SUITABILITY OF OSMOTIC DRYING TECHNIQUE FOR PRODUCT DEVELOPMENT IN JACK FRUIT (*Artocarpus heterophyllus Lam*)

by

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "Suitability of Osmotic drying technique for product development in Jack fruit ***Artocarpus heterophyllus Lam***" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship, or other similar title of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "Suitability of Osmotic drying techniques for product development in Jack fruit ***Artocarpus heterophyllus Lam***" is a record of research work done independently by Miss. BINDU P OOMMEN under my guidance and supervision and that it has not previously formed the basis for the award of any degree fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

India with its diverse agroclimatic conditions is reported to be one of the few countries of the world capable of growing various kinds of tropical, subtropical and temperate fruits Raul *et al.* (1992). Recent food production statistics indicate that India is the second largest producer of fruits in the world after Brazil with a production touching 27-83 million tonnes which accounts for around eight per cent of the world production.

Inspite of high level of production of fruits in India, lack of post harvest technology and linkages, results in a national loss of Rs. 5000 crores per annum (Rajkumar 1995).

Sethi (1993) had stated that 20 to 30 per cent of the fruits produced in our country are not utilized properly. Nearly 30 per cent of the fruits are lost due to spoilage during handling, transportation and lack of storage and processing facilities (Poonia, 1994).

According to Kumar (1994) India is a country with 327 million hectares of land spread, of which about 145 million hectares are under cultivation. It has to support 850 million population which grows continuously at the rate of about 2 per cent per annum in a developing country like India, where majority of population suffer from different degrees of nutritional inadequacies, preservation of all available food resources is an essentiality. According to Rao (1991), the fruits and vegetable can serve as a source of essential nutrients like Vitamin C and β carotene and minerals whose intake in a majority of our population is already below par.

(Efforts are needed to convert surplus production of fruits and vegetables to value added products. Processed products are of great demand because of their ready to eat convenient nature and unique taste. Being rich in essential minerals, vitamins and other nutritive factors, fruit products are quite popular. Besides, they are delicious and have universal appeal unlike other food products. Hence fruits have to be processed in a form in which they can be made available to the consumers during the off season.)

The principle of preservation of food is based on the manipulation of environmental factors, among which drying is a method. Siddappa *et al.* (1986). Although preservation is still the Principle reason for dehydration, other important factors like significant reduction of weightloss and bulk play an important part in the process.

Recently Osmotic dehydration of foods got attention due to its great importance in the food processing industry. According to Islam and Flink (1982), Osmotic dehydration increased nutrient retention during subsequent air drying.

Jack fruit or Panasa is a heavily flavoured fruit, most popular in South India and is considered the greatest among fruits along with the mango and Banana Gopalan *et al*, (1992). These fruits are available in plenty during seasons. The abundant supply of fruits results in glut leading to enormous wastage.

Several studies have been made by Lalsingh and Girdharilal (1986) on dehydration of potatoes, onion, garlic, cauliflower. However little or no work has been done on Osmotic dehydration of jackfruits. Efforts were, therefore, directed for tapping the potential of ripe jake fruit to an value added product which could be accepted by the masses.

Hence the present study entitled "Suitability of Osmotic drying technique for product development in jack fruit *Artocarpus heterophyllus lam*" is outlined. The study analyse the feasibility of osmotic drying, technique for products development in two varieties of jack fruit namely soft flesh type and firm flesh type. The study also ascertain, organoleptic and shelflife qualities and the consumer acceptance of the products developed.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Literature pertaining to the study entitled Suitability of Osmotic drying technique for product development in Jack fruit *(Artocarpus hetrophyllus Lam)* are reviewed under the following headings.

2.1 Profile of Jack fruit and its nutritional significance.

2.2 Importance of fruits and fruit based products.

2.3 Need for processing.

2.4 Osmotic dehydration - A method on preservation.

2.5 Effect of Pretreatments on drying

2.5.1 Sugar concentration

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2.5.3 Immersion time

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2.1 Profile of Jack fruit and its nutritional significance.

"If it was possible to mould honey into a ball then it would be the pulp of Jack fruit" - this is a free translation of a line from old Tamil Poetry.

Jack fruit *(Artocarpus heterophyllus Lam)* is a tropical ever green tree belonging to the family Moraceae. It is thought to be native of India and widely cultivated in Southern Asia, the East Indies and other warm areas of both the hemisphere (Morton, 1965). Amban (1987) had stated that jack fruit is very important because it gives more yield per tree than any other fruit tree in this country. According to Amban (1987) on an average 200 to 800 and 2000 to 3000 fruits (each weighing 5 to 20 kg) per tree (of about 12 to 30 years) can be harvested annually. More over, owing to the numerous culinary uses and due to its availability during monsoon period, it is also called as poor man's food (Amban 1987).

The total production of Jack fruit in the year 1994 in Kerala has been estimated as 29,94,39,000 in number with an area of 72,239 hectors (Farm Guide 1994).

According to Madhavan (1994) among the fruits grown in Kerala Jack fruit tops the list in term of production. (14.9 lakh tons).

Krishnamurthi and Giri (1949) had reported that Jackfruit is an important source of pectin and contains about 1.9 per cent protein on fresh weight bases. Sadasivan and Neelakantan (1976) had found that Jack fruit bulbs are rich in sugar and contain fair amounts of Carotene, protein and minerals. According to Hossain *et al.* (1979). Jack fruit containes 2.64 - 11.77mg of ascorbic acid and 250 - 1740 mg Carotene. Zaghlol *et al.* (1983) had reported that Jack fruit contains glucose (10.94 per cent) fructose (1.42 per cent), Xylose (0.18 per cent), rhamnose (10.44 per cent), arabinose (1.51 per cent), galactose (2.47 per cent), galacturonic acid (64.5 per cent) and three other unknown and sugars (13.4 per cent). Delpench (1980) observed large difference in the Jack fruit starch when compared with other tropical fruit starches with respect to amylase hydrolysis, swelling power and solubility behaviour. Jackfruits are normally fibrous and are composed of mono, di and poly saccharides (Berry and Kalra, 1987).

According to Singh (1986) Jackfruit yields only 30 per cent edible matter which consits of the fleshy part under the seeds. The fleshy part on percentage basis has moisture 73.1, protein 0.6, fat 0.6, carbohydrate 23.4, fiber 1.8 and ash 0.5 and on the other hand the seeds are more nutritious, contains on percentage basis moisture 51.6, protein 6.6, fat 0.4, carbohydrate 38.4 and fiber 1.5.

2.2 Importance of fruits and fruit based products

According to Geetha (1982) cheapest fruits are also highly nutritive as they are large store house of essential vitamins and mineral salts and comprise a rich dietary. Rao (1991) had pointed out that the fruits and vegetables are the only source of essential nutrients like vitamin C and β carotene whose intake in a majority of our population are already below the adequate levels. According to Manson (1994) the people who eat more fruits and vegetables have a 54 per cent lower risk of getting heart stroke when compared with those who eat the least.

Maini *et al.* (1982) reported that more fruits are preserved by drying than by any other method and it has the major advantage of greater concentration in dry form, production with minimum labour, less expensive and economic require minimum equipment for processing and storage. Rao *et al.* (1986) reported that fruits like pineapple, pear, papaya can be successfully sundried and stored for future use. Amban (1987) observed that Jack Preserve was found to be an acceptable and appealing product. Jayaraman and Gupta (1991) standarised the preparation of dried papaya and Jack fruit and they were found to be best in appearance, flavour and texture. Singaravelu and Arumugam (1993) standardised the method for drying sapota flakes which showed a shelf life of 120 days with pretreatments and 30-40 days without pretreatments.

Thirumaran *et al.* (1986) established a simple processing technique for the preparation of papaya candy. Mohammed *et al.* (1993) developed pineapple candy which was organoleptically acceptable.

Different fruit powders with Avocado, Banana, Mango and Guava were standardised by Pruthi and Lal (1959). Passion fruit Juice powder has been standardised by Pruthi (1960). Sadasivan and Neelakantan (1976) had reported that Jackfruit can be utilised for making squash. Sonde (1989) has reported that the products like canned Jack fruit bulbs in syrup, Jack fruit squash, canned curried raw Jack fruit, raw Jack pickle, canned Jack fruit seeds in brain, roasted Jack seeds and Jack seed flour can be developed at commercial level. Bose (1990) had pointed out that Jackfruit bulbs can be utilised for making pickles, fruit leather or thin pappad besides canning.

2.3 Need for processing

Processing of food can be defined as adding value to conventional and innovative basic food items, through various permutations and combinations providing protection, preservation, packaging, convenience carriage and disposability (Rao, 1989).

According to Pandey (1991) India rank third in the production of fruits after Brazil and United States. Rao (1991) pointed out that India with the population over 860 million produce on an average about 74 million tonns of horticultural produce. Sethi (1993) reported that India is one of the largest producer of fruits (27 millions tons) in the world.

Cook (1975) pointed out that high perishability of fruits lead to a high degree of wastage which is reported even in developed countries like the U.S.A with their well advanced and sophisticated techniques and marketing facilities.

Swami *et al.* (1977) pointed out that cultivation of new fruits and development of products from many of the notable fruits could bring benefit nutritionally and economically. Kaushal (1989) had stressed on the rise in demand for processed fruits and vegetables because of the increased defence requirements and urbanisation trend.

2.4 Osmotic dehydration - A method of Preservation

Osmotic dehydration is rather a new innovation for producing better quality dehydrated products (Anon 1986). It has been the subject of scientific investigation by Ponting *et al.* as early as in 1966.

According to Chaudhari *et al.* (1993) in Osmotic dehydration process, there is a simultaneous counter current mass transfer of water from solution to hypertonic solution and of solute from solution into the sample. He also stated that Osmotic dehydration process can be applied to fruits like apple, apricot, banana, blueberry, citrus fruits, grapes, guava, mango (green and ripe), melon, papaya and pineapple.

Advantage of direct Osmosis in Comparison with other drying process include minimized heat damage to colour and flavour, less discoloration of the fruit by enzymatic Oxidative browning Ponting *et al.* (1960). Contreas and Smyrl (1981) noted that Osmosis was effective in preventing fruit discoloration by enzymatic oxidative browning, thus procluding the use of sulphurdioxide. According to Le Maguer (1988) Osmotic process represent a potential saving in energy and improvement of the over all quality of the product. Rahman (1992) pointed out that Osmotic dehydration improves the quality of products in terms of colour, flavour or aroma and texture.

According to Islam and Flink (1982) Osmotic dehydration increased nutrient retention during the subsequent air drying. Lerici *et al.* (1985) reported that Osmotically treated fruits were better in colour and texture than untreated fruits. The shrinkage of the material during osmosis for characterisation of the process was considered by Lenart and Flink (1984). Shahabuddin and Hawladaar (1990) reported that Osmotic dehydration alone can remove 30-40 percent water content of pineapple fruit.

Bolin *et al.* (1983) revealed that the syrup remaining after Osmotic drying can be recycled as table syrup, concentrated beverage wines and jellies.

2.4.1 Effect of Sugar as Osmotic agent

According to Rahman (1992), the most commonly used osmotic agents are sucrose for fruits and sodium chloride for vegetables and fishes. He stressed that a number of Osmotic agents can be used in Osmotic dehydration either singly or in combination. Osmotic agents reduce water activity of a solution substantially for increasing the driving force. According to Lein (1987) sugar solution was an effective agent, for reducing the drying process and in connection it was also reported by Lein (1987) that glucose, sucrose and fructose were the different sugars used as osmotic agents and the type of the sugar solution did not noticeably affect the product acceptance.

Taste scores reported by Hawkes and Flink (1978) found high organoleptic acceptability in the sucrose treated Apple slices. It has been stated that fruit dried using sugar are candy, due to high percentage of sugar added to the fruit. Islam and Flink (1982) reported that flavour retention is more when sugar or sugar syrup is used as Osmotic agents and oxidative browning is prevented. Mazza (1983) reported that pretreatments like sucrose dipping before air drying would affect moisture transport and quality.

Videv *et al*. (1990) opined that there was increase in the weight loss of the fruit with an increase in sugar concentration. Amount of sugar absorbed by Pineapple rings increaed with increasing sugar concentration, at 50° Brix the sugar concentration increased by 10 per cent, at 60° Brix the increase was by 16 per cent and at 70° Brix it was increased by 25 per cent (Beristein *et al*. 1990).

Angela *et al*. (1991) observed that the pineapple and papaya fruits immersed in sucrose 70° Brix syrup lowered the final water content of the fruits. Different treatment before drying for various periods of time in hypertonic solution of sugar resulted in weight loss, sugar penetration and increase in the shrinkage in the apple rings and treatment in 70° Brix at 50°C + 30 minutes was adjusted to be the best treatment as reported by Sharma *et al*. (1991).

Yang and Maguer (1992) reported that when strwberries were osmotically dehydrated more than 40 per cent of moisture and less than 1 per cent of sucrose in strawberries were removed by 63 per cent sucrose solution. Hough *et al.* (1993) found in a sample model of osmotic dehydration of apples in 55/100g of sugar syrup a diffussability rate of 1.5×10^{-10} m^2.

2.4.2 Effect of temperature on treatments

An increase in temperature upto a certain extent is known to increase the rate of Osmosis. Further increase in temperature affects the semipermeability of the cell walls and reduces the rate of Osmosis. Ponting *et al.* (1966) reported enzymatic browning and flavour deterioration above 49°C but, according to Le Maguer (1988), the reported temperature limit is 60°C. Rahman and Lamb (1990) had also reported that solid concentration became nearly constant above 60°C which indicated negligible increase in the rate of sucrose diffusion above 60°C.

Bongiwar and Sreenivasan (1977) reported that 50°C was found to be the most suitable temperature for obtaining osmotically dried banana product at which 50 per cent weight loss occurred within 3 hours with out any damage to the quality in case of banana fruit. George (1994) in her study with the drying of plantain also found the same.

Rabbit eye blue berries were dried using an experimental high temperature fluized bed (HTFB) at 170°C the moisture content was reduced to 0.7 from 5.8 and after osmotic dehydration in sucrose, the moisture content was 1.3 and when dried in a drawer at 150°C it reduced 0.28, (Kim and Tolendo, 1987). Sivakumar *et al.* (1989) observed that blanching of bitter gourd rings in 5 per cent sodium chloride and drying them in tray drier at 70°C followed by 60°C at intervals gave dark green, soft texture, slightly salty and less bitter product.

Rahman (1992) had stated that temperature of osmotic solution is the most important parameter affecting the kinetics of Osmotic dehydration. According to Raul *et al.* (1992) pears and apple cubes when osmotically treated, solid gains were similar at 5°C and 25°C in both pear and apple cubes reaching a value of about 11 per cent and found that water diffusion was greater at 25°C than at 50°C making it possible to obtain a weight loss of approximately 30 per cent. Elizabeth (1993) observed that pear fruits when hand peeled and canned in sugar syrup (20° Brix) at 100°C the fruit firmness decreased.

2.4.3 Effect of Immersion Time on Treatments

In general, as the time of immersion increased, the weight loss also increased but the rate at which this occurs decreases. Ponting *et al.* (1966) reported that there is a rapid water loss when the samples were immersed in water for one hour and slows down there after. Similar observations were reported by Hawker and Flink (1978) in the osmotic dehydration of apple.

According to Hawkes and Flink (1978) rate of weight loss decreased from 10 to 5 per cent per hour after 20 to 30 per cent moisture was removed. Torregian *et al.* (1987) reported that in case of cherries, maximum water loss took place within the first two hours.

Farkas and Lazar (1969) reported that there is a rapid uptake of solute within the first one and a half hour of Osmosis. Beristain *et al.*(1990) pointed out that in case of pineapple, water loss and sugar gain appeared to increase exponentially with time.

Sharma *et al.*(1991) opined that pretreatment in 70 per cent sugar solution and at 50°C and 30 minutes immersion time was the best for canning. Raul *et al.* (1992) reported that on treatment of pear and apple cubes in a sucrose solution, solid gains were similar at 50°C reaching a value of about 11 per cent in four hours. According to Yang and Maguer (1992) about 40 per cent of moisture and less than one per cent of sucrose in straw berries were removed in a period of two hours from the treated fruit.

2.4.4 Effect Of Preservatives On Treatments

Khateib *et al.* (1988) had reported that preservatives like Sorbic acid and,glycerol, nitrite, potassium sorbate, BHA, BHT and sodium metabisulphate can be used in food industry within permissible limits of legal standards.

According to Renganna and Padival (1981) Sulphiting is the treatment of fruits and vegetables with soluble sulphites to prevent browning. They further stated that small concentration of sulphurdioxide may help in protecting the flavour in products. Sulphiting is also reported to be a suitable pretreatment for dehydrated products since it prevents the major problem of discolouration observed in dehydrated products. Similar observations were reported by Sheeja (1994) during storage of papaya fruit pulp.

According to Joslyn and Braverman (1954) sulphurdioxide is also thought to be an enzyme poison, inhibiting the growth of microorganisms, and essential enzymes. sulphurdioxide, sulphate, bisulphate salts and metabisulphate salts are reported to act similarly. Rengamma and Padival (1981) had reported that the preservative action is due to the free sulphurdioxide present and not due to combined or total sulphurdioxide.

According to Sethi (1960) sulphiting treatment helps to maintain better colour, flavour and the Jack fruit bulbs are free of mould growth during storage. Nury *et al.* (1963) reported that SO_2 could retard degradation of colour and texture and allowed the dried products to remain acceptable for almost a year. Bhatnagar and Subramanyam (1973) reported that sulphurdioxide prevents deterioration of natural colour during processing and storage. They also reported that in the absence of sulphitation, the product becomes brown. Kikon (1975) and Rao (1986) reported that the rate of browning was inversely proportional to SO_2 concentrations in the dried material. A study conducted by Sethi (1991) on mango pulp revealed that samples treated with sulphurdioxide, alone were found to help in the retention of carotenoids. A study by Perlette (1992) in grape juice have shown that sulphitation improved the colour of the product. Similar results were reported by Mir and Nath (1993) in their studies on mango bars. The colour of mango bars darkened during storage, but changes were negligible in sulphited samples.

According to Sethi and Malini (1991) juices prepared from sulphited mango pulp had better flavour than those with out sulphited. Studies on solar dried figs by Pawar *et al.* (1992) indicated that samples pretreated with sulphitation retained more sugar than blanched and control. A study conducted by Mohammed *et al.* (1993) had proved that treatment with sulphur dioxide prior to processing had increased the retention of arcobic acid in pineapple candy besides the improvement in organoleptic qualities.

