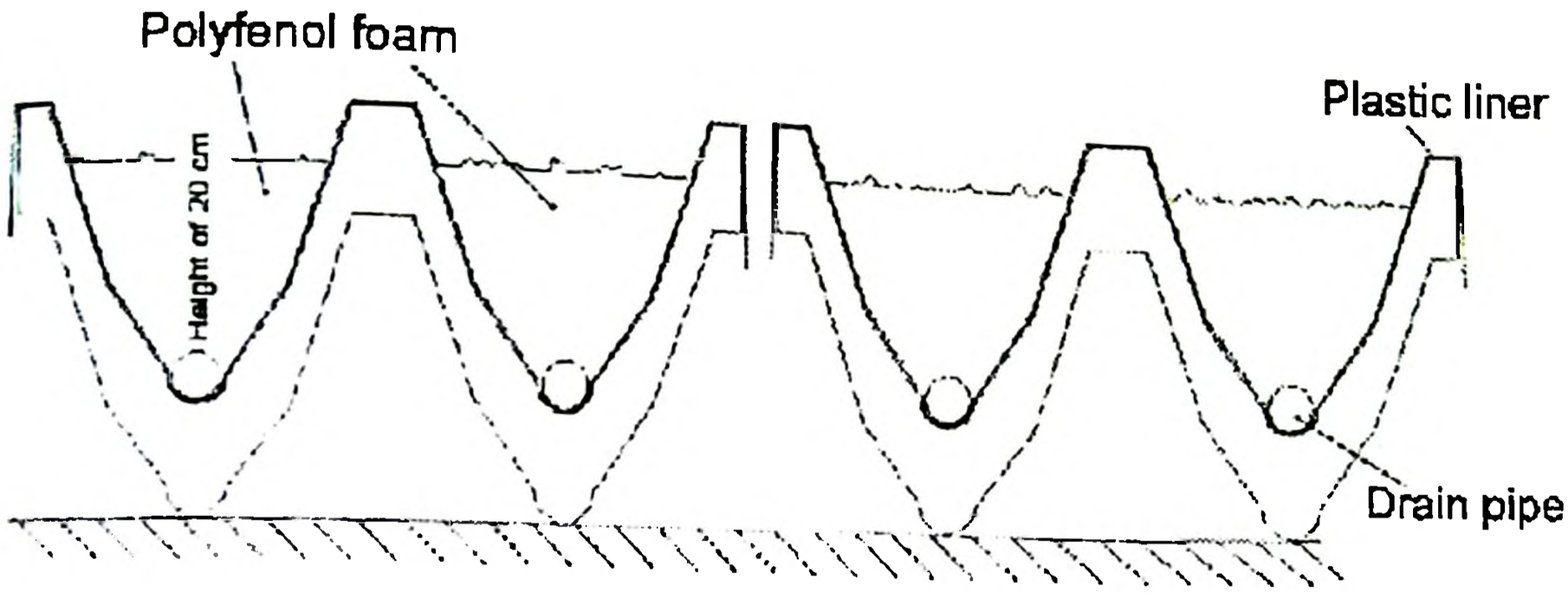
Gutter cultivation

Cultivation in polystyrene gutters is fairly new. There are two types of gutters. Two rows of plants are planted in the V-shaped gutter. W-shaped gutters enable rows of plants to be planted in each gutter. A plastic sheet is placed in the gutters, on top of which is a drainage hose and the substrate. In this way, the polystyrene gutters can be used for numerous cultures.

A V-gutter has one drainage hose. A W-gutter has two drainage hoses. Two rows of gutter are placed per bed. There are two slots in the gutters, one for a potential heating tube and the other for a drainage tube. The gutters are also placed on a small slope

The advantage of gutter cultivation is that it requires less substrate. A smaller volume of substrate enables better control over the cultivation (water dosage, etc.). The polystyrene gutter is also an insulator, so that during the winter (cold climates) there is a saving of heating fuel, since the results in a higher root temperature

than cultivation in beds. A disadvantage of gutter cultivation is that it is an expensive system, but this is compensated because of the use of less substrate.



