NUTRITIVE VALUE AND ORGANOLEPTIC EVALUATION OF THAMARA VENDA GENOTYPES

(Abelmoschus caillei)

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "Nutritive value and organoleptic evaluation of Thamara venda genotypes (*Abelmoschus caillei*)" *is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.*

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1. INTRODUCTION

Nutritional know-how, coupled with judicious selection of the locally available seasonal items, can go a long way in the formulation of a balanced menu. In addition to adequate proteins and calories mainly procurable from carbohydrates and fats, a balanced diet should also have an adequate supply of vitamins and minerals. Here comes the importance of vegetables in the human dietary.

Vegetables are described as protective foods in the light of different vitamins and minerals they contain. Yellow vegetables provide vitamin A and green leafy vegetables furnish high quantities of calcium and iron in addition to vitamin A. The young tender growing leaves have more ascorbic acid than the mature ones.

There is yet another component of a balanced diet which is often forgotten - the dietary fibre. Lately, this component has attracted the attention of nutritionists who now consider it no less important than the other dietary essentials (Kanwar *et al.*, 1997). Importance of vegetables is again highlighted here as they being the good sources of dietary fibre for mankind.

Okra (*Abelmoschus esculentus* (L.) Moench.), belonging to the family *Malvaceae* is a native of tropical Africa. It was grown in the Mediterranean region even in the distant past. It is an important

summer vegetable crop valued for its immature and green fruits in India and other parts of the world. It is described as a crop with great potentials of import and scope for boosting the quality production to earn maximum profit. Okra is an important vegetable in the tropics and subtropics and is grown widely in the whole of northern India both for vegetable and seed purposes. In Kerala, this is one of the popular vegetables grown round the year either in the garden land or in rice fallows.

Okra has good nutritional value and it is a popular, tasty and gelatinous vegetable used in a number of local dishes. It is valued for its young tender pods which are rich sources of different minerals and vitamins. Its average nutritional value is far superior in comparison with that of tomato and brinjal. The young tender pods can be cooked in curries, stewed, cooked into soups and also canned and dried. Okra is a rich source of calcium, phosphorus and other mineral matters. Apart from these, okra mucilage and okra seeds are also valuable by-products. Okra mucilage is essential in certain cooking patterns and is even decribed to have hypoglyceamic properties. Okra seeds are rich sources of proteins which are comparable to that of soybeans.

The prevailing situation of wide spread malnutrition and the alarming rate of population explosion have directed the scientists to explore the untapped nutritional sources. Researches in this area have shown the importance of many crops which were rather

unnoticed. It is imperative on the part of the Government to exhort people to take nutritious food and the type of vegetables to be used regularly.

There are a large number of vegetables on which no systematic studies regarding their nutritive value have been done. The Guinean type of okra (*Abelmoschus caillei*) is a second edible okra species with a distribution limited to West and Central Africa. It is also cultivated in Kerala to a very small extent. It has been shown that Thamara venda, as it is locally known , adorns many remarkable traits like perennial nature, resistance to Yellow Vein Mosaic Virus (YVMV), good cooking qualities etc. (Chacko, 1996). Being an under exploited crop, no serious attempt had so far been conducted to analyse the nutritive value and organoleptic qualities of *Abelmoschus caillei.* In this context, a study is being undertaken with an objective to analyse the nutritive value and organoleptic qualities of *A. caillei* at different maturity levels.

Review of Literature

2. REVIEW OF LITERATURE

Thamara venda *(Abelmoschus caillei)*, an under exploited vegetable is the Guinean type of okra which is the second edible okra species with a distribution limited to West and Central Africa. It is cultivated in Kerala to a very small extent.

Since the research work done on this particular vegetable is very meagre, literature pertaining to relevant aspects of *Abelmoschus* species and also of other indigenous vegetables are reviewed here.

The literature colleted is presented under the following heads:

2.1 Nutritional importance of vegetables

2.2 Nutritional importance of okra

2.3 Nutritional composition of okra at different maturity levels

2.4 Studies on under exploited vegetables

2.5 Organoleptic evaluation

2.1 Nutritional importance of vegetables

The nutritional contribution of different vegetables is sufficiently varied that it is wise to serve a variety of vegetables to ensure that all the necessary nutrients from the vegetable category

are included in the diet. Calcium and iron are the two minerals found in significant amounts in vegetables. Vegetables also help to meet the body's need for sodium, chlorine, cobalt, copper, magnesium, manganese, phosphorus and potassium. Vegetables are useful in the diet for their cellulose content. They provide the roughage necessary to promote motility of food through the intestines (McWilliams, 1974).

Mudambi and Rao (1985) reported that fat content of vegetables other than green leafy vegetables and roots and tubers is negligible and therefore the calorie content per 100 gram varies from 40-80 kilo calories depending on the carbohydrate content. According to Passmore and Eastwood (1986), the value of vegetables as a source of energy is very small. Most provide from 10-50 kilo calories per 100 g. The large bulk of vegetables helps to promote satiety and this, with their low energy value makes them useful in the prevention and treatment of obesity. According to the authors, the chief nutritive value of vegetables is as a supply of beta carotene, ascorbic acid and folate.

The main purposes of vegetables in a human diet are that they embellish the existing diet with nutrients, enrich the staple main food, make it more palatable and improve the digestion and sometimes they have a curative action (Indira and Peter, 1988). Gopalan *et al.* (1989) reported that vegetables other than green leafy vegetables and roots and tubers not only add variety to the diet but

also provide vitamin C and minerals.

Recently one component of vegetables, dietary fibre, has got wide attention. It has been described as a protective agent against many of the present day diseases of affluence. Cashel and Lewis (1990) are of the opinion that the dietary fibre content of foods has been a major area both of demand for data and provision of a confusing number of options. In an Australian study conducted by Jones *et al.* (1990), the dietary fibre content of different vegetables were found out. It was revealed that these vegetables varied quantitatively and qualitatively in their dietary fibre content. The fibre content of most vegetables, according to them, fell within the narrow range of 1-4 per cent.

Manay and Shadaksharaswamy (1995) opined that the intake of the vegetables has been too low in our daily diet because we are not able to appreciate the vast potential of vegetables in our diet and therefore continue to depend too much on cereals. Though we have made some progress in increasing the production of food grains, our performance in respect of fruits and vegetables has lagged behind. Vegetables are cultivated in about 5 million hectares with a production of 32.5 million tonnes.

National Institute of Nutrition (1996) analysed vegetables like tomato, capsicum, bottle gourd, french beans, brinjal and field beans and reported that the dietary fibre content of these vegetables

varied from 1.7 to 6.6 per cent.

Vegetables play a pivotal role in our health security which is endangered by the malnutrition of the protective foods. Among protective foods, vegetables are excellent sources of roughage, carbohydrates, protein, vitamins and minerals like calcium and iron (Dutt, 1996; Ramesh *et al.*, 1997).

Vegetarianism is mushrooming all over the world now. It has been given an official approval in the American Government's revised Dietary Guidelines for Americans (Sheth, 1997). Contrary to the popular belief, people who follow vegetarian diet are not likely to suffer from nutritional deficiencies. According to the author, a vegetable diet should be well balanced and low in fat. Vegetarianism not only reduces the food costs but also lower blood cholesterol, Non Insulin Dependent Diabetes and has lower risks of developing some of the serious scourges of mankind like atherosclerosis, diverticular disturbances of colon, haemorrhoids, gall stones and even constipation and obesity (Kanwar *et al.*, 1997).

Indian Council of Medical Research recommends that an adult should consume about 300 g of vegetables daily. When compared to the consumption rates of developed countries, Indians on an average consume only about 120 g of vegetables per day (Rani *et al.*, 1997).

Coming to the Indian scenario, the country has a variety of

soils and climates. Consequently fruits and vegetables we grow are unmatched for variety, tastes and uses. Fruits and vegetables have been part of our dietary and woven intricately into eating patterns in various parts of the country (Prasad, 1981). Vegetables form an important component of the Indian dietary in which they are normally prepared and consumed in the form of different types of curries as traditionally formulated in various regions of the country. They are also important as components of the rations for troops in forward areas and on board ships and submarines (Jayaraman *et al.*, 1991).

2.2 Nutritional importance of okra

Okra is reported to be of African origin and was introduced into the United States and West Indies under the Spanish name "Gumbo". It grows in many parts of the world viz. India, Malaysia, the Philippines, West Asia, the Meditarranean region, Central-East and West Africa, Central America and in general, throughout the tropics (Cooke, 1958).

Okra has good nutritional value and it is a popular, tasty and gelatinous vegetable used in a number of local dishes (Grubben, 1977; Markose and Peter, 1990). Martin and Ruberte (1978) attributed okra's popularity to its adaptability and resistance to hot and humid weather.

The total production of fresh vegetables (excluding onion and potatoes) in India is estimated as 12 million tonnes, out of which bhindi alone constitutes 2.7 million tonnes per annum (Sundaram, 1979). According to the author, India's annual export of vegetables is of the order of about 4,000 to 5,000 tonnes, 50 per cent of which is okra alone.

Okra (*Abelmoschus esculentus* Linn., Family *Malvaceae*), an annual herb of semihardy nature is valued in India and other countries for its delicious and nutritious edible green pods (Kalra *et al.*, 1982; Dutta, 1991; Saimbhi, 1993; Pulekar *et al.*, 1993 and Babu *et al.*, 1994). Stone *et al.* (1986) reported that in addition to use in the fresh state, okra may also be preserved for later use. It is no doubt that bhindi is one of the most important fruit vegetables grown throughout the tropics and warmer parts of the temperate zone (Thomas *et al.*, 1991; Sharma and Arora, 1993). Markose (1991) opined that okra has nutritional, economic and medicinal importance.

Pal *et al.* (1951) indicated that okra contains 740 IU of beta carotene, 0.08 mg of thiamine, 0.07 mg of riboflavin, 30 mg of ascorbic acid and 1.1 mg of niacin per 100 g. According to Aykroyd *et al.* (1956), tender pods of okra are a rich source of minerals, lecithin and other phosphorus compounds.

Studies by Singh *et al.* (1976) indicated that salinity caused a

considerable decrease in the protein content, negligible change in sugars, crude fibre and a measurable adaptive increase in ascorbic acid.

Okra is a vegetable of high nutritive value grown all over India. The Average Nutritive Value of okra is 3.21 which is higher than tomato, egg plant and most cucurbits except bitter gourd (Grubben, 1977; Butani *et al.*, 1978). According to Arlin (1977), cooked okra pods give 91 per cent water, 25 K cal of energy, 2 g protein, fat in traces, 5 g carbohydrates, 78 mg calcium, 0.4 mg iron, 420 IU vitamin A, 0.11 mg thiamine, 0.15 mg riboflavin, 1.8 mg niacin and 17 mg ascorbic acid per 100 g. Ascorbic acid content of okra was found to be 203 mg per 100 g in a study by Keshinro and Ketiku (1979).

Kalra *et al.* (1982) studied and reported the following values for different proximate principles of okra pods on fresh weight basis: moisture 88.5-91 per cent, protein 0.91-2.1 per cent, fat 0.21-0.44 per cent, crude fibre 0.73-1.8 per cent, reducing sugars 1.08-2.81 per cent, total sugars 2.25-3.36 per cent, and total ash 0.6-0.7 per cent. According to Achinewhu (1983), ascorbic acid content of fresh okra was high (98.8 mg /100 g) but losses through exposure and traditional cooking methods were considerable.

Several authors have reported that green tender fruits of okra are rich in vitamins, proteins, calcium, iron, magnesium and other

minerals. Okra with its rich calcium content provides a valuable supplementary item in the tropical diet which is basically starchy in nature lacking calcium and iron (Markose and Peter, 1990; Dutta, 1991; Nath *et al.*, 1994). 100 g of ladies finger contains 1.9 g of protein, 1.2 g of fibre, 35 K cal of energy, 66 mg calcium and 56 mg phosphorus (Gopalan *et al.*, 1989).

Hirst and Jones (1958) described mucilages and gums as water soluble polysaccharides found in wide spread number of plants. According to the authors, different varieties of okra are used because of their different content of mucilage, the mucilaginous variety being more popular in West Africa and Creole cookery.

According to BeMiller (1973), okra mucilage behave like egg white at higher concentrations, forming threads and stabilising foams and hence have been found to have potential uses as an extender for serum albumin and as an additive to the dried egg white.

A typical Ghanian okra soup, as mentioned by Wolfe *et al.* (1977) would contain approximately 0.2-0.3 per cent mucilage by weight. They observed that okra mucilage which was an acidic polysaccharide composed of galacturonic acid, galactose, rhamnose and glucose. A study by Mahdy and Sebaiy (1984) revealed the pH values of 1 per cent solution of extracted okra mucilage as 6.9-7.5. According to them, the constituents of okra mucilage are high in

ash, protein and also in methyl pentose, glucose, galactose and fructose.

Tomoda *et al.* (1985; 1987; 1989) reported that okra mucilage was one of the most important major plant mucilages. They observed considerable activity for most of the mucilages isolated from members of *Malvaceae* and especially the *Abelmoschus* spp. Later they reported that the mucilages obtained from *Abelmoschus esculentus*, *Hibiscus moschatus* and *Hibiscus syriacus* had anticomplementary and hypoglycemic properties. According to Kotzekidou and Roukas (1986), the normal pH of okra fruit was between 5.8-6.4.

Karakoltsidis and Constantinides (1975) analysed whole okra seeds for its chemical composition and compared them to soybean and described them as potential seed protein, for the first time.

In a study of okra seeds, Savello *et al.* (1980) observed that grinding and sifting produced a meal with 33 per cent protein, 26 per cent lipids and 6 per cent ash. Protein had a chemical score of 55 with isoleucine as the limiting amino acid. According to the authors, minerals of whole seed included 135 mg of calcium per 100 g and 335 mg of magnesium with much lesser amounts (<5 mg) of copper, iron, manganese and zinc.

Six varieties of okra seeds were analysed by Kalra *et al.* (1981)

and found that protein content of different varieties varied from 18.5 to 29.1 per cent on dry weight basis. Further results of fractionation of protein in variety Pusa Sawani revealed that albumin, globulin, prolamine and glutelin accounted for 26.1, 29.2, 13.3 and 16.4 per cent of total nitrogen respectively.

Wandawi (1983) described okra seeds as potential high protein sources because of its high lysine level. It can serve as a supplement to cereal based diets in which lysine is generally the first limiting amino acid. Elements like potassium, sodium, magnesium, calcium, iron, zinc, manganese and nickel are also abundant in okra seeds.

Jideani and Adetula (1993) investigated the use of maize, soybean and okra seed flour in weaning food formulas. They reported that the inclusion of okra in the blend increased protein and fat relative to soybean-maize blend.

In a study by Siddiqui *et al.* (1994), protein content and pepsin digestibility of unconventional seed proteins were analysed. The respective values for okra seeds were found out to be 90 per cent and 59.3 per cent. In a similar study, Grant *et al.* (1995) reported that okra seeds contained low levels of essentially non toxic lectins, moderate amounts of trypsin inhibitors and negligible quantities of alpha amylase inhibitors and therefore had great potential as dietary protein sources for man and livestock.

Martin *et al.* (1979) processed okra seeds into a curd which contained 33.0-43.0 per cent protein, 40.9-52.6 per cent oil and 0.011-0.039 per cent gossypol in dry mass. Okra seed curd, according to them, was an attractive food which can be prepared in the home or by large scale processing. The authors also found that oil content of okra seed was 18.1 per cent on dry weight basis.

Kalra *et al.* (1981) analysed six varieties of okra seeds and found that oil content of okra seeds varied from 13.5 per cent to 22.7 per cent on dry weight basis. The variety Pusa Sawani contained the highest oil content.

Randel (1981) is of the opinion that the hammer milled okra seeds are not accepted and are of doubtful value unless possibly improved by finer grinding and sieving.

Okra seed is a good source of oil and many scientists have included it under lesser exploited source of oil (Devapalin *et al.*, 1982; Lakshminarayana, 1987).

Bryant *et al.* (1988) observed that okra seed products had significant potential as viable new protein source. The protein solubility indicated that the okra seed products were generally more soluble than common soya products.

Rao *et al.* (1992) observed that the whole okra seeds contained

15 per cent oil compared with 33 per cent in kernels alone. The crude oil could be refined to yield an edible grade oil. The seed meal had a protein content of 42 per cent and is rich in several amino acids.

There are many observations on the content of gossypol, a toxic chemical in okra seeds. Goldblatt (1969) reported that gossypol irritated the gastrointestinal tract, led to pulmonary oedema of lungs, paralysis and in extreme cases, even death.

Karakoltsidis and Constantinides (1975) reported that gossypol content of okra seed was insignificant (3.2 mg per 100 g dried seeds). This amount is believed to be too low to be toxic. Martin *et al.* (1979) found that gossypol content of okra seed oil was only 7 mg per 100 g of dried seeds.

According to Martin (1982), okra can be described as a potential multi purpose crop for the temperate and tropic zones. The immature okra pods are commonly consumed as a vegetable. In addition, okra has attributes that could permit it to be used for other purposes. Leaves, buds and flowers are edible, dried seeds could provide oil, protein, vegetable curd and a coffee derivative or substitute. Foliage could be used for biomass and dried stems could serve as a source of paper pulp or fuel.

2.3 Nutritional composition of okra at different maturity levels

Studies were carried out by Chauhan and Bhandari (1971) on the cultivar Pusa Sawani to determine times of harvest for fresh consumption and for seed production. According to the authors, pods should be harvested for consumption 6-9 days after flowering for tenderness, maximum protein content (2.08 %) and low crude fibre.

According to Iremiren and Okiy (1981), growth of okra plants from early sowing was vigorous than that of the plants from later sowings and they flowered earlier and had a longer harvest duration. They also reported that sowing dates did not generally affect the percentage of moisture, oil and protein in the pods.

Protein and free sugars decreased with age whereas fibre, starch and unavailable carbohydrates increased with age (Longe *et al.*, 1982). There were differences, anyway, among the varieties in the content of soluble sugars and structural carbohydrates.

Variation exists in plant and pod morphology, seed and life sizes or shapes of local and improved cultivars of okra although days to flowering is the most important character in separating the okra genotypes (Ariyo and Aken'ova, 1986).

Balasubramanian and Sadasivam (1987) conducted chemical analyses from 7th-42nd day after flowering and reported that during the early stages of maturation, the soluble components like non-protein nitrogen, free amino acids and total sugars were present in higher quantities than in later stages. Protein, oil and starch contents increased gradually from 7th-42nd day. The rate of oil accumulation was highest between 21-28 days after flowering.

The contents of twenty elements were determined in the substrate and in developing okra plant cultivars like Perkins Dwarf and Feher Torpe by Hodossi and Pankotai (1987). According to them, phosphorus, copper, sodium, iron, aluminium, titanium and nickel contents of the leaves decreased and there was an increase in the potassium content during development. Zinc, phosphorus and iron content of the fruit decreased and silicon increased with age. In Perkins Dwarf, there was a decrease in the content of copper and an increase in boron and aluminium. Seeds were richer than the pericarp in aluminium, iron and zinc.

According to Bhuibhar *et al.* (1989), each of the various phases of the plant requires a particular set of climatic conditions for its satisfactory performance which is a determining factor in the yield. They found that the vegetative growth of okra was the best when sowing was done on 4th July as compared to later sowings.

In a study by Singh *et al.* (1990), it was revealed that there

was a gradual increase in fresh weight and dry weight of the fruits upto 21days after fruit set. Nitrogen, phosphorus, iron, protein and starch contents decreased gradually with the age of the fruits whereas crude fibre content increased with age. Sugar content, increased upto 8 days and declined thereafter. Results indicated that fruits should be harvested 6-9 days after fruit set for maximum crop.

Iremiren *et al.* (1991) opined that the age at which the okra pods were harvested had no effect on vegetative growth or pod yield per hectare. However, pods harvested 7 days after pod set were of poorer quality mainly due to an increase in crude fibre and reduction in moisture, crude protein and ash contents.

Nataray *et al.* (1992) reported that the nitrogen rates and picking levels did not significantly affect the quality parameters except seed protein content which increased with the rate of nitrogen application to the mother plant.

In a symposium on small scale vegetable production in Indonesia, Ketsa and Chutichudet (1994) revealed that the pericarp and seed soluble solid contents and pericarp fibre contents increased with pod maturity while there was a decrease in the pericarp ascorbic acid and pod calcium pectate towards pod maturity.

Studies conducted by Thind and Malik (1995) on germinating okra cultivar Pusa Sawani, it was observed that the accumulation of starch in the embryo axes and the cotyledons started after 24 hours and continued till 72 hours into germination. According to the authors, high activity of isocitrate lyase in the cotyledons indicated the operation of glyoxylate cycle which converts stored lipid into carbohydrates.

2.4 Studies on under exploited vegetables

As the prospects of food shortages become more and more acute, people must depend increasingly on plants rather than animals for protein in their diet (NAS, 1975a). The increasing food shortage problem in relation to population explosion and the widespread malnutrition have demanded the exploitation of unutilised and under-utilised resources of foods rich in nutrients.

As reported by CSIR (1972), the seeds of *Solanum nigrum* commonly called 'manithakali' contained 17.5 per cent protein and the fruits also contained glucose, fructose, vitamin C and carotene. *Solanum torvam* commonly called as 'anachunda' is another under-exploited vegetable and the dried fruits contain about 8.3 per cent protein, 12.3 per cent moisture, 1.7 per cent fat, 5.1 per cent minerals and 17.6 per cent crude fibre.

The young shoots and tender leaves of 'Chaya', an under-

exploited vegetable, is reported to be high in protein, calcium, iron, thiamine, riboflavin, niacin and ascorbic acid (NAS, 1975b).

Imungi and Potter (1983) reported that cowpea leaves contained a high quantity of minerals including iron, calcium, phosphorus and zinc. Levels of vitamin C, total carotene and free and total folacin were 410 mg, 57 mg, 334 mcg and 2012 mcg respectively per 100 g of solids.