Sethi (~~1985~~ 1993) had pointed out that Litchi pulp treated either with 500 ppm sulphurdioxide or 500 ppm sulphurdioxide.. with 1 per cent citric acid had a self life of one year Manan *et al.* (1992) conducted storage studies in Apricot pulp preserved with 547 ppm sulphurdioxide, the study indicated that the pulp was acceptable up to nine months at room temperature. They had further stated that squash made from this pulp had good shelflife for six months and highly acceptable. Singaravelu and Arumugan (1993) had stated that sulphitation increased the shelf life of dried Sapota flakes three fold than that of control (30-40 days).

2.5. Shelflife qualities of dried products

Sarbjit and Bhatia (1982) proved that certain varieties of dehydrated tomato seeds had a shelf life of about 6 months at room temperature though retention of chlorophyll and β carotene was poor. According to Hsu *et al.* (1989) the total soluble proteins decreased with storage time in fruits.

According to Mukhtha *et al.* (1982) dehydrated pineapple slices stored at room temperature gave good product based on the chemical composition and organoleptic qualities. According to Mir and Nath (1993) storage of mango bars for 90 days increased the reducing sugar significantly but the overall acceptability and textural changes decreased. Mahajan and Chopra (1990) found that T.S.S content of stored apple fruits increased as the storage period advanced, reaching a peak at 150 days and declined there after. The titerable acidity gradually declined linearly with advancement in storage period, Mahajan *et al.* (1994).

According to Angela *et al.* (1987) dehydrated blue berry products had a good texture, flavour and overall acceptability and had a shelf life of16 to 64 months depending on the storage temperature. Vegetables dehydrated to yield vegetable curry mix had a shelflife of about 18 months under ambient conditions Food packer, (1990). The Osmotic dehydration preserves the flavour and nutritional characteristics provides a final product of good quality which had better scores for appearance colour taste and flavour (Anon 1990).

According to Nuri (1963) when fruits are dehydrated the soluble solid contents become great enough, so the fruit will resist microbial spoilage for fairly extended period of time.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study entitled "Suitability of osmotic drying technique for product development in Jack fruit *(Artocarpus heterophyllus Lam)*" is a comprehensive study aimed at standardisation of osmotic drying technique for product development in jack fruit varieties and its evaluation on organoleptic and shelf life qualities.

3.1 Selection of the Fruit

According to Gopalan *et al.*(1992) the jack fruit is a heavily flavoured fruit most popular in South India and is considered as the biggest among fruits along with the mango and banana.

As regards the quantum of yield/Unit area, jack fruit occupies almost first position among the South Indian fruits and ranked next to mango and banana in total annual production. Jack fruit is seasonal and available in plenty at a particular period of the year. Abundant supply of this fruit results in glut leading to heavy post harvest losses.

According to Package of Practices (1994) Jack fruit may be classified into two groups as soft flesh type and firm flesh types, Soft flesh type has more mealy soft flesh and firm flesh type has crisp juicy flesh. According to Sonde (1989) the above two groups are further divided depending on the taste, shape, size of fruit, odour of flesh, nature, shape and diversity of prickles on the rind, for the maintanance of separate varieties.

Commercial production and popularisation of Jack fruit products has not been taken up by any of the industries so far. Even though studies on Jack fruit products such as jam, jelly, candy and squash have been made long ago, many more products are to be developed. Because of these reasons, the two varieties of jack fruit, firm flesh and soft flesh were selected for the study.

Required quantity of the fruit for the study was collected from the instructional farm of the College of. Agriculture, Vellayani and from the nearby private farms.

3.2 Treatments selected for the study

Lerci *et al.* (1984) conducted experiments of direct osmosis in the dehydration of fruits such as apples, pears, peaches and plums and found that fruits treated with osmotic solution were better in flavour, texture and colour than the untreated fruits. The sensory evaluation showed that osmo-dehydrated litchi halves scored over other treatments and the product was superior in colour, flavour and appearance as compared to conventionaly dried litchies (Shaema *et al.* 1992).

In a previous study conducted by George (1994) on osmotic dehydration of palayamkodan variety, it was indicated that sugar concentrations of 60° Brix and 70° Brix were most feasible for preparing acceptable dried products. Contreras and Smryl (1981) indicated that concentrated sucrose solution (50° - 70° Brix) has been the most commonly used osmotic solution.

Immersion of food materials in osmotic solution was found to influence the quality of the product. Adambournou and castaigne (1983) found that the sucrose gain and waterloss in dehydration experiments were found to be faster in the first 20 minutes at 40°C and 60°C. Ponting *et al.* (1966) reported that there was a rapid water loss when the samples were immersed in water for 60 minutes and slows down there after. Similarly temperature of the osmotic solution, directly influences the acceptability and appearance of the dried products. Kanawadi and Maharaj (1993) suggested a temperature of 60° - 90°C for dehydrating pears. George (1994) in her study reported that a temperature of 50°C to 60°C was most feasible for preparing acceptable dried products with a palayamkodan variety of banana.

Shelf life of dried products seemed to be affected by the treatments with preservatives. Singaravelu and Arumugan (1993) stated that sulphitation increased the shelflife of dried sapota flakes three fold than that of control. Soleha (1992) reported that glycerol treated fruit mix retained more sulphurdioxide, showed less bacterial infestation.

Based on the above findings the following treatments were selected for the present study (Table 1).

3.3 The processing technique

The Jack fruit bulbs were obtained by removing the outer pricky rind and the inner portion consisting of the pithy white portion below the outer rind and the central gummy core.

Table 1 Treatments selected for the study

Sl.No.	Treatments	Sl.No.	Treatments	Sl.No.	Treatments	Sl.No	Treatments
1	$V_1C_1T_1I_1P_1$	19	$V_1C_1T_1I_2P_2$	37	$V_2C_1T_1I_1P_1$	55	$V_2C_1T_1I_2P_2$
2	$V_1C_2T_1I_1P_1$	20	$V_1C_2T_1I_2P_2$	38	$V_2C_2T_1I_1P_1$	56	$V_2C_2T_1I_2P_2$
3	$V_1C_1T_2I_1P_1$	21	$V_1C_1T_2I_2P_2$	39	$V_2C_1T_2I_1P_1$	57	$V_2C_1T_2I_2P_2$
4	$V_1C_2T_2I_1P_1$	22	$V_1C_2T_2I_2P_2$	40	$V_2C_2T_2I_1P_1$	58	$V_2C_2T_2I_2P_2$
5	$V_1C_1T_3I_1P_1$	23	$V_1C_1T_3I_2P_2$	41	$V_2C_1T_3I_1P_1$	59	$V_2C_1T_3I_2P_2$
6	$V_1C_2T_3I_1P_1$	24	$V_1C_2T_3I_2P_2$	42	$V_2C_2T_3I_1P_1$	60	$V_2C_2T_3I_2P_2$
7	$V_1C_1T_1I_2P_1$	25	$V_1C_1T_1I_1P_3$	43	$V_2C_1T_1I_2P_1$	61	$V_2C_1T_1I_1P_3$
8	$V_1C_2T_1I_2P_1$	26	$V_1C_2T_1I_1P_3$	44	$V_2C_2T_1I_2P_1$	62	$V_2C_2T_1I_1P_3$
9	$V_1C_1T_2I_2P_1$	27	$V_1C_1T_2I_1P_3$	45	$V_2C_1T_2I_2P_1$	63	$V_2C_1T_2I_1P_3$
10	$V_1C_2T_2I_2P_1$	28	$V_1C_2T_2I_1P_3$	46	$V_2C_2T_2I_2P_1$	64	$V_2C_2T_2I_1P_3$
11	$V_1C_1T_3I_2P_1$	29	$V_1C_1T_3I_1P_3$	47	$V_2C_1T_3I_2P_1$	65	$V_2C_1T_3I_1P_3$
12	$V_1C_2T_3I_2P_1$	30	$V_1C_2T_3I_1P_3$	48	$V_2C_2T_3I_2P_1$	66	$V_2C_2T_3I_1P_3$
13	$V_1C_1T_1I_1P_2$	31	$V_1C_1T_1I_2P_3$	49	$V_2C_1T_1I_1P_2$	67	$V_2C_1T_1I_2P_3$
14	$V_1C_2T_1I_1P_2$	32	$V_1C_2T_1I_2P_3$	50	$V_2C_2T_1I_1P_2$	68	$V_2C_2T_1I_2P_3$
15	$V_1C_1T_2I_1P_2$	33	$V_1C_1T_2I_2P_3$	51	$V_2C_1T_2I_1P_2$	69	$V_2C_1T_2I_2P_3$
16	$V_1C_2T_2I_1P_2$	34	$V_1C_2T_2I_2P_3$	52	$V_2C_2T_2I_1P_2$	70	$V_2C_2T_2I_2P_3$
17	$V_1C_1T_3I_1P_2$	35	$V_1C_1T_3I_2P_3$	53	$V_2C_1T_3I_1P_2$	71	$V_2C_1T_3I_2P_3$
18	$V_1C_2T_3I_1P_2$	36	$V_1C_2T_3I_2P_3$	54	$V_2C_2T_3I_1P_2$	72	$V_2C_2T_3I_2P_3$

Key: V - Variety	C - Sugar concentration	T - Temperature of Osmotic Solution	I - Immersion time	P - Preservative used in Osmotic solution
V_1- Soft flesh type	C_1- 60°Brix	T_1- 0°C	I_1- 30 Minute	P_1- Sodium metabisulphate (0.4 per cent)
V_2- Firm flesh type	C_2- 70°Brix	T_2- 50°C	I_2- 60 Minute	P_2- Sodium metabisulphate (0.4 per cent) and glycerol (15 per cent)
		T_3- 70°C		P_3- Sodium metabisulphate (0.4 per cent) and glycerol (20 per cent)

Jack fruit bulbs taken for processing were slitted longitudinally, to remove the seeds and white highly sticky latex. These fruit pieces were subjected to various pretreatments. Weight loss of the products after the initial dewatering was recorded. The weight of the jackfruit before and after initial dewatering was noted. The samples were then subjected to open sun drying till the desired moisture level (below 10 per cent) was obtained.

3.3.1 Method of drying

Drying is one of the oldest and cheapest methods of preservation. Maini (1982) has reported that more fruits were preserved by drying than any other method as they had more advantages like greater concentration in dried form, cheaper to produce with minimal labour, processing equipment, storage and distribution costs.

Plain sundrying was applied in the present study. The treated Jack fruit slices were spread out in aluminium trays covered with a net to protect them from flies and other insect attack and was kept over direct sunlight. The slices were turned over at intervals to get an even rate of drying. The time taken for drying the Jackfruit bulbs to the required moisture level was noted.

3.3.2 Sealing of the dried products

The net weight of the dried product was noted for each treatment. The products were then packed in polypropylene covers, each weighing 100g. They were then sealed using a heat sealer and stored at room temperature.

3.4 Analytical work carried out in the study

3.4.1 Assessment of nutritional and chemical constituents in the products

Tests conducted on the fresh samples and the dried products were moisture, acidity, reducing sugar and vitamin C.

Samples subjected to different treatments were drawn at monthly intervels in required quantities for analysis.

Moisture was determined by drying a known weight of samples in an oven at 55°C to 60°C according to procedure outlined in A.O.A.C (1970). Total acidity was determined by titrating a known weight of juice with N/10 Sodium hydroxide using phenolphthalene as indicator. The sugar was determined by the method of Lane and Eynon (A.O.A.C, 1965). Vitamin C was determined by the method of A.O.A.C (1986).

3.4.2 Assessment of organoleptic qualities of the products

Sensory analysis has been defined as 'a scientific discipline used to evoke, measure, analyse and interpret reaction to those characteristics or foods and material as they are perceived by the sense of sight, smell, taste, touch and hearing' (Cruess 1966).

The panel members for sensory analysis at the laboratory level were selected from a group of students. These judges were selected through triangle test as suggested by Mahony (1985). According to Amerine *et al.* (1965), small highly sensitive panels would usually give more reliable results than large less sensitive groups. Thus 10 members were selected as judges for the acceptability trial.

The sensory analysis of panel members were done using the scoring method. Scoring test was used for quality evaluation as suggested by Swaminathan (1974). The major quality attributes included in the score card were appearance, flavour, colour, taste, texture and overall acceptability. The scores assigned for each attribute ranged from 1 to 5 viz. Very good (5), good (4), fair (3), poor (2) and very poor (1). Scores for overall acceptability was obtained by determining the average mean scores for each character. A score card developed for the study is presented in Appendix I.

3.4.3 Assessment of the consumer acceptance of the products

Consumer acceptance of the products was assessed with the help of suitably structured score cards which was served to 50 consumers. Quality attributes assessed were appearance, flavour, colour, taste and texture. Overall acceptability was determined by adding the scores obtained for each attributes.

3.4.4 Assessment of the changes in chemical and organoleptic qualities with storage

All the samples (in duplicate) were drawn randomly in required quantities for analysis in each month. Changes in acidity and reducing sugar with storage was analysed. Similarly organoleptic assessment of the products was also conducted at periodical intervals, since any deterioration in the products could be identified as and when it occurs.

3.4.5 Assessment of microbial infestation

The products prepared were assessed for microbial contamination viz. bacteria, fungi and yeast. For the detection of bacteria fungi and yeast, nutrient agar, potato dextrose agar and maltose extract were used respectively.

3.5.0 Cost benefit analysis

Cost benefit analysis was worked out considering the cost of major food materials that contributed to the expense of raw materials. Fuel used and labour charges were also included for determining the cost.

RESULTS AND DISCUSSION

Salient findings of the study entitled Suitability of osmotic drying technique for product development in Jack fruit (*Artocarpus heterophyllus Lam*) were discussed under the following headings.

4.1 Effect of pretreatments on the weight loss, moisture loss and drying time.

4.2 Nutritional and chemical analysis of the dried Jackfruit products.

4.3 Assessment of Organoleptic qualities and its changes during storage period.

4.4 Assessment of microbial contamination of the products.

4.5 Cost benefit analysis of the dried Jackfruit.

Dehydration involves the use of artificial heat to vapourize water and some special means of removing water vapour from the system, after it has separated from the fruit tissues (Nuri *et al.* 1963). According to (Heid and Maynard 1963) when heat from any source other than sunlight is used to reduce moisture the process is called dehydration. When fruits are dehydrated, the soluble solid contents become great enough, so the fruits will resist microbial spoilage for fairly extended period of time.

Rahman (1992) has the opinion that osmotic dehydration is a process in which water diffuses from dilute solution to concentrated solution (hypertonic Solution) through a semi-permeable membrane until concentration equilibrium is reached.

4.1 Effect of pretreatments on weight loss, moisture loss and drying time

According to Lovino *et al.* (1993) Osmotically, dehydrated products which are more sweeter, ensure a higher quality and have a great demand in the market. Islam and Flink (1982) pointed out that pretreatments like direct osmosis increased nutrient retention during subsequent drying. Singh (1993) stated that the degree of dehydration depends on the concentration of the solution, the temperature and the time of exposure.

4.1.1 Weight loss during dehydration

Dehydrated product as the name indicates have a markedly lower weight than the fresh products. Bolin *et al.* (1983) pointed out that dehydrated products provide a consistent product which is an important modern marketing requirement. The dried products are of light weight and hence are convenient in packaging and transportation. After removing water from a fruit or vegetable less energy is required for further processing and preservation and there is less shipping weight per unit of fresh product (Huxcol, 1982).

The weight loss of the products after initial dewatering was assessed and the results are given in Table 2.

Table 2 Effect of Pretreatments on the weight loss of Jack fruits before drying

Sl. No.	Treat-ments	Weight after straining (g/kg)		Percentage of weight loss		Sl. No.	Treat-ments	Weight after Straining (g/kg)		Percentage of weight loss	
		V_1	V_2	V_1	V_2			V_1	V_2	V_1	V_2
1	$C_1T_1I_1P_1$	930	930	7.0	7.0	19	$C_1T_1I_2P_2$	929	928	7.1	7.2
2	$C_2T_1I_1P_1$	925	925	7.5	7.5	20	$C_2T_1I_2P_2$	923	923	7.7	7.7
3	$C_1T_2I_1P_1$	900	900	10.0	10.0	21	$C_1T_2I_2P_2$	898	898	10.2	10.2
4	$C_2T_2I_1P_1$	895	895	10.5	10.5	22	$C_2T_2I_2P_2$	893	892	10.7	10.8
5	$C_1T_3I_1P_1$	850	850	15.0	15.0	23	$C_1T_3I_2P_2$	848	848	15.2	15.2
6	$C_2T_3I_1P_1$	845	844	15.5	15.6	24	$C_2T_3I_2P_2$	843	843	15.7	15.7
7	$C_1T_1I_2P_1$	929	928	7.1	7.2	25	$C_1T_1I_1P_3$	930	929	7.0	7.1
8	$C_2T_1I_2P_1$	923	923	7.7	7.7	26	$C_2T_1I_1P_3$	924	924	7.6	7.6
9	$C_1T_2I_2P_1$	898	899	10.2	10.1	27	$C_1T_2I_1P_3$	900	898	10.0	10.2
10	$C_2T_2I_2P_1$	893	892	10.7	10.8	28	$C_2T_2I_1P_3$	894	894	10.6	10.6
11	$C_1T_3I_2P_1$	849	849	15.1	15.1	29	$C_1T_3I_1P_3$	850	850	15.0	15.0
12	$C_2T_3I_2P_1$	843	843	15.7	15.7	30	$C_2T_3I_1P_3$	844	843	13.6	15.7
13	$C_1T_1I_1P_2$	930	829	7.0	7.1	31	$C_1T_1I_2P_3$	929	928	7.0	7.1
14	$C_2T_1I_1P_2$	925	925	7.5	7.5	32	$C_2T_1I_2P_3$	923	923	7.7	7.7
15	$C_1T_2I_1P_2$	900	899	10.0	10.1	33	$C_1T_2I_2P_3$	898	898	10.2	10.2
16	$C_2T_2I_1P_2$	895	895	10.5	10.5	34	$C_2T_2I_2P_3$	892	892	10.8	10.8
17	$C_1T_3I_1P_2$	850	850	15.0	15.0	35	$C_1T_3I_2P_3$	848	848	15.2	15.2
18	$C_2T_3I_1P_2$	845	844	15.5	15.6	36	$C_2T_3I_2P_3$	843	843	15.7	15.7

Initial weight - 1kg

As indicated in Table 2 the samples treated with 60° Brix sugar concentration was found to have a weight loss ranging from 7.00 to 15.20 per cent and that treated with 70° Brix had a weight loss of 7.50 to 15.70 per cent in both varieties of jack fruit. It was noticed that percentage of weight loss increased with increase in sugar concentration as supported by Rahman and Lamb (1989). He stated that weight loss from fruits increased with increase in sugar concentrations.