Bed with 2 w-Gutters 60cm wide`

FERTILIZATION

Anthurium prefers smaller doses of fertilizers and at frequent intervals than giving larger doses at longer intervals. Nitrogen, Potassium, Calcium, Phosphorus, Magnesium and Sulphur are the important elements required in anthurium nutrition The main methods of fertilizer application are.

1). Foliar application

Young plants may be sprayed a fertilizer mixture containing higher ratio of nitrogen (3 1 1) @ 2 g/l, once a week For flowering plants, it is better to reduce the quantity of nitrogen to increase the post harvest longevity of flower. Application of 1 2 2 NPK mixture 2-3 g/l twice a week is found to be beneficial. A deficiency of calcium resulting from low pH can cause fading of the spathe colour and so application of lime @ 5 g per plant per month is recommended Nikado (1994) observed that flower size increased by the application of foliar fertilizers

2). Fertigation

Since anthurium leaves contain a thick layer of wax; fertigation or applying fertilizers to the roots through irrigation water is preferred to foliar application. A subsidiary advantage of fertilization via the irrigation pipes is that the leaves and flowers remain clean. Under green house conditions anthuriums are fertigated with a solution containing nitrogen 14 ppm, potassium 176 ppm, calcium 60 ppm, magnesium 24 ppm, nitrate 91 ppm, sulphate 48 ppm and phosphate 31 ppm, besides trace elements. For plants growing in pots, organic manures dissolved in water can be drenched in the medium once in a fortnight. For this, cow dung or neem cake is mixed with 10-15 times the quantity with water and kept for three or four days. After this, the slurry is filtered and used for drenching the medium. There are also possibilities of using microbial fertilizers/ vermin compost/ coir pith compost along with inorganic nutrients

3). Slow release fertilizers

Slow release fertilizers are preferred during rainy season, when the chances of rinsing out of fertilizers will be high. Slow release fertilizers should be applied only twice or thrice a year. SLF such as osmocote, multicote etc gradually become available for several months

IRRIGATION SYSTEMS

As stated previously, various materials can be used as a growing medium in the bed, depending on the requirements and availability of the material. The medium used for plants grown under a shade curtain must retain sufficient water under conditions where there is little rain. On the other hand, if there is much rain, the growing medium must have good drainage properties. The requirements for water retention of a growing medium used in cultivation under a waterproof roof (such as glass or plastic) are less stringent. The growing conditions will be more manageable.

Generally speaking, there are six different systems for irrigation and fertilization.

1 Natural irrigation through rainfall. Use of slow-release fertilizers (such as Osmocote) or manually pouring of fertilizers on the bed is recommended.

2. Sprinklers above the crop, spraying the bed slowly with slow-release fertilizers or manually pouring the fertilizers.

3. One sprinkler line per bed for irrigation and fertilization.

4. Two sprinkler lines per bed for irrigation and fertilization.

5. Four internal drip lines per bed for irrigation and fertilization.

6. A knot system with one dripper spike per pot for irrigation and fertilization.

Sometimes use is also made of one or two sprinkler lines per bed, in combination with internal drip lines. Often electric valves automatically control the irrigation lines.

Water management

The plants are to be watered at least twice daily during summer months. A thorough irrigation has to be given in the morning; irrigation in the after noon should be timed in such a way as to leave sufficient time for the water to evaporate so that the plants will not be damp during night hours. The method of irrigation practiced in commercial farms is sprinkler irrigation or drip irrigation through which fertilizers are also often given. The optimum pH range is between 5.2 and 6.2. If the pH is too low, colour stability of the spathe will be affected.

HARVESTING

Flower starts opening from base upwards. The stems are harvested when three-fourth flowers on spadix are almost fully developed and the stem is sufficiently hardened. Keeping quality is maximum when $3/4^{th}$ of the length of spadix had changed colour (Kamemoto, 1962). It will take one week for reaching correct stage of harvesting. The flowers are cut in the morning with a sharp knife. The stem is cut diagonally near the bottom. Pulling the knife towards you, holding the stem between the thumb and index finger, makes the cut. The aim is to cut the stem at maximum length. About 3cm of stem will be left on the plant to prevent rotting of the stem. While cutting the flowers with one hand, you should hold the cut flowers in a fan shape in the other

hand. This will cause least amount of damage. The flowers are placed in buckets of clean water without delay, to prevent them from drying out.