Khalil *et al.* (1986) investigated the chemical and cooking characteristics of field pea (*Pisum arvense*), moth bean (*Vigna aconitifolia*) and pigeon pea (*Cajanas cajan*). They reported that the crude protein content was 24.5 per cent for field pea, 22.7 per cent for moth beans and 21.3 per cent for pigeon pea on 8.5 per cent, 10 per cent and 10 per cent moisture basis respectively.

Prakash *et al.* (1993) reported that the seeds of *Chenopodium* species contained 106-142 g / kg protein and 30-62 g / kg fat.

In another study, four wild leafy vegetables in Coted'Ivoire were analysed by Herzog *et al.* (1993). The leaves were found to be good in iron and calcium. Special attention was drawn to their contents of mucilages.

Study on free aminoacid content in certain nonconventional leafy vegetables detected twelve free amino acids including seven

essential amino acids in various concentrations. Particularly the three wild species exhibited very impressive amino acid profiles indicating their high nutritive value (Handique, 1993).

Nutritive value of some selected Tanzanian plant food sources was analysed by Mnembuka and Eggum (1993). According to them, the nutritive value of plant materials between species as well as between varieties within species differed considerably.

In a similar study conducted by Yeoh and Wong (1993) to find out the nutritive value of lesser utilised tropical plants, it was revealed that these were rich in protein, had a good complement of amino acids and favourable amounts of minerals, sugars, lipids and fibre. Further more, antinutritional factors, such as trypsin and chymotrypsin inhibitors and cyanide were not detected. Overall, these plants represented potential food sources with high protein content and good nutritive value.

Crude protein content of the desert truffles *Tirmania nivea* and *Terfezia boudieri* was found to be 16.3 per cent and 12.82 per cent respectively (Ibrahim and Saeed, 1994). According to Aghora *et al.* (1994), the protein content of vegetable cowpea ranged from 2.5-5.94 percent.

According to Kuriakose (1995), the stolons of lotus which can be used as a vegetable is a fair source of protein (2.7 %) and a poor

source of fat (0.11 %) and fibre (0.8 %).

Udosen (1995) conducted studies to find out the proximate and mineral composition of lesser known Nigerian vegetables in order to determine their nutritive value. He studied *Ocimum bacillicum*, *Colocasia esculentus*, *Manihot utillisima*, *Marsdenia latifolium*, *Piper guineense*, *Vernonia amygdalina* and *Ocimum veride*. The moisture content ranged from 69.4 to 90.0 per cent. The ash, crude fat, crude protein and crude fibre contents of the leaves in mg per 100 g dry matter ranged from 4.5-10.9 per cent, 2.7-9.0 per cent, 13.1-21.7 per cent and 8.0-21.5 per cent respectively.

Water leaf is a green leafy vegetable that grows in a semi-wild environment in the tropics. Akachukku and Fawusi (1995) reported that the nutritive value of water leaf compared favourably with other vegetables.

Wesche *et al.* (1995) studied the nutritional value of wild species of Amaranthus and observed their potential as a food source. Histochemical studies showed higher levels of starch in leaves of some species, moderate amounts of tannins in all leaves, high protein concentration in stems and leaves and moderate amounts of alkaloids in tissues.

Awoyinka *et al.* (1995) reported the nutrient content of young cassava leaves and assessment of their acceptance as a green

vegetable in Nigeria. Cassava leaves contained a high level of crude protein (29.3-32.4 % on dry weight) compared to amaranthus (19.6 %). Ash content was 4.6-6.4 per cent in cassava leaf samples but 13.1 per cent on dry weight in amaranthus. Dietary fibre was very high in all samples (26.9-39 % on dry weight) while cyanide potential was low.

The unconventional leafy vegetables found in the forest and cultivable wasteland of Konkan like drumstick leaves, math, katemath, bharangi and kawala contained comparatively higher amounts of crude protein, crude fat, ash, crude fibre and total carbohydrate (Shingade *et al.*, 1995).

Nutritional evaluation of another under exploited crop, Rabi french beans as carried out by Singh and Sood (1997) revealed that moisture, crude protein, ether extracts, crude fibre, mineral matter, carbohydrates and energy of the varieties of beans ranged from 9.9-10.71; 20.65-22.75; 3.54-4.23; 1.54-1.63; 3.58-8.65; 57.70-59.77 per cent and 376.46-378.94 K cal per 100 g respectively.

2.4.1 Thamaravenda- a perspective

Thamaravenda, in the beginning, was considered to be a form of *Abelmoschus manihot* belonging to the family *Malvaceae*. This species forms were mainly cultivated in West Africa, Papua New Guinea and sparsely grown in the Indian sub-continent

(Waalkes,1966). This plant is mainly cultivated for its tender pods for use as vegetable and for fibre and mucilage in industry. It is resistant to YVMV (Arumugham and Muthukrishnan, 1975), powdery mildew (Mc Leod *et al.*, 1983; Jambhale and Nerkar, 1983) and Jassids (Jambhale and Nerkar, 1992), therefore being tried in inter-specific hybridisation with the ultimate aim of developing a resistant cultivar.

In a study undertaken by the University of Ibadan, Nigeria, by Chedda and Fatokun (1990), it was observed that significant differences occurred between exotic and local material and the rang of variability among local accessions indicated that West Africa was a centre of diversity for okra. One of the agronomic type identified was the Guinean type or *Abelmoschus caillei.*

In West Africa, both *Abelmoschus esculentus* and *Abelmoschus caillei* are cultivated, forming a single group although with diverse ecotypes (Koechlin, 1991). *Abelmoschus esculentus* diversity in West Africa is higher than elsewhere.

According to Thomas *et al.* (1991), *Abelmoschus caillei* is late maturing and more photosensitive than *Abelmoschus esculentus* and they are often denominated as dry season okra which produces in dry seasons- in contrast to the okra of rainy season- *Abelmoschus esculentus.*

A study of geographical distribution of two species of okra was carried out by Hamon and Hamon (1991). They studied both *A.esculentus* and *A.caillei* and showed that both were cultivated in almost all villages from the Gulf of Guinea to southern limit of Sahel. It was shown that although grown for the same purpose, the two species were clearly managed as two separate crops by local growers and that the conditions which allowed gene flow between both crops existed and the rate of spontaneous introgression was low. The genetic integrity of the two species did not therefore seem threatened to the relative balance between them which was mainly tied to the choice of the growers.

Hamon *et al.* (1991) had also reported a much greater diversity among wild species of *A.moschatus* and *A.manihot* than the cultivated forms of *A.esculentus* and *A.caillei.* A greater richness in varietal types occurred in West Africa where the two cultivated species were grown together.

In the national level, according to Rana and Thomas (1991), India is an important centre of diversity for okra where *A.esculentus* and seven related wild species (*A.moschatus*, *A.ficulneus*, *A.tuberculatus*, *A.crinitis*, *A.manihot*, *A.angulosus* and *A.caillei*) are distributed. Exploration and collection of landraces and wild species undertaken by the NBPGR have resulted in, to date, a base collection of 1806 accessions.

Traditional cultivars of okra especially *A.esculentus* are highly susceptible to YVMV, shoot and fruit borer and generally they are annual having a short fruiting period. In this context, an okra form locally known as "Thamara venda" (*A.cailliei*) deserve importance since it adorns many remarkable traits, such as resistance to YVMV, tolerance to fruit and shoot borer, adaptability, good cooking quality and perennial nature suitable for ratooning (Chacko,1996).

2.5 Organoleptic evaluation

Kramer (1959) defined food quality as the composite of those characteristics that differentiate individual units of a product and have significance in determining the degree of acceptability of that unit by the user. According to Amerine *et al.* (1965), foods are submitted to sensory examination to provide information that can lead to product improvement, quality maintenance, the development of new products or analysis of the market.

According to Sensory Evaluation Division of the Institute of Food Technologists (Anon,1975), the sensory evaluation is defined as a scientific discipline used to evoke, measure, analyse and interpret results of those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing. The definition makes clear that sensory evaluation encompasses all the senses and not taste testing alone.

The main feature of the changed pattern of consumer demand for fresh fruits and vegetables in Europe in the years following the end of World War II was a considerable increase in consumption per caput, reflecting an upward movement of incomes. It can be assumed that after a period of quantitative expansion, the sector of food market has entered a far more quality conscious phase in which consumers will attach greater priority to the nutritional and organoleptic properties like feel, taste and smell of the product (ECC, 1975).

According to Ranganna (1977), quality is the ultimate criterion of the desirability of any food product to the consumer. Over all quality depends on quantity, nutritional and other hidden attributes and sensory quality. Langlais *et al.* (1977) opined that the quality of a finished product or its ingredients is a compromise between many factors, one of which is a high level of sensory appeal.

Baghurst (1990) foresees that changes in consumer demand and in food supply and marketing will undoubtedly occur in coming decades. Health consciousness in the general community and the food industry is increasing. Food choice is often stated to be influenced by price, convenience, tastiness, healthfulness and freshness.

According to Stone and Sidel (1993), sensory evaluation helps in ensuring that the consumer gets consistent, non-defective and

enjoyable foods. For consumers, the perceivable sensory attributes like colour, appearance, feel, aroma, taste and texture are the deciding factors in food acceptance (Pal *et al.*, 1995).

Too often vegetables are prepared with loud overtones of duty and virtue, but with little intention of providing delight. Well prepared vegetables can be the highlight of the meal. Their bright colours give a welcome lift to a meal that might otherwise appear to be drab; their varied textures add interest to a meal; their many shapes afford a means of creating a more attractive plate and their diverse flavours may be used effectively to complement other flavours (McWilliams, 1974).

Okra, which appears bright green, firm, free of blemishes and no longer than three inches likely will be enjoyable to eat, but very young pods tend to taste "greasy" (Woodroof and Shelor, 1958). According to Ryall and Lipton (1972), pods upto 5 inches can be satisfactory; however, they may be more fibrous than desirable. Regardless of length, pods that are dull, flaccid and yellowish are inferior, particularly because of their high fibre content. Kulkarni *et al.* (1988) observed that all varieties of okra are not equally suitable for processing, as some of them become mucilaginous, soft and mushy on processing.

Material and Methods

3. MATERIALS AND METHODS

The methods followed and the materials used in the evaluation of nutritive value and organoleptic qualities of Thamaravenda genotypes are given under the following heads :

1. Field culture
2. Collection of samples
3. Nutrient analysis
4. Organoleptic evaluation
5. Statistical analysis

3.1 Field culture

The crop was raised in the vegetable field of Department of Olericulture, College of Horticulture, Vellanikkara, as per the Package of Practices Recommendations of KAU (1993).

3.1.1 Selection of genotypes

Twenty genotypes of *Abelmoschus caillei*, available and maintained in the Department of Olericulture, College of Horticulture, Vellanikkara, were selected for the study. Okra variety, Pusa Sawani, was selected as the control variety. Plate 1-6 shows the different genotypes selected for the study.

3.1.2 Preparation of the land

The land was prepared by digging followed by levelling. Spacing alloted was 60cm between rows and 45cm between plants. Treatments were raised in two equal rows of 5m length which formed a plot in each replication. Plate 7 shows the field used for the study.

3.1.3 Cultivation of *A.caillei*

Sowing of the seeds was done in the beginning of July. Four or five seeds were sown in each pit of a row which had the same genotype. Pusa Sawani seeds were also sown in a separatre row. For sowing, the different genotypes were selected on a random basis. Gap filling and thinning of the seedlings were done so as to retain a single plant in each pit. The crops received timely management and adequate fertilizer application as per the Package of Practices Recommendations of KAU (1993).

3.2 Collection of samples

Fruits from each genotype of *A.caillei* were collected at three different maturity levels - 5th, 8th and 11th days after flowering. Similarly, the control variety, Pusa Sawani, was also collected at the three maturity levels.

3.3 Nutrient analysis

The quantities of ten nutrients i.e. moisture, protein, fat, total carbohydrate, starch, crude fibre, calcium, phosphorus, iron and vitamin C were estimated in Thamara venda genotypes and also in the control variety. Mucilage content of the Thamara venda genotypes and Pusa Sawani was also estimated.

3.3.1 Moisture

Moisture analysis was carried out in the fruit samples immediately after harvesting according to the method of A.O.A.C (1980).

3.3.2 Protein

Protein content was analysed in dried samples. Nitrogen content was estimated by Microkjeldhal digestion and distillation method as decribed by Jackson (1958) which was then multiplied with a factor of 6.25 to get the protein content.

3.3.3 Fat

The fat content of the dried samples was estimated using the method of A.O.A.C. (1955).

3.3.4 Total carbohydrate

The total carbohydrate content of the dried samples was

anlysed using a method described by Sadasivam and Manikam (1992).

3.3.5 Starch

The starch content was analysed in the dried samples colourimetrically (Sadasivam and Manikam, 1992).

3.3.6 Crude fibre

Crude fibre content of the dried samples was estimated by acid-alkali digestion method as suggested by Chopra and Kanwar (1978).

3.3.7 Calcium and Iron

For estimating the calcium and iron contents of the dried samples, a diacid extract of the samples was prepared and was estimated in an Atomic Absorption Spectrophotometer.

3.3.8 Phosphorus

The phosphorus content was analysed on dry weight basis (DWB) using a diacid extract and was estimated in Spectrophotometer.

3.3.9 Vitamin C

The vitamin C content of the fresh samples was estimated by the method of A.O.A.C. (1955) using 2,6 dichlorophenol indophenol dye.

3.3.10 Mucilage

The mucilage content of the fresh samples was estimated by extracting the mucilage with ethyl alcohol.

3.4 Organoleptic evaluation

Organoleptic evaluation of the fresh pods of the Thamara venda genotypes and that of the control variety was conducted at the laboratory level.

3.4.1 Selection of judges

A series of acceptability trials were carried out using simple triangle tests at the laboratory level to select a panel of ten judges between the age group of 18-35 years (Jellinek, 1985).

3.4.2 Preparation of the samples for acceptability studies

The fresh samples were made into "mezhukkupuratti", a locally relished dish made with many type of vegetables, with onion,

pepper, salt and turmeric powder. For this, 50 g of the fresh samples were taken and cut into small pieces. 100 g of onion was chopped and sauted in one table spoon of oil. A pinch of turmeric powder and a half tea spoon of pepper powder were added. Then the chopped samples were added and cooked for 10 minutes.

3.4.3 Sensory evaluation

The sensory evaluation was carried out using a score card based on a five point hedonic scale for parameters like texture, doneness, colour, flavour and taste. The score card developed for the study is presented in Appendix 1. Evaluation of the dish was carried out by ten judges.

3.5 Statistical analysis

The statistical analysis of the study was carried out using two-way ANOVA and the categorisation of the genotypes was carried out by Duncan's Multiple Range Test (DMRT). Coefficient of concordance between the different genotypes in the case of different chemical constituents was found out using Friedmenn's concordance test.

Plate 2. Genotypes AM 3, AM 4, AM 5 and AM 12 taken for the study

Plate 3. Genotypes AM 14, AM 18, AM 23, AM 24 and AM 27


AM 1
AM 3
AM 4
AM 5
AM 12

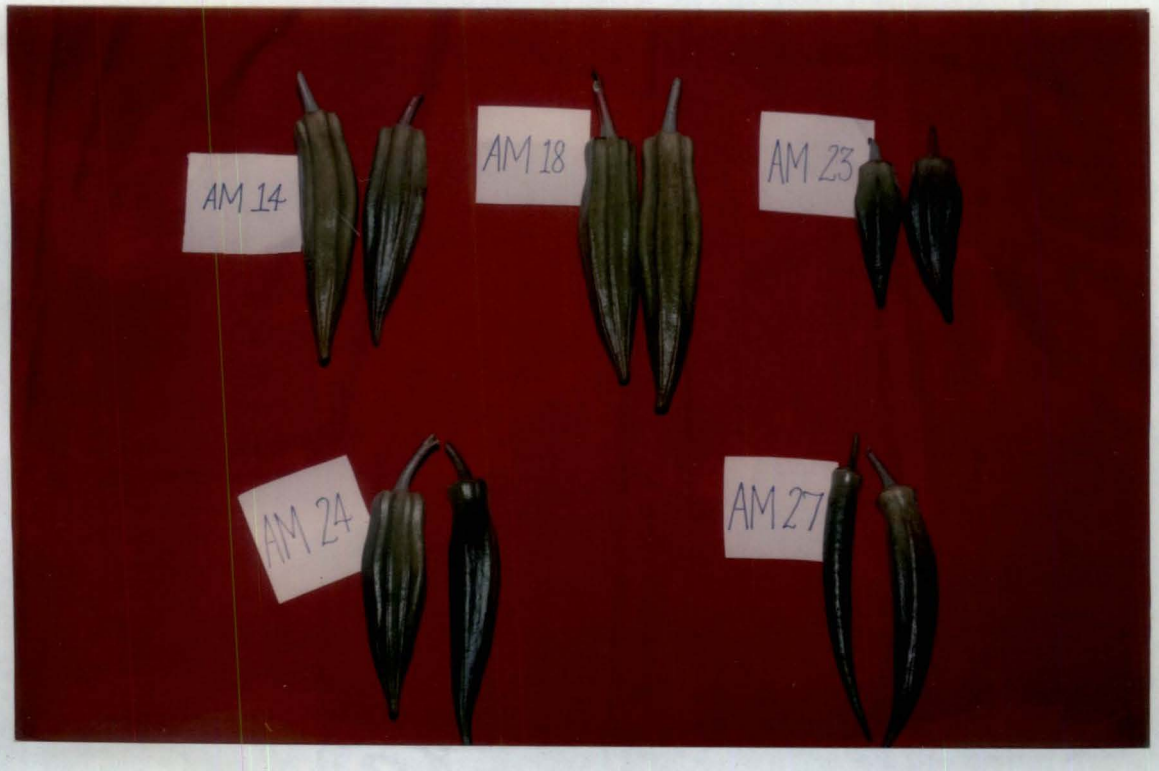

AM 14
AM 18
AM 23
AM 24
AM 27

Plate 4. Genotypes AM 19, AM 20 and AM 21

Plate 5. Genotypes AM 11, AM 33, AM 34 and AM 36


AM 19
AM 20
AM 21

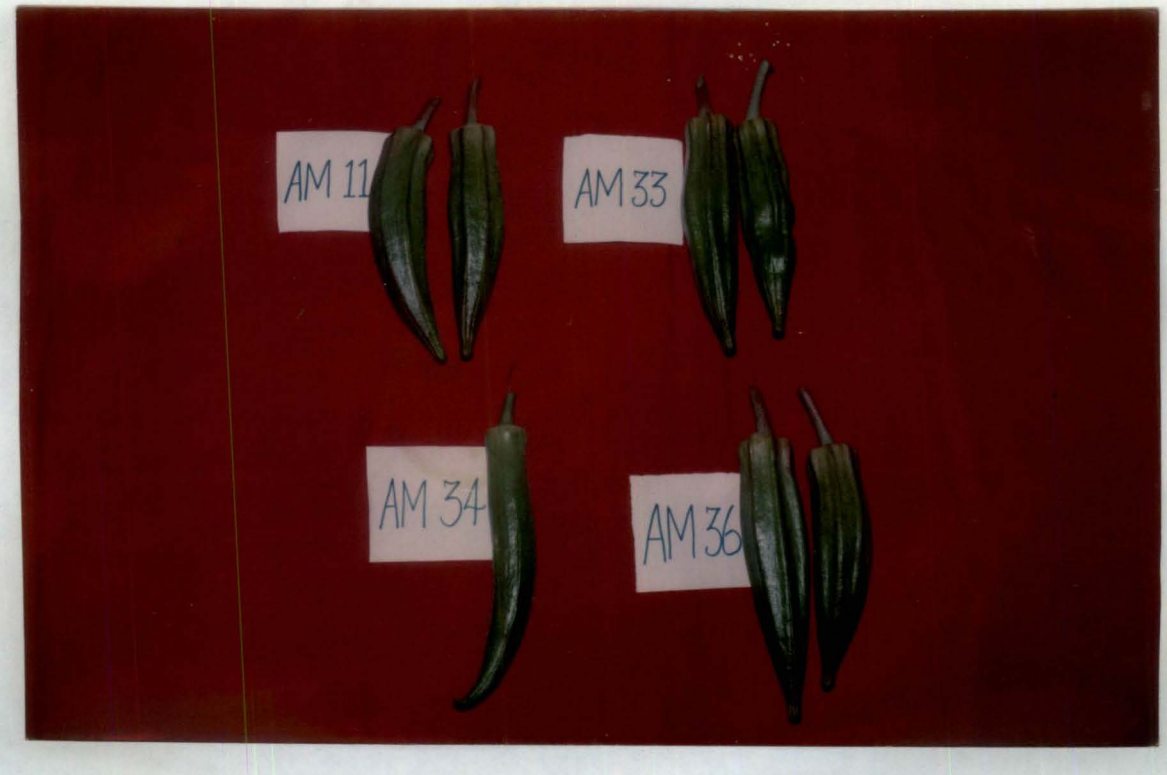

AM 11
AM 33
AM 34
AM 36

Plate 6. Genotypes AM 35 in the field

Plate 7. View of the field


II
NUTRITIVE VALUE AND
ORGANOLEPTIC EVALUATION
OF THAMARA VENDA
GENOTYPES

Results

4. RESULTS

The results pertaining to the study entitled 'Nutritive value and organoleptic evaluation of Thamara venda genotypes (*Abelmoschus caillei*)' are presented under the following heads:

1. Chemical composition of Thamara venda genotypes
2. Acceptability of Thamara venda genotypes

4.1 Chemical composition of Thamara venda genotypes

The Thamara venda genotypes were analysed for ten nutrients i.e. moisture, protein, fat, total carbohydrate, starch, fibre, calcium, phosphorus, iron and vitamin C and also for mucilage content at three different maturity levels – 5th, 8th and 11th days after flowering (DAF).