From the Table 2 it is also clear that percentage of weight loss increased with increase in temperature and it ranged from 7.00 to 15.10 per cent in both the varieties of jack fruit. Rahman (1992) remarked that water loss increased with the increase of temperature. Beristain *et al.* (1990) pointed out that in the case of pineapple, water loss and sugar gain appeared to increase exponentially with immersion time. This statement stands right, as seen by the linear increase in the percentage of weight loss (0.2 per cent) with increase in immersion time in the present study.

4.1.2 Percentage of moisture loss in dried Jackfruit products

The most important factor which determines the extent of deterioration in dried products during storage is the moisture content of the final product. According to Ali (1989) the moisture to be removed from a particular product is determined by initial moisture content of the product.

Table 3 Effect of pretreatments on moisture loss and drying time

Sl. No.	Treatment	Time taken in hours V_1	Time taken in hours V_2	Moisture in percentage (Dried) V_1	Moisture in percentage (Dried) V_2	Sl. No.	Treatment	Time taken in hours V_1	Time taken in hours V_2	Moisture in percentage (Dried) V_1	Moisture in percentage (Dried) V_2
1	$C_1T_1I_1P_1$	58	58	9.6	9.5	19	$C_1T_1I_2P_2$	55	57	9.5	9.6
2	$C_2T_1I_1P_1$	46	46	9.4	8.8	20	$C_2T_1I_2P_2$	46	46	9.1	9.3
3	$C_1T_2I_1P_1$	54	54	9.4	9.5	21	$C_1T_2I_2P_2$	54	53	9.0	9.3
4	$C_2T_2I_1P_1$	43	43	9.3	8.7	22	$C_2T_2I_2P_2$	43	43	9.2	9.0
5	$C_1T_3I_1P_1$	54	54	9.5	9.5	23	$C_1T_3I_2P_2$	53	53	9.3	9.6
6	$C_2T_3I_1P_1$	42	42	9.6	9.0	24	$C_2T_3I_2P_2$	43	42	9.3	9.3
7	$C_1T_1I_2P_1$	58	58	9.5	9.4	25	$C_1T_1I_1P_3$	58	58	9.4	9.5
8	$C_2T_1I_2P_1$	46	46	9.1	9.4	26	$C_2T_1I_1P_3$	46	46	9.5	9.1
9	$C_1T_2I_2P_1$	54	53	9.4	9.5	27	$C_1T_2I_1P_3$	54	54	9.6	9.1
10	$C_2T_2I_2P_1$	43	43	9.5	9.4	28	$C_2T_2I_1P_3$	43	43	9.5	9.3
11	$C_1T_3I_2P_1$	54	53	9.4	9.6	29	$C_1T_3I_1P_3$	54	54	9.3	9.2
12	$C_2T_3I_2P_1$	42	42	9.6	9.3	30	$C_2T_3I_1P_3$	42	42	9.4	9.3
13	$C_1T_1I_1P_2$	58	57	9.5	9.6	31	$C_1T_1I_2P_3$	58	58	9.4	9.5
14	$C_2T_1I_1P_2$	46	46	9.5	9.5	32	$C_2T_1I_2P_3$	46	46	9.5	9.2
15	$C_1T_2I_1P_2$	54	54	9.5	9.4	33	$C_1T_2I_2P_3$	54	54	9.5	9.5
16	$C_2T_2I_1P_2$	43	43	9.4	9.3	34	$C_2T_2I_2P_3$	43	43	9.6	9.3
17	$C_1T_3I_1P_2$	54	54	9.2	9.1	35	$C_1T_3I_2P_3$	54	54	9.5	9.3
18	$C_2T_3I_1P_2$	43	42	9.4	9.4	36	$C_2T_3I_2P_3$	42	42	9.4	9.5

CD-0.250

Average temperature 36°C; Moisture in percentage (Fresh 76.2)

Table 3 gives a detailed description of the moisture loss after dehydration of the dried products.

Jackfruit contains 76.2 per cent moisture a (NIN 1991). As indicated in the Table 3, moisture content of the different treated products ranged from 9.0 to 9.6 per cent in soft flesh type and 8.7 to 9.6 per cent in firm flesh type of jack fruit. Maynard and Heid (1963) suggested a moisture level below 10 per cent for storing dried fruits to reduce microbial contamination. Moisture content of samples treated at 50°C ranged from 9.0 to 9.6 in soft flesh variety and 8.7 to 9.5 in firm flesh variety where as in samples treated at 70°C, moisture level ranged from 9.2 to 9.6 in soft flesh samples and 9.0 to 9.6 in firm flesh sampels. The moisture content of samples without heating ranged from 8.8 to 9.6 in soft flesh samples and 9.1 to 9.6 in firm flesh sampels.

In jack fruit samples immersed in sugar solution for 30 minutes, moisture content was between 9.2 to 9.6 per cent in soft flesh samples and 8.7 to 9.6 per cent in firm flesh samples where as in samples immersed for 60 minutes, moisture ranged from 9.0 to 9.6 per cent in both varieties.

The moisture content of samples treated in 60° Brix and 70° Brix sugar solution ranged from 9.2 to 9.6 per cent and 9.1 to 9.6 per cent respectively in soft flesh as against 8.7 to 9.6 per cent and 9.0 to 9.5 per cent respectively in firm flesh samples. Similarly the samples treated with different preservative levels P_1, P_2 moisture levels obtained were 9.0 to 9.5, and in P_3 it was between 9.3 to 9.4 in both the varieties. The above results threw light to the fact that preservative, sucrose concentration, temperature, immersion time has not much influenced the moisture levels in the products.

The variation in moisture content of treated samples may be due to the sample piece geometry. According to Rahman (1992) osmotic concentration behaviour depended on sample piece geometry and on variation of surface area per unit volume or mass and diffusion length of the component involved in mass transport.

Camirand *et al.* (1968) reported that chemical treatment cause moisture loss in fish and meat while it had little effect in the case of fruits. It was also found that preservative used had no effect on percentage of moisture loss in the products dried. The above results indicated that there was no significant difference in the moisture content of the two varieties of jack fruit tried in the study but out of thirty six treatment combinations, difference was observed between the four pairs of treatment combinations viz., $C_2T_2I_1P_1$, $C_2T_2I_2P_1$ and $C_2T_3I_1P_1$, $C_2T_1I_1P_1$ and $C_1T_1I_2P_3$, $C_2T_2I_2P_1$ and $C_1T_2I_2P_2$, $C_1T_3I_1P_2$ in soft flesh samples. In the case of firm flesh samples significant difference was observed between the eight pairs of treatment combinations viz., $C_1T_2I_1P_2$ and $C_1T_2I_2P_2$, $C_1T_3I_1P_2$ and $C_1T_3I_2P_2$, $C_1T_1I_1P_2$ and $C_1T_1I_2P_2$, $C_2T_2I_1P_1$ and $C_2T_2I_2P_1$, $C_2T_2I_1P_1$ and $C_2T_3I_1P_1$, $C_1T_1I_2P_2$, $C_1T_2I_2P_3$, $C_1T_2I_2P_2$ and $C_1T_3I_2P_2$, $C_1T_1I_2P_1$ and $C_1T_2I_2P_2$.

4.1.3 Drying time and Drying Ratio of Jack fruit Products

The drying time is directly related to the moisture content such that higher moisture level increased the drying time and when the moisture content is less, the time required for drying is also less (Kim 1987).

Angela *et al.* (1982) had reported that treatment with omotic dehydration would reduce processing time.

As indicated in Table 3 drying time taken by diffrently treated samples ranged between 42 to 58 hours. It was also observed that among the various treatments, samples treated with 70° Brix, the highest sugar concentration used was found to take the least time (42 hours) for drying than the other treatments. It was also noted that unheated samples required more drying time (58 hours) than heated samples (54 hours). This may be due to the fact that the water lost from the fruit increased with increased sugar concentration, temperature and immersion time. It was also observed that preservative used had no effect on drying time.

Drying ratio is the ratio between the weight of original fruit to the weight of final dried product. The drying ratio of jack fruit products are presented in Table 4.

The samples treated with 60° Brix sugar concentration and 70° Brix sugar concentration had the drying ratio between 0.29 and 0.30 in both varieties. Soft flesh samples (V_1) had the

Table 4 Effect of pretreatments on drying and weight loss after drying   Initial weight - 1kg

Sl. No.	Treatments	Final weight (g/kg) V_1	Final weight (g/kg) V_2	Weight loss (g/kg) V_1	Weight loss (g/kg) V_2	Sl. No.	Treatments	Final weight (g/kg) V_1	Final weight (g/kg) V_2	Weight loss (g/kg) V_1	Weight loss (g/kg) V_2
1	$C_1T_1I_1P_1$	300 (0.3)	300 (0.3)	700	700	19	$C_1T_1I_2P_2$	298 (0.298)	300 (0.3)	698	700
2	$C_2T_1I_1P_1$	300 (0.3)	300 (0.3)	700	700	20	$C_2T_1I_2P_2$	295 (0.295)	296 (0.296)	705	704
3	$C_1T_2I_1P_1$	300 (0.3)	300 (0.3)	700	700	21	$C_1T_2I_2P_2$	300 (0.300)	297 (0.297)	700	703
4	$C_2T_2I_1P_1$	300 (0.3)	300 (0.3)	700	700	22	$C_2T_2I_2P_2$	295 (0.295)	296 (0.296)	705	704
5	$C_1T_3I_1P_1$	300 (0.3)	300 (0.3)	700	700	23	$C_1T_3I_2P_2$	294 (0.294)	300 (0.3)	706	700
6	$C_2T_3I_1P_1$	300 (0.3)	300 (0.3)	700	700	24	$C_2T_3I_2P_2$	299 (0.299)	298 (0.298)	701	702
7	$C_1T_1I_2P_1$	290 (0.290)	290 (0.290)	710	710	25	$C_1T_1I_1P_3$	300 (0.3)	300 (0.3)	700	700
8	$C_2T_1I_2P_1$	299 (0.299)	298 (0.298)	701	708	26	$C_2T_1I_1P_3$	300 (0.3)	300 (0.3)	700	700
9	$C_1T_2I_2P_1$	301 (0.301)	300 (0.3)	698	700	27	$C_1T_2I_1P_3$	300 (0.3)	294 (0.294)	700	706
10	$C_2T_2I_2P_1$	299 (0.299)	298 (0.298)	701	702	28	$C_2T_2I_1P_3$	300 (0.3)	300 (0.3)	700	700
11	$C_1T_3I_2P_1$	300 (0.300)	298 (0.298)	700	698	29	$C_1T_3I_1P_3$	295 (0.295)	293 (0.293)	705	707
12	$C_2T_3I_2P_1$	295 (0.295)	294 (0.294)	705	706	30	$C_2T_3I_1P_3$	295 (0.295)	295 (0.295)	705	705
13	$C_1T_1I_1P_2$	300 (0.3)	295 (0.295)	700	705	31	$C_1T_1I_2P_3$	300 (0.3)	300 (0.3)	700	700
14	$C_2T_1I_1P_2$	300 (0.3)	300 (0.3)	700	700	32	$C_3T_1I_2P_3$	300 (0.3)	300 (0.3)	700	700
15	$C_1T_2I_1P_2$	300 (0.3)	298 (0.298)	700	698	33	$C_1T_2I_2P_3$	300 (0.3)	293 (0.293)	700	707
16	$C_2T_2I_1P_2$	300 (0.3)	300 (0.3)	700	700	34	$C_2T_2I_2P_3$	296 (0.296)	296 (0.296)	704	704
17	$C_1T_3I_1P_2$	298 (0.298)	300 (0.3)	698	700	35	$C_1T_3I_2P_3$	300 (0.3)	292 (0.292)	700	708
18	$C_2T_3I_1P_2$	300 (0.3)	300 (0.3)	700	700	36	$C_2T_3I_2P_3$	300 (0.3)	300 (0.3)	700	700

The numbers in parentheses indicates drying ratio.

drying ratio between 0.29 and 0.30 where as firm flesh samples (V_2) had the drying ratio between 0.29 and 0.30. Not much difference was observed between treatments and varieties with respect to drying ratio.

From the results of the present study, it can be concluded that the percentage of weight loss of jack fruit samples after initial dewatering increased with the increase in sugar concentration (0.5). With the increase in temperature, the percentage of weight loss was 8 and that with the increase in immersion time, the weight loss was almost same for both the varieties (0.2 per cent).

It was also noted that higher the sugar concentration (70° Brix), higher temperature (70°C) and immersion time (60 minutes) applied in this study were observed to reduce the drying time. However preservatives used had no effect on drying time. Drying ratio was not found to vary with the variety.

4.2 Nutritional and Chemical analysis of the dried Jackfruit products

Gopalan *et al.* (1992) reported that fresh Jackfruit contains moisture 76.2 per cent; Fiber 1.1 g; calcium 20 mg; phosphorus 41mg; iron 0.5mg; β carotene 175 ug; potassium 191 mg; sodium 41.4 mg and vitamin C 7 mg.

Acidity, reducing sugar and Vitamin C content in fresh and dried Jackfruit products were determined and results are presented in Table 5.

Table 5 Nutritional and chemical characters of fresh and dried Jack fruit products

Nutrient contents	Fresh Jackfruit V_1	V_2	Dried Jackfruit V_1	V_2
Acidity (per cent)	2.34	2.32	0.48	0.43
Reducing sugar (g per 100g)	4.39	4.40	1.52	1.54
Vitamin C (mg per 100g)	7.00	7.00	0.18	0.19

As per the Table 5, it was found that in fresh Jackfruit the acidity was 2.34 g in V_1 and 2.32 in V_2 where as in dried soft flesh and firm flesh samples, acidity was reduced to 0.48 g and 0.43 g respectively.

Reducing sugar of fresh Jackfruit was 4.39 g in V_1 and 4.40 in V_2 and in dried soft flesh and firm flesh samples reducing sugar was reduced to 1.52 and 1.54 respectively.

Zaghlol *et al.* (1983) noted that fresh Jackfruit contains acidity 2.34 per cent and reducing sugar 4.39 g per 100 g.

The Vitamin C content of fresh Jack fruit was 7 mg in both varieties where as in dried soft flesh samples and in firm flesh samples the Vitamin C was reduced to 0.18 mg, 0.19 mg respectively. Mathew (1989) pointed out that there was a significant destruction of ascorbic acid in the sun dried vegetable products. It was also supported by Gupta *et al.* (1984) who had stated that drying reduces the level of ascorbic acid.

4.2.1 Effect of storage on acidity content of Jack fruit Products

The acid content of the dried fruit products was measured with regard to the total content of citric acid in the product as suggested by Ranganna (1991). According to Mahony (1986) change in the acidic content produces sourness in the stored products.

The growth of microorganisms is also affected by acidity. The acid foods like fruits are less succeptable to the attack of microorganisms (Kordylas, 1990).

pH value of Jackfruit variety varikka and kuzha in the present study was observed to be 5.4 and 5.5 respectively. The pH needs to be lowered for the adequate preservation of dried fruit product and sugar is added to mask the acidity to quite an extent, as stated by Tonaki *et al.* as early as 1973.

Table 6 indicates the influence of variety on acidity during storage period.

Table 6 Influence of variety on acidity content during storage

Varieties	(Acidity in per cent) Storage period in months					Percentage of decrease in acidity
	1	2	3	4	5	
V^1	0.45	0.43	0.43	0.42	0.40	9
V_2	0.43	0.43	0.42	0.41	0.40	7

As indicated in Table 6, the values obtained for V_1, for acidity during five months of storage period ranged from 0.40 to 0.45 where as in V_2 it was between 0.40 to 0.43.

Firm flesh type samples were less acidic than soft flesh type samples. Dutta (1966) pointed out that soft flesh bulbs (kuzha) are more acidic than firm flesh bulbs (varikka). It was observed in the present study that during storage the acidity was found to decrease in the Jack fruit product. The decrease was accounted to be 9 per cent in V_1 and 7 per cent in V_2. This findings was supported by Mahajan *et al.* (1994) that the titrable acidity gradually declined linearly with advancement in storage period.

Statistical analysis revealed that there was no significant difference in acidity between the two varieties, through out the storage period.

Table 7 indicates the influence of preservatives on acidity content during storage.

Table 7 Influence of preservative on acidity content during storage

Preservatives	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
P_1	0.43	0.43	0.40	0.40	0.40	7
P_2	0.44	0.45	0.43	0.42	0.41	7
P_3	0.45	0.45	0.44	0.43	0.42	7

Effect of preservative on the acidity content indicates that in P_1, P_2 and P_3, acidity values ranged between 0.40 to 0.43, 0.41 to 0.45, and 0.42 to 0.45 respectively during the storage period. The decrease in acidity was accounted to be 7 per cent in P_1, P_2 and P_3. This decrease in acidity during storage period may be due to the interaction between organic constituents of product and enzymes. From the table it is noted that the samples having 20 per cent preservative level had slightly more acid content than other samples.

Further analysis of the data revealed that (Table 7) there was no significant difference in acidity values between preservative levels P_1 and P_2 throughout the storage period. Similarly no significant difference was observed between the treatment P_2 and P_3 and between P_1 and P_3.

Interaction effect of varieties and preservatives on acidity during storage is presented in Table 8.

As indicated in Table 8, values obtained for treatment combinations V_1P_1, V_1P_2 and V_1P_3 ranged between 0.39 to 0.43, 0.38 to 0.41, 0.37 to 0.43 respectively during storage period where as in V_2P_1, values ranged between 0.38 to 0.43 and 0.40 to 0.43 respectively in V_2P_2 and V_2P_3. The decrease in acidity content during storage was accounted to be 9 per cent in V_1P_1, 12 per cent in V_1P_2 and 14 per cent in V_1P_3 where as 12 per cent in V_2P_1 and V_2P_2 and 7 per cent in V_2P_3 respectively.