FLORAL INJURY

Factors such as mode of transportation, conditions during transport and while in storage at the distributors, time lag from shipment to ultimate sale ("Chain-of-life") are very important in the maintenance of quality and extending shelf life. During summer, flowers are damaged while they are stored in containers left in the open at airports where the temperature within the containers may increase.

VASE LIFE

Anthurium flower has a naturally exclusive appearance. However the flower is easily damaged, which will result in low selling prices. If properly treated anthuriums have a vase life up to 3 weeks. The spathe of anthurium is very tender and highly prone to bruising during handling. This renders stem unsaleable. Besides calcium deficiency also causes colour break down of spathe. The stems of anthurium are highly prone to water stress during storage and transport. The stem should hence be kept in water for the maximum period of time

Anthurium cultivars can be divided into easily declining and non-easily declining according to their vase life. The easily declining cultivars have red phyllaries, while the non-easily declining cultivars have green phyllaries (Guo-Zhao Wu *et al.*, 2003). Although anthuriums are sensitive to low temperatures, they have a long vase life when properly handled. The end of their vase life is usually the inability to draw water from the vase solution and is associated with loss of glossiness and then blueing of the spathe

FLORAL PRESERVATIVES

Pulsing with silver nitrate to improve water relations can extend their vase life considerably. Treat the flowers with 1milli molar silver nitrate (170mg/L) for ten minutes at room temperature improves vase life of flowers. A few other recommended floral preservatives in anthurium are:

I. Pulsing with benzyl adenine (150 ppm) for 8 hours

II. Sodium hypochlorite-73ppm +sucrose 1%

III. Various commercial preservatives like Flora life, Ever bloom, Rose lift etc

Benzyl Adenine treatment is found to be highly effective in improving vase life. BA being a natural anti-senescence compound increases the water uptake and cell integrity (Akhiladevi and Jawaharlal, 2004). Waxing of the spadix tissue was recommended which is now found to result in the discoloration of spathe (Mujaffar and Sankat, 2003). Increase in vase life of anthurium flowers with floral preservatives and carbohydrate soft drinks was reported by Surang (1988).

STORAGE OF FLOWERS

Flowers of anthurium are very sensitive to low temperature. Flowers can be stored wet at 13°c for two to four weeks. The storage below 13°c causes darkening of spathe. The temperature in storage is an important factor for determining the post harvest life of flowers. Flowers stored at high temperature decline due to high rates of respiration and transpiration and at low temperature are subjected to chilling injury.

Natural plant hormone cytokinin plays an important antiageing role in plants. Researchers in Hawaii have identified the genes that regulate cytokinin production in plants. Now they are trying to over express those regulatory genes to increase cytokinin levels and there by increasing the vase life of the flowers.

GRADING

The spikes are graded according to the size of the spathe and length of the stalk. Width of the spathe and length of the spathe along the spadix is taken as the size. The costs of the flowers depend on the size, quality and market preference.

General grade standards of anthurium

1) Proper maturity of spike ($1/3^{rd}$ to $2/3^{rd}$ flowers open)

2) Uniformity of flower colour and size

3) Large and straight stem

4) Glossiness of spathe

5) Free from damage or disease

Table: 5 Grading based on the size of the spathe

Grade	Size (inches)
Extra large	>6
Large	5-6
Medium	4-5
Small	3-4
Miniature	2-3
Pee Wee	< 2
Corsage	< 2

PACKING AND TRANSPORTING

Anthurium flowers are packed in cardboard cartons. Care should be taken that the flowers are protected against physical injury. The cartons are lined with polythene sheets and layers of newspapers. The cut end of each flower stalk should be wrapped with cotton pad soaked with water and covered with polythene strip or wax paper and securely tied. The spathe is enclosed in a polythene cover and the flowers are then placed in cartons.