4.1.1 Moisture

The moisture content of different genotypes of *Abelmoschus caillei* are given in Table 1. The mean moisture content ranged between 90.16 per cent to 92.04 per cent in the twenty genotypes. The highest moisture content was reported in genotype AM 33 and lowest in AM 24. The control variety, Pusa Sawani had a mean value of 91.08 per cent. Figure 1 shows the comparison of the mean moisture content of the Thamara venda genotypes with that of Pusa Sawani.

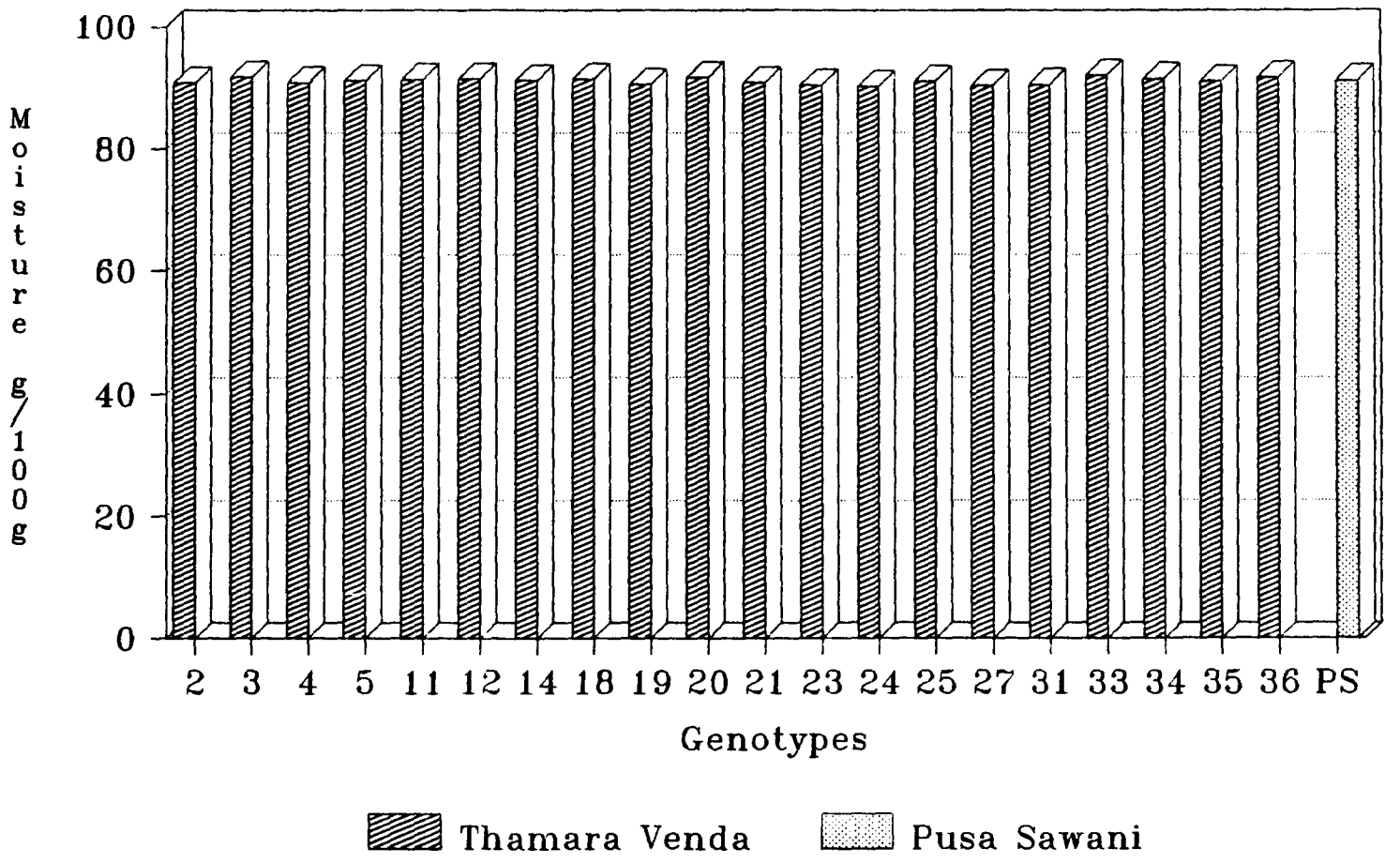
Table 1. Moisture content of Thamara venda genotypes and Pusa Sawani on fresh weight basis (g/100 g)

S.No.	Genotype	5 DAF	8 DAF	11 DAF	Mean	DMRT Category
1	AM 2	91.97	90.18	90.14	90.76	BCD
2	AM 3	92.01	91.76	91.46	91.74	AB
3	AM 4	92.27	90.90	89.32	90.83	BCD
4	AM 5	92.66	90.79	89.87	91.11	ABCD
5	AM 11	92.75	91.44	89.81	91.33	ABC
6	AM 12	92.49	91.41	90.40	91.43	ABC
7	AM 14	91.71	91.50	90.15	91.12	ABCD
8	AM 18	91.94	91.23	90.92	91.36	ABC
9	AM 19	91.68	90.70	89.17	90.52	CD
10	AM 20	92.38	91.80	90.69	91.62	AB
11	AM 21	91.95	90.94	89.31	90.73	BCD
12	AM 23	91.79	90.12	89.39	90.43	CD
13	AM 24	91.12	90.25	89.12	90.16	D
14	AM 25	90.74	90.52	91.83	91.03	ABCD
15	AM 27	91.07	90.53	89.22	90.27	D
16	AM 31	91.41	90.41	89.57	90.46	CD
17	AM 33	92.92	92.56	90.63	92.04	A
18	AM 34	91.77	91.72	90.89	91.46	ABC
19	AM 35	92.42	90.99	89.75	91.05	ABCD
20	AM 36	92.46	91.88	90.57	91.64	AB
	Mean	**91.98**	**91.08**	**90.11**		
	PS (Control)	92.13	90.95	90.17	91.08	ABCD
	CD	**0.33****				

PS – Pusa Sawani ** -significant at 5% level

On the basis of DMRT, the different genotypes were arranged into seven groups on the basis of moisture content. Pusa Sawani was included in the fourth group (ABCD) with four other genotypes of *Abelmoschus caillei* namely AM 5, AM 14, AM 25 and AM 35. This

Fig.1. Comparison of moisture content of Thamara Venda genotypes with Pusa Sawani



indicated that Pusa Sawani had no significant difference between these four genotypes. The members of different groups had significant difference between themselves.

On 5 DAF, the moisture contents ranged between 90.74 to 92.92 per cent with a mean value of 91.98 per cent. The lowest and highest values were reportedly found in AM 25 and AM 33 genotypes respectively. The control variety, Pusa Sawani had a moisture content of 92.13 per cent.

The moisture content at 8 DAF ranged from 90.12 to 92.56 per cent with a mean value of 91.08 per cent.The lowest was observed in AM 23 genotype and highest in AM 33 genotype. Pusa Sawani had 90.95 per cent moisture.

On 11 DAF, the moisture content ranged between 89.12 to 91.83 per cent. The mean value obtained was 90.11 per cent. The lowest moisture content was found in AM 24 genotype and the highest in AM 25 genotypes. The mean value was almost equal to that of Pusa Sawani value which was 90.17 per cent.

Table 1 shows that there was a decreasing trend in the moisture content as the level of maturity increased. Though the difference between the maturity levels of different genotypes was not widely different, there obtained a significant difference between the different maturity levels.

4.1.2 Protein

The mean protein content of Thamaravenda genotypes on dry weight basis at three different maturity levels are furnished in Table 2. Mean protein values of the different genotypes ranged from 14.19 per cent to 17.65 per cent. The highest mean value was found in the genotype AM 5 and the lowest value in the genotype AM 4. The control variety, Pusa Sawani, was found to have a mean protein content of 16.21 per cent. This value was found to be less than those of many of the genotypes of *Abelmoschus caillei* and only the genotypes AM 2 (15.85%), AM 4 (14.19 %), AM 18 (15.38 %), AM 27 (14.73 %) and AM 35 (15.96 %) were found to have lesser values than the control variety. Figure 2 shows the comparison of the protein content of different genotypes with the control variety.

DMRT classified the different genotypes on the basis of mean values of protein into three categories. The five genotypes which had a value in between 17.28 per cent and 17.65 per cent were included in the category, A. Those with a value between 14.73 per cent and 17.28 per cent were included in the category, AB and this group included 15 genotypes including the control variety Pusa Sawani. It showed that Pusa Sawani had no significant difference from these genotypes in its mean protein content. The remaining sole genotype, AM 4, was grouped into a category, B with its lowest value of 14.19 per cent.

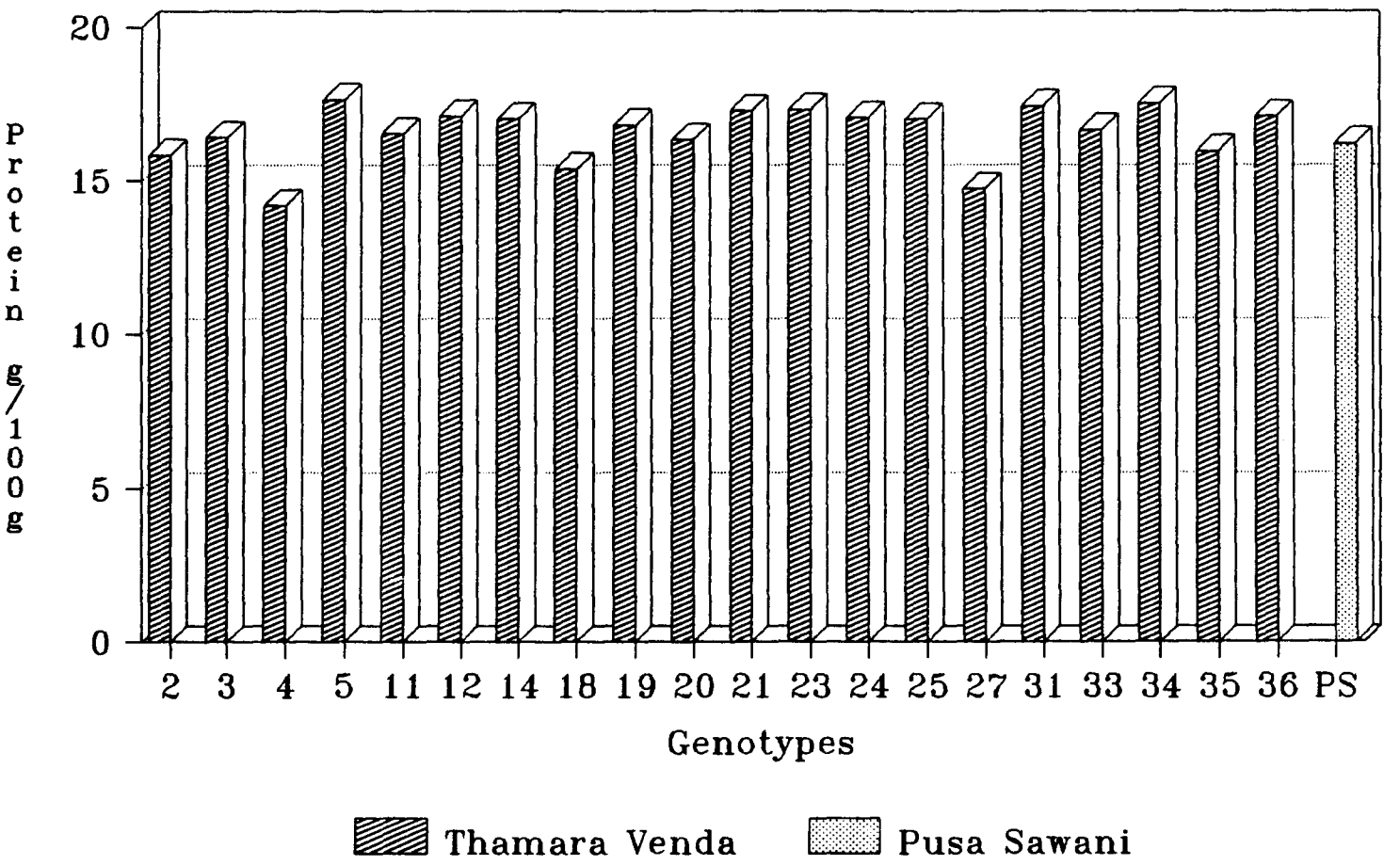
Table 2. Protein content of Thamara venda genotypes and Pusa Sawani on dry weight basis (g/100 g)

S.No.	Genotype	5DAF	8 DAF	11DAF	Mean	DMRT Category
1	AM 2	17.00	16.09	14.47	15.85	AB
2	AM 3	18.97	15.73	14.57	16.42	AB
3	AM 4	15.74	13.91	12.91	14.19	B
4	AM 5	19.42	18.58	14.96	17.65	A
5	AM 11	17.61	16.01	16.00	16.54	AB
6	AM 12	19.24	16.64	15.47	17.12	AB
7	AM 14	18.97	17.64	14.49	17.03	AB
8	AM 18	16.98	15.86	13.30	15.38	AB
9	AM 19	17.79	17.16	15.51	16.82	AB
10	AM 20	18.43	15.62	14.96	16.34	AB
11	AM 21	18.59	16.78	16.47	17.28	A
12	AM 23	16.42	17.09	18.42	17.31	A
13	AM 24	17.82	18.93	14.43	17.06	AB
14	AM 25	16.35	19.61	15.08	17.01	AB
15	AM 27	14.96	11.36	17.88	14.73	AB
16	AM 31	18.34	14.94	19.03	17.44	A
17	AM 33	18.03	17.58	14.34	16.65	AB
18	AM 34	18.81	18.32	15.46	17.53	A
19	AM 35	16.09	17.43	14.23	15.96	AB
20	AM 36	18.34	17.48	15.47	17.10	AB
	Mean	**17.70**	**16.64**	**15.37**		
	PS(Control)	17.23	15.77	15.62	16.21	AB
	CD	**0.9545****				

** -significant at 5% level

When the protein content of the genotypes at three different maturity levels was analysed, it was found that the mean protein content at 5th day after flowering ranged from 14.96 per cent (AM 27) to 19.42 per cent (AM 5) with a mean value of 17.70 per cent.

Fig.2. Comparison of protein content of Thamara Venda genotypes with Pusa Sawani



The control variety, Pusa Sawani, had a protein content of 17.23 per cent.

On 8th day after flowering, the protein values were found to range between 11.36 per cent to 19.61 per cent. The highest value was found in AM 25 and lowest in AM 27. The genotypes were found to have a mean value of 16.64 per cent. The control variety had a protein content of 15.77 per cent.

The protein content ranged between 12.91 per cent to 19.03 per cent on 11th day after flowering. The highest protein content was found in the genotype AM 31 and the lowest in AM 4 with a mean value of 15.37 per cent.

The table clearly shows that the protein content of the different genotypes of *A. caillei* and the control variety decreased as maturity increased. The statistical analysis showed that the difference in the protein content between the three maturity levels was significant.

4.1.3 Fat

Fat content analysed on dry weight basis are furnished in Table 3. It is shown in the table that the mean values ranged from 12.52 to 14.83 g/100 g. The genotype, AM 18, had the lowest mean value and the genotype, AM 23 had the highest value. The control

variety, Pusa Sawani, had been found to have a value of 10.45 g/100 g. Figure 3 depicts the fat content of *A. caillei* genotypes and Pusa Sawani.

On the basis of the fat content, the twenty genotypes were grouped statistically into ten classes. All the classes contained one or two genotypes except the group, CDE which harboured nine genotypes (Table 3). The genotypes included in the same class were not significantly different from each other but different from genotypes of other classes statistically. Pusa Sawani was significantly different from all the genotypes of *A. caillei* since it was included in the category, F separately.

When the different genotypes were analysed at different maturity levels, it was found that at 5 days' maturity, the fat content ranged between 10.50 to 14.30 g/100 g with a mean fat content of 12.40 g/100 g. The lowest and the highest were found respectively in AM 18 and AM 23 genotypes. The control variety, Pusa Sawani, had been found to have a value of 9.77 g/100 g.

On 8 DAF, the fat content varied from 12.80 g/100 g in AM 21 to 14.47 g/100 g in AM 23 with a mean value of 13.55 g/100 g. The control variety had a value of 10.40 g/100 g which was far less than the mean value for Thamara venda genotypes.

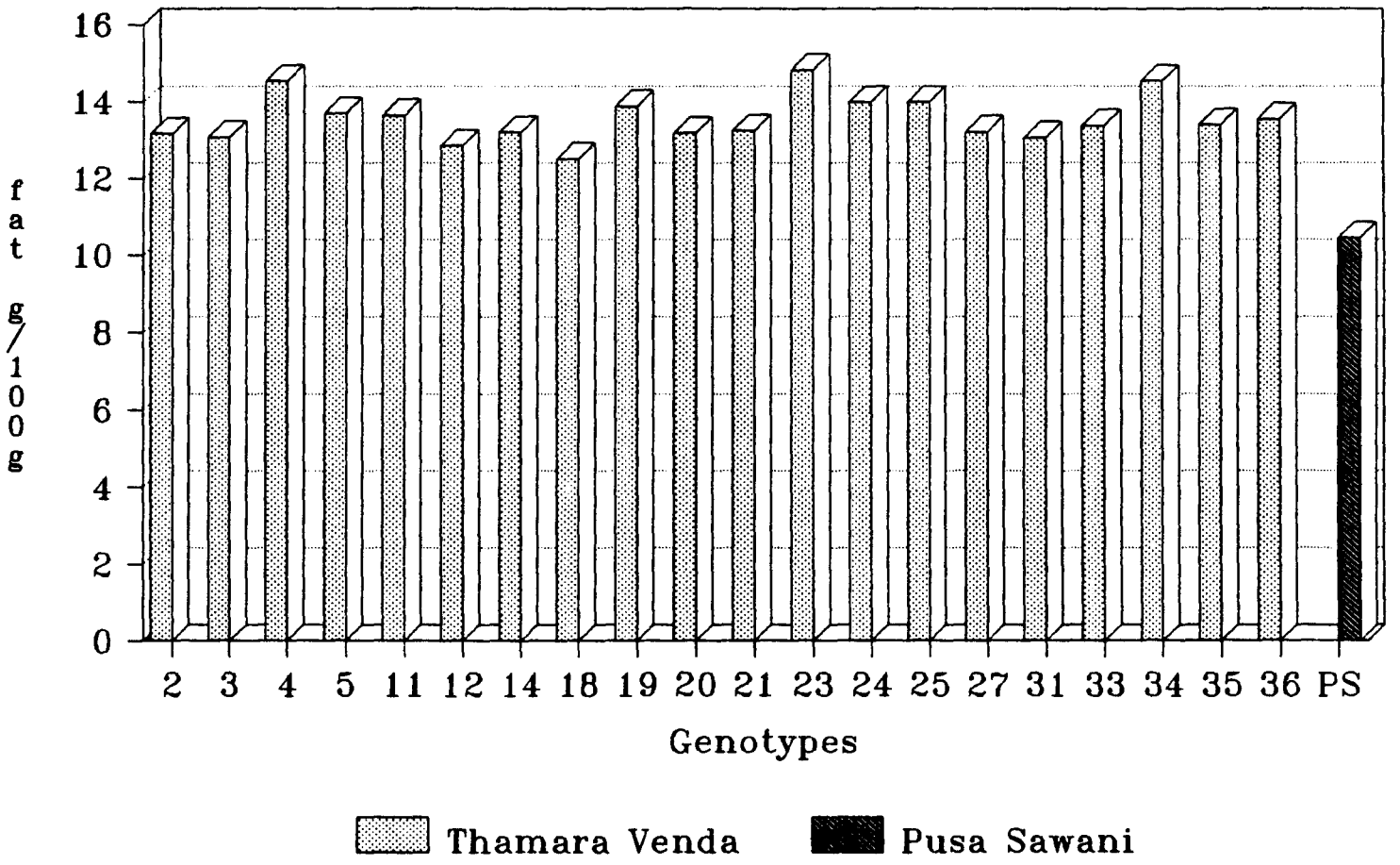
Table 3. Fat content of Thamara venda genotypes and Pusa Sawani on dry weight basis **(g/100 g)**

S.No.	Genotype	5 DAF	8 DAF	11 DAF	Mean	DMRT Category
1	AM 2	11.97	13.23	14.30	13.17	CDE
2	AM 3	12.13	13.30	13.83	13.09	CDE
3	AM 4	13.73	14.13	15.80	14.55	AB
4	AM 5	12.17	13.93	15.0	13.70	BCD
5	AM 11	12.87	12.93	15.17	13.66	BCD
6	AM 12	11.42	13.0	14.17	12.86	DE
7	AM 14	11.73	13.43	14.47	13.21	CDE
8	AM 18	10.50	13.0	14.07	12.52	E
9	AM 19	13.10	14.27	14.29	13.89	ABCD
10	AM 20	11.40	13.47	14.70	13.19	CDE
11	AM 21	12.83	12.80	14.13	13.25	CDE
12	AM 23	14.30	14.47	15.73	14.83	A
13	AM 24	13.53	13.73	14.73	14.0	ABC
14	AM 25	12.47	14.16	15.37	14.0	ABC
15	AM 27	10.67	13.63	15.37	13.22	CDE
16	AM 31	11.70	13.0	14.50	13.07	CDE
17	AM 33	12.70	13.20	14.23	13.38	CDE
18	AM 34	13.77	14.30	15.57	14.55	AB
19	AM 35	12.43	13.07	14.73	13.41	CDE
20	AM 36	12.48	13.90	14.30	13.56	BCDE
	Mean	**12.40**	**13.55**	**14.72**		
	PS (Control)	9.77	10.4	11.17	10.45	F
	CD	**0.3342****				

** - significant at 5% level

When the pods reached 11 days' maturity, the fat content ranged from 13.83 g/100 g to 15.80 g/100 g in the twenty genotypes with a mean value of 14.72 g/100 g. The lowest value was found in the genotype AM 3 and the highest in AM 4. The mean fat content of the control variety was found to be 11.17 per cent.