Table 8 Interaction effect of varieties and preservatives on acidity during storage

Treatment combinations	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
V_1P_1	0.43	0.43	0.42	0.40	0.39	9
V_1P_2	0.41	0.41	0.40	0.39	0.38	12
V_1P_3	0.43	0.41	0.40	0.39	0.37	14
V_2P_1	0.43	0.42	0.41	0.40	0.38	12
V_2P_2	0.43	0.43	0.41	0.40	0.40	12
V_2P_3	0.43	0.43	0.42	0.41	0.40	7

Kuzha variety (V_1) treated at different preservative levels,secured more difference in acidity at zero and 20 per cent preservative levels where as in varikka (V_2) not much difference in acidity was observed at zero, 15 and 20 per cent preservative levels during storage.

Statistical analysis of the data revealed that there was no significant difference between varieties at different preservative levels, throughout the storage period. It has been stated by Ranganth and Dubash (1981) that acidity decreases on storage. This statement stands right, as seen by the linear decreases in the acidity in this study.

The influence of time of immersion on acidic content during storage is presented in Table 9.

Table 9 Influence of immersion time on acidity content during storage

Immersion time	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
I_1	0.43	0.42	0.41	0.39	0.38	12
I_2	0.42	0.42	0.41	0.38	0.38	10

The values obtained for the treatments ranged between 0.38 to 0.43 in I_1 and 0.38 to 0.42 in I_2 during storage. The decrease in acidity during storage was accounted to be 12 per cent in I_1 and 10 per cent in I_2. From the Table it was observed that acidity content of samples decreased with increase in storage period. Similar decrease in acidity during storage was reported in pear candy by Bhatia (1985).

It was observed that a difference in acidity was obtained in the samples immersed for different time intervals. More acidic content was observed in samples immersed for 30 minutes than in samples immersed for 60 minutes. The low acidity observed in the products may be due to more sucrose absorption taking place in samples due to prolonged immersion. Naraian (1993) reported that considerable amount of solute penetration takes place if the osmotic dehydration time is long.

No significant difference was observed in acidity content between I_1 and I_2 through out the storage period.

Interaction effect of varieties and time of immersion on acidity content during storage is presented in Table 10.

Table 10 Interaction effect of varieties and immersion time on acidity content during storage

Treatment combinations	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
V_1I_1	0.43	0.43	0.42	0.40	0.38	12
V_1I_2	0.42	0.43	0.43	0.38	0.35	17
V_2I_1	0.43	0.43	0.42	0.40	0.37	14
V_2I_2	0.43	0.43	0.43	0.38	0.36	16

The values obtained for V_1I_1 ranged between 0.38 to 0.43 where as in V_2I_1 it was ranged between 0.37 to 0.43. In V_1I_2 and V_2I_2 values ranged between 0.35 to 0.43 and 0.36 to 0.43 respectively during storage period. The decrease in acidity during storage was accounted to be 12 per cent in V_1I_1, 17 per cent in V_1I_2 where as 14 per cent in V_2I_1 and 16 per cent in V_2I_2.

It was noticed that (Table 10) no significant difference in acidity was observed during storage period between two varieties at different immersion time intervals but acidity value decreases during storage period, for each treatment combinations. Similar decrease in acidity during storage was immersion reported in amla candy by Tripathi *et al.* (1985).

Table 11 depicts the influence of temperature on acidity content of samples during storage period.

Table 11 Influence of temperature on acidity content during storage

Temperature	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
T_1	0.45	0.45	0.44	0.42	0.42	7
T_2	0.45	0.45	0.42	0.42	0.42	7
T_3	0.45	0.45	0.43	0.42	0.42	7

Effect of temperature on the acidity content indicated that in T_1, T_2 and T_3 the values were 0.42 to 0.45 respectively during storage. The decrease in acidity during storage was accounted to be 7 per cent in samples treated with different temperatures.

Statistical analysis of the data revealed that there was no significant difference in acidity value observed between samples treated at different temperature levels. It may be due to the fact that processing and pretreatment had negligible effect on acidity (Sandhu *et al*, 1988).

Table 12 indicates the interaction effect of varieties and temperature on acidity of samples during storage.

As indicated in Table 12, the values obtained for V_1T_1, V_1T_2, V_1T_3 ranged between 0.37 to 0.43, 0.39 to 0.43 and 0.31 to 0.41 respectively during storage period where as in V_2T_1, V_2T_2, V_2T_3 the values ranged between 0.39 to 0.43, 0.38 to 0.43 and 0.36 to 0.43 respectively during storage period.

Table 12 Interaction effect of varieties and temperature on acidity on sample during storage

Treatment combinations	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
V_1T_1	0.43	0.41	0.40	0.39	0.37	14
V_1T_2	0.43	0.43	0.42	0.40	0.39	9
V_1T_3	0.41	0.41	0.40	0.39	0.37	10
V_2T_1	0.43	0.43	0.43	0.41	0.39	9
V_2T_2	0.43	0.42	0.41	0.40	0.38	12
V_2T_3	0.43	0.43	0.41	0.40	0.36	16

The decrease in acidity during storage was accounted to be 14 per cent V_1T_1, 9 per cent in V_1T_2 and 10 per cent in V_1T_3 where as 9 per cent in V_2T_1, 12 per cent in V_2T_2 and 16 per cent in V_2T_3 were observed.

Statistical analysis of the data revealed that there was no significant difference in acidity between the two varieties treated at different temperature level, through out the storage period.

Influence of sugar concentration of samples on acidity during storage period is given in Table 13.

Table 13 Influence of sugar concentration on acidity content during storage

Treatments	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
C_1	0.44	0.42	0.41	0.41	0.38	14
C_2	0.42	0.40	0.38	0.38	0.38	10

The values obtained for the dried jack fruit products treated with different sugar concentrations ranged between 0.38 to 0.44 in C_1 and 0.38 to 0.42 in C_2 during storage. The decrease in acidity during storage period was accounted to be 14 per cent in C_1 and 10 per cent in C_2 samples. It was noticed that acid content decreases with increase in storage period. Similar decrease in acidity during storage was reported in ber candy by Chavan *et al.*(1991).

Sample treated with 70° Brix was less acidic than samples treated with 60° Brix. It was noted that the acidity was lower in the products which had a higher concentration of sugar. This proves the fact that increase in sugar concentration reduces acidity as reported in earlier studies of George (1994). No significant difference in acidity was observed between the samples treated at different sugar concentrations through out the storage period as revealed in Table 13.

Interaction effect of varieties and sugar concentration on acidity during storage is presented in Table 14.

Table 14 Interaction effect of varieties and sugar concentration on acidity during storage period

Treatment combinations	(Acidity in per cent) Storage period in months 1	2	3	4	5	Percentage of decrease in acidity
V_1C_1	0.43	0.43	0.43	0.42	0.41	7
V_1C_2	0.40	0.39	0.37	0.36	0.35	13
V_2C_1	0.43	0.43	0.43	0.42	0.41	5
V_2C_2	0.40	0.40	0.36	0.35	0.34	15

Values obtained for V_1C_1, V_1C_2, V_2C_1, V_2C_2 ranged between 0.41 to 0.43 0.35 to 0.40 0.41 to 0.43 and 0.35 to 0.40 respectively during the storage period. The decrease in acidity during storage period was accounted to be 7 per cent in V_1C_1, 13 per cent in V_1C_2, 5 per cent in V_2C_1 and 15 per cent in V_2C_2.

The values obtained for each samples decreased with the increase in storage period.

Statistical analysis of the data revealed that there was no significant difference in acid content between the two varieties at different sugar concentrations.

In general among the different treatments proposed, samples treated with 20 per cent glycerol level (P_3), 30 minutes immersion time (I_1), 60° Brix and without heating secured more acidic values than other treatments applied. It was also observed that firm flesh type samples were less acidic than soft flesh samples, but there was no significant difference between the two varieties in acidity content. During storage acidity was found to decrease in the dried Jack fruit products.

4.2.2 Effect of storage on reducing sugar content of Jackfruit products

Changes in reducing sugar level of the two varieties during storage is presented in Table 15.

Table 15 Influence of variety on reducing sugar level during storage

Varieties	(Reducing sugar g/100g) Storage period in months					Percentage of increase in reducing sugar
	1	2	3	4	5	
V_1	1.52	1.51	1.51	1.53	1.61	6
V_2	1.54	1.54	1.56	1.62	1.63	6
CD	0.011	0.236	0.181	0.172	0.003	

As indicated in Table 15, the values obtained for V_1 for reducing sugar content during storage period ranged from 1.52 to 1.61 where as in V_2, it was in the range of 1.54 to 1.63. The increase in reducing sugar content was accounted to be 6 per cent in both varieties.

As per the Table 15, the mean score obtained for soft flesh samples were found to be lower when compared to the firm flesh samples. Storage was found to influence the reducing sugar level positively (Mir and Nirankarnath 1993). As the storage period increases, the reducing sugar in both the varieties increased gradually.

Statistical analysis of the data revealed that the mean scores obtained for the reducing sugar level for the two varieties was found to be significant only in first month and last month of its storage period.

The influence of preservatives on reducing content during storage is presented in Table 16.

Table 16 Influence of Preservative on reducing sugar level during storage

Preservatives	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
P_1	1.48	1.48	1.48	1.50	1.58	6
P_2	1.48	1.50	1.52	1.53	1.54	4
P_3	1.48	1.48	1.48	1.58	1.59	7
CD	0.013	0.289	0.221	0.212	0.003	

Effect of preservative on the reducing content indicated that in P_1, P_2 and P_3, reducing content values ranged between 1.48 to 1.58, 1.48 to 1.54 and 1.48 to 1.59 respectively during the storage period. The increase was accounted to be 6 per cent in P_1, 4 per cent in P2, 7 per cent in P_3.

Statistical analysis of the data revealed that no significant variation was observed in reducing sugar in the products treated with different preservative levels, during the first fourth month of its shelflife.

Interaction effect of preservatives and varieties on the reducing sugar level during storage is given in Table 17.

Table 17 Interaction effect of varieties and preservatives on reducing sugar level during storage

Treatment combinations	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
V_1P_1	1.52	1.52	1.52	1.53	1.56	3
V_1P_2	1.52	1.52	1.53	1.54	1.54	1
V_1P_3	1.53	1.53	1.53	1.54	1.54	0.6
V_2P_1	1.55	1.54	1.55	1.56	1.56	0.6
V_2P_2	1.54	1.56	1.58	1.60	1.63	6
V_2P_3	1.53	1.53	1.54	1.58	1.60	4
CD	0.018	0.409	0.314	0.299	0.005	

As indicated in Table 17 values obtained for treatment combinations V_1P_1, V_1P_2, V_1P_3 ranged between 1.52 to 1.56, 1.52 to 1.54 and 1.53 to 1.54 respectively during storage where as in V_2P_1, V_2P_2, V_2P_3, values ranged between 1.55 to 1.56, 1.54 to 1.63 and 1.53 to 1.60 respectively. It was observed that reducing sugar content increased during storage in each treatments. Pawar *et al.* (1988) observed that reducing sugar content increases during storage in dried fruits.

The increase was accounted to be 3 per cent in V_1P_1, 1 per cent in V_1P_2, 0.6 per cent in V_1P_3 where as it was 0.6 per cent in V_2P_1, 6 per cent in V_2P_2 and 4 per cent in V_2P_3.

Statistical analysis of the data revealed that there was no significant difference in reducing sugar content between the varieties treated with different preservative level up to the fourth month of its storage period.

Influence of time of immersion on reducing sugar during storage is given in Table 18.

Table 18 Influence of immersion time on reducing sugar level during storage

Immersion time	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
I_1	1.48	1.48	1.52	1.53	1.54	4
I_2	1.50	1.50	1.54	1.55	1.56	4
CD	0.018	0.236	0.181	0.173	0.002	

The values obtained for the products treated with different immersion time ranged between 1.48 to 1.54 in I_1 and 1.50 to 1.56 in I_2 during storage. The increase in reducing sugar was accounted to be 4 per cent in I_1 in samples treated at different immersion time period.

No significant difference was observed between samples, in reducing sugar with different periods of immersion.

The interaction effect between varieties and time of immersion on reducing sugar level during storage is given Table 19.

Table 19 Interaction effect of immersion time and variety on reducing sugar level during storage

Treatment combinations	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
V_1I_1	1.44	1.44	1.45	1.48	1.50	4
V_1I_2	1.43	1.44	1.46	1.48	1.53	2
V_2I_1	1.52	1.52	1.52	1.53	1.55	7
V_2I_2	1.53	1.53	1.54	1.59	1.60	4
CD	0.015	0.334	0.256	0.244	0.004	

The values obtained for V_1I_1 and V_2I_1 ranged between 1.44 to 1.50 and 1.52 to 1.55. In V_1I_2 and V_2I_2 values ranged between 1.43 to 1.53 and 1.53 to 1.60 respectively during storage period.

The increase in reducing sugar was accounted to be 4 per cent in V_1I_1, 2 per cent in V_1I_1, 7 per cent in V_2I_1 and 4 per cent in V_2I_2.

It is evident from the table that firm flesh samples secured higher mean values for reducing sugar than soft flesh samples at different immersion time levels. It may be partially due to the chemical constituent present in the fruit.

Statistical analysis of the data revealed that no significant difference was observed between the samples treated at different immersion time levels in each month in reducing sugar content.

Table 20 Influence of temperature of Osmotic solution on reducing sugar level during storage

Temperature	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
T_1	1.38	1.40	1.43	1.48	1.48	7
T_2	1.48	1.56	1.60	1.62	1.64	10
T_3	1.49	1.56	1.59	1.60	1.63	9
CD	0.013	0.289	0.221	0.211	0.003	

Table 20 depicts the influence of temperature of osmotic solution on reducing sugar during storage.

Effect of temperature on the reducing sugar content as indicated in T_1,T_2 and T_3 was 1.38 to 1.48, 1.48 to 1.64, 1.49 to 1.63, respectively during storage. On the basis of the mean values, it was noticed that reducing sugar content increased with storage on samples treated at different temperature levels. The increase in reducing sugar was accounted to be 7 per cent in T_1, 10 per cent in T_2, 9 per cent in T_3.

Statistical analysis of the data revealed that no significant difference observed between the samples treated at different temperature levels during the storage period.

Interaction effect of temperature and varieties on reducing sugar during storage is presented in Table 21.

Table 21 Interaction effect of temperature and variety on reducing sugar level during storage

Treatment combinations	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
V_1T_1	1.43	1.43	1.44	1.44	1.45	1.0
V_1T_2	1.43	1.43	1.49	1.52	1.52	6.0
V_1T_3	1.42	1.42	1.42	1.42	1.43	0.6
V_2T_1	1.52	1.52	1.53	1.53	1.53	0.6
V_2T_2	1.52	1.52	1.52	1.55	1.57	3.0
V_2T_3	1.53	1.53	1.54	1.58	1.63	6.0
CD	0.018	0.409	0.313	0.299	0.004	

As indicated in Table 21, the values obtained for V_1T_1, V_1T_2, V_1T_3 ranged between 1.43 to 1.45, 1.43 to 1.52 and 1.42 to 1.43 respectively where as in V_2T_1, V_2T_2, V_2T_3 the values ranged between 1.52 to 1.53, 1.52 to 1.57 and 1.53 to 1.63 respectively during storage period. The increase in reducing sugar during storage period was accounted to be 1 per cent in V_1T_1, 6 per cent in V_1T_2 and 0.6 per cent in V_1T_3 where as in V_2T_1 it was 0.6 per cent, 3 per cent in V_2T_2 and 6 per cent in V_2T_3.

Statistical analysis of the data revealed that significant difference was observed between two varieties treated at 50°C for the first month of shelflife but no significant difference was observed in subsequent months of storage period.

No difference was observed in reducing sugar for two consecutive months but difference was observed between the first and final month of storage period.

The influence of sugar concentration on reducing sugar during storage period is presented in Table 22.

Table 22 Influence of sugar concentration on reducing sugar level during storage

Treatments	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
C_1	1.46	1.52	1.53	1.60	1.62	10
C_2	1.50	1.62	1.64	1.68	1.70	12
CD	0.010	0.236	0.181	0.172	0.002	

The values obtained ranged between 1.46 to 1.62 in C_1 and 1.50 to 1.70 in C_2 during storage. The increase in reducing sugar was accounted to be 10 per cent in C_1 and 12 per cent in C_2.

Statistical analysis of the data revealed that significant difference observed between samples treated with different sugar concentrations during its first month of its storage period. It was observed that samples treated with 70° Brix sugar concentration secured more scores than the samples treated with 60° Brix sugar concentrations. This finding was found in accordance with the work done by George (1994). She observed that the samples treated with 70° Brix sugar concentration secured higher scores than the samples treated with 60°Brix sugar concentration in osmotically treated dried banana products.

The interaction effect of sugar concentration and varieties on reducing sugar during storage period is given in Table 23.

Table 23 Interaction effect of sugar concentration and variety on reducing sugar level during storage

Treatment combinations	(Reducing sugar g/100g) Storage period in months 1	2	3	4	5	Percentage of increase in reducing sugar
V_1C_1	1.50	1.52	1.54	1.57	1.58	4
V_1C_2	1.52	1.53	1.55	1.58	1.60	3
V_2C_1	1.53	1.56	1.56	1.57	1.58	5
V_2C_2	1.56	1.67	1.68	1.68	1.70	8
CD	0.018	0.334	0.256	0.244	0.004	

Values obtained for V_1C_1, V_1C_2, V_2C_1, V_2C_2, ranged between 1.50 to 1.58, 1.53 to 1.58, 1.52 to 1.60 and 1.56 to 1.70 respectively during storage.

The increase in reducing sugar during storage period was accounted to be 4 per cent in V_1C_1, 3 per cent in V_1C_2, 5 per cent in V_2C_1 and 8 per cent in V_2C_2.

No significant difference was observed between to varieties treated at different sugar concentrations during its storage period. Among treatment combinations V_2C_2 secured higher score than the other treatment combinations and it was also observed that reducing sugar content in this treatment increased during storage period.

On evaluation of reducing sugar content of dried jack fruit products undergone different treatments indicated that 60 minutes immersion time (I_2), 70°C temperature (T_2) and 70° Brix sugar concentration were found to influence the reducing sugar content of the dried products during storage when compared to other treatments. It was also noted that firm flesh samples (V_1) had more reducing sugar content than soft flesh samples (V_2). Storage was found to postively influence the reducing sugar level of the dried jack fruit products.