Now a days display boxes are used where the flowers can be seen from outside The stems should be held tightly in the boxes so that they are not subjected to jerk movements during transport. Non-returnable corrugated boxes are used for transport. The most common used box sizes for packing anthurium are 21.6 x 50.8 x 91.4cm or 27.9 x 43.2 x 101.6cm Flowers are arranged in opposite directions and paper pieces are put in between to keep them intact to provide aeration

MARKETING

In India, anthurium cut flowers are mainly produced in Coorg in Karnataka, entire state of Kerala, Yercaud in Tamil Nadu North-eastern states like Mizoram,

Meghalaya and in some areas near Mumbai in Maharashtra. Farmers are now marketing through various agencies. Mizoram farmers are marketing their produce in Mumbai, Bangalore and New Delhi through an agency named Zopar enterprise (Ghosh, 2004).

How ever the total quantity produced is insignificant when compared to demand potential. By proper recognisation of marketing channel and by resorting to judicious promotional strategies, it is possible to increase the demand of flowers in the coming years. A strong domestic market is the springboard to flourishing export trade. The first step in marketing is to promote more growers to produce anthurium to meet our own internal market.

There is significant rise in demand of cut flowers in the international market. Because of our nearness and availability of regular air flights, there is greater potential for export to Europe, Middle East and even to Maldives.

CONCLUSION

With its myriads of colours, showy spathe, long vase life and growing demand, anthurium is fast becoming a prime cut flower of the tropics. The high humid stretch of the tropical belt offers great scope for growing anthuriums in commercial scale, without much infrastructure facilities. Utilizing the natural resources fully, more scientific location specific systems are to be developed for the better exploitation of the crop. Coupled with this, more attention has to be bestowed on growing superior varieties, adopting latest technology and resorting to better post harvest management including marketing, in order to develop a strong anthurium industry in the country.

In a highly fashion driven technology like floriculture, the preferences change from time to time. The Indian floriculture industry must strive to maintain the existing standards and meet future requirements

1. A hi-tech export oriented postproduction needs of importation of technologies such as pre cooling, cold storage/refrigerated/transport facilities.

2. Up gradation of growing structure, technology and increasing the number of EOU's at a faster rate, construction of auction houses in the important metropolitan cities.
3. Developing domestic markets within the country will impart strength and resilience to the export sector.
4. Raising trained manpower on operational and managerial aspects.
5. Intensive location specific research on production aspects.
6. Co-coordinated action of entrepreneurs, technical experts, growers and traders

DISCUSSION

1). Is there any disadvantage of slow release fertilizer application in anthurium?

Yes. Slow release fertilizers provide only major nutrients or they do not supply minor nutrients. Also it may cause floral malformation in some cases.

2). How many flowers are produced per year?

An average of 6 –8 flowers are produced per year.

3). What are the reasons of high vase life if anthurium?

Ethylene is the hormone responsible for senescence. In orchids and anthuriums ethylene production is very slow. It may be the reason of extended vase life.

4). It is said the plants of the aroid family like Dieffenbachia are toxic. Do anthurium possess any such property?

Yes. The plant is toxic. If eaten in large quantities, it causes skin irritation and cause severe pain in mouth. This effect is due to the presence of calcium oxalate crystals

5). What is the average economic life span of an anthurium plant?

Average economic life span is about six to seven years. The plant will start giving good quality flowers from third year onwards.

6). Why anthurium planting is not recommended under coconut plantations?

In coconut plantations there is no control over light. Anthurium requires more systematic shade conditions. So it is not generally recommended under coconut plantations

7). What is flori card scheme?

The krishibhavans in some districts have launched the state government's flori card scheme. It helps the cardholder to receive loans up to Rs.25, 000 from the State Bank of India

8). Which are the sources of planting materials in Kerala?

- TBGRI,Palode
- Model floriculture and Tissue culture unit, Kazhakkoottam
- Hafi Orchids, Kalamassery
- Kairali Orchids,Edappally
- Deep Biotech,Edappally
- Toyo Floriculture Company, Quilon etc

9). Are their any societies for self-help in cultivation and marketing in Kerala?

Yes. There are many. One such society tucked away in the rural area of the Ernakulam district is anthurium cut flower society. It is the dream child of Jose Vallookkaran and Saju T.D.of Karukutty village. It was started in 1999,armed with 500 plants. At present there are 150 members in the society. The society helps in providing loans and subsidies from various banks, Krishibhavan and CADA for building greenhouses and setting up farms.