Fig.3. Comparison of fat content of Thamara Venda genotypes with Pusa Sawani



As observed in Table 3, the fat content showed a trend of increase as days after flowering increased. On statistical analysis, it was found that there was significant difference in the fat content between the different maturity levels in different genotypes.

4.1.4 Total Carbohydrate

Total carbohydrate was analysed on DWB in the twenty genotypes of *A. caillei* and in the control variety, Pusa Sawani and the values are furnished in Table 4. From the table, it can be seen that the mean values ranged from 12.23 per cent to 17.81 per cent. The lowest value was obtained in the genotype AM 4 and the highest in AM 3. Pusa Sawani had a mean value of 12.61 per cent. Figure 4 compares the total carbohydrate content of *A. caillei* and Pusa Sawani.

Statistically, the various genotypes were differentiated into ten categories. The categories AB and ABC had five members each. Pusa Sawani was separately grouped into a class, EF which showed that it had significant difference from all the genotypes of *A. caillei.*

The total carbohydrate values on 5 DAF ranged between 8.34 per cent (AM 18) and 13.36 per cent (AM 27) with a mean value of 11.21 per cent. The total carhohydrate content of the control variety was found to be 8.65 per cent.

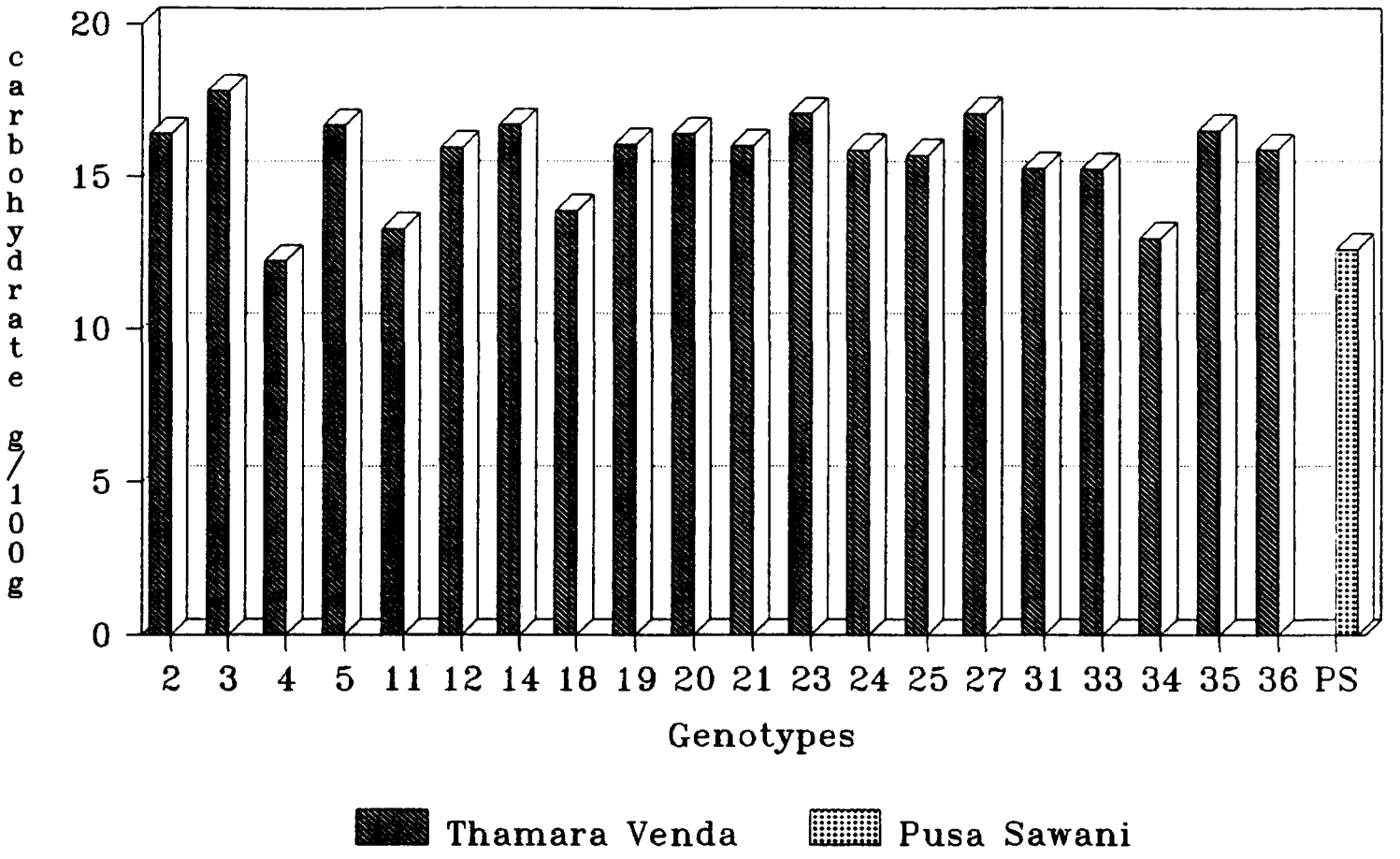
Table 4. Total Carbohydrate content of Thamara venda genotypes and Pusa Sawani on dry weight basis (g/100 g)

S.No.	Genotype	5DAF	8DAF	11DAF	Mean	DMRT Category
1	AM 2	12.30	16.78	20.18	16.42	AB
2	AM 3	12.39	16.67	24.37	17.81	A
3	AM 4	8.70	9.74	18.26	12.23	F
4	AM 5	12.38	14.07	23.62	16.69	AB
5	AM 11	9.62	11.23	18.95	13.27	CDEF
6	AM 12	12.39	11.78	23.71	15.96	ABC
7	AM 14	11.67	14.74	23.07	16.71	AB
8	AM 18	8.34	13.80	19.50	13.88	BCDEF
9	AM 19	11.27	16.78	20.15	16.07	ABC
10	AM 20	11.56	15.47	22.23	16.42	AB
11	AM 21	12.79	12.81	22.38	16.01	ABC
12	AM 23	12.56	17.49	21.38	17.08	A
13	AM 24	10.34	17.52	19.81	15.89	ABC
14	AM 25	10.38	15.34	21.45	15.72	ABCD
15	AM 27	13.36	16.58	21.34	17.09	A
16	AM 31	10.74	16.37	18.74	15.28	ABCDE
17	AM 33	10.15	15.60	19.99	15.25	ABCDE
18	AM 34	9.92	10.09	18.94	12.98	DEF
19	AM 35	11.25	15.63	22.71	16.53	AB
20	AM 36	11.98	14.27	21.44	15.90	ABC
	Mean	**11.21**	**14.64**	**21.11**		
	PS (Control)	8.65	11.24	17.93	12.61	EF
	CD	**0.9249****				

** -significant at 5% level

On 8 DAF, the total carbohydrate values ranged from 9.74 per cent to 17.52 per cent in the Thamara venda genotypes with a mean value of 14.64 per cent. The lowest value was obtained in the genotype AM 4 and the highest in AM 24. Pusa Sawani had a value of 11.24 per cent.

Fig.4.Comparison of carbohydrate content of Thamara Venda genotypes with Pusa Sawani



When the pods of *A. caillei* were of 11 days' maturity, the total carbohydrate content ranged between 18.26 per cent and 24.37 per cent. The lowest value was seen in the genotype AM 4 and the highest in AM 3. The mean value was 21.11 per cent and the Pusa Sawani was found to have a value of 17.93 per cent.

The table shows that the value of total carbohydrate increased as the maturity increased. It was also found that there was significant difference in the total carbohydrate content between the different maturity levels in different genotypes.

4.1.5 Starch

The starch content of *A. caillei* genotypes and the control variety, Pusa Sawani on DWB are given in Table 5. The mean values for starch varied from 3.87 per cent (AM 4) to 7.30 per cent (AM 5). The control variety had been found to have a mean value of 4.34 per cent. Figure 5 shows the comparison of starch content of Thamara venda genotypes and Pusa Sawani.

DMRT classified the genotypes into 13 classes. Each class had only two or less members in it. Pusa Sawani was included in a separate group (GH) which indicated that Pusa Sawani was significantly different from most of the genotypes of *A. caillei.*

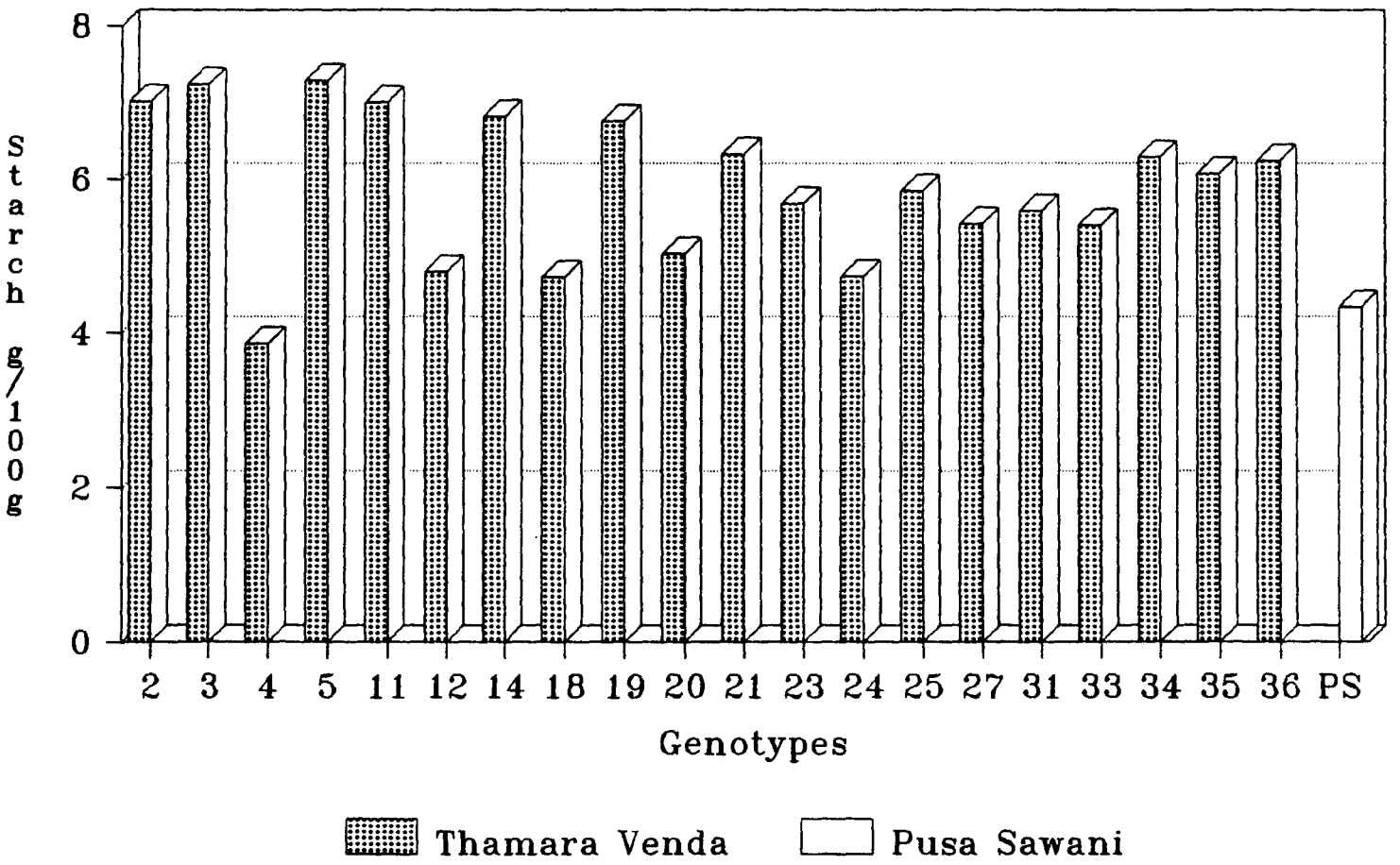
Table 5. Starch content of Thamara venda genotypes and Pusa Sawani on dry weight basis (g/100 g)

S.No.	Genotype	5DAF	8 DAF	11 DAF	Mean	DMRT Category
1	AM 2	4.02	6.73	10.31	7.02	AB
2	AM 3	5.09	6.53	10.14	7.25	A
3	AM 4	2.48	3.09	6.03	3.87	H
4	AM 5	5.05	6.49	10.37	7.30	A
5	AM 11	4.56	6.24	10.24	7.01	AB
6	AM 12	3.89	4.37	6.13	4.80	EFGH
7	AM 14	4.28	5.77	10.43	6.83	ABC
8	AM 18	2.81	4.63	6.75	4.73	FGH
9	AM 19	4.72	5.67	9.93	6.77	ABC
10	AM 20	3.74	4.05	7.30	5.03	DEFGH
11	AM 21	3.72	5.75	9.54	6.34	ABCD
12	AM 23	5.04	4.87	7.16	5.69	BCDEFG
13	AM 24	2.39	4.35	7.47	4.74	FGH
14	AM 25	4.43	4.82	8.34	5.86	ABCDEF
15	AM 27	2.74	4.70	8.84	5.43	CDEFG
16	AM 31	4.53	4.02	8.22	5.59	BCDEFG
17	AM 33	4.55	4.25	7.42	5.41	CDEFG
18	AM 34	3.56	5.30	10.05	6.30	ABCD
19	AM 35	3.64	5.34	9.26	6.08	ABCDEF
20	AM 36	3.38	5.61	9.77	6.25	ABCDE
	Mean	**3.93**	**5.13**	**8.69**		
	PS (Control)	2.41	4.30	6.31	4.34	GH
	CD	**0.4743****				

** - significant at 5% level

On 5 DAF, the starch content ranged between 2.39 per cent to 5.09 per cent with a mean value of 3.93 per cent. The lowest and highest values were found in the genotypes AM 24 and AM 3 respectively. Pusa Sawani had a starch content of 2.41 per cent.

Fig.5.Comparison of starch content of Thamara Venda genotypes with Pusa Sawani



When the pods were of eight days' maturity, the starch content ranged between 3.09 per cent and 6.73 per cent. The lowest value was found in AM 4 and the highest in AM 2 genotypes. The mean starch content was found to be 5.13 per cent. Pusa Sawani had a value of 4.30 per cent.

On 11 DAF, the starch content ranged from 6.03 per cent to 10.43 per cent with a mean value of 8.69 per cent. The lowest and highest values were respectively found in the genotypes AM 4 and AM 14. Pusa Sawani had a value of 6.31 per cent.

As observed in the table, there was an increasing trend in the starch content as maturity increased. On analysing statistically, it was found that there was significant difference in the starch content between the different maturity levels.

4.1.6 Crude fibre

Crude fibre content of *A. caillei* genotypes and the control variety was estimated and furnished in Table 6. The mean fibre content of Thamara venda genotypes ranged between 9.28 per cent and 15.17 per cent. The genotype AM 35 was found to have the lowest amount and AM 4, the highest. The control variety was found to have a mean value of 18.72 per cent. Figure 6 compares the crude fibre content of Thamara venda genotypes and Pusa Sawani.

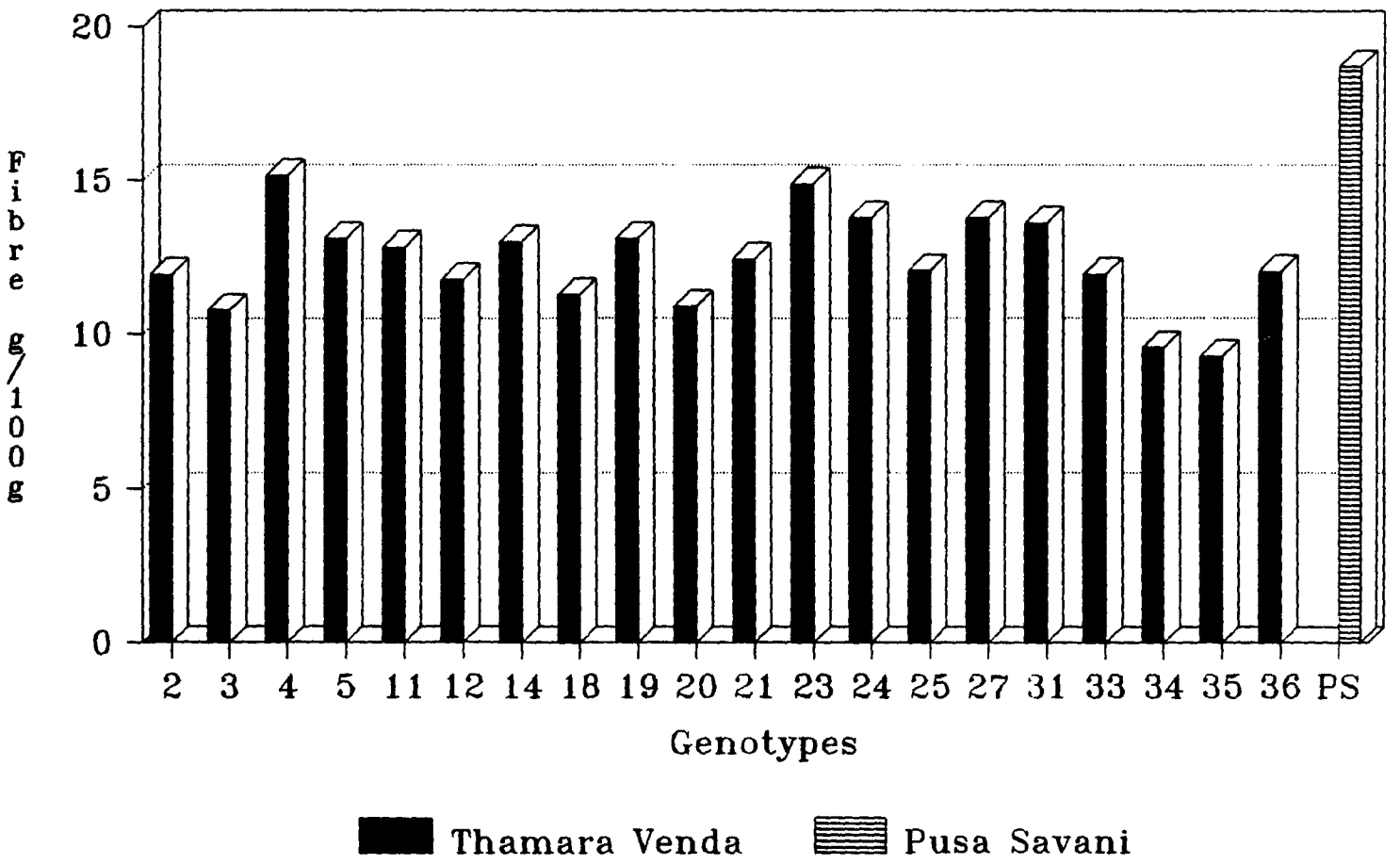
Table 6. Crude fibre content of Thamara venda genotypes and Pusa Sawani on dry weight basis (g/100 g)

S.No.	Genotype	5 DAF	8 DAF	11 DAF	Mean	DMRT Category
1	AM 2	8.5	10.0	17.33	11.94	CDE
2	AM 3	8.33	10.0	14.0	10.78	EFG
3	AM 4	11.0	13.67	20.83	15.17	B
4	AM 5	9.33	12.67	17.33	13.11	BCDE
5	AM 11	9.17	10.83	18.5	12.83	BCDE
6	AM 12	8.67	10.83	15.83	11.78	CDEF
7	AM 14	8.5	12.17	18.33	13.00	BCDE
8	AM 18	8.0	10.67	15.17	11.23	DEFG
9	AM 19	9.33	12.67	17.33	13.11	BCDE
10	AM 20	8.33	8.83	15.5	10.89	EFG
11	AM 21	9.0	11.83	16.5	12.44	CDE
12	AM 23	12.67	13.17	18.83	14.89	B
13	AM 24	9.83	12.83	18.67	13.78	BC
14	AM 25	9.17	11.0	16.0	12.06	CDE
15	AM 27	8.67	13.17	19.5	13.78	BC
16	AM 31	10.17	11.5	19.17	13.61	BCD
17	AM 33	9.0	12.0	14.83	11.94	CDE
18	AM 34	7.83	9.17	11.67	9.56	FG
19	AM 35	8.17	9.0	10.67	9.28	G
20	AM 36	8.33	9.33	18.5	12.05	CDE
	Mean	**9.10**	**11.27**	**16.73**		
	PS (Control)	14.0	17.5	24.67	18.72	A
	CD	**0.7869****				

** - significant at 5% level

The different genotypes were classified into eleven groups according to their crude fibre content on the basis of DMRT. The control variety, with its highest value was grouped as a separate group, A and it showed that Pusa Sawani had significant difference from the genotypes of *A. caillei* in fibre content.

Fig.6.Comparison of fibre content of Thamara Venda genotypes with Pusa Sawani



When the pods were of 5 days' maturity, the fibre values ranged from 7.83 per cent (AM 34) to 12.67 per cent (AM 23). The mean fibre content of *A. caillei* genotypes was 9.10 per cent. Pusa Sawani had a much higher value of 14.0 per cent.

On 8 DAF, the crude fibre values ranged between 8.83 per cent to 13.67 per cent with a mean value of 11.27 per cent. The highest was reported in AM 4 and the lowest in AM 20. The control variety was reported to have a value of 17.50 per cent which was much higher than those of Thamara venda genotypes.

On 11 DAF, the crude fibre content ranged from 10.67 per cent to 20.83 per cent with a mean value of 16.73 per cent. The highest and the lowest values were found in the genotypes AM 4 and AM 35 respectively. Here also, Pusa Sawani had a far greater value of 24.67 per cent.