4.3.1 Assessment of the Organoleptic qualities of the Jack fruit products

Assessment of the organoleptic qualities are generally carried out to draw conclusions about a particular food from a large population through the selection of a limited number of panel members (Singh 1992). Organoleptic assessment of the dehydrated products is of much importance since they constitute a major part of our export potential (Rao 1993). According to Mahony (1985) the organoleptically assessed samples formed a true representative of the products developed and organoleptic assessment stands essential for the further development of the products.

Torregian (1993) has the opinion that Osmotic dehydration of fruits and vegetable would improve the nutritional, sensorial and functional properties of the products than other methods of dehydration.

Table 24 depicts the mean scores obtained for different quality attributes in organoleptic assessment for firm and soft flesh type variety Jack fruit products.

Table 24 Organoleptic qualities of the dried products as influenced by the variety

Varieties	Appearance	Flavour	colour	Taste	Texture	Over all acceptability
V_1	4.41	4.11	3.61	4.52	4.59	4.47
V_2	4.54	4.26	3.55	4.51	4.65	4.52
CD	0.060	0.060	0.060	-	-	0.036

Meanscore obtained for appearance in soft flesh type (V_1) was 4.41 as against 4.54 in firm flesh type (V_2). With respect to flavor attribute, mean score of V_1 was 4.11 as against 4.26 in V_2. Mean scores secured for attributes like colour, taste and texture were 3.61, 4.52, 4.59 respectively in V_1 as against 3.55, 4.51, 4.65 respectively in V_2. While considering the over all acceptability, mean score of V_1 was 4.47 as against 4.52 of V_2.

In all the quality attribute scores, except that of colour and over all acceptability, firm flesh samples scored higher than the soft flesh variety samples indicating their higher sensorial qualities, among the products.

Significant difference in appearance between the two varieties was observed and it was found that firm flesh type sample was superior to soft flesh type samples. The main reasons for the difference in appearance is the difference in physical structure of two varieties of jack fruit.

As indicated by CD values significant difference was observed in two varieties with regard to flavour attribute. Soft flesh samples scored higher with respect to colour and taste. Texture was found to be better in firm flesh type. But the difference was not significant as indicated by CD values.

While considering the over all acceptability, significant difference was noticed and firm flesh type samples were more acceptable than soft flesh type samples.

General appearance of the final product is one of the factors which influence consumer acceptance of the product. Inability of the soft flesh variety to retain its structure explains the reason for the lower scores for appearance in soft flesh variety.

Table 25 depicts the mean scores obtained for samples treated with different levels of preservatives.

Khaleib *et al.* (1988) reported that preservatives like sorbic acid, glycol, glycerol and sodium metabisulphite are being used in food industry within the permissible limits of legal standards.

Table 25 Organoleptic qualities of the dried products as influenced by preservatives

Preser-vatives	Appea-rance	Flavour	Colour	Taste	Texture	Overall Accept-ability
P_1	4.36	4.05	3.35	4.46	4.58	4.44
P_2	4.37	4.08	3.41	4.45	4.63	4.45
P_3	4.70	4.43	3.99	4.63	4.65	4.60
CD	0.080	0.070	0.070	0.090	-	0.045

According to Jackson and Mohamed (1971), Sodium metabisulphate can be used to inactivate poly phenol oxidase - enzyme which is responsible for browning during storage.

As indicated in Table 25, mean score obtained for various quality attributes like appearance, flavour, colour, taste and texture were found to be 4.36, 4.05, 3.35, 4.46, 4.58 respectively for P_1 as against 4.37 4.08, 3.41, 4.45, 4.63 respectively for P_2. The samples treated with sodium metabisulphate along with 20 per cent glycerol (P_3) scored a mean score of 4.70, 4.43, 3.99, 4.63, 4.65 respectively for appearance, flavour, colour, taste and texture attributes. In the over all acceptability, mean scores of P_1, P_2 and P_3 were 4.35, 4.45, 4.60 respectively. As evidenced from the Table the products treated with sodium metabisulphate along with 20 per cent glycerol was found to secure higher scores in all quality attributes viz., apperance, flavour, colour, taste and texture and also in over all acceptability when compared to the samples treated with other two levels of preservatives.

Statistical results obtained indicated no significant difference in various quality attributes between the samples treated with preservative levels of P_1 and P_2 but there existed significant difference in all quality attributes except in texture between the samples treated with preservative levels of P_2 and P_3.

To support the above finding Soleha (1992) pointed out that fruit mixture treated with 15 or 20 per cent glycerol showed significantly better colour, appearance, texture and flavour than untreated fruit mixture.

The Table 26 depicts the interaction effect of preservative with the variety.

Mean scores obtained corresponding to the various quality attributes given in the Table were found to be 4.23, 3.39, 3.24, 4.48 and 4.57 in V_1 P_1 as against 4.49, 4.12, 3.46, 4.44 and 4.60 in V_2 P_1. In V_1 P_2, mean scores obtained for various quality attributes were found to be as 4.34, 3.98, 3.66, 4.45 and 4.69 respectively as against the mean values of 4.39, 4.18, 3.16, 4.45 and 4.56 respectively with V_2 P_2.

Meanscores obtained for various quality attribute were found to be as 4.67, 4.36, 3.94, 4.63 and 4.70 respectively with

V_1 P_3 but with V_2 P_3, meanscores were found to be as 4.73, 4.03, 4.52, 4.63 and 4.60 respectively.

Table 26 Interaction effect of varieties and preservatives on organoleptic qualities

Treatment combination	Appearance	Flavour	Colour	Taste	Texture	Overall acceptability
V_1 P_1	4.23	3.99	3.24	4.48	4.57	4.37
V_1 P_2	4.34	3.98	3.66	4.45	4.69	4.43
V_1 P_3	4.67	4.36	3.94	4.63	4.70	4.61
V_2 P_1	4.49	4.12	3.46	4.44	4.60	4.50
V_2 P_2	4.39	4.18	3.16	4.45	3.56	4.47
V_2 P_3	4.73	4.49	4.03	4.63	4.60	4.59
CD	0.110	-	0.100	0.127	0.126	0.063

Considering the overall acceptability, meanscores of V_1 P_1, V_1 P_2 and V_1 P_3 were found to be as 4.37, 4.43 and 4.61 respectively as against meanscores of 4.50, 4.47 and 4.59 respectively in V_2 P_1, V_2 P_2 and V_2 P_3.

Table 26 also reveals that significant difference was observed in appearance, flavour and in colour between the two varieties at preservative levels of P_1 but the difference was not significant in the attributes like taste and texture as reflected by CD values. In the case of overall acceptability also, significant difference was observed between the two varieties at P_1 level and it was observed that firm flesh samples had higher scores than the soft flesh samples.

Assessment of products of two varieties that treated with 15 per cent glycerol level along with sodium metabisulphate indicated significant difference in attributes like colour and in texture. This was supported by Dutta (1970) stating that firm flesh varities is better in producing quality products when compared to soft flesh variety. However no significant difference was observed in appearance, flavour and in taste of the samples of the two varieties with the above preservative levels. In over all acceptability, no significant difference was observed between the samples and firm flesh samples treated were scored better than the soft flesh samples.

With regard to the dried. Jackfruit Products treated with 20 per cent glycerol level, significant difference was observed in the attributes like flavour and in colour between the two varieties. The results clearly confirmed that firm flesh samples treated at different preservative levels were secured better than soft flesh samples treated with the same preservative levels. More studies are needed to get a clear understanding of the variation in attributes in the two varieties, treated with 15 and 20 per cent glycerol levels.

Table 27 gives a picture of the effect of immersion time on organoleptic qualities of the dried Jack fruit products.

Table 27 organoleptic qualities of the dried products as influenced by immersion time

Immersion time	Appearance	Flavour	Colour	Taste	Texture	Over all accepta-bility
I_1	4.46	4.27	3.56	4.54	4.64	4.50
I_2	4.49	4.10	3.60	4.49	4.60	4.44
CD	-	0.060	0.061	-	-	0.036

Mean scores of I_1 were 4.46, 4.27, 3.56, 4.54 and 4.64 respectively for various quality attributes like appearance, flavour, colour, taste and texture where as mean scores of I_2 were 4.49, 4.10, 3.60, 4.49 and 4.60 respectively for the same.

Quality attributes except flavour were not found to vary significantly with the difference in immersion time in the two varieties. However higher mean scores were found in the sample immersed for 30 minutes in the case of overall acceptability, than those immersed for 60 minutes and this may be due to the fact that rapid uptake of solute takes place within the first half hour of osmosis. According to Karel (1976) sugar uptake was rapid, reaching the maximum level after half an hour of treatment after which it remained constant.

Table 28 depicts the interaction of immersion time with the variety.

Table 28 Interaction effect of varieties and Immersion time

Treatment combination	Appearance	Flavour	Colour	Taste	Texture	Overall accept-ability
V_1 I_1	4.47	4.68	3.56	4.53	4.65	4.48
V_1 I_2	4.36	4.51	3.54	4.51	4.54	4.46
V_2 I_1	4.56	4.70	3.65	4.57	4.66	4.59
V_2 I_2	4.51	4.47	3.58	4.44	4.63	4.45
CD	0.090	0.080	0.050	0.103	0.103	0.050

Mean scores obtained for V_1 I_1 for various quality attribute like appearance, flavour, colour, taste and texture were found to be 4.47, 4.68, 3.56, 4.53 and 4.65 as against 4.56, 4.70, 3.65, 4.57, and 4.66 respectively with V_2 I_1. The values of V_1 I_2 for attributes like appearance, flavour, colour, taste and texture were found to be 4.36, 4.51, 3.54, 4.51 and 4.54 respectively as against the value of V_2 I_2 as 4.51, 4.47, 3.58, 4.44 and 4.63.

Significant difference were observed in quality attributes like appearance and taste between the two different variety samples immersed for 60 minutes in osmotic solution but significant difference was observed only in colour attribute between the samples immersed for 30 minutes. While considering the over all acceptability, firm flesh samples treated at two different immersion level secured higher scores than the soft flesh variety that was treated similarly. This can be explained by the fact that porosity and cellular arrangement of cells of firm flesh samples makes them to absorb more sucrose than the soft flesh samples and proved more acceptable. It is noted that the samples of both varieties that immersed for 30 minutes had secured higher scores than the other in various quality attributes. This effect may be due to the fact that more shrinkage will be there in the samples immersed for higher time as shown by Lenart and Flink (1984). From the above findings it was concluded that immersion time positively affected the quality attributes like appearance, taste and texture.

Table 29 depict the mean scores obtained for quality attribute in the samples that immersed in differently heated sugar solutions.

Raul *et al.* (1992) reported that the variables that exert the greatest influence on the Osmotic concentrations were the processing time and temperature.

Table 29 Organoleptic qualities of the dried products as influenced by the temperature

Treatment	Appearance	Flavour	Colour	Taste	Texture	Overall acceptability
T_1	4.19	4.42	3.24	4.37	4.60	4.31
T_2	4.61	4.63	3.64	4.56	4.64	4.57
T_3	4.62	4.62	3.87	4.60	4.63	4.61
CD	0.080	0.070	0.070	0.090	0.073	0.045

Table 29 - Mean scores obtained for various quality attributes like appearance, flavour, colour, taste and texture were found to be 4.61, 4.63, 3.64, 4.56 and 4.64 respectively for samples treated in 50°C heated Osmotic solution as against 4.62, 4.62, 3.87, 4.60 and 4.63 respectively for samples treated in 70°C heated osmotic solution. Samples treated in unheated osmotic solution secured comparatively lower scores of 4.19, 4.42, 3.24, 4.37, and 4.60 for various quality attributes. In overall acceptability, the scores were 4.57, 4.61 and 4.31 respectively for the samples treated at different temperature leveles 0°C, 50°C, and 70°C.

Significant differences observed in colour and in texture attribute, between the samples that immersed in 50°C and 70°C heated sugar solutions. It can be observed that samples treated at 70°C were scored better in all attributes than those heated to 0°C and 50°C. In Kiwi fruits dehydration temperature above 50°C adversely affected colour (Vial *et al*, 1990). Kanawadi and Maharaj (1993) reported that sensory characters especially texture was affected by temperature in dehydrated peas.

It was found that significant difference was observed in all attributes in the samples treated at 0°C and 50°C. Heating of the Osmotic solution increases the very process of Osmosis and the sweetness, may justify the high acceptability of the product. Adambournou and Castaigne (1983) on conducting dehydration experiments using Osmosis at 60°C and 40°C found that sucrose gain and water loss was faster at 60°C that at 40°C. It was noted by Beristein *et al.* (1990) that higher temperature increase the rate at which sugar was transported in to the ring. Equilibrium was reached faster and higher temperature promot faster water migration from the fruit. Browning is the another cause for the low scores obtained for the samples immersed in unheated osmotic solution.

Table 30 depicts the interaction effect of varieties and temperature.

Table 30 Interaction effect of varieties and temperature on organoleptic qualities

Treatment combinations	Appearance	Flavour	Colour	Taste	Texture	Overall accept-ability
V_1 T_1	4.13	4.39	3.31	4.40	4.67	4.29
V_1 T_2	4.55	4.62	3.60	4.59	4.67	4.55
V_1 T_3	4.56	4.58	3.93	4.56	4.63	4.57
V_2 T_1	4.26	4.45	3.17	4.33	4.53	4.32
V_2 T_2	4.67	4.65	3.68	4.53	4.61	4.59
V_2 T_3	4.68	4.65	3.80	4.65	4.63	4.65
CD	-	0.110	0.141	0.090	0.116	0.105

Mean scores obtained for corresponding various quality attributes like appearance, flavour, colour, taste and texture were found to be as 4.55, 4.62, 3.60, 4.59, and 4.67 respectively for V_1 T_2 as against the values of 4.67, 4.65, 3.68, 4.53 and 4.61 respectively for V_2 T_2. With respect to V_1 T_3 mean scores obtained for various quality attribute were found to be as 4.56, 4.58, 3.93, 4.56 and 4.63 respectively as against 4.68, 4.65, 3.80, 4.65, and 4.63 respectively with V_2 T_3. Mean scores obtained for various quality attributes were found to be 4.13, 4.39, 3.31, 4.40 and 4.67 for V_1 T_1 where as V_2 T_1 had the values of 4.26, 4.45, 3.17, 4.33 and 4.53 for various quality attribute like appearance flavour, colour, taste and texture. The overall acceptability meanscores of V_1 T_1, V_1 T_2, V_1 T_3, V_2 T_1, V_2 T_2, V_2 T_3 were found to be as 4.29, 4.55, 4.57, 4.32, 4.59 and 4.65 respectively for corresponding quality attributes.

Significant difference was observed in colour attribute between the varieties at its corresponding temperature levels. shrinkage, one of the osmotic characterisation causes the soft flesh type samples to be scored less than the firm flesh type samples. However no significant difference was observed in other attributes like apperance, falvour, taste and texture between the varieties at its corresponding temperature levels. While considering the over all acceptability, no significant difference was observed between the two varieties at its corresponding temperature levels.Present study confirm that a higher temperature of pretreatment is more suitable than the lower temperature pretreatment, for drying Jack fruit. This is contradictory to the earlier findings. Hough *et al.* (1993) reported that temperature of 45°C was suitable for developing osmotically dehydrated products using apple slices but Kanawadi and Maharaj (1993) suggested a temperature of 60°C-90°C for dehydration peas.

Two different sugar concentration 60° Brix and 70° Brix was tried to treat Jack fruits before drying and the results are presented in Table 31. Lein (1987) found that the sugar solution was an effective agent, for reducing the drying process and in the connection, it was also reported by Lein (1987) that glucose, sucrose and fructose were the different sugars used as osmotic agents and type of the sugar solution did not noticeably affect the acceptance of the product.

Table 31 Organoleptic qualities of the dried products as influenced by the sugar concentration

Concen-trations	Appearance	Flavour	Colour	Taste	Texture	Overall accept-ability
C_1	4.55	4.60	3.62	4.56	4.61	4.53
C_2	4.40	4.51	3.55	4.46	4.63	4.46
CD	0.060	0.060	0.061	0.073	-	0.060

As revealed in the Table 31, samples treated at 60° Brix solution secured the scores of 4.55, 4.60, 3.62, 4.56 and 4.61 respectively for quality attributes like appearance, flavour, colour, taste and texture where as sample treated at 70° Brix sugar solution secured the scores of 4.40, 4.51, 3.55, 4.46 and 4.63 respectively. Overall acceptability of the sample treated with 60° Brix and 70° Brix sugar concentration was found to be

4.53 and 4.46 respectively making significant difference in the acceptability of the product.

Significant difference was observed in flavour between the samples treated with different sugar concentration and it was found that sample treated with 60° Brix retained more flavour in samples than in 70° Brix sugar solution.

In colour assessment significant difference was observed between the samples of 60° Brix and 70° Brix but in texture, no significant difference was observed between the samples. When comparing the scores of taste, a significant difference was observed and it can be pointed out that samples treated at 60° Brix retained better taste than the samples treated at 70° Brix.

While considering the overall acceptability significant difference was observed between the samples of 60° Brix and 70° Brix but Scmoggi *et al.* (1986) suggested 60-70 Brix sucrose concentration solution for drying fruits.

Table 32 gives the interaction effect of sugar concentration and varieties.

Table 32 depicts that V_1 C_1 secured the scores of 4.54, 4.60, 3.57, 4.60 and 4.62 respectively for quality attributes like appearance, flavour, colour, taste and texture where as V_2 C_1 secured the scores of 4.56, 4.60, 3.66, 4.53 and 4.59 respectively.

Table 32 Interaction effect of variety and concentrations of Osmotic solution on organoleptic qualities

Treatment combinations	Appearance	Flavour	Colour	Taste	Texture	Overall accept-ability
V_1 C_1	4.54	4.60	3.57	4.60	4.62	4.53
V_1 C_2	4.28	4.46	3.66	4.43	4.68	4.41
V_2 C_1	4.56	4.60	4.66	4.53	4.59	4.54
V_2 C_2	4.52	4.57	4.44	4.48	4.58	4.50
CD	0.090	0.080	0.070	0.103	0.103	0.051

Treatment combination V_1 C_2 secured the scores of 4.28, 4.46, 3.66, 4.43 and 4.68 respectively for the same where as V_2 C_2 secured the scores 4.52, 4.57, 3.44, 4.48 and 4.58 respectively.