The society covers Ernakulam, Aleppey and Thrissur districts of Kerala and delivers about 1500 flowers every week. The collected flowers are taken to private sellers who send them to cities like Delhi, Kolkata, Mumbai and Bangalore. The society gives award to the best anthurium grower.

10). What is the price of an anthurium flower?

The price is around Rs 2.0-2.5 per inch of the spathe across. In season (August-February), the cost of a 6-inch flower comes to about Rs 13.

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ABSTRACT

Flowers are fast emerging as potential money-spinners for many third world countries. The fact that the global floriculture trade is expanding at the rate of 15 per cent itself indicates that floriculture is emerging as the most lucrative business recently.

A glance at the world trade of cut flowers reveals that the top ten privileged ones hail from the subtropical and temperate regions. They have a hoary past and have colorful tales of their own. Closely following the list is anthurium, the legendary tropical 'flower with a tail'.

Anthurium is native to the western slopes of the Andes, in Southern Columbia and Northern Ecuador. Ranked 11th in the global trade anthurium is next only to orchids among tropical flowers. India is endowed with agro climatic conditions congenial for growing anthuriums. It is grown in Kerala, Karnataka, Tamil Nadu, NE states like Mizoram, Meghalaya, Sikkim etc. The zonation of Kerala with respect to floriculture also gives due importance to anthuriums in the state.

Anthurium constitutes the largest genus of the family Araceae. It consists of over 500 species of which *Anthurium andreanum* is used for cut flowers. Some of the popular varieties are Tropical, Elan, Cancan, Agnihotri (red), Nitta, Gino orange (orange), Acropolis, Titicaca (white), Marian seefurth, Cheers (pink), Fantasia, Red dragon (obake), Midori, Pistache (green) etc.

Anthuriums thrive best at a temperature between 18 and 28^{0}C, require RH of over 70 per cent and 70 - 80 per cent shade. Yield and quality in anthuriums are much influenced by light intensity. High temperature coupled with poor aeration is an important problem for growing anthuriums during summer season, particularly in the plains.

In vitro propagation is the reliable and fast method of obtaining large collection of clonal plants. Tissue cultured plants, micro cuttings, plugs etc are gaining popularity now. The media used in anthurium are wood shavings, coarse sand, leaf mould, small brick pieces, coir pith compost, charcoal, coconut pieces, etc. Sugar cane bagasse is used in some places. People are now changing to synthetics like polyphenol foam (oasis), rock wool, lava stone, pine bark etc.

Studies have shown that initially the potting mixture need be filled to about one-fourth to one-third. Subsequently, with the growth of the plant, fresh medium is added,

which will encourage the growth of the plant, providing good drainage and delaying repotting time.

In Coorg anthuriums are cultivated in beds, where as pot cultivation is popular in Kerala. Cultivation in the high rainfall areas can better be done under a rain shelter, which significantly improves the quality of flowers and reduces mortality of plants. V-channel/gutter cultivation is becoming popular now, which requires less substrate.

Fertigation is preferred to foliar application of fertilizers. However during rainy season the chances of rinsing out of fertilizers will be high. Hence slow release fertilizers (SLF) such as osmocote, multicote etc are preferred which need to be applied only two to four times a year.

Anthuriums have a vase life up to three weeks. Waxing of the spadix tissue was recommended which is now found to result in the discoloration of spathe. Optimum storage temperature for anthurium is between 13 and 18^{0}C. This deprives the grower to transport it together with several other flowers that require still lower temperature.

With its myriad of colours, showy spathe, long vase life and growing demand, anthurium is fast becoming a prime cut flower of the tropics. The high humid stretch of the tropical belt offers great scope for growing anthuriums on commercial scale. Utilising the natural resources fully, more scientific and location specific systems are to be developed for the better exploitation of the crop. Coupled with this, more attention has to be bestowed on growing superior varieties, adopting latest technology and resorting to better post harvest management including marketing, in order to develop a strong anthurium industry in the country.