It was obvious from the table that the crude fibre content increased as maturity increased. Statistical analysis showed a significant difference in crude fibre content between the three different maturity levels.

4.1.7 Calcium

The mean values of calcium of different genotypes of *A. caillei*

and the control variety, Pusa Sawani are given in Table 7. The mean values ranged from 92.60 to 140.60 mg/100g. The highest mean value was found in the genotype AM 14 and the lowest in AM 23. Pusa Sawani had a mean calcium content of 110.70 mg/100g. The comparison of calcium content of Thamara venda genotypes and Pusa Sawni is shown in figure 7.

Statistically, the different genotypes were classified into three groups on the basis of calcium content. The group A included the best ten genotypes, the group AB included the next ten genotypes including Pusa Sawani. The group B was found to occupy the sole member, the genotype AM 23. This indicated that calcium content of Pusa Sawani was not significantly different from the nine genotypes of Thamara venda included in this group.

On 5 DAF, the calcium content ranged between 106.2 to 163.8 mg/100g. The lowest and the highest values were respectively found in AM 5 and AM 33 genotypes. The mean value was found to be 138.62 mg/100g. The control variety had a value of 129.5 mg/100g.

On 8 DAF, the calcium conntent ranged from 90.3 mg/100g in AM 5 to 144.2 mg/100g in AM 36 with a mean value of 120.66 mg/100g. Pusa Sawani was found to have a value of 114.6 mg/100g.

When the pods were of 11 days' maturity, the calcium content varied between 95.0 (AM 25) and 144.9 mg/100g (AM 19) with a

mean value of 114.34 mg/100g. The control variety had a value of 88.0 mg/100g.

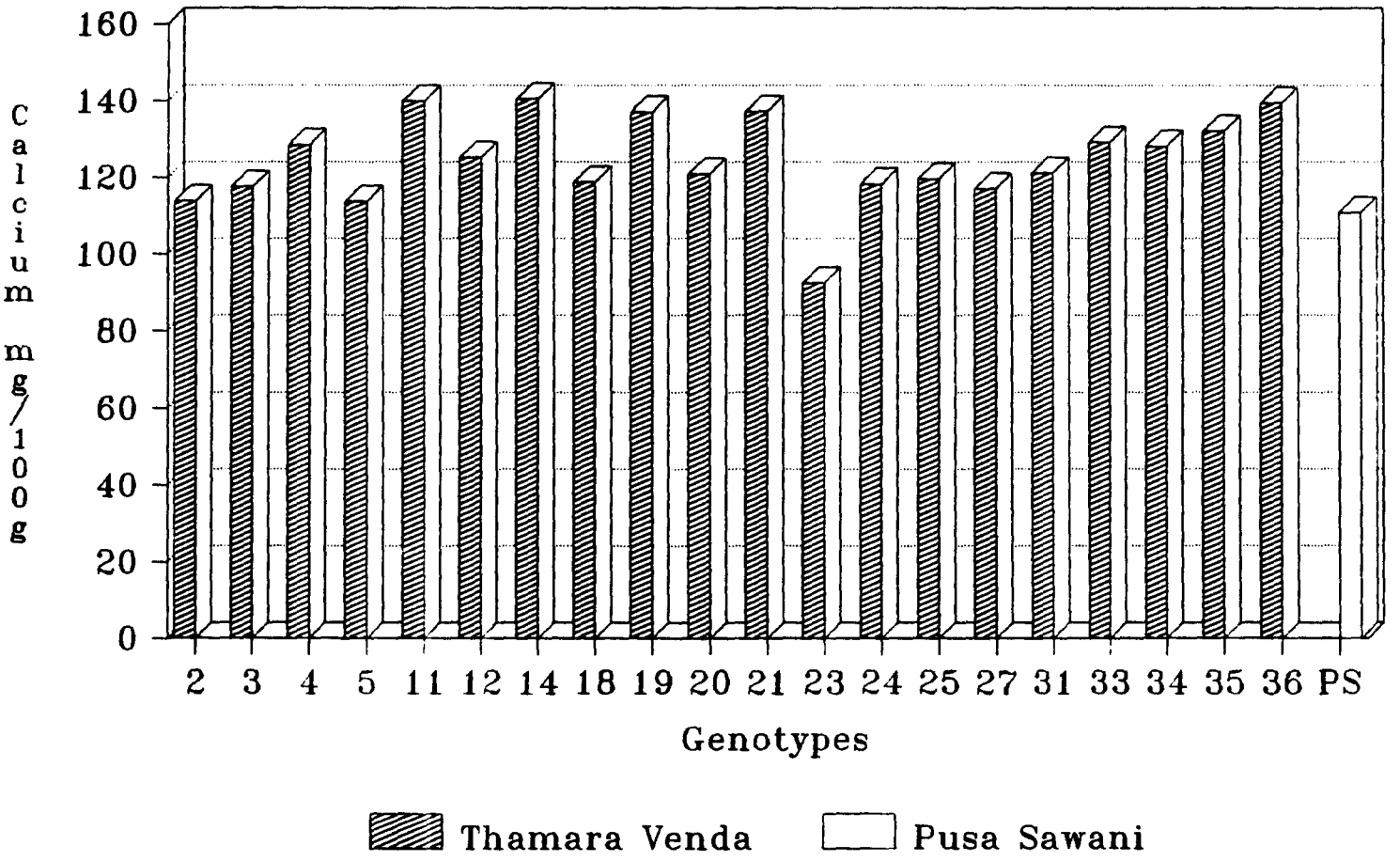
Table 7. Calcium content of Thamara venda genotypes and Pusa Sawani on dry weight basis (mg/100 g)

S.No.	Genotype	5 DAF	8 DAF	11 DAF	Mean	DMRT Category
1	AM 2	122.4	120.0	99.0	113.8	AB
2	AM 3	115.2	115.1	122.5	117.6	AB
3	AM 4	143.5	124.4	117.5	128.5	A
4	AM 5	106.2	90.3	144.5	113.7	AB
5	AM 11	147.6	133.2	138.8	139.9	A
6	AM 12	142.6	126.4	106.6	125.2	A
7	AM 14	158.5	139.8	123.6	140.6	A
8	AM 18	138.7	119.9	97.9	118.8	AB
9	AM 19	152.8	113.6	144.9	137.1	A
10	AM 20	147.9	114.1	100.8	120.9	AB
11	AM 21	146.5	134.9	130.3	137.2	A
12	AM 23	112.0	111.5	54.3	92.60	B
13	AM 24	124.2	124.0	106.6	118.3	AB
14	AM 25	163.4	100.3	95.0	119.6	AB
15	AM 27	121.8	114.9	114.7	117.1	AB
16	AM 31	128.5	118.6	116.5	121.2	AB
17	AM 33	163.8	113.0	110.5	12901	A
18	AM 34	153.8	125.6	104.8	128.1	A
19	AM 35	138.7	129.3	128.4	132.1	A
20	AM 36	144.3	144.2	129.5	139.3	A
	Mean	**138.62**	**120.66**	**114.34**		
	PS (Control)	129.50	114.60	88.0	110.7	AB
	CD	**9.449****				

** - significant at 5% level

Calcium values showed a decrease as the maturity increased. Significant difference in the calcium content was observed between

Fig.7 Comparison of calcium content of Thamara Venda genotypes with Pusa Sawani



the 5th and the 8th DAF and also between the 5th and the 11th DAF. But no significant difference was reported between the 8th and the 11th DAF.

4.1.8 Phosphorus

Phosphorus content of the Thamara venda genotypes and Pusa Sawani on DWB are presented in Table 8. The mean phosphorus content of Thamara venda genotypes ranged between 91.61 to 111.0 mg/100g. The highest value was obtained in AM 25 and the lowest in AM 4 genotypes. The control variety, Pusa Sawani had been found to have a phosphorus content of 102.8 mg/100g. The comparison of phosphorus content of Thamara venda genotypes and Pusa Sawani is shown in figure 8.

Statistically, the genotypes were grouped into seven classes based on their phosphorus content. The group namely ABCD was found to be the largest one which accommodated seven genotypes of *A. caillei* and the control variety, Pusa Sawani. So the control variety can be said to have no significant difference between these seven genotypes in its phosphorus content but was significantly different from other genotypes of *A. caillei.*

On 5 DAF, the phosphorus content ranged between 95.71 and 130.44 mg/100g with a mean value of 109.13 mg/100g. The lowest

and the highest values were obtained in the genotypes AM 5 and AM 25 respectively. The control vareity had a phoshorus content of 109.45 mg/100g.

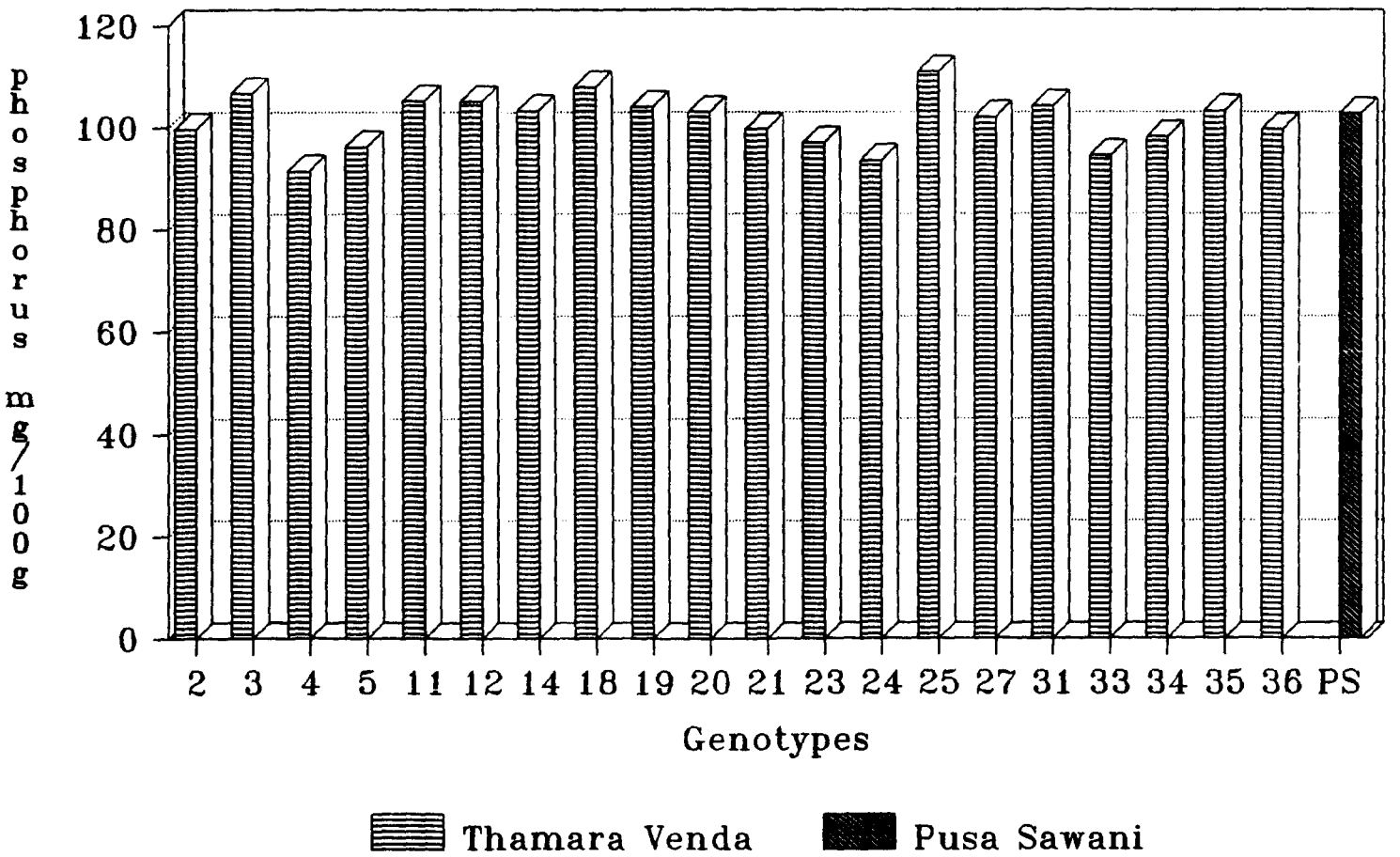
Table 8. Phosporus content of Thamara venda genotypes and Pusa Sawani on dry weight basis (mg/100 g)

S.No.	Genotype	5 DAF	8 DAF	11 DAF	Mean	DMRT Category
1	AM 2	100.4	102.03	96.75	99.74	ABCD
2	AM 3	109.03	113.46	97.54	106.70	AB
3	AM 4	100.55	92.30	81.97	91.61	D
4	AM 5	95.71	91.85	101.29	96.28	BCD
5	AM 11	121.47	106.64	87.56	105.20	ABC
6	AM 12	113.48	107.71	94.0	105.10	ABC
7	AM 14	114.22	105.59	90.14	103.30	ABCD
8	AM 18	117.45	109.83	97.0	108.10	AB
9	AM 19	111.17	98.72	102.37	104.10	ABC
10	AM 20	116.34	99.37	93.28	103.0	ABCD
11	AM 21	106.41	95.64	97.01	99.69	ABCD
12	AM 23	105.67	99.28	86.27	97.07	BCD
13	AM 24	94.43	94.0	92.26	93.56	CD
14	AM 25	130.44	107.74	94.86	111.0	A
15	AM 27	111.17	101.73	93.39	102.1	ABCD
16	AM 31	112.34	98029	101.87	104.2	ABC
17	AM 33	102.16	96.57	84.85	94.53	CD
18	AM 34	107.49	98.62	88.42	98.18	BCD
19	AM 35	105.74	106.0	98.29	103.3	ABCD
20	AM 36	106.92	109.02	83.17	99.70	ABCD
	Mean	**109.13**	**101.72**	**93.12**		
	PS (Control)	109.45	103.26	95.72	102.80	ABCD
	CD	**3.7252****				

** - significant at 5% level

Phosphorus content on 8 DAF was found to range between 91.85 and 113.46 mg/100g with a mean value of 101.72 mg/100g.

Fig.8 Comparison of phosphorus content of Thamara Venda genotypes with Pusa Sawani



The highest value was observed in the genotype AM 3 and the lowest in AM 5. Pusa Sawani had a value of 103.26 mg/100g.

On 11 DAF, the phosphorus content ranged from 81.97 to 101.87 mg/100g with a mean value of 93.12 mg/100g. The lowest and the highest were respectively found in AM 4 and AM 31 genotypes. The control variety had a phosphorus content of 95.72 mg/100g.

Phosphorus content of the genotypes also showed a decreasing trend as the days after flowering increased. But here the values showed significant difference between different maturity levels.

4.1.9 Iron

The mean iron content of different genotypes of *A. caillei* and the control variety are given in Table 9. The mean iron content ranged from 1.00 mg/100g (AM 24) to 1.58 mg/100g (AM 23) in Thamara venda genotypes. The control variety, Pusa Sawani, had a mean iron content of 0.89 mg/100g. Figure 9 shows the comparison of iron content of *A. caillei* genotypes and Pusa Sawani.

According to DMRT, there were twelve categories of genotypes based on mean iron content (Table 9). The genotypes which were included in the same category had no significant difference between the genoypes of the same class but they were significantly different

from the genotypes of other classes. The control variety, Pusa Sawani, was included in the last group G as a single member and this indicated that the iron content of Pusa Sawani was significantly different from Thamara venda genotypes.

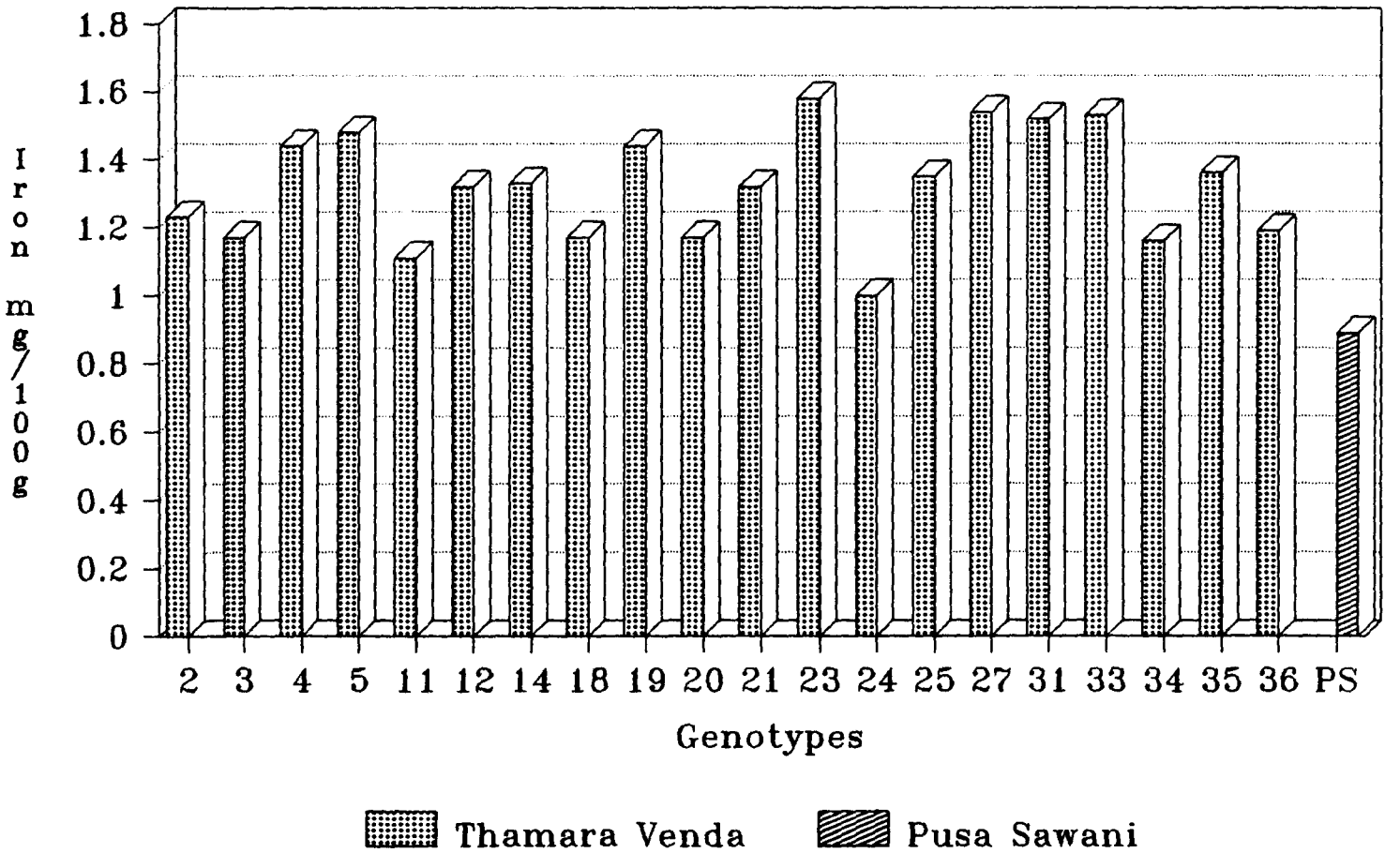
Table 9. Iron content of Thamara venda genotypes and Pusa Sawani on dry weight basis (mg/100 g)

S.No.	Genotype	5DAF	8DAF	11DAF	Mean	DMRT Category
1	AM 2	1.79	1.10	0.80	1.23	BCDEF
2	AM 3	1.84	1.34	0.33	1.17	DEFG
3	AM 4	2.03	1.55	0.73	1.44	ABCDE
4	AM 5	1.77	1.72	0.96	1.48	ABCD
5	AM 11	1.74	1.14	0.46	1.11	EFG
6	AM 12	2.05	1.26	0.65	1.32	ABCDEF
7	AM 14	1.91	1.63	0.45	1.33	ABCDEF
8	AM 18	1.81	1.37	0.33	1.17	DEFG
9	AM 19	2.01	1.63	0.68	1.44	ABCDE
10	AM 20	1.88	1.27	0.35	1.17	DEFG
11	AM 21	1.92	1.44	0.60	1.32	ABCDEF
12	AM 23	2.03	1.65	1.06	1.58	A
13	AM 24	1.35	1.17	0.49	1.00	FG
14	AM 25	1.83	1.63	0.60	1.35	ABCDE
15	AM 27	2.0	1.76	0.86	1.54	AB
16	AM 31	1.91	1.74	0.90	1.52	ABC
17	AM 33	1.83	1.73	1.03	1.53	AB
18	AM 34	1.76	1.19	0.52	1.16	DEFG
19	AM 35	2.01	1.76	0.31	1.36	ABCDE
20	AM 36	1.73	1.45	0.39	1.19	CDEFG
	Mean	**1.86**	**1.48**	**0.63**		
	PS (Control)	1.33	0.91	0.43	0.89	G
	CD	**0.1062****				

** - significant at 5% level

When the genotypes were analysed at three different maturity

Fig.9 Comparison of iron content of Thamara Venda genotypes with Pusa Sawani



levels, it was found that on 5 DAF, the iron content varied from 1.35 to 2.05 mg/100g with a mean value of 1.86 mg/100g. The highest and lowest values were found in the genotypes AM 12 and in AM 24 respectively. The control variety, Pusa Sawani, had an iron content of 1.33 mg/100g.

On 8 DAF, the iron content was found to vary from 1.10 to 1.76 mg/100g. The lowest value was reported in the genotype AM 2 and the highest in AM 27. Pusa Sawani had a much lower value of 0.91 mg/100g.

The iron content ranged between 0.31 and 1.06 mg/100g on 11 DAF with a mean value of 0.63 mg/100g. The lowest value was observed in the genotype AM 35 and the highest in AM 23. Pusa Sawani had a value of 0.43 mg/100g.

From Table 9, it is obvious that the iron content of the Thamara venda genotypes and the control variety decreased as maturity increased and this decrease was found to be statistically significant in different maturity levels.