No significant difference was observed in between the two variety samples that treated in 60° Brix sugar concentration in different attribute except in colour but significant difference was observed in between the varieties that treated in 70° Brix sugar concentration in attributes like apperance and flavour.

From the above results it can be concluded that the samples treated with the preservative sodium metabisulphate along with 20 per cent glycerol showed highest acceptability with respect to apperance, flavour, colour, taste and texture. Samples treated with sodium metabisulphate along with 15 per cent glycerol also gave satisfactory product.

Taking into consideration of the varietial difference, firm flesh samples showed higher scores than soft flesh samples at different preservative levels. Different immersion time proposed in the study indicated that samples immersed for 60 minutes secured better scores in quality attributes than the samples immersed for 30 minutes.

No significant difference was observed in quality attributes like apperance, flavour, taste and texture between the two varities at its corresponding temperature levels except in colour attribute. Firm flesh samples retained better colour than soft flesh samples in different treatments. The present study also revealed that a higher temperature (70°C) is more suitable than the lower temperature as pre treatment in two varieties of jack fruit before drying.

On assessing the different sugar concentration levels proposed (60° Brix and 70° Brix) in the study, samples treated with 60° Brix sugar concentration retained better sensorial characters than samples treated with 70° Brix. In over all acceptability samples treated with 60° Brix secured better score, indicating 60° Brix concentration can be suggested for drying jack fruit.

While assessing the interaction effect of varieties and treatments, firm flesh samples scored better than soft flesh samples in all the pre treatments applied.

Treatment of 70° Brix sugar concentration, heated at 50°C and immersed for 30 minutes along with the preservative sodium metabisulphate (0.4 per cent) and 20 per cent glycerol was adjudged to be the best treatment among the various treatments proposed in the present study for drying jack frut.

4.3.2 Changes in the organoleptic qualities of the products during storage

According to Nabtisi and Movoghan (1989), fruits and vegetables could be dehydrated to produce crispy but tender puffed food products having the colour and appearance of the original. Perishability of dehydrated foods, inspite of the presence of a large number of spoilage organisms, is prevented naturally, because of their low moisture content (Fraizer *et al*, 1978).

During storage of dehydrated fruits, the first indiscribable change that occur in the product is change in colour than in flavour Nuri (1962). According to Angela *et al*.(1987) dehydrated blue berry products had a good texture, flavour and overall acceptability and a shelf life of 16 - 64 months based on the storage temperature. Vegetable dehydrated to yield vegetable curry mix had found to have a shelf life of about 18 months under ambient condition as reported in Food packer (1990).

Changes in sensory characteristics of Mango bars during 90 days of storage at different temperature, was studied by Mir and

Nath (1993). The study indicated that storage decreased overall acceptability of the product. .

Table 33 Effect of storage on organoleptic qualities with respect to variety

Quality attributes		Storage period in months 1	2	3	4	5
Appearance	V_1	4.41	4.13	3.88	3.56	3.30
	V_2	4.54	4.19	3.77	3.33	2.89
CD		0.060	-	0.064	0.065	0.073
Flavour	V_1	4.11	4.11	3.91	3.52	3.14
	V_2	4.26	4.26	3.77	3.31	2.89
CD		0.060	0.057	0.057	0.069	0.072
Colour	V_1	3.61	3.95	3.61	3.27	2.98
	V_2	3.55	3.98	3.55	3.14	2.74
CD		0.061	-	0.057	0.061	0.066
Taste	V_1	4.52	4.07	3.83	3.38	3.04
	V_2	4.51	4.16	3.73	3.36	2.88
CD		0.061	0.057	0.066	-	0.068
Texture	V_1	4.59	4.36	4.09	3.72	3.46
	V_2	4.65	4.24	3.99	3.63	3.34
CD		0.082	0.062	0.056	0.072	0.066
Overall acceptability	V_1	4.47	4.12	3.86	3.49	3.18
	V_2	4.52	4.17	3.76	3.35	2.94
CD		0.036	0.030	0.030	0.032	0.032

Table 33 depicts the mean scores obtained for different quality attributes in dried jackfruit products during its storage period.

Mean scores obtained for the overall acceptability attribute in V_1 was found to be as 4.47, 4.12, 3.86, 3.49 and 2.18 respectively during storage as against was 4.52, 4.17, 4.76, 3.35, 2.94 in V_2.

From the Table 33 it is evident that there was a significant difference between the soft flesh type samples (V_1) and firm flesh samples (V_2) in quality attributes except in colour throughout the storage period and in colour evaluation, no significant difference observed in first three months but significant difference was observed in the following two months. Firm flesh samples were found to be superior than soft flesh type samples in all the attributes through out the storage period. According to Ambadan (1986) jack fruit halwa prepared out of the two varieties (varikka and kuzha) varikka variety was found to yield good quality products.

Statistical analysis further revealed that no noticeable difference was observed in mean score values between Consecutive months but notable difference was observed in mean scores in the initial stage and in the fifth month. However all attribute scores decreased with the storage period.

Table 34 depicts the mean scores of different quality attributes obtained for the products that are treated with different preservative levels.

Table 34 Effect of storage on organoleptic qualities with respect to preservatives

Quality attributes		Storage period in months 1	2	3	4	5
Appearance	P_1	4.36	4.03	3.63	3.28	2.86
	P_2	4.37	4.03	3.77	3.35	2.91
	P_3	4.70	4.41	4.07	3.70	3.51
CD		0.080	0.074	0.079	0.080	0.073
Flavour	P_1	4.05	4.05	3.74	3.26	2.74
	P_2	4.08	4.08	3.71	3.29	2.79
	P_3	4.43	4.43	4.07	3.69	3.51
CD		0.070	0.070	0.070	0.084	0.088
Colour	P_1	3.35	3.78	3.35	2.96	2.58
	P_2	3.41	3.82	3.41	3.02	2.66
	P_3	3.99	3.29	3.99	3.63	3.51
CD		0.070	0.072	0.070	0.074	0.081
Taste	P_1	4.46	4.01	3.65	3.21	2.68
	P_2	4.45	3.97	3.60	3.17	2.78
	P_3	4.63	4.37	4.07	3.72	3.43
CD		0.090	0.070	0.080	0.083	0.083
Texture	P_1	4.58	4.16	4.01	3.63	3.31
	P_2	4.63	4.23	4.00	3.59	3.28
	P_3	4.65	4.51	4.10	3.80	4.60
CD		-	0.076	0.068	0.088	0.081
Over all Accepat-ability	P_1	4.44	4.01	3.68	3.27	2.81
	P_2	4.45	4.03	3.70	3.28	2.88
	P_3	4.60	4.40	4.06	3.71	3.50
CD		0.036	0.036	0.036	0.039	0.040

Organoleptic evaluation of products during storage period, revealed that the treatments P_1, P_2, P_3 secured mean scores of 4.44, 4.45 and 4.60 respectively during the first month and in the final or 5th month scores were 2.81, 2.88 and 3.50 respectively, for its overall acceptability. Statistical analysis clearly indicates that only low difference in scores (0.10) between the two consecutive months. But comparatively higher difference in scores (0.24) was observed between the first and final month of storage period.

Significant difference was observed between the samples treated with different levels of preservatives throughout the storage period in all quality attributes and it can be pointed out that samples treated at P_3 level were superior than those treated with other two levels. It can be observed from the Table that score reduced with the storage period. In contrast to the above finding Sharma *et al.* (1992) observed that osmo-dehydrated litchies dipped in 1000 ppm for So_2 solution for 5 minute maintained better colour, flavour and texture for more than one year against the conventionally dried products.

In Table 35 the interaction effect of varieties and preservatives on organoleptic qualities during storage is given.

During the first month, the values obtained for treatement combinations V_1 P_1, V_1 P_2, V_1 P_3. V_2 P_1, V_2 P_3, were 4.37, 4.43, 4.59, 4.50, 4.47, 4.61 respectively and during fifth month the

Table 35 Interaction effect of varieties and preservatives on organoleptic qualities during storage.

Quality attributes		Storage period in months 1	2	3	4	5	Quality attributes		Storage period in months 1	2	3	4	5
Appearance	V_1P_1	4.23	3.91	3.58	3.37	3.05	Taste	V_1P_1	4.48	4.01	3.72	3.21	2.86
	V_1P_2	4.34	3.92	3.78	3.42	3.13		V_1P_2	4.45	3.97	3.78	3.26	2.97
	V_1P_3	4.67	4.56	4.28	3.89	3.72		V_1P_3	4.63	4.23	3.98	3.67	3.31
	V_2P_1	4.49	4.15	3.69	3.20	2.68		V_2P_1	4.44	4.02	3.58	3.21	2.49
	V_2P_2	4.39	4.14	3.76	3.58	3.48		V_2P_2	4.45	3.97	3.43	3.08	2.58
	V_2P_3	4.73	4.27	3.85	3.52	3.31		V_2P_3	4.63	4.51	4.15	3:78	3.56
CD		0.108	0.104	0.111	0.113	0.127	CD		0.127	0.099	0.114	0.118	0.117
Flavour	V_1P_1	3.99	3.99	3.81	3.38	2.92	Texture	V_1P_1	4.57	4.16	4.00	3.58	3.27
	V_1P_2	3.98	3.98	3.84	4.22	2.99		V_1P_2	4.69	4.42	4.07	3.68	3.38
	V_1P_3	4.36	4.36	4.07	4.76	3.50		V_1P_3	4.70	4.52	4.19	3.91	3.73
	V_2P_1	4.12	4.12	3.68	3.55	2.56		V_2P_1	4.60	4.17	4.03	3.68	3.35
	V_2P_2	4.18	4.18	4.58	4.16	2.58		V_2P_2	4.56	4.05	3.94	3.51	3.19
	V_2P_3	4.19	4.49	4.07	3.63	3.53		V_2P_3	4.60	4.50	4.01	3.70	3.48
CD		0.105	0.070	0.099	0.119	0.125	CD		0.126	0.107	0.096	0.124	0.114
Colour	V_1P_1	3.24	3.68	3.24	2.96	2.56	Overall acceptability	V_1P_1	4.37	3.95	3.67	3.30	2.93
	V_1P_2	3.66	3.90	3.66	3.23	2.94		V_1P_2	4.43	4.04	3.82	3.40	3.35
	V_1P_3	3.94	4.27	3.94	2.62	3.45		V_1P_3	4.59	4.39	4.10	3.68	3.53
	V_2P_1	3.46	3.88	3.46	2.97	2.41		V_2P_1	4.50	4.06	3.78	3.24	2.70
	V_2P_2	3.16	3.73	3.16	2.80	2.38		V_2P_2	4.47	4.01	3.85	3.45	3.38
	V_2P_3	4.03	4.32	4.03	3.64	3.43		V_2P_3	4.61	4.42	4.05	3.77	3.54
CD		0.100	0.102	0.098	0.105	0.114	CD		0.063	0.051	0.052	0.055	0.50

values were 2.93 3.35, 3.53, 2.70, 3.38 and 3.54 respectively for the over all acceptability.

It is evident that the significant difference was observed in appearance between two varieties at its corresponding preservative levels during storage period. Both variety that treated, without any glycerol level secured low scores in each month. It may be due to the dark brown colour appeared in the samples which was more intense than in the plain dried samples. Rao (1976) reported that the rate of browning was inversely proportional to So_2 Concentrations in the dried material and Soleha (1991) reported that glycerol retained more So_2 in sample during storage.

In flavour evaluation, significant difference was observed in varieties, that treated with zero glycerol level but no significant difference was observed in the sample that treated with 15 and 20 per cent glycerol level. Low scores obtained for samples of both varieties, that treated with zero glycerol level may be due to the dark colour change observed in samples which indirectly influence flavour evaluation.

Colour preference was found to be significantly affected in the varieties that treated with different glycerol levels. Significant difference was observed in firm flesh type (V_2) and soft flesh type (V_1) with each different levels of preservatives Low scores were obtained by the samples of both vareities, treated without any glycerol. Soleha (1991) had reported, that preservative-glycerol affect the colour of the products.

In taste evaluation of each month, no significant difference was observed between two varieties, V_2 and V_1 at its corresponding preservative levels. Similarly no significant difference was observed in texture between the varieties treated without any glycerol but significant difference was observed between the samples of V_1 and V_2 at 15 and 20 per cent glycerol levels.

In overall acceptability, significant difference was observed only between the V_1 and V_2 samples, without treated with glycerol.

Bhatia *et al.* as early as in (1958) found that Jack fruit which had given blanching and sulphiting prior to drying, produced products of good colour and storage life. There was notable difference in the mean scores obtained for all the attributes in the initial stages and during fifth month of evaluation and hence it can be stated that there was a linear and steady decrease in over all acceptability in dried jackfrut products.

Table 36 depicts the effect of storage on organoleptic qualities with respect to immersion time.

Table 36 Effect of storage on organoleptic qualities with respect to immersion time

Quality attributes		Storage period in months 1	2	3	4	5
Appearance	I_1	4.46	4.13	3.79	3.35	2.98
	I_2	4.49	4.19	3.86	3.54	3.21
CD		-	0.060	0.064	0.065	0.073
Flavour	I_1	4.27	4.27	3.91	3.45	3.00
	I_2	4.10	4.10	3.78	3.38	3.00
CD		0.067	0.057	0.057	-	-
Colour	I_1	3.56	4.01	3.56	3.21	2.84
	I_2	3.60	3.91	3.60	3.20	2.88
CD		0.010	-	-	-	-
Taste	I_1	4.54	4.14	3.78	3.40	2.93
	I_2	4.49	4.09	3.77	3.34	2.99
CD		0.060	0.057	-	-	-
Texture	I_1	4.64	4.34	4.05	3.71	3.43
	I_2	4.60	4.27	4.03	3.64	3.37
CD		-	0.062	-	-	-
Overall acceptability	I_1	4.52	4.18	3.82	3.42	3.04
	I_2	4.47	4.11	3.81	3.42	3.10
CD		0.036	0.030	-	-	0.032

During the first month of over all acceptability the values obtained for treatments I_1 and I_2 were 4.52 and 4.47 respectively where as in the fifth month the value for I_1 and I_2 were 3.04 and 3.10 respectively. No significant difference was observed in apperance in the first month of shelflife but in the case of flavour attribute significant difference was observed in first three months of shelflife. In colour attribute, significant difference was observed in first two months of its shelflife. No significant difference was observed between the samples dipped in different immersion period in taste and texture attributes.

Comparing the value of scores for over all acceptability there was only a slight change between the scores obtained for two consecutive months but there was a difference in the value obtained for each attribute in the first and fifth month in organoleptic qualities.

In Table 37, the interaction effect of time of immersion and varieties on organoleptic qualities during storage is presented.

During the first month, in over all acceptability assessment the values obtained for the treatment combinations V_1I_1, V_1I_2, V_2I_1, V_2I_2 were 4.46, 4.58, 4.59 and 4.45 respectively where as in the fifth month the values obtained were 3.15, 3.22, 2.92 and 2.98 respectively.

Significant difference was observed in appearance between the two different varieties that immersed for 30 minutes and for 60 minutes during its storage Period. But in flavour evaluation no significant difference was observed in first months of its storage period.

Table 37 Interaction effect of varieties and time of immersion on organoleptic qualities during storage.

Quality attributes		Storage period in months 1	2	3	4	5	Quality attributes		Storage period in months 1	2	3	4	5
Appearance	V_1I_1	4.47	4.05	3.86	3.46	3.20	Taste	V_1I_1	4.53	4.08	3.85	3.43	3.09
	V_1I_2	4.36	4.21	3.90	3.66	3.40		V_1I_2	4.51	4.06	3.80	3.32	2.99
	V_2I_1	4.56	4.20	3.72	3.24	2.76		V_2I_1	4.57	4.21	3.71	3.36	2.77
	V_2I_2	4.51	4.17	3.81	3.42	3.02		V_2I_2	4.44	4.12	3.73	3.35	2.99
CD		0.088	0.085	0.091	0.092	0.103	CD		0.103	0.081	0.093	0.096	0.096
Flavour	V_1I_1	4.68	4.11	3.93	3.56	3.11	Texture	V_1I_1	4.65	4.40	4.09	3.79	3.47
	V_1I_2	4.51	4.18	3.88	3.47	3.17		V_1I_2	4.54	4.54	4.34	3.71	3.44
	V_2I_1	4.70	4.43	3.78	3.33	2.89		V_2I_1	4.66	4.27	4.00	3.69	3.38
	V_2I_2	4.47	4.09	3.67	3.29	2.89		V_2I_2	4.63	4.21	3.98	3.57	3.30
CD		0.090	0.081	0.081	0.097	0.102	CD		0.103	0.087	0.079	0.101	0.095
Colour	V_1I_1	3.56	3.93	3.58	3.22	2.89	Overall acceptability	V_1I_1	4.46	4.11	3.86	3.48	3.15
	V_1I_2	3.54	3.97	3.65	3.32	3.07		V_1I_2	4.58	4.13	3.86	3.50	3.22
	V_2I_1	3.65	3.59	3.54	3.19	2.79		V_2I_1	4.59	4.24	3.77	3.38	2.92
	V_2I_2	3.58	3.86	3.56	3.08	2.68		V_2I_2	4.45	4.09	3.75	3.34	2.98
CD		0.103	0.083	0.093	0.086	0.093	CD		0.051	0.042	0.042	0.045	0.046

In colour and taste evaluation no significant difference was observed between the treatment combinations V_1I_1 and V_2I_1 and between the V_2I_1 and V_2I_2 throughout the storage period.

Similarly in texture evaluation, no significant difference was observed between the treatment combinations V_1I_2 and V_2I_2 in the first month but there was significant difference betwen these treatments through out the storage period.

With regards to over all accepatbility, significant difference was observed between the varieties treated at different immersion levels.

Table 38 presents the effect of storage on organoleptic qualities with respect to temperature.

During the first month in over all acceptabilitty, scores obtained for treatments T_1, T_2 and T_3 were 4.31, 4.57 and 4.61 respectively. Similarly in the fifth month the values obtained were 2.92, 3.17 and 3.17 respectively.

Significant difference was observed between the dried fruit products that are unheated and heated at 50°C with respect to all attributes and the difference was maintained through out the storage period. However no significant difference was observed between the products that treated at 50°C and that with 70°C.