4.10 Vitamin C

The vitamin C content of the Thamara venda genotypes and the control variety, Pusa Sawani, on fresh weight basis are presented in Table 10. The table shows that the mean values of

viamin C ranged between 78.67 and 92.29 mg/100g. The lowest vitamin C content was found in AM 5 and the highest in AM 25. The control variety had a mean vitamin C content of 63.13 mg/100g. The comparison of vitamin C content of Thamara venda genotypes and Pusa Sawani is shown in figure 10.

On the basis of vitamin C content, the genotypes were statistically classified into eight categories, the last one (E) accommodating only the control variety. There was no significant difference between the genotypes included in the same class but there occurred significant difference between genotypes of different classes. Since the control variety was included separately, it can be said to have significant difference from all the genotypes of *A. caillei.*

On 5 DAF, the vitamin C values ranged between 84.76 to 106.8 mg/100g with a mean value of 97.02 mg/100g. The genotypes with the highest and the lowest values of vitamin C were AM 35 and AM 34 respectively. Pusa Sawani contained 76.07 mg of vitamin C per 100 g of edible portion on 5 DAF.

On 8 DAF, the vitamin C content was found to range between 75.42 mg/100 g and 90.72 mg/100g. The highest value was seen in the genotype AM 25 and the lowest in AM 5. The mean value obtained (83.59 mg/100g) was much higher than the value for Pusa Sawani (63.47 mg/100g).

On 11 DAF, the vitamin C content ranged from 68.64 mg/100g in the genotype AM 18 to 83.12 mg/100g in the genotype AM 20 with a mean value of 76.10 mg/100g. Pusa Sawani was found to have a much lower value of 49.85 mg/100g.

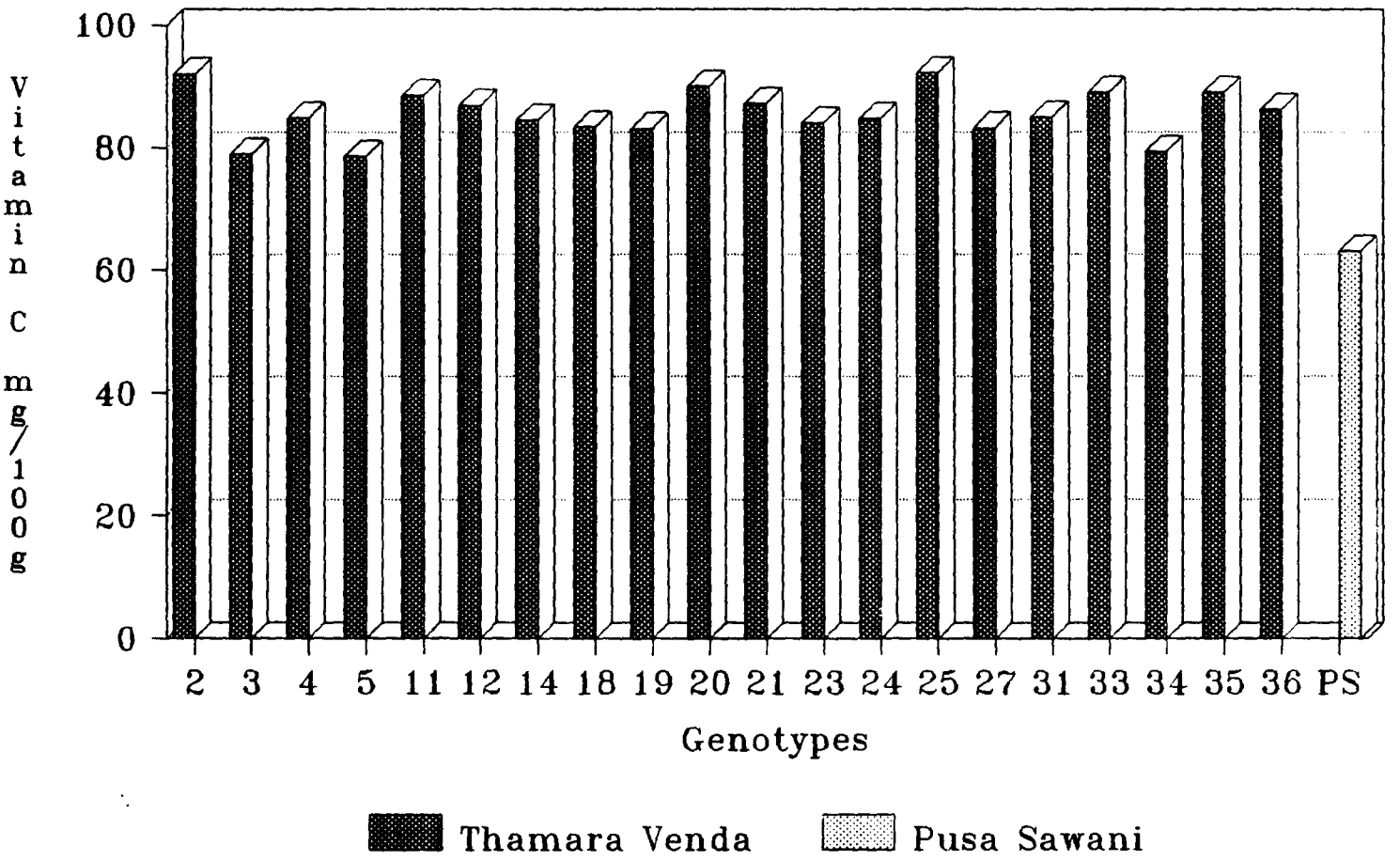
Table 10. Vitamin C content of Thamara venda genotypes and Pusa Sawani on fresh weight basis (mg/100 g)

S.No.	Genotype	5DAF	8DAF	11DAF	Mean	DMRT Category
1	AM 2	106.33	89.80	80.03	92.05	AB
2	AM 3	91.98	76.53	68.62	79.04	D
3	AM 4	93.70	79058	81.28	84.85	ABCD
4	AM 5	86.64	75.42	73.95	78.67	D
5	AM 11	105.32	83.03	77.32	88.56	ABC
6	AM 12	98.59	82.53	79.60	86.91	ABC
7	AM 14	88.09	87.09	78.45	84.54	BCD
8	AM 18	94.32	87.42	68.64	83.46	CD
9	AM 19	92.17	83.31	73.89	83.12	CD
10	AM 20	98.42	88.42	83.12	89.99	ABC
11	AM 21	96.15	88.33	77.06	87.18	ABC
12	AM 23	96.39	82.34	73.34	84.02	CD
13	AM 24	97.59	81.68	75.08	84.78	ABCD
14	AM 25	104.28	90.72	81.86	92.29	A
15	AM 27	98.02	79.39	72.35	83.25	CD
16	AM 31	97.62	84.67	72.70	85.0	ABCD
17	AM 33	101.01	83.31	82.91	89.07	ABC
18	AM 34	84.76	80.22	73.08	79.35	D
19	AM 35	106.8	84.42	75.92	89.05	ABC
20	AM 36	102.16	83.59	72.83	86.19	ABCD
	Mean	**97.02**	**83.59**	**76.10**		
	PS (Control)	76.07	63.47	49.85	63.13	E
	CD	**2.4073****				

** - significant at 5% level

As the days after flowering increased, the vitamin C content

Fig.10 Comparison of vitamin C content of Thamara Venda genotypes with Pusa Sawani



showed a decreasing trend. Statistically, it was found that there was significant difference between the different maturity levels on vitamin C content.

4.1.11 Mucilage

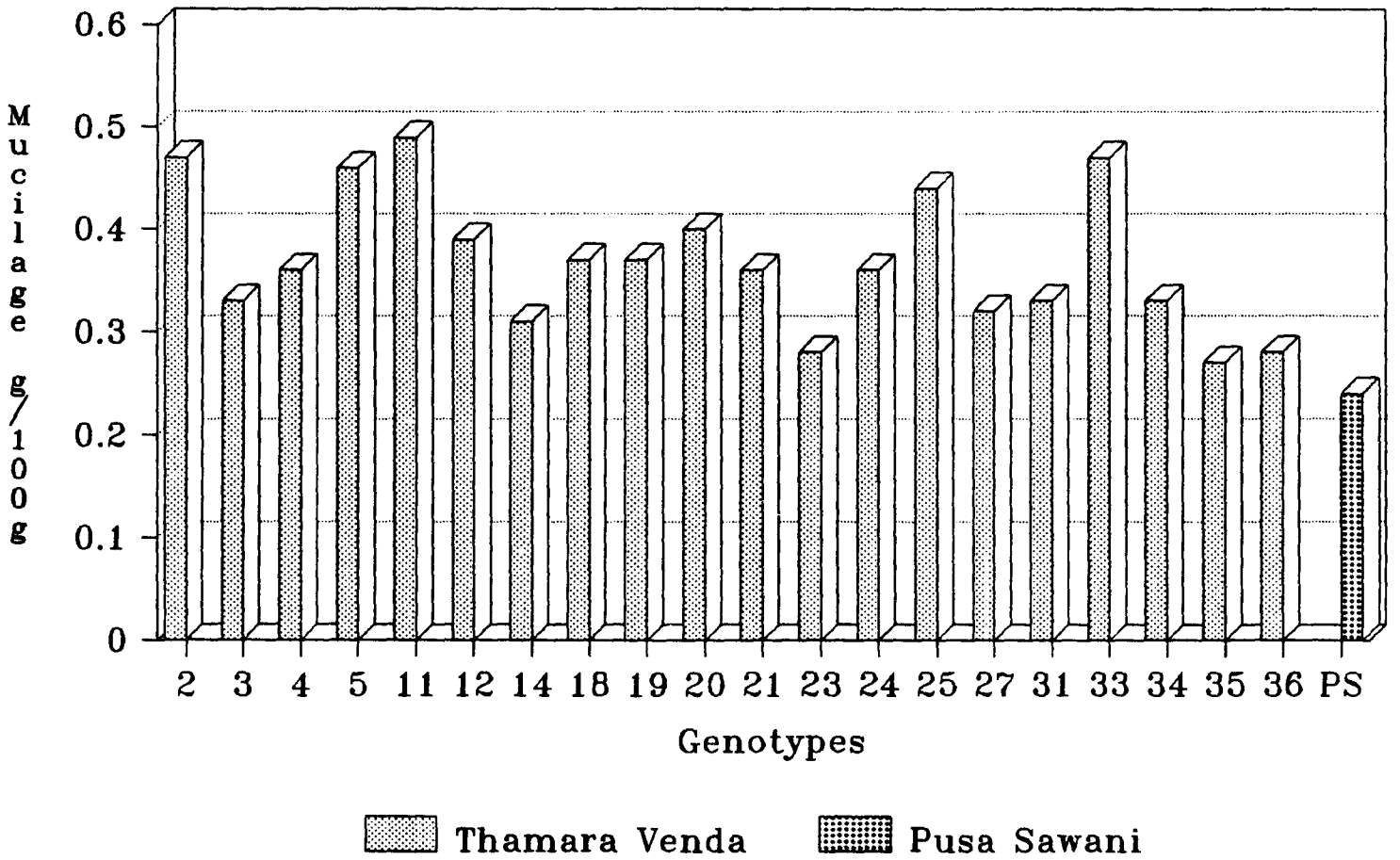
Table 11. Mucilage content of Thamara venda genotypes and Pusa Sawani on fresh weight basis (g/100 g)

S.No.	Genotype	5DAF	8DAF	11DAF	Mean	DMRT Category
1	AM 2	0.37	0.46	0.58	0.47	AB
2	AM 3	0.23	0.31	0.46	0.33	AB
3	AM 4	0.21	0.40	0.47	0.36	DE
4	AM 5	0.26	0.47	0.65	0.46	AB
5	AM 11	0.32	0.47	0.68	0.49	A
6	AM 12	0.21	0.40	0.57	0.39	BCD
7	AM 14	0.23	0.29	0.41	0.31	DEF
8	AM 18	0.23	0.37	0.50	0.37	CD
9	AM 19	0.19	0.27	0.66	0.37	CD
10	AM 20	0.24	0.38	0.57	0.40	BCD
11	AM 21	0.28	0.35	0.45	0.36	CDE
12	AM 23	0.18	0.22	0.43	0.28	EF
13	AM 24	0.25	0.34	0.49	0.36	CDE
14	AM 25	0.32	0.45	0.56	0.44	ABC
15	AM 27	0.20	0.27	0.48	0.32	DEF
16	AM 31	0.19	0.27	0.53	0.33	DE
17	AM 33	0.31	0.44	0.65	0.47	AB
18	AM 34	0.16	0.31	0.52	0.33	DE
19	AM 35	0.17	0.22	0.43	0.27	EF
20	AM 36	0.20	0.26	0.37	0.28	EF
	Mean	**0.24**	**0.35**	**0.52**		
	PS (Control)	0.15	0.25	0.31	0.24	F
	CD	**0.0279****				

** - significant at 5% level

The mucilage content of the twenty genotypes of *A. caillei* and

Fig.11 Comparison of mucilage content of Thamara Venda genotypes with Pusa Sawani



the control variety, Pusa Sawani, estimated on a fresh weight basis are furnished in Table 11. The mean mucilage content ranged from 0.27 per cent to 0.49 per cent in twenty Thamara venda genotypes. The highest value was obtained in the genotype AM 11 and the lowest in AM 35. The control variety had been found to have a mean mucilage content of 0.24 per cent. Figure 11 shows the comparison of mucilage content of Thamara venda genotypes and Pusa Sawani.

According to DMRT, the different genotypes were grouped into eleven categories. The genotypes belonging to the same group had no significant difference between themselves but they differ from the genotypes of other classes. The control variety, Pusa Sawani, which had the least value was included separately in the group namely F and this shows that significant difference in the mucilage content existed between the genotypes of *A. caillei* and the control variety, Pusa Sawani.

When the genotypes were analysed at three different maturity levels, it was found that the values for mucilage ranged from 0.16 per cent to 0.37 per cent on 5 DAF with a mean mucilage content of 0.24 per cent. The highest value was observed in the genotype AM 2 and the lowest in AM 34 respectively. Pusa Sawani had a value of 0.15 per cent.

The mucilage content on 8 DAF showed that the values ranged between 0.22 per cent and 0.47 per cent with a mean value of 0.35

per cent. The lowest value was found in the genotypes AM 23 and AM 35 and the highest values in AM 5 and AM 11. The mean mucilage content at 8 DAF of Pusa Sawani was observed as 0.25 per cent.

On 11 DAF, the mucilage content ranged from 0.37 per cent and 0.68 per cent with a mean value of 0.52 per cent. The genotype AM 36 had the lowest value and AM 11 had the highest observed value. The mean value obtained for *A. caillei* genotypes was very much higher than the value obtained for the control variety (0.31 %).

Mucilage content showed a general increasing trend as maturity increased. When analysed statistically, it was found that there was significant difference in the mean mucilage content of Thamara venda genotypes and Pusa Sawani between the different maturity levels.

4.2 Sensory Evaluation

The mean sensory evaluation scores were obtained for the twenty Thamara venda genotypes and the control variety, Pusa Sawani by scoring the cooked dish by ten judges for five quality attributes like colour, doneness, texture, flavour and taste. The five quality attributes were described on a five point scale and the total score was obtained out of 25. The mean total scores obtained for

different genotypes are furnished in Table 12. Figure 12 shows the comparison of mean sensory evaluation scores of *A. caillei* genotypes and Pusa Sawani.

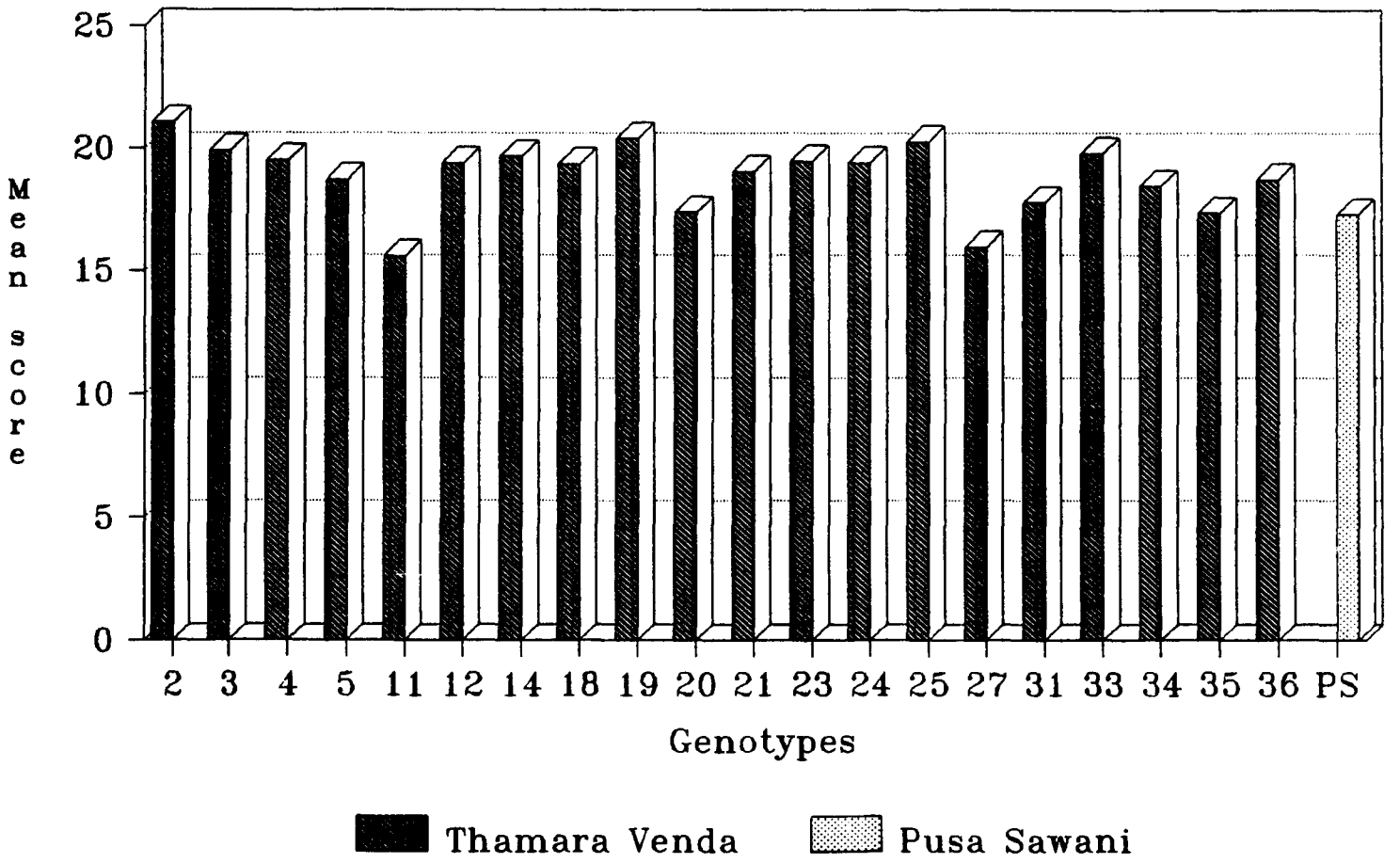
Table 12. Sensory evaluation score of Thamara venda genotypes and Pusa Sawani.

S.No.	Genotype	5DAF	8DAF	11DAF	Mean	DMRT Category
1	AM 2	21.2	21.3	20.7	21.07	A
2	AM 3	20.2	20.1	19.5	19.93	BC
3	AM 4	19.9	19.4	19.3	19.53	BCDE
4	AM 5	19.1	17.9	19.2	18.73	DEF
5	AM 11	16.2	15.1	15.5	15.60	H
6	AM 12	20.3	18.5	19.4	19.4	BCDE
7	AM 14	20.1	19.4	19.6	19.7	BCD
8	AM 18	19.4	19.7	19.0	19.37	BCDE
9	AM 19	21.1	20.2	20.0	20.43	AB
10	AM 20	18.1	17.7	16.4	17.4	G
11	AM 21	19.2	18.6	19.4	19.07	CDE
12	AM 23	20.2	19.3	19.0	19.50	BCDE
13	AM 24	20.1	19.6	18.6	19.43	BCDE
14	AM 25	20.9	20.4	18.6	20.3	AB
15	AM 27	15.9	14.8	17.2	15.97	H
16	AM 31	18.8	17.4	17.2	17.80	FG
17	AM 33	20.5	19.5	19.4	19.80	BCD
18	AM 34	17.8	18.7	18.9	18.47	EF
19	AM 35	18.5	17.5	16.1	17.37	G
20	AM 36	19.6	17.4	19.2	18.73	DEF
	Mean	**19.36**	**18.63**	**18.61**		
	PS (Control)	17.9	17.2	16.8	17.30	G
	CD	**0.3783****				

** - significant at 5% level

As can be seen from the Table 12, the mean total scores for

Fig.12.Sensory evaluation of
Thamara Venda genotypes with Pusa Sawani



the different genotypes of *A. caillei* varied from 15.60 to 21.07. The genotype AM 11 had the lowest score which implicated the least acceptability and the genotype AM 2 had the highest mean score. Pusa Sawani was obtained a mean score of 17.30.

According to DMRT, the different genotypes were classified into eleven categories based on their mean total sensory evaluation scores. Most of the groups contained only one or two members except the group, BCDE which implicated that the acceptability levels were significantly different between different genotypes.

When the different genotypes were analysed in the three maturity levels, it was found that mean scores in the different genotypes varied from 15.90 to 21.20. The lowest and the highest scores were obtained in the genotypes AM 27 and AM 2 respectively with a mean score of 19.36. The control variety, Pusa Sawani, had a score of 17.9.

On 8 DAF, the scores varied from 15.10 in the genotype AM 11 to 21.30 in AM 2. The mean value for the genotypes was 18.63 and the control variety had a score of 17.20.