Table 38 clearly indicate that products treated at 50°C heated sugar solution secured more scores than the products

Table 38 Effect of storage Organoleptic qualities with respect to temperature

Quality attributes		Storage period in months 1	2	3	4	5	Quality attributes		Storage period in months 1	2	3	4	5
	T_1	4.19	3.84	3.51	3.14	2.87		T_1	4.37	3.99	3.64	3.28	2.91
Appearance	T_2	4.61	4.32	4.00	3.63	3.23		T_2	4.56	4.28	3.87	3.39	2.92
	T_3	4.62	4.31	3.96	3.56	3.19	Taste	T_3	4.60	4.21	3.81	3.43	3.05
CD		0.080	0.074	0.079	0.080	0.089	CD		0.090	0.070	0.080	0.083	0.083
	T_1	4.42	4.06	3.65	3.24	2.90		T_1	4.60	4.26	4.04	3.65	3.38
Flavour	T_2	4.63	4.23	3.93	3.53	3.12		T_2	4.64	4.35	4.04	3.68	3.39
	T_3	4.62	4.27	3.95	3.47	3.03	Texture	T_3	4.63	4.32	4.04	3.68	3.45
CD		0.070	0.070	0.070	0.084	0.088	CD		0.052	0.076	-	-	0.042
	T_1	3.24	3.63	3.24	2.90	2.55		T_1	4.31	3.96	3.61	3.24	2.92
Colour	T_2	3.64	4.01	3.64	3.45	2.89	Overall acceptability	T_2	4.57	4.21	3.89	3.50	3.17
	T_3	3.87	4.24	3.86	3.26	3.14		T_3	4.61	4.26	3.92	3.52	3.17
CD		0.074	0.059	0.070	0.074	0.081			0.045	0.038	0.036	0.039	0.040

immersed in 70°C heated sugar solution. The loss of membrane integrity due to heating in the cause of poor Osmotic behaviour of the products that treated at 70°C.

In Table 39 the interaction effect of temperature and variety on organoleptic qualities during storage period is presented.

During the first month of overall acceptability assessment the values obtained for the treatment combinations V_1T_1, V_1T_2, V_2T_1, V_2T_2 and V_2T_3 were 4.29, 4.60, 4.32, 4.59 and 4.65 respectively, similarly in fifth month the values obtained were 3.08, 3.22, 3.26, 2.77, 3.00 and 3.08 respectively.

Significant difference was observed in appearance between the varieties at its corresponding temperature through out the storage period. Firm flesh type samples secured more scores than soft flesh samples through out the storage period.

However no significant difference was observed in flavour attribute between the two varieties of jack fruits at the corresponding temperature through out the storage period. In colour attribute, significant difference was observed between the sample at Corresponding temperature throughout the storage period. According to Videl *et al.* (1990) temperature above 50°C causes internal browning in the apple rings and also a loss of the fruity flavour. No significant difference was observed in taste and in texture between the fruit samples at corresponding

Table 39 Interaction effect of varieties and temperatute on organoleptic qualities during storage

Quality attributes		Storage period in months 1	2	3	4	5	Qiality attributes		Storage period in months 1	2	3	4	5
Appearance	V_1T_1	4.13	3.95	3.65	2.97	2.62	Taste	V_1T_1	3.30	3.98	3.62	3.27	2.98
	V_1T_2	4.55	4.20	4.02	3.72	3.08		V_1T_2	4.53	4.23	3.90	3.34	3.18
	V_1T_3	4.56	4.13	3.84	3.64	3.41		V_1T_3	4.59	4.20	3.81	3.43	3.40
	V_2T_1	4.26	4.73	3.37	3.32	3.12		V_2T_1	4.33	3.98	3.66	3.29	3.00
	V_2T_2	4.67	4.34	3.98	3.54	3.38		V_2T_2	4.54	4.23	3.70	3.43	3.24
	V_2T_3	4.68	4.39	3.96	3.48	2.97		V_2T_3	4.65	4.28	3.92	3.43	3.41
CD		0.108	0.104	0.111	0.113	0.127	CD		0.090	0.099	0.114	0.118	0.117
Flavour	V_1T_1	4.39	4.07	3.49	3.43	3.08	Texture	V_1T_1	4.63	4.49	4.38	3.01	2.88
	V_1T_2	4.62	4.13	3.96	3.64	3.24		V_1T_2	4.61	4.60	4.58	3.77	3.44
	V_1T_3	4.58	4.39	3.93	3.48	3.08		V_1T_3	4.53	4.50	4.48	3.59	3.58
	V_2T_1	4.45	4.15	3.59	3.45	2.71		V_2T_1	4.61	4.61	4.60	3.71	3.70
	V_2T_2	4.65	4.20	3.99	3.59	2.99		V_2T_2	4.71	4.71	4.68	3.85	3.55
	V_2T_3	4.65	4.44	3.97	3.46	2.97		V_2T_3	4.63	4.61	4.60	3.71	3.70
CD		0.116	0.099	0.099	0.119	0.125	CD		0.116	0.104	0.096	0.124	0.114
Colour	V_1T_1	3.88	3.65	3.31	3.73	3.35	Overall acceptability	V_1T_1	4.29	4.01	3.70	3.35	3.08
	V_1T_2	4.31	3.96	3.60	3.25	2.82		V_1T_2	4.55	4.20	3.92	3.56	3.22
	V_1T_3	4.53	4.24	3.93	3.48	3.05		V_1T_3	4.60	4.19	3.96	3.55	3.26
	V_2T_1	4.03	3.72	3.17	3.08	2.78		V_2T_1	4.32	4.04	3.75	3.13	2.77
	V_2T_2	4.48	4.07	3.70	2.37	2.96		V_2T_2	4.59	4.25	3.87	3.44	3.00
	V_2T_3	4.64	4.35	3.80	3.52	3.21		V_2T_3	4.65	4.31	3.99	3.49	3.08
CD		0.105	0.102	0.098	0.105	0.114	CD		0.063	0.051	0.052	0.055	0.056

temperature throughout the storage period. From the Table 39 is also evident that scores of all attributes decreased with storage period.

Table 40 Effect of storage on organoleptic qualities with respect to sugar concentration

Quality attributes		Storage period in months 1	2	3	4	5
Appearance	C_1	4.55	4.26	3.92	3.58	3.25
	C_2	4.40	4.05	3.73	3.31	2.94
CD		0.062	0.060	0.064	0.065	0.073
Falvour	C_1	4.60	4.22	3.88	3.51	3.08
	C_2	4.51	4.15	3.80	3.32	2.94
CD		0.067	0.057	0.057	0.069	0.072
Colour	C_1	3.62	4.05	3.62	3.22	2.87
	C2	3.55	3.88	3.55	3.19	2.86
CD		0.061	0.059	0.057	-	-
Taste	C1	4.56	4.11	3.79	3.42	2.94
	C2	4.46	4.12	3.75	3.31	2.99
CD		0.073	-	-	0.068	-
Texture	C1	4.61	4.30	4.03	3.66	3.38
	C2	4.63	4.30	4.05	3.69	3.42
CD		-	-	-	-	-
Overall acceptability	C1	4.53	4.19	3.85	3.48	3.10
	C2	4.46	4.10	3.78	3.36	3.03
CD		0.060	0.030	0.030	0.032	0.032

Table 40 depicts the effect of storage on organoleptic qualities with respect to sugar concentration is given.

During the first month in over all acceptability attribute, the values obtained for C_1 and C_2 were 4.53 and 4.46 respectively. Similarly in the fifth month the values obained were 3.10 and 3.03 respectively

Significant difference was observed in appearance and in flavour between the samples that treated with different sugar concentration solutions throughout the shelf-life period and it was found out that 60°Brix sugar solution retained better apperance and falvour than 70° Brix solution. Increased sugar content in the concentrated fruits produced a sweet flavour in the processed fruit and when dried, they form the candy (Farkas and Lazar, 1969).

On assessment of taste and colour, attribute, a significant difference was observed between the samples treated with 60° Brix and 70° Brix sugar solution. For colour, samples treated with 60° Brix secured more scores but in taste evaluation samples treated with 70° Brix sugar solution secured more scores. This was supported by the studies conducted by Farkar and Lazar 1969) that Osmotically dehydrated products which were more sweeter, ensured a higher quality and had great demand in the market (Lovino *et al.* 1993). In texture evaluation no significant difference was observed between the samples treated with 60° Brix and 70° Brix sugar solution.

While considering the over all acceptability, significant difference was observed between the samples treated with 60° Brix and 70° Brix, through out the storage period. Sample of 60°Brix secured more scores than sample of 70°Brix in each month.

There was a notable difference between the mean scores obtained for the initial stages and in the fourth month as evidenced from the Table 40 and hence it can be concluded that there was a linear and steady decrease in the overall acceptability of the dried jack fruit products with storage.

The interaction effect of sugar concentration and varieties on organoleptic qualities during storage is given in Table 41.

During the first month of assessment, the values obtained for over all acceptability for the treatment combinations V_1C_1, V_1C_2, V_2C_1, V_2C_2 were 4.53, 4.41, 4.54 and 4.50 respectively were as in the fifth month, the values obtained for similar products were 3.18, 3.18, 3.02 and 2.87 respectively.

Significant difference was observed in apperance and in flavour between the two different varieties that treated in 60° Brix and 70°Brix sugar solution, during the storage period.

In colour and taste evaluation, no significant difference was observed between the treatment combinations V_1C_1, and V_2C_1 and between V_2C_1 and V_2C_2 through out the storage period. Similarly in texture evaluation, significant difference was

Table 41 Interaction effect of varieties and sugar concentration on organoleptic qualities during storage period

Quality attributes		Storage period in months 1	2	3	4	5	Quality attributes		Storage period in months 1	2	3	4	5
Appearance	V_1C_1	4.54	4.22	3.99	3.65	3.40	Taste	V_1C_1	4.60	4.06	3.83	3.43	3.07
	V_1C_2	4.28	4.04	3.77	3.47	3.18		V_1C_2	4.43	4.07	3.82	3.33	3.02
	V_2C_1	4.56	4.31	3.84	3.51	3.09		V_2C_1	4.53	4.17	3.76	3.42	3.80
	V_2C_2	4.52	4.07	3.69	3.16	2.68		V_2C_2	4.48	4.16	3.68	3.29	2.96
CD		0.088	0.085	0.091	0.092	0.103	CD		0.050	0.081	0.093	0.096	0.096
Flavour	V_1C_1	4.60	4.08	3.89	3.53	3.13	Texture	V_1C_1	4.62	4.35	4.07	3.69	3.42
	V_1C_2	4.46	4.13	3.93	3.50	3.14		V_1C_2	4.69	4.38	4.10	3.74	3.49
	V_2C_1	4.60	4.36	3.88	3.48	3.03		V_2C_1	4.57	4.26	3.98	3.63	3.34
	V_2C_2	4.57	4.17	3.77	3.14	2.75		V_2C_2	4.58	4.22	4.00	3.53	3.34
CD		0.090	0.081	0.081	0.097	0.102	CD		0.103	0.087	0.079	0.101	0.093
Colour	V_1C_1	3.57	3.99	3.57	3.16	2.89	Overall acceptability	V_1C_1	4.53	4.14	3.85	3.49	3.18
	V_1C_2	3.66	3.91	3.66	3.38	3.08		V_1C_2	4.41	4.11	3.78	3.48	3.18
	V_2C_1	3.66	4.10	3.66	3.27	2.84		V_2C_1	4.54	4.24	3.83	3.46	3.02
	V_2C_2	3.44	3.85	3.44	3.00	2.63		V_2C_2	4.50	4.09	3.70	3.24	2.87
CD		0.103	0.083	0.080	0.086	0.093	CD		0.051	0.042	0.042	0.045	0.046

observed between the treatment combinations V_1C_2 and V_2C_2 through out the storage period.

The present study confirms that dehydrated jack fruit product of two varieties had a shelf life of five month at ambient temperature. It can also be pointed out that jack fruit product of both the varieties remained acceptable with regards to taste, texture, apperance and flavour upto five months though the scores decreased gradually.

Significant difference was observed between the samples treated with different levels of preservative through out the storage period in all the quality attribute. It can be concluded that samples treated as P_3 levels were superior than those treated with other two levels, in shelf life. Significant difference was observed in apperance and in colour, between two varieties at its corresponding preservative levels during the storage period. In flavour evaluation, significant difference was observed in varieties, only in samples that treated with zero glycerol levels but in texture evaluation no significant difference was observed between the varieties treated with out glycerol but in taste evaluation of each month, no significant difference was observed between the two varieties at its corresponding preservative levels. In overall acceptability, significant differnce was observed only in between the V_1 and V_2 samples, without treated with glycerol. Firm flesh samples (V_2)

treated at different levels of preservatives were observed to score better than those treated soft flesh samples (V_1).

Effect of immersion time on the quality attribute during storage indicated no significant difference between the samples immersed for two levels. Significant difference was observed in quality attributes among the varieties treated at different immersion level during storage period.

With regard to the temperature applied for processing two varieties of jack fruit revealed that products heated at 50°C and that with out heating showed significant difference in quality attribute during storage. However no significant difference was observed between the product that treated at 50°C and 70°C.

Impact of sugar concentraticn cn the quality attributes of dried jack fruit product when analysied, found that in all quality attributes expect in texture, significant difference was observed in the samples that treated with different sugar concentration during storage period. It was also revealed that 60° Brix sugar solution retained better appearance, colour and flavour in the dried jackfruit products.

Among the various pre treatments applied in the present study, the samples given the pre treatments 30 minutes immersion time, 60°C temperature, 60° Brix sugar concentration and the preservative sodium metabisulphate (0.4 per cent) along with 20 per cent glycerol, secured better scores than other pre treatments used, through out its storage period though storage decreased the overall acceptability of dried jack fruit products.

4.3.3 Assessment of Consumer acceptance of the dried Jack fruits product

Quality is a degree of excellence and a composite characteristic determining acceptability (Neelofer 1992). According to Kordylas (1991) the overall acceptability depends on the concentration or amount of particular component, the nutritional and other hidden attributes of a food and its palatability or sensory quality. The absence of nutritional qualities and the preference of harmful or toxic ingredients are parameters which are of vital interest to the consumer.

Peterson (1990) pointed out that comparatively large consumer group are generally used to determine consumer reaction. Hence, consumer acceptance was tested, by assessing the quality parameters among fifty consumers.

Consumer acceptance was assessed in terms of quality attribute viz Appearance, flavour, colour, taste and texture. The overall acceptability of the dried Jackfruit samples were assessed with respect to different treatments, to assess the effect of the same on the organoleptic qualities of the products.

The overall acceptability scores obtained for consumer acceptance of dried Jack Fruit products are given in Table 42.

Table 42 Overall acceptability of the products assessed by consumers

Sl. No.	Treatment	Overall acceptability %		Sl. No.	Treatment	Overall acceptability %		Sl. No.	Treatment	Overall acceptability %	
		V_1	V_2			V_1	V_2			V_1	V_2
1	$C_1T_1I_1P_1$	69	70	13	$C_1T_1I_1P_2$	68	66	25	$C_1T_1I_1P_3$	65	66
2	$C_3T_1I_1P_1$	63	69	14	$C_2T_1I_1P_2$	70	71	26	$C_2T_1I_1P_3$	69	70
3	$C_1T_2I_1P_1$	84	86	15	$C_1T_2I_1P_2$	83	84	27	$C_1T_2I_1P_3$	70	71
4	$C_2T_2I_1P_1$	88	89	16	$C_2T_2I_1P_2$	81	82	28	$C_2T_2I_1P_3$	89	87
5	$C_1T_3I_1P_1$	79	80	17	$C_1T_3I_1P_2$	80	80	29	$C_1T_3I_1P_3$	70	70
6	$C_2T_3I_1P_1$	82	85	18	$C_2T_3I_1P_2$	71	72	30	$C_2T_3I_1P_3$	81	83
7	$C_1T_1I_2P_1$	68	71	19	$C_1T_1I_2P_2$	69	70	31	$C_1T_1I_2P_3$	68	69
8	$C_2T_1I_2P_1$	62	68	20	$C_2T_1I_2P_2$	69	67	32	$C_2T_1I_2P_3$	68	69
9	$C_1T_2I_2P_1$	86	88	21	$C_1T_2I_2P_2$	82	81	33	$C_1T_2I_2P_3$	72	74
10	$C_2T_2I_2P_1$	85	87	22	$C_2T_2I_2P_2$	83	84	34	$C_2T_2I_2P_3$	87	88
11	$C_1T_3I_2P_1$	78	81	23	$C_1T_3I_2P_2$	78	80	35	$C_1T_3I_2P_3$	66	69
12	$C_2T_3I_2P_1$	83	82	24	$C_2T_3I_2P_2$	72	74	36	$C_2T_3I_2P_3$	80	83

The percentage scores of overall acceptability obtained for the products ranged between 62 - 89 per cent in soft flesh type samples and 66 - 89 per cent in firm flesh type variety products. Among the different products, 60° Brix sugar treated samples secured a percentage score between 65-86 per cent in soft flesh type as against 66-89 per cent in firm flesh type variety.

Among the different products, 70° Brix sugar treated samples secured a percentage scores between 62-89 in soft flesh variety as against 67 - 89 per cent in firm flesh type variety.

Among the 36 treatments of soft flesh variety products the samples treated with 70 per cent sugar solution, heated to 50°C and immersed in the osmotic solution for 30 minutes with a preservative level 20 per cent glycerol was adjudged to be the best Product with the maximum score of 89 per cent. Where as in firm flesh type, the product with 70 per cent sugar solution heated to 50°C, immersed in the osmotic solution for 30 minutes without any glycerol treatment was proved to be the most acceptable product with the maximum score of 89 per cent.

In both the varieties, maximum score was attained by the samples given higher sugar concentration (70°Brix). The fact that heating of the osmotic solution increases the very process of osmosis and thus the sweetness, may justify the acceptability of the product. In this connection, Beristein *et al.* (1990) reported that the sugar content of the pineapple rings increased by 10 per cent at 50°Brix, by 16 per cent at 60°Brix and by 25 per cent at 70° Brix.

Lowest score (62 per cent) was obtained for the treatment $C_2T_1I_2P_1$ (70° Brix, without heating, 60 minute immersion time and without any glycerol)treatment in soft flesh type variety. In the case of firm flesh type products (Table 43), treatments $C_1T_1I_1P_1$ and $C_1T_1I_1P_2$ scored less (66 per cent) than other treatments. It was clearly noted that low scores obtained by these treatments was due to the temperature of osmotic solutions. Higher acceptance was observed in the firm flesh variety products compared to the soft flesh type.