When the pods reached 11 days' maturity, the mean sensory evaluation scores ranged from 15.5 (AM 11) to 20.7 (AM 2) with a mean value of 18.61. The control variety, Pusa Sawani, was found to have a value of 16.8.

Statistical analysis showed that there was a significant difference in the acceptability of different genotypes in the different maturity levels. There was significant variation between the 5th and the 8th days and also between the 5th and the 11th days of maturity in accepatability levels. But the mean values were not significantly different between the 8th and 11th days after flowering.

Discussion

5. DISCUSSION

The study on the "Nutritional composition and organoleptic evaluation of Thamara venda genotypes" was made to evaluate the chemical constituents and the acceptability of twenty genotypes of Thamara venda (*Abelmoschus caillei*). Pusa Sawani (*Abelmoschus esculentus*) was taken as the control variety to compare the constituents and the acceptability of Thamara venda genotypes. All the analysis were carried out at three maturity levels i.e. 5th , 8th and 11th days after flowering. The constituents like moisture, protein, fat, total carbohydrate, starch, fibre, calcium, phosphorus, iron, vitamin C and mucilage were estimated at three different maturity levels. The acceptability of the genotypes was also carried out through organoleptic evaluation using score card. The results of the study are discussed below under the following heads:

5.1. Chemical constituents

5.2. Organoleptic evaluation

5.1 Chemical constituents

The mean moisture content of the twenty genotypes of *A. caillei* varied from 90.16 per cent to 92.04 per cent. The control variety had a moisture content of 91.08 per cent. The moisture content of both Thamara venda genotypes and the control variety was found to be in accordance with the values reported by Kalra *et al.* (1982). The findings of the present study were found to be

slighly higher than the values reported by Nehry *et al.* (1978), and Gopalan *et al.* (1989) who observed the moisture content in okra pods as 87.55, 89.7 and 89.6 per cent respectively. Though the moisture content did not show much variation, Pusa Sawani was significantly similar in its moisture content to only four genotypes of *A. caillei.* i.e. AM 5, AM 14, AM 25 and AM 35.

As the pods increased in maturity, there was a significant decrease in the moisture level, the mean values of the different Thamara venda genotypes in three different maturity levels being 91.98, 91.08 and 90.11 per cent respectively. The control variety also had a decreasing trend as the following values for the different maturity levels show: 92.13, 90.95 and 90.17 per cent respectively. This finding is in tune with the findings of Iremiren *et al* (1991) who also observed a decreasing trend in the moisture content of okra varieties.

The mean protein content of Thamara venda genotypes ranged from 14.19 per cent to 17.65 per cent on DWB. The control variety also had similar values for protein (16.21 %). The protein content of the okra pods showed considerable difference on fresh as well as on dry weight basis as indicated by Arlin (1977), Kalra *et al.* (1982) and Gopalan *et al.* (1989) who observed the protein contents as 2, 1.50 and 1.9 per cent respectively on fresh weight basis.

The findings of the study also indicated that there was a

decreasing trend in the protein content of most of the genotypes of Thamara venda and also that of Pusa Sawani with an increase in maturity. Similar trend had been observed by Longe *et al.* (1982), Kalra *et al.* (1982) and Iremiren *et al.* (1991). A contradictory report was observed by Balasubramanian and Sadasivam (1987). According to them, protein content of the okra pods increased gradually from the 7th to 42nd day. The protein content of majority of the genotypes was found to be almost same and did not differ significantly from the control variety.

The mean fat content of the Thamara venda genotypes ranged from 12.52 to 14.83 g/100 g on DWB while Pusa Sawani had a mean value of 10.45 g/100 g. As in the case of protein, here also the fat values differed a lot on fresh weight basis. Arlin (1977) reported only trace amounts of fat in okra pods. In an Egyptian study by Nehry *et al.* (1978), the fat content was found to range from 0.29–0.40 per cent. The fat values reported in okra pods are 0.21–0.44 per cent (Kalra *et al.*, 1982) and 0.2 per cent (Gopalan *et al.*, 1989).

The results also indicated an increase in the fat content as the days after flowering increased. The mean values of twenty genotypes at different maturity levels were 12.40, 13.55 and 14.72 g/100 g respectively. The respective values for Pusa Sawani were 9.77, 10.4 and 11.17 g/100 g. This finding lends support to the view expressed by Balasubramanian and Sadasivam (1987) who reported an

increase in the fat content of okra pods from 7th to 42nd days. The fat content of the Thamara venda genotypes was found to be higher than that of the control variety and the fat content of most of the genotypes was significantly different from other genotypes.

The total carbohydrate content of the Thamara venda genotypes ranged from 12.23 to 17.81 per cent which was found to be higher than the values reported by Arlin (1977), Nehry *et al.* (1978) and Gopalan *et al.* (1989). They observed a carbohydrate content of 5 , 6.59–6.83 and 6.4 per cent respectively in the fresh okra pods. Pusa Sawani was found to have a value of 12.61 per cent.

As the maturity of the pods increased, there was an increase in the total carbohydrate content in the Thamara venda genotypes and Pusa Sawani. The mean values for the Thamara venda genotypes were 11.21, 14.64 and 21.11 per cent respectively for the increasing maturity levels. The respective values for the control variety were 8.65, 11.24 and 17.93 per cent.

There are contradictory reports on the influence of age on the carbohydrate content. According to Longe *et al.* (1982) and Balasubramanian and Sadasivam (1987), free sugars decreased with age in okra pods. Kalra *et al.* (1982) were of the opinion that the total sugars were more in tender pods (31.82 %) except in the smallest size (20.0 %) which were undermature pods. Singh *et al.*

(1990) reported that sugar content increased upto 8 days and declined thereafter. The total carbohydrate content of most of the Thamara venda genotypes was significantly different from other genotypes and all the genotypes differed statistically from the control variety with respect to total carbohydrate. This finding agrees with the observation of Longe et al (1982) who observed differences in the soluble sugars among the different varieties of okra.

The starch content of the Thamara venda genotypes significantly differed from the control variety. The mean values for the starch content of the different genotypes of *A. caillei* ranged from 3.87 to 7.30 per cent on DWB. Pusa Sawani had a mean value of 4.34 per cent. Since the different genotypes were classified into 13 groups, it was clear that most of the genotypes differed significantly from each other with respect to starch.

It was observed in the present study that there was an increase in the starch content with increasing age. The starch values of Thamara venda genotypes at three maturity levels were 3.93, 5.13 and 8.69 per cent respectively. The respective values for the control variety were 2.41, 4.3 and 6.31 per cent. This is in support of the views expressed by Longe *et al.* (1982), Balasubramanian and Sadasivam (1987) and Singh *et al.* (1990).

The fibre content of Pusa Sawani differed significantly from

the twenty Thamara venda genotypes selected for the study. The mean values for crude fibre on DWB in different genotypes of Thamara venda ranged from 9.28 to 15.17 per cent. In the case of crude fibre, Pusa Sawani outweighed Thamara venda genotypes, the mean value being 18.72 per cent.

The findings also indicated an increasing trend in crude fibre with an increase in age. The fibre content of Thamara venda genotypes at three maturity levels were 9.1, 11.27 and 16.73 per cent and the respective values for the control variety were 14.0, 17.5 and 24.67 per cent. This supports the findings of Rao and Sulladmath (1977), Kalra *et al.* (1982), Longe *et al.* (1982), Iremiren *et al.* (1991) and Ketsa and Chutichudet (1994) who also observed an increasing trend in the fibre content of okra pods with increase in maturity. The low fibre content of the Thamara venda genotypes at different stages of harvest is a plus point of acceptability.

The mean calcium content of *A. caillei* genotypes ranged from 92.6 to 140.6 mg/100 g and that of the control variety was 110.7 mg/100 g. Similar values were reported by and Nehry *et al.* (1978) who reported a calcium content of 98.45 mg/100 g. A lower calcium content of 66 mg/100 g was reported by Gopalan *et al.* (1989). The calcium content of eleven genotypes had significant difference from the control variety.

From the present study, it had been shown that the calcium

content of the Thamara venda genotypes and Pusa Sawani decreased as age advanced. A similar finding was reported by Ketsa and Chutichudet (1994). The calcium content in Thamara venda genotypes in three maturity levels were 138.62, 120.66 and 114.34 mg/100 g and the respective values for the control variety were 129.5, 114.6 and 88.0 mg/100 g.

The mean phosphorus content of Thamara venda genotypes on DWB ranged from 91.61 to 111.0 mg/100 g while that of Pusa Sawani was 102.8 mg/100 g. This is higher than the earlier report by Nehry *et al.* (1978) and Gopalan *et al.* (1989) who reported the phosphorus content as 56.15-94.33 mg/100 g and 56 mg/100 g respectively. Except the seven genotypes included in the group, ABCD, the phosphorus content of all the other genotypes significantly differed from the control variety.

From the results, it can be seen that there was a decreasing trend in the phosphorus content as the pods increased in maturity. This finding was found to be similar to that observed by Hodossi and Pankotai (1987) and Singh *et al.* (1990) who also reported a decrease in phosphorus content as age increased. The phosphorus values of *A. caillei* genotypes at different maturity levels were 109.13, 101.72 and 93.12 mg/100 g. The respective values of Pusa Sawani were 109.45, 103.26 and 95.72 mg/100 g.

The analysis of the iron content of *A. caillei* genotypes showed

that the mean values ranged from 1.00 to 1.58 mg/100 g and the iron content of the genotypes differed significantly from the control variety (0.89 mg/100 g).

As in the case of calcium and phosphorus, iron content also showed a decrease as age advanced. Similar trend was observed in the control variety also. All these observations were in accordance with the findings observed by Hodossi and Pankotai (1987) and Singh *et al.* (1990). The decreasing values of iron in Thamara venda genotypes were 1.86, 1.48 and 0.63 mg/100 g. The respective values for Pusa Sawani were 1.33, 0.91 and 0.43 mg/100 g.

The mean vitamin C content of Thamara venda genotypes ranged from 78.67 to 92.29 mg/100 g. The vitamin C content of Pusa Sawani was 63.13 mg/100 g. The present finding is almost similar to the value of 98.8 mg/100 g as reported by Achinewhu (1983). The ascorbic acid content in the present study is much higher than the values reported by Pal *et al.* (1951) and Arlin (1977). They reported the ascorbic acid content as 30 mg and 17 mg respectively per 100 g of fresh okra pods. According to Keshinro and Ketiku (1979), the ascorbic acid content of fresh okra was much higher and was estimated as 203 mg/100 g. According to Gopalan *et al.* (1989), the ascorbic acid content of ladies finger is 13 mg/100 g.

Just like the control variety, the vitamin C content of the Thamara venda genotypes also decreased as age advanced. This

finding strongly supports the views expressed by Kitagawa (1972) and Rao and Sulladmath (1977). The decreasing values of Thamara venda genotypes were 97.02, 83.59 and 76.10 mg/100 g. The respective values for Pusa Sawani were 76.07, 63.47 and 49.85 mg/100 g.

Okra pods are specially characteristic for their mucilage content. The values obtained for mucilage content in the present study ranged from 0.27 to 0.49 g/100 g. All the Thamara venda genotypes are specially characterised by high quantities of mucilage than the control variety and the mucilage content of the Thamara venda genotypes varied significantly from the control variety. Wolfe *et al.* (1977) reported that a typical Ghanian okra soup would contain approximately 0.2-0.3 per cent mucilage by weight.

Mucilage content in both Thamara venda genotypes and okra varieties showed an increasing trend with the age. The increasing mucilage content in the Thamara venda genotypes at three different maturity levels were 0.24, 0.35 and 0.52 per cent respectively. The respective values for Pusa Sawani were 0.15, 0.25 and 0.31 per cent.

It is clear that the genotypes differed very much in their chemical composition. In the case of nutrients like iron, vitamin C and fat as well as mucilage, the mean values of the control variety were lower than the lowest obtained in *A. caillei* genotypes. The total

carbohydrate, starch and calcium contents of Pusa Sawani had lower dispositions when compared to Thamara venda genotypes. In the case of protein, moisture and phosphorus, the mean values for Pusa Sawani were comparable with those of *A. caillei*. But in crude fibre content, Pusa Sawani outweighed the Thamara venda genotypes. It had been shown statistically that there was no concordance between the different genotypes in the case of different chemical constituents. Hence it is difficult to select a particular genotype with better nutritive value.

5.2 Acceptability of Thamara venda genotypes

Cooking qualities of Thamara venda genotypes also were analysed in comparison with the okra variety. Ten judges scored the dish for finding out the acceptability and to compare the product with that of Pusa Sawani. The mean scores varied from 15.60-21.07. Pusa Sawani had a mean score of 17.30. These values show that Thamara venda genotypes generally had a higher acceptability level than the Pusa Sawani. Though the mucilage content of *A. caillei* genotypes were higher, it can be shown that this feature did not hinder the acceptability levels. The genotypes AM 2 (21.07) had the highest acceptability score and AM 11(15.60), the lowest. Both these genotypes had been found to have very high mucilage content of 0.47 and 0.49 respectively and so it can be stressed that this factor did not affect the acceptability of Thamara venda genotypes.

The acceptability scores were found to decrease as maturity increased. This shows that the pods were more acceptable in younger stages than in mature stages. This may be due to the increase in the crude fibre content which adversely affected the acceptability level. Finding of the present study is in support of the view expressed by Iremiren *et al.* (1991). According to him, the pods harvested seven days after pod set were of poorer quality mainly due to an increase in crude fibre and reduction in moisture, crude protein and ash contents.

Summary

SUMMARY

The study on "Nutritive value and organoleptic evaluation of Thamara venda (*Abelmoschus caillei*) genotypes" was made to evaluate the chemical composition and acceptability of twenty genotypes of *Abelmoschus caillei* and also to make a comparison of these aspects with the control okra variety, Pusa Sawani. The Thamara venda genotypes taken for the study were collected from the Department of Olericulture, College of Horticulture, Vellanikkara under the Kerala Agricultural University.

The major chemical constituents like moisture, protein, fat, total carbohydrate, starch, crude fibre, calcium, phosophorus, iron, vitamin C and mucilage were estimated in *A. caillei* genotypes and in the control variety, Pusa Sawani at three different maturity levels i.e. 5^{th}, 8^{th} and 11^{th} days after flowering. The organoleptic evaluation of both the Thamara venda genotypes and the control variety was also assessed on five quality attributes on a five point scale by ten judges after cooking.

The salient features of the findings of the study are presented here. The mean moisture content of the twenty genotypes of *A. caillei* varied from 90.16 per cent to 92.04 per cent. The control variety had a moisture content of 91.08 per cent. As the pods increased in maturity, there was a significant decrease in the moisture level. The mean protein contents of the Thamara venda

genotyes ranged from 14.19 per cent to 17.65 per cent on DWB and that of Pusa Sawani was 16.21 per cent. There obtained a decreasing trend in the protein content as the pods increased in maturity. The mean fat content of the Thamara venda genotypes varied from 12.52 to 14.83 g/100 g on DWB. Pusa Sawani was reported to have a mean value of 10.45 g/100 g. The results showed an increase in the fat content as the days after flowering increased. The mean total carbohydrate content of *A. caillei* genotypes ranged from 12.23 to 17.81 per cent on DWB while Pusa Sawani had a value of 12.61 per cent. As the pods increased in maturity, there was significant increase in the total carbohydrate content. The mean starch values ranged from 3.87 to 7.30 per cent on DWB while in Pusa Sawani, it was 4.34 per cent. Starch content in different maturity levels showed a significant increase with the increasing age. The mean crude fibre content of the Thamara venda genotypes ranged from 9.28 to 15.17 per cent on DWB and Pusa Sawani had a mean crude fibre content of 18.72 per cent. The crude fibre content was found to increase as maturity increased.

Coming to the vitamins and minerals, the calcium content of *A. caillei* genotypes varied from 92.6 to 140.6 mg/100 g on DWB and that of Pusa Sawani was 110.7 mg/100 g. From the present study, it had been shown that the calcium content decreased as age advanced. The mean phosphorus content of the Thamara venda genotypes on DWB ranged from 91.61 to 111.0 mg/100 g and Pusa Sawani was found to have a mean value of 102.8 mg/100 g.

Phoshporus content showed a decreasing trend as pods increased in maturity. The mean iron content of *A. caillei* genotypes varied in a range of 1.0 to 1.58 mg/100 g and the control variety had a mean value of 0.89 mg/100 g. The mean iron content showed a decrease as age advanced. The mean vitamin C content of the Thamara venda genotypes ranged from 78.67 to 92.29 mg/100 g on fresh weight basis. Pusa Sawani was found to have a value of 63.13 mg/100 g. Vitamin C content showed a decreasing trend as the days after flowering increased.

The mucilage content of the Thamara venda genotypes ranged from 0.27 to 0.49 g/100 g on fresh weight basis which was found to be higher than the mucilage content (0.24 mg/100 g) of Pusa Sawani. The mucilage content in both the Thamara venda genotypes and okra variety showed an increasing trend with the age.

The organoleptic evaluation was carried out using a score card by ten judges. The judges assessed the parameters like colour, texture, doneness, flavour and taste of the cooked dish on a five point scale of both Thamara venda genotypes and Pusa Sawani. The mean total scores of the Thamara venda genotypes ranged from 15.60 to 21.07 while that of Pusa Sawani was 17.30. The acceptability scores were found to decrease as maturity increased in the Thamara venda genotypes and in control variety.

References

REFERENCES

Achinewhu, S.C. 1983. Ascorbic acid content of some Nigerian local fruits and vegetables. *Qualitar Pl. Pl. Fds Hum. Nutr.* **33**(4): 261-266

Aghora, T.S., Mohan, N. and Somkumar, R.G. 1994. Evaluation of vegetable cowpea (*Vigna uniguiculata* L.) for earliness, protein content and green pod yield. *Legume Res.* **17**(2): 138-140

Akachukku, C.O. and Fawusi, M.O.A. 1995. The growth characteristics, yield and nutritive value of water leaf, *Talinum triangulare* (Jacq.) Willd. in a semi-wild environment. *Discovery and Innovation* **1**(2): 163-172

Amerine, M.A., Pangborn, R.M. and Roessler, E.B. 1965. *Principles of Sensory Evaluation of Food.* Academic Press, New York

Anon. 1975. *Minutes of Division Business Meeting Institute of Food Technologists.* Sensory Evaluation Division, Chicago

A. O. A. C. 1955. *Official and Tentative Methods of Analysis.* 8th ed. Association of Official Agricultural Chemists, Washington, D.C.

A.O.A.C. 1980. *Official Methods of Analysis.* 13th ed. Association of Official Analytical Chemists, Washington, D.C.

Ariyo, O.J. and Aken'ova, M.E. 1986. Evaluation of varieties of Okra (*Abelmoschus esculentus* (L.)) for distinctness and uniformity. *Nigerian J. Agron.* **1**(3): 97-102

Arlin, M. 1977. *The Science of Nutrition.* 2nd ed. MacMillan Publishing Co. Inc., New York. p. 419

Arumugham, R. and Muthukrishnan, C.R. 1975. Nitrogen compounds in relation to resistance to Yellow Vein Mosaic disease of Okra (*Abelmoschus esculentus* (L.) Moench.). *Progressive Hort.* **10**(2): 17-21

Awoyinka, A.F., Abegunde, V.D. and Adewusi, S.R.A. 1995. Nutrient content of young cassava leaves and assessment of their acceptance as a green vegetable in Nigeria. *Pl. Fds Hum. Nutr.* **47**(1): 21-28

Aykroyd, W.R., Patwardhhan, V.N. and Ranganathan, S. 1956. The nutritive value of Indian foods and the planning of satisfactory diets. *Health Bull.* **23**: 2-4

Babu, K.V.S., Prasanna, K.V. and Rajan, S. 1994. Evaluation of F1 hybrids of Okra (*Abelmoschus esculentus* (L.) Moench). *J. trop. Agric.* **32**: 152-153

Baghurst, K. 1990. Social factors and the changing food supply. *Fd Aust.* **42**(1): 44

Balasubramanian, T. and Sadasivam, S. 1987. Changes in starch, oil, protein and amino acids in developing seeds of Okra (*Abelmoschus esculentus* (L.) Moench.). *Qualitar Pl. Pl. Fds Hum. Nutr.* **37**(1): 41-46

BeMiller, J.N. 1973. *Industrial Gums.* 2nd ed. Academic Press, London.p.360

Bhuibhar, B.R., Mahakal, K.G., Kale, P.B. and Wankhade, S.G. 1989. Effect of time of sowing and number of pickings of green fruits on growth and seed yield of Okra (*Abelmoschus esculentus* (L.) Moench.). *PKV Res. J.* **13**:1

Bryant, L.A., Montecalvo, J., Morey, K.S. and Loy, B. 1988. Processing, functional and nutritional properties of Okra seed products. *J. Fd Sci.* **53**(3): 810-816

Butani, D.K., Verma, S. and Varma, S. 1978. Insect pests of vegetables and their control – Lady's finger. *Pesticides* **10**(7): 31-37

Cashel, K. and Lewis, J. 1990. Interpretation of dietary fibre data – a nutritionist's perspective. *Fd Aust.* **42**(7): 348-350

Chacko, R.S. 1996. Genetic improvement and cytogenetical studies in Thamara venda (*Abelmoschus manihot* (L.)). M.Sc. (Hort.) thesis.

Kerala Agricultural University, Vellanikkara, Thrissur, Kerala.

Chauhan, K.S. and Bhandari, Y.M. 1971. Pod development and germination in Okra (*Abelmoschus esculntus* (L.) Moench.). *Indian J. agrl. Sci.* **41**(10): 852-856

Chedda, H.R. and Fatokun, C.A. 1990. Studies on Okra germplasm in Nigeria. *Report of an International Workshop on Okra Genetic Resources.* National Bureau for Plant Genetic Resources, New Delhi, India. p. 20-23

Chopra, S.L. and Kanwar, J.S. 1978. *Analytical Agricultural Chemistry.* Kalyani Publishers, Ludhiana.

Cooke, T.C.I. 1958. *The Flora of the Presidency of Bombay.* Vol. I . Botanical Survey of India, Calcutta.

CSIR. 1972. *The Wealth of India Raw Materials.* Vol. 9. Publications and Informations Directorate, CSIR, New Delhi. p. 391-395

Devapalin, V., Tanchoraux, R. and Arai, K. 1982. Chemical composition of some oil seeds in Thailand. *Japan agrl Res. Quart.* **16** (3): 224-227

Dutt, S. 1996. Making vegetables more nutritive by nutrient management. *Indian Hort.* **40**(4): 1

Dutta, O.P. 1991. Genetics and Breeding of Okra (*Abelmoschus esculentus* (L.) Moench.). Recent Advances in Tropical Vegetable Production. *Compendium of Lectures of Summer Institute of Recent Advances in Tropical Vegetable Production.* Kerala Agricultural University, Vellanikkara, Trichur. p. 220-236

*ECC. 1975. The production of fruits and vegetables meeting taste quality standards. *int. Inf. Agri.* **169**: 300

Goldblatt, B. 1969. Gossypol. *Toxic constituent of Plant Food Stuff.* Academic Press, New York.

Gopalan, C., Sastri, B.V.R. and Balasubramanian, S.C. 1995. *Nutritive Value of Indian Foods.* National Institute of Nutrition, Hyderabad. p. 29-51

Grant, G., More, L.J., McKenzie, N.H., Dorward, P.M., Buchan, W.C, Telek, L. and Pusztai, A. 1995. Nutritional and haemagglutination properties of several tropical seeds. *J. agrl Sci.* **124**(3): 437-445

Grubben, G.J.H. 1977. Okra. *Tropical Vegetables and their Genetic Resources.* International Bureau for Plant Genetic Resources, Rome. p.111-114

*Hamon, S. and Hamon, P. 1991. Future prospects of the genetic integrity of two species of okra (*Abelmoschus esculentus* and *Abelmoschus*

caillei) cultivated in West Africa. *Euphytica* **58**(2): 101-111

Hamon, S., Charrier, A., Koechlin, J. and Sloten, D.V. 1991. Potential contribution to okra breeding through the study of their genetic resources. *Report of an International Workshop on Okra Genetic Resources.* National Bureau for Plant Genetic Resources, New Delhi. p. 20-23

Handique, A.K. 1993. Free amino acid content in non-conventional leafy vegetables. *Crop Res.* **6**(1): 189-193

*Herzog, F., Farah, Z., and Amado, R. 1993. Nutritive value of four wild leafy vegetables in Cote d' Ivorie. *int. J. Vitamin Nutr. Res.* **63**(3): 234-238

Hirst, E.L. and Jones, J.K.N. 1958. *Encyclopedia of Plant Physiology.* Springer - Verlay, Berlin. p. 500

*Hodossi, S. and Pankotai, A. 1987. Elemental composition of Okra (*Abelmoschus esculentus* (L.) Moench.) and changes in it at different growth stages. *Zoldsegtermesztesi Kutato Intezet Bulletinje.* **20**: 65-72

*Ibrahim, N.A. and Saeed, A.A. 1994. Protein content and amino acid analysis of the desert truffles. *Ann. agric. Sci. Moshtohor.* **32**(3): 1569-1573

Imungi, J.K. and Potter, N.N. 1983. Nutrient contents of raw and cooked cowpea leaves. *J. Fd Sci.* **48**(4): 1252-1254

Indira, P. and Peter, K.V. 1988. *Underexploited Tropical Vegetables.* Kerala Agricultural University, Mannuthy, Trichur, Kerala. p.1

Iremiren, G.O. and Okiy, D.A. 1981. Effects of sowing date on the growth, yield and quality of Okra (*Abelmoschus esculentus* (L.) Moench.) in Southern Nigeria. *J.agric. Sci.,UK.* **106**(1): 21-26

Iremiren, G.O., Osara, A.W. and Okiy, D.A. 1991. Effects of age of harvesting after pod set on the growth, yield and of Okra (*Abelmoschus esculentus*). *exp. Agric.* **27**(1): 33-37

Jackson, M.L. 1958. *Soil Chemical Analysis.* Asia Publishing House, New Delhi. p.498

Jambhale, N.D. and Nerkar, Y.S. 1983. Transfer of resistance to Yellow Vein Mosaic from related species into Okra (*Abelmoschus esculentus*). *Indian J. Genet.* **45**(2): 268-270

Jambhale, N.D. and Nerkar, Y.S. 1992. Screening of okra cultivars, related species and interspecific hybrid derivatives for resistance to powdery mildew. *J. Maharashtra agic. Univ.* **17**(1): 53-54

Jayaraman, K.S., Gopinathan, V.K., Gupta, D.K.D. and Rao, N.B.

1991. Development of a ready-to-use quick cooking ddehydrated vegetable curry mix (avial) containing yoghurt and coconut. *Indian Fd Packer.* **5**(1): 3-5

Jellinek, G. 1985. *Sensory Evaluation of Food - Theory and Practice.* Ellis Horwood Ltd. Chichester England and VCH Verlagsgerellschaft mbH, Weinhein, Federal Republic of Germany. p. 284

Jideani, V.A. and Adetula, H.O. 1993. The potential of Okra seed flour for weaning foods in West Africa. *Ecol. Fd Nutr.* **29**(4): 275-283

Jones, G.P., Briggs, D.R., Wahlqvist, M.L., Flentje, L.M. and Shiell, B.J. 1990. Dietary fibre content of Australian foods. *Fd Aust.* **42**(2): 76-79

Kalra, C.L., Manan, J.K. and Pruthi, J.S. 1981. CFTRI Experimental Station, Ludhiana.(Unpublished data).

Kalra, C.L., Pruthi, J.S., Teotia, M.S. and Raina, B.L. 1982. Influence of variety, size, grade and number of ridges of Okra on the canned Okra (*Hibiscus esculentus* L.). *Indian Fd Packer.* **36**(2): 53

Kanwar, K.C., Kanwar, U. and Shah, S. 1997. Friendly fibres. *Sci. Reporter.* **34**(5): 9-14

Karakoltsidis, P.A. and Constantinides, S.M. 1975. Okra seeds : a new

protein source. *J. agrl Fd Chem.* **23**(6): 1204-1207

KAU. 1993. *Package of Practices.* Directorate of Extension, Kerala Agricultural University, Mannuthy, Trichur, Kerala.

Keshinro, O.O. and Ketiku, A.O. 1979. Effect of traditional cooking methods on the ascorbic acid content of some Nigerian leafy and fruit vegetables. *Fd Chem.* **4**(4): 303-310

Ketsa, S. and Chutichudet, B. 1994. Pod growth, development, biochemical changes and maturity indices of Okra cv. OK#2. *Acta Horticultare* **369**: 368-377

Khalil, J.K., Sawaya, W.N. and Al-Mohammad, H.M. 1986. Effects of experimental cooking on the yield and proximate composition of three selected legumes. *J. Fd Sci.* **48**(4): 1252-1254

*Koechlin, J.1991. African Okras (*Abelmoschus* spp.): Study of the diversity with regard to breeding. *Travaux et Documents Microfliches* **72**: 7

Kotzekidou, P. and Roukas, T. 1986. Characterization and distribution of *Lactobacilli* during lactic fermentation of okra (*Hibiscus esculentus*) *J. Fd Sci.* **51**(3): 623-625

Kramer, A. 1959. Glossary of some terms used in the sensory (panel) evaluation of foods and beverages. *Fd Technol.* **13**: 733-736

Kulkarni, S.G., Osara, A.W. and Okiy, D.A. 1988. Effects of age of harvesting after pod set on the growth, yield and quality of okra (*Abelmoschus esculentus*). *expt. Agric.* **27**(1): 33-37

Kuriakose, K.J. 1995. Standardisation of dehydration techniques in Anachunda (*Solanum torvum* Swartz.), Black nightshade (*Solanum nigrum* L.) and Lotus (*Nelumbo nucifera* Gaertn.). M.Sc.(Hort.) thesis. Kerala Agricultural University, Vellanikkara, Trichur

Lakshminarayana, G. 1987. Potential of some unconventional vegetable oils for edible oils for edible use. *Proc. Nutr. Soc. India* **33**: 38-48

Langlais, R., Lauster, M., Lohre, G. and Kugler, E. 1977. *Sensory Properties of Foods*. Applied Sciences Publishers.

Longe, O.G., Fetuga, B.L. and Aken'ova, M.E. 1982. Changes in the composition and carbohydrate constituents of Okra (*Abelmoschus esculentus* Linn.) with age. *Fd Chem.* **8**(1): 27-32

Mahdy, A.R.E. and Sebaiy, L.A.E. 1984. Preliminary studies on the mucilages extracted from okra fruits, taro tubers, Jew's mellow leaves and fenugreek seeds. *Fd Chem.* **14**(4): 237-249

Markose, B.L. 1991. Management of Okra. Recent Advances in Tropical Vegetable Production. *Compendium of Lectures of Summer Institue*

on Recent Advances in Tropical Vegetable Production. Kerala Agricultural University, Vellanikkara, Trichur. p.404

Markose, B.L. and Peter, K.V. 1990. *Review of Research on Vegetables and Tuber Crops-Okra.* Directorate of Extension, Kerala Agricultural University, Mannuthy, Kerala. p. 109

Manay, N.S. and Shadaksharaswamy, M. 1995. *Foods- Facts and Principles.* New Age International (P) Ltd. Publishers, New Delhi. p.199

Martin, F.W. 1982. Okra, potential multiple purpose crop for the temperate zones and tropics. *econ. Bot.* 36(3): 340-345

Martin, F.W. and Ruberte, R. 1978. *Vegetables for the Hot Humid Tropics.* USDA Mayagnez Institute of Tropical Agriculture, University of Puerto Rico.

Martin, F.W., Telek, L., Ruberte, R. and Santiago, A.G. 1979. Protein, oil and gossypol contents of vegetable curd made from okra seeds. *J. Fd Sci.* **44**(5): 1517-1519

McLeod, J.M., Witcher, W., Epps, W.M. and Robbin, M.L. 1983. Resistance of Okra plant introductions to root knot nematode and fusarium wilt. *Hort. Sci.* **18**(2): 249-250

McWilliams, M.M. 1974. *Food Fundamentals.* John Wiley and Sons, Inc.,

New York. p.51

Mnembuka, B.V. and Eggum, B.O. 1993. The nutritive value of some selected Tanzanian plant food sources. *Pl.Fds Hum.Nutr.* 44(1): 1-10

Mudambi, S.R. and Rao, S. 1985. *Food Science.* Wiley Eastern Limited, New Delhi. p. 157-158

NAS. 1975a. *The Winged Bean- A High Protein Crop for the Tropics.* National Academy of Sciences, Washington, D.C. p. 17-21

NAS. 1975b. *Underexploited-Tropical Plants with Promising Economic Value.* National Academy of Sciences, Washington, D.C.

Nataray, S.E., Kulkarni, G.N., Vyakaranahal. B.S. and Shashidhara, S.D. 1992. Effect of nitrogen levels and picking of fresh fruits on seed quality of okra (*Abelmoschus esculentus* (L.) Moench.). *Karnataka J. agrl Sci.* **5**(1): 51-53

Nath, P., Sundari, V. and Singh, D.P. 1994. *Vegetables for the Tropical Region.* Indian Council of Agricultural Research, New Delhi. p. 164-170

Nehry, E.F.I., Ghorab, E.M.I. and Younes, R. 1978. Nutritive value of local varieties of fresh and sundried okra (*Hibiscus esculentus*) pods and

seeds. *Qualitas Pl. Pl. Fds Hum. Nutr.* **28**(3): 227-231

NIN. 1996. Dietary fibre content of Indian foods. NIN Annual Report 1995-1996. National Institute of Nutrition, Hyderabad. p.46-47

Pal, B.P., Singh, H.B. and Swarup, V. 1951. Taxonomic relationships and breeding possibilities of species related to Okra (*Abelmoschus esculentus*). *Bot. Gaz.* **113**: 455-464

Pal, D., Sachdeva, S. and Sing, S. 1995. Methods for determination of sensory quality of foods: a criticl appraisal. *J. Fd Sci. Technol.* **32**(5): 357-367

Passmore, R. and Eastwood, M.A. 1986. *Human Nutrition and Dietetics.* 8th ed. English Language Book Society, Edinburg. p. 201-202

Prakash, D., Nath, P. and Pal, M. 1993. Composition, variation of nutritional contents in leaves, seed proteins, fat and fatty acid profile of *Chenopodium* species. *J. Sci. Fd Agric.* **62**(2): 203-205

Prasad, K. 1981. Key note address of All India Food Preservers' Association 37th Annual General Meeting. *Indian Fd Packer* **35**(2): 15

Pulekar, C.S., Jadhav, S.N. and Patil, B.P. 1993. Effect of irrigation and gross mulching on yield and economics of summer okra in Konkan. *J. Maharashtra agric. Univ.* **18**: 202-205

Ramesh, M.N., Sathyanarayana, K. and Girish, A.B. 1997. Determination of degree of cooking of vegetables by compression testing. *J.Fd Sci. Technol.* **34**(3): 218-221

Rana, R.S. and Thomas, T.A. 1991. Plant genetic resources activities in okra - an Indian perspective. *Report of an International Workshop on Okra Genetic Resources.* National Bureau for Plant Genetic Resources. p.38-47

Randel, P.F. 1981. Digestibility of hammer filled okra seed (*Abelmoschus esculentus*). *J.Agric. Univ. Puerto Rico.* **65**(4): 408-411

Rani, P.J., Kannan, M. and Thamburaj, S. 1997. Nutritive value of vegetables. *Kisan Wld* **16**: 53-54

Ranganna, S. 1977. *Manual of Analysis of Fruit and Vegetable Products.* Tata McGraw - Hill Publishing Company Limited, New Delhi.

Rao, G.K.P. and Sulladmath, U.V. 1977. Changes in certain chemical constituents with maturation of okra (*Abelmoschus esculentus* (L.) Moench.) pods. *Veg. Sci.* **4**(1): 37-42

Rao, S.J., Azeemoddin, G., Ramayya, D.A. and Rao, S.D.T. 1992. Processing of Indian okra seed. *J. Oil Technol. Ass. India* **24**(4): 137-140

Ryall, A.L. and Lipton, W.J. 1972. *Handling, Transportation and Storage of Fruits and Vegetables.* Vol I. The AVI Publishing Company, Inc. p.127-127

Sadasivam, S. and Manikam, A. 1992. *Biochemical Methods for Agricultural Sciences.* Wiley Eastern Ltd., New Delhi and Tamil Nadu Agricultural University, Coimbatore

Saimbhi, M.S. 1993. Agro-techniques for Okra. *Advances in Horticulture Vegetable Crops.* Part I. Malhothra Publishing House, New Delhi. p.529

Savello, P.A., Martin, F.W. and Hill, J.M. 1980. Nutritional composition of okra seed meal. *J. agrl Fd Che.* **28**(6): 1163-1166

Sharma, B.R. and Arora, S.K. 1993. Improvement of Okra. *Adavances in Horticulture Vegetable Crops.* Part I. Malhothra Publishing House, New Delhi. p.343-346

Sheth, P.R. 1997. Vegetarianism and fasting. *Sci. Reporter* **34**(12): 3-5

Shingade, M.Y., Chavan, K.N. and Gupta, D.N. 1995. Proximate composition of unconventional leafy vegetables from the Konkan region of Maharashtra. *J. Fd Sci. Technol.* **32**(5): 429-431

Siddiqui, S.F., Pasha, M.K., Ahmad, F. and Ahmad, M. 1994. Digestability

of some non-conventional seed proteins. *J. Oil Technol. Ass. India* **26**(2): 49-51

Singh, J. and Sood, D.R. 1997. Nutritional evaluation of Rabi French Beans. *J. Fd Sci.Technol.* **34**(4): 354-356

Singh, K., Mengal, J.L. and Gupta, U.S. 1976. Compositional changes in Okra (*Abelmoschus esculentus* (L.) Moench) fruits as affected by sodium salts. *Progresive Hort.* **7**(4): 19-27

Singh, S., Mandal, A.B. and Ram, T. 1990. Physico chemical changes in developing fruits of okra. *Indian J. Pl Physiol.* **33**(3):266-268

Stone, H. and Sidel, J. 1993. *Sensory Evaluation Practices.* Academic Press Inc., London

Stone, M.B., Toure, D., Greig, J.K. and Neaewbanij. 1986. Effects of pretreatment and dehydration temperature on colour, nutrient retention and sensory characteristics of okra. *J. Fd Sci.* **51**(5): 1201-1203

Sundaram, G. 1979. *Fresh Fruits and Vegetables : A Source of Production.* Export Promotion Council. p. 1

Thind, S.K. and Malik, C.P. 1995. Carbohydrate metabolism in Okra (*Abelmoschus esculentus* (L.) Moench) seeds during germination.

Acta Physiologiae Pl. **17**(4): 321-326

Thomas, T.A., Bisht, I.S., Patel, D.P., Agarwal, R.C. and Rana, R.S. 1991. *Catalogue on Okra (Abelmoschus esculentus* (L.) Moench) *Germplasm.* Part II. Nationa Bureau of Plant Genetic Resources, New Delhi, India. p. 1

Tomoda, M., Shimizu, N. and Gonda, R. 1985. Plant mucilages: isolation and characterisation of a mucilage, "Okra-mucilage R", from the roots of *Abelmoschus esculentus. Chem. Pharmaceutical Bull.* **33**(8): 3330-3335

Tomoda, M., Shimizu, N., Gonda, R., Kanwari, M., Yamada, H. and Hikino, H. 1989. Anticomplementary and hypoglycaemic activity of okra and Hibiscus mucilages. *Carbohydrate Res.* **190**(2): 323-328

Tomoda, M., Shimizu, N., Oshima, Y., Takahashi, M., Murakami, M. and Hikino, H. 1987. Hypoglycaemic activity of twenty plant mucilages and three modified products. *Planta Medica.* **53**(1): 8-12

Udosen, E.O. 1995. Proximate and mineral composition of some Nigerian vegetables. *Discovery and Innovation* **7**(4): 383-386

*Waalkes, J.V.B. 1966. Malesian Malvaceae, rensed. *Blumea* **14**(1): 1-25

Wandawi, H.A. 1983. Chemical composition of seeds of two okra cultivars.

J. agrl Fd Chem. **31**(6): 1355-1358

Wesche, E.P., Maiti, R., Garcia, D.G., Gonzalez, O.I. and Sosa, A.F. 1995. Contributions to the botany and nutritional value of some wild Amaranthus species (Amaranthaceae) of Nuevo Leon, Mexico. *eco. Bot.* **49**(4): 423-430

Wolfe, M.L., Chaplin, M.F. and Otchere, G. 1977. Studies on the mucilages extracted from okra fruits (*Hibiscus esculentus* (L.)) and baobab leaves (*Adansonia digitata* (L.)). *J. Sci. Fd Agric.* **28**(6): 519-529

*Woodroof, J.G. and Shelor, E. 1958.Okra for processing. *Georgia agrl Expt. Sta. Bull. N.S.*56

Yeoh, H.H. and Wong, P.F.M. 1993. Food value of lesser utilised tropical plants. *Fd Chem.* **46**(3): 239-241

* - originals not seen

Appendix

APPENDIX

SCORE CARD FOR ORGANOLEPTIC EVALUATION

No.	Character	Description	Score
I	COLOUR	Yellowish green	5
		Olive green	4
		Yellowish brown	3
		Brown	2
		Dark brown	1
II	DONENESS	Adequately cooked	5
		Soft	4
		Mushy	3
		Overcooked	2
		Raw & slimy	1
III	TEXTURE	Highly tender	5
		Slightly tender	4
		Neither tender nor fibrous	3
		Slightly fibrous	2
		Fibrous	1
IV	FLAVOUR	Excellent	5
		Good	4
		Fair	3
		Poor	2
		Very poor	1
V	TASTE	Excellent	5
		Good	4
		Fair	3
		Poor	2
		Very poor	1

NUTRITIVE VALUE AND ORGANOLEPTIC EVALUATION OF THAMARA VENDA GENOTYPES

(Abelmoschus caillei)

By

SONA THAMPI K.

ABSTRACT OF A THESIS

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ABSTRACT

The study on "Nutritive value and organoleptic evaluation of Thamara venda (*Abelmoschus caillei*) genotypes" was an assessment of the chemical composition and acceptability of Thamara venda genotypes in comparison with the okra variety, Pusa Sawani, at three different maturity levels i.e. 5th, 8th and 11th days after flowering.

It has been found in the study that the twenty genotypes of *A. caillei* differed very much in their chemical composition. In the case of fat, iron, vitamin C and mucilage, the mean values of the control variety were lower than the lowest obtained for *A. caillei* genotypes. Pusa Sawani was found to have a lower disposition in the case of total carbohydrates, starch and calcium contents in comparison with the Thamara venda genotypes. The mean moisture, protein and phosphorus contents of Pusa Sawani were found to be in comparison with those of Thamara venda genotypes. But in crude fibre content, Pusa Sawani outweighed the Thamara venda genotypes. Statistically, it had been found that there was no concordance between the different genotypes of *A. caillei* in the case of different chemicl constituents.

The present study also implicated significant decreases in moisture, protein, fat, calcium, phosphorus, iron and ascorbic acid contents of the pods as the days after flowering increased in both

the Thamara venda genotypes and in Pusa Sawani. Total carbohydrate, starch, crude fibre and mucilage contents showed significant increases with increasing age in both the Thamara venda genotypes and in Pusa Sawani.

Studies on the acceptability levels revealed that the Thamara venda genotypes generally had higher acceptability than Pusa Sawani. The acceptability was also found to decrease as the pods increased in maturity.