Assessment of consumer preference of dried Jack fruit products are given in Table 43 and 44.

It depicts that the dried Jackfruit products prepared out of two varieties of Jackfruit were found to be acceptable to majority of the consumers (94 per cent), Since they have given higher scores (80 per cent) for many products however treatments such as $C_1T_1I_1P_1$, $C_1T_1I_2P_1$, $C_1T_1I_1P_2$, $C_1T_1I_2P_2$, $C_1T_1I_1P_3$, $C_1T_1I_2P_3$, $C_2T_1I_1P_1$, $C_2T_1I_2P_1$, $C_2T_1I_1P_2$, $C_2T_1I_2P_2$, $C_2T_1I_1P_3$ and $C_2T_1I_2P_3$ were not found to be of much acceptable for the consumers.

Most of the treatments were found to be acceptable to majority of the consumers (97 per cent) since they gave scores above 60 per cent for all the treatments. However the

Table 43 Assessment of Consumer preference of firm flesh variety products

Overall acceptability Scores (in percentage)	Treatments 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Above 80	3	-	90	96	81	10	1	-	92	15	82	70	7	3	90	90	85	81
60 - 79	92	90	10	4	19	75	89	92	8	80	18	19	85	93	10	9	15	19
Below 60	2	10	-	-	1	15	9	8	-	5	-	11	8	4	-	1	-	-

Overall acceptability scores (in percentage)	Treatments 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Above 80	2	-	80	92	83	-	-	-	80	97	79	78	1	-	80	92	78	79
60 - 79	88	90	20	8	17	98	97	92	20	3	20	20	93	98	19	6	20	19
Below 60	10	10	-	-	-	2	3	6	-	-	1	2	6	2	1	2	2	4

Table 44 Assessment of consumer preference of soft flesh variety products

Overall acceptability Scores (in percentage)	Treatments 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Above 80	3	-	89	94	80	8	90	-	92	13	82	68	7	3	80	68	84	79
60 - 79	90	90	11	6	20	77	10	92	8	82	18	21	85	93	20	11	16	21
Below 60	7	10	-	-	-	15	-	8	-	5	-	11	8	4	-	1	-	-

Overall acceptability scores (in percentage)	Treatments 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Above 80	2	-	85	90	84	80	-	-	80	95	80	76	1	-	79	92	1	77
60 - 79	88	90	15	10	16	18	97	94	20	5	19	22	93	98	20	8	93	19
Below 60	10	10	-	-	-	2	3	6	-	-	1	2	6	2	1	2	6	4

treatments such as $C_1T_2I_2P_1$, $C_1T_2I_1P_1$, $C_2T_2I_2P_1$, $C_2T_2I_1P_3$, $C_2T_2I_2P_3$, were not found to be much acceptable for the consumers, since for these treatments lesser scores (60 per cent) were awarded.

4.4 Assessment of microbial contamination of dried jack fruit products

The microbial damage in a product is brought about by the changes in chemical and physical factors. Among this pH is one of the important factors which determinet the survival and growth of microorganisms during storage. According to Nuri *et al*, (1963) when fruits are dehydrated, the soluble solid contents become great enough and hence they will resist microbial spoilage for fairly extended periods of time.

The products when assessed for microbial contamination during storage period, it was found that all the samples were free from microbial contamination till five months.

The presence of poor flavour and a loss of appetizing appearance indicated the microbial decay in the food by the action of the microorganisms towards the end of fifth month.

On viewing the sample under the microscope at the end of fifth month, the product showed colonies of Aspergillus and Pencillium which confirmed the presence of microbial decay. Analysis of decayed dried pomegranate by Kahtan (1990) showed that the organism responsible were Aspergillus and Pencillium.

Table 45 Cost benefit analysis of the dried Jack Fruit products

Sl. No.	Treatments	Cost V_1	V_2	Sl. No.	Treatments	Cost V_1	V_2	Sl. No.	Treatments	Cost V_1	V_2
1	$C_1T_1I_1P_1$	12.30	16.30	13	$C_1T_1I_1P_2$	12.55	16.55	25	$C_1T_1I_1P_3$	12.80	16.80
2	$C_2T_1I_1P_1$	13.60	17.60	14	$C_2T_1I_1P_2$	13.85	17.85	26	$C_2T_1I_1P_3$	14.10	18.10
3	$C_1T_2I_1P_1$	12.30	16.30	15	$C_1T_2I_1P_2$	12.55	16.55	27	$C_1T_2I_1P_3$	12.80	16.80
4	$C_2T_2I_1P_1$	13.60	17.60	16	$C_2T_2I_1P_2$	13.85	17.85	28	$C_2T_2I_1P_3$	14.10	18.10
5	$C_1T_3I_1P_1$	12.30	16.30	17	$C_1T_3I_1P_2$	12.55	16.55	29	$C_1T_3I_1P_3$	12.80	16.80
6	$C_2T_3I_1P_1$	13.60	17.60	18	$C_2T_3I_1P_2$	13.85	17.85	30	$C_2T_3I_1P_3$	14.10	18.10
7	$C_1T_1I_2P_1$	12.30	16.30	19	$C_1T_1I_2P_2$	12.55	16.55	31	$C_1T_1I_2P_3$	12.80	16.80
8	$C_2T_1I_2P_1$	13.60	17.60	20	$C_2T_1I_2P_2$	13.85	17.85	32	$C_2T_1I_2P_3$	14.10	18.10
9	$C_1T_2I_2P_1$	12.30	16.30	21	$C_1T_2I_2P_2$	12.55	16.55	33	$C_1T_2I_2P_3$	12.80	16.80
10	$C_2T_2I_2P_1$	13.60	17.60	22	$C_2T_2I_2P_2$	13.85	17.85	34	$C_2T_2I_2P_3$	14.10	18.10
11	$C_1T_3I_2P_1$	12.30	16.30	23	$C_1T_3I_2P_2$	12.55	16.55	35	$C_1T_3I_2P_3$	12.80	16.80
12	$C_2T_3I_2P_1$	13.60	17.60	24	$C_2T_3I_2P_3$	13.85	17.85	36	$C_2T_3I_2P_3$	14.10	18.10

Since the product failed to maintain the various organoleptic qualities, the storage study was discontinued.

4.5 Cost benefit analysis of the dried Jackfruit products

Cost benefit analysis was carried out to assess the expenditure to be arised to obtain dehydrated products which are subjected to different treatments. Major determinants of the cost of the products were food materials, (jack fruits, Sugar and preservatives) included, labour charges and fuel expenses.

The cost of the products are presented in Table 45. As seen from the Table the cost of the products with different treatments ranged from Rs. 16.30 to 18.10 per kg in firm flesh type samples where as in soft flesh type samples, the cost ranged between Rs. 12.30 to 14.10 per kg. Cost difference is mainly attributed to the higher cost of firm flesh type variety. Not much variation was observed in the cost of the products between the treatments in both the varieties.

From the above observations and findings the developed fruit product is found to be low cost and nutritious. More over it is easy to prepare at home and has got a good shelf life of five months. Since dried jack fruit products of both varieties are accepted by the majority of the consumers, it can be recommended for consumption.

SUMMARY

SUMMARY

The study entitled "Suitability of Osmotic drying technique for product development in Jackfruit *Artocarpus hetrophyllus lam*" is a comprehensive study aimed at standardisation of Osmotic drying technique for product development in Jackfruit varieties and its evaluation on organoleptic and shelf-life qualities.

Results of the study indicated that weightloss of the products were found to be 7.0 to 15.7 per cent in firm and in soft flesh varieties of jack fruit. The effect of pretreatment on weightloss indicated that percentage of weightloss increased with increase in sugar concentration, temperature and immersion time. It was also observed that preservatives used has no effect on percentage of weightloss in jack fruit products.

Moisture level of the products ranged between 9.0 to 9.6 per cent in soft flesh variety and 8.7 to 9.6 per cent in firm flesh variety The effect of pretreatments on moisture less indicated that preservatives, sucrose concentration, temperature and immersion time had not found to influence the moisture levels in the final products. It was also observed that there was no significant difference in the moisture content and weight loss between the two varieties of Jack fruit.

The time taken for drying the differently treated products of both varieties ranged between 42 to 58 hours. It was also observed that among the various treatments, samples treated with

70° Brix, the highest of sugar concentration used was found to take the least time (42 hours) for drying. It was also noted that unheated samples required more drying time (58 hours) than treated samples (54 hours).

Assessment of chemical components indicated that in fresh Jack fruit the acidity was 2.34g in soft flesh samples and 2.32 in firm fresh samples where as in dried samples, acidity was reduced to 0.48g and 0.43g respectively.

Reducing sugar content of fresh Jack fruit was 4.39g in soft flesh samples and 4.40 in firm flesh samples, where as it was reduced to 1.52 and 1.54 respectively in dried samples. The vitamin C content of fresh Jack fruit was 7mg in both varieties where as in dried products, vitamin C was reduced to traces.

Effect of pretreatments on the chemical constituents indicates that among the different treatments proposed samples treated with 20 per cent glycerol level (P_3), 30 minute immersion time (I_1), 60°Brix and 0°C temperature had secured higher acidic values than other treatments applied. It was also observed that firm flesh samples were less acidic than soft flesh samples, but there was no significant difference between the two varieties in acidity content. During storage, acidity was found to decrease in the dried Jack fruit products.

On evaluation of reducing sugar content of the differently treated samples indicated that , samples treated with 60 minute immersion time (I_2), 70°C temperatures (T_2) and 70°Brix sugar concentration was found to influence the reducing sugar content of the dried products. It was also noted that firm flesh samples (V_2) had more reducing content than soft flesh samples (V_1). Storage was found to positively influence the reducing sugar level of the dried Jack fruit products.

Assessment of the organoleptic qualities of the dried Jack fruit products revealed that samples treated with the preservative sodium metabisulphate along with 20 per cent glycerol showed highest acceptability with respect to appearance, flavour, colour, taste and texture.

Taking into consideration of the varietal difference, firm flesh samples showed higher scores than soft flesh samples at different preservative levels and it was observed that samples immersed for 30 minutes secured better scores in quality attributes than the samples immersed for 60 minutes.

Effect of the temperature on the quality of products indicated that a higher temperature (70°C) is more suitable than the lower temperature for pretreatments in two varieties of Jackfruits before drying. Significant difference was observed only in colour attributes between two varieties at its corresponding temperature levels. Firm flesh samples retained better colour than soft flesh samples in different treatments.

Impact of different sugar concentration tried (60°Brix and 70°Brix) in the study revealed that samples treated with 60°Brix sugar concentration retained better appearance, colour and texture.

Results of the present study proved that dried Jackfruit products of two varieties had a shelf life of five months at ambient temperature after which microbial infestation was detected in the sample. The products of both the varieties remained acceptable with regard to taste, texture, appearance and flavour up to five months though the scores decreased gradually.

Impact of pretreatments on changes in the quality parameters depicted a significant difference in samples treated at different preservative levels (P_2 and P_3) throughout the storage period in all quality attributes. It can be concluded that samples treated with sodium metabisulphate (0.4 per cent) and 20 per cent glycerol (P_3 level) were superior than those treated with other two levels, in shelf life.

Effect of immersion time on the quality attribute during storage indicated no significant difference between the samples immersed at different periods during its storage period.

Effect of temperature on the shelf life qualities showed a significant difference in samples between heated and unheated. However, no significant difference was observed between the products that treated at 50°C and 70°C.

Impact of sugar concentration on shelf life of dried Jackfruit product when analyzed, revealed that samples treated with 60°Brix sugar solution retained better organoleptic qualities than the samples treated with 70°Brix sugar solution.

Among the various pretreatments applied in the present study, the pretreatment 30 minute immersion time, 70° temperature, 60°Brix sugar concentration and a preservative (sodium metabisulphate (0.4 per cent) along with 20 per cent glycerol) proved to the best treatment for the quality retention in the stored jackfruit products though storage decreased the overall acceptability.

Consumer acceptance of the products revealed that among the thirty-six treatments tried in the study in the soft flesh variety, the samples treated with 70 per cent sugar solution heated to 50°C and immersed in the osmotic solution for 30 minute with preservative level 20 per cent glycerol was adjudged to be the best product with the maximum score of 89 per cent and in firm flesh variety samples given same treatment but without having any glycerol was proved to be the most acceptable product.

Cost of the products of firm flesh samples ranged from Rs.16.30 to 18.10 per kg and in soft flesh samples, it ranged between 12.30 to 14.10 per kg.

From the above observations and findings the developed fruit product is found to be low cost and nutritious. More over it is easy to prepare at home and has got a good shelf life of five months. Since dried jack fruit products of both varieties are accepted by the majority of the consumers, it can be recommended for consumption.

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APPENDICES

APPENDIX I

SPECIMEN EVALUATION CARD FOR COMPOSITE SCORING TEST

Date:

Name:

Time:

Product:

Assign Scores for each sample for various characteristics

Quality attributes	Maximum Score	Code no of samples 1	2	3	4	5
Appearance	5					
Colour	5					
Flavour	5					
Texture	5					
Taste	5					
Totalscore	25					

Comments:

APPENDIX II

Effect of variety on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	15.43**	0.02	0.06	03.06	-	-	11.54**	0.023	0.064	47.20**	0.023	0.085	121.69**	0.026	0.073
2	Flavour	28.46**	0.02	0.06	28.46**	0.021	0.057	21.76**	0.021	0.057	34.56**	0.025	0.069	45.08**	0.026	0.072
3	Colour	04.88**	0.02	0.02	00.69	-	-	4.88*	0.020	0.057	15.65**	0.022	0.061	52.72**	0.024	0.066
4	Taste	00.09	-	-	11.12**	0.021	0.057	9.44**	0.024	0.066	0.41	-	-	23.34**	0.024	0.068
5	Texture	03.21	-	-	15.70**	0.022	0.062	11.04**	0.020	0.056	6.31*	0.026	0.027	11.52**	0.024	0.066
6	Over all acceptability	06.75**	0.013	0.036	07.81**	0.011	0.030	44.85**	0.011	0.030	69.49**	0.012	0.032	205.10**	0.012	0.032
	Chemical characters Acidity	72.00**	-	-	38.77**	-	-	58.91**	-	-	938.00**	-	-	1008.00**	-	-
	Reducing sugar	257.74**	0.004	0.010	0.06	0.083	0.024	-	0.064	0.018	4.46*	0.061	0.017	46879.49**	0.001	0.002
	Moisture (VPITC)	0.11	0.09	0.25												

APPENDIX III

Effect of preservative on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	48.80**	0.03	0.08	139.14**	0.027	0.074	122.77**	0.028	0.079	47.20**	0.023	0.065	256.88**	0.032	0.089
2	Flavour	87.35**	0.03	0.07	134.70**	0.025	0.070	125.75**	0.025	0.070	128.57**	0.030	0.084	370.11**	0.032	0.088
3	Colour	197.31**	0.03	0.07	241.54**	0.026	0.072	384.62*	0.025	0.070	383.45**	0.027	0.074	612.76**	0.029	0.081
4	Taste	18.84**	-	0.09	150.41**	0.025	0.070	154.77**	0.029	0.080	208.80**	0.030	0.083	380.39**	0.030	0.083
5	Texture	2.18	-	-	89.41**	0.027	0.076	9.30**	0.025	0.068	26.16**	0.032	0.088	75.44**	0.029	0.081
6	Over all acceptability	62.82**	0.018	0.045	578.19**	0.013	0.036	530.72**	0.013	0.038	830.83**	0.014	0.039	1399.40**	0.014	0.040
	Chemical characters															
	Acidity	108.00**	-	-	72.00**	-	-	58.91**	-	-	1440.00**	-	-	1224.00**	-	-
	Reducing sugar	0.28	0.005	0.013	1.97	0.010	0.028	1.94	0.078	0.022	2.03	0.074	0.211	4.28*	0.001	0.004

APPENDIX IV

Interaction effect of varieties and preservatives on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	4.86**	0.04	0.11	208.05**	0.038	0.104	185.59**	0.040	0.111	182.27**	0.041	0.113	375.04**	0.046	0.127
2	Flavour	0.82	-	-	164.80**	0.036	0.099	160.57**	0.036	0.099	163.41**	0.119	0.043	424.84**	0.045	0.125
3	Colour	58.20**	0.04	0.10	266.32**	0.037	0.102	519.89**	0.035	0.098	449.35**	0.038	0.105	713.90**	0.041	0.114
4	Taste	18.91**	0.046	0.127	181.93**	0.036	0.099	203.13**	0.041	0.114	220.30	0.116	0.043	476.72**	0.042	0.117
5	Texture	9.14**	0.046	0.120	134.55**	0.039	0.107	29.89**	0.035	0.096	46.49**	0.045	0.124	104.74**	0.041	0.114
6	Over all acceptability	82.84**	0.023	0.063	599.64**	0.018	0.051	629.44**	0.019	0.052	720.99**	0.020	0.055	1667.05**	0.020	0.056
	Chemical characters Acidity	1440.00**	-	-	282.46**	-	-	327.27**	-	-	4538.00**	-	-	4988.00**	-	-
	Reducing sugar	282.81**	0.008	0.018	4.14*	0.0145	0.040	3.83**	0.011	0.031	8.75**	0.010	0.029	4726.57**	0.001	0.005

APPENDIX V

Effect of immersion time on Organoleptic/Chemical characteristics in jack fruit

	Organoleptic qualities	Months														
		I			II			III			IV			V		
Sl. No.	Character	F	SE	CD	F	SE	CD	F	SE	CD	F	SE	CD	F	SE	CD
1	Appearance	0.93	-	-	4.35*	0.02	0.06	4.15*	0.02	0.08	34.39**	0.02	0.07	37.38**	0.03	0.07
2	Flavour	34.87**	0.02	0.08	34.87**	0.02	0.06	20.02**	0.06	0.02	3.83	-	-	0.89	-	-
3	Colour	2.07	-	-	10.49**	0.02	0.06	2.07	-	-	0.03	-	-	0.98	-	-
4	Taste	1.79	-	-	4.00**	0.02	0.06	0.34	-	-	3.82	-	-	2.47	-	-
5	Texture	1.09	-	-	19.51**	0.01	0.03	0.45**	0.01	0.03	-0.06	-	-	13.16**	0.01	0.03
6	Over all acceptability	9.82**	0.013	0.036	19.51**	0.011	0.030	0.045**	0.011	0.030	-0.060	-	-	13.16**	0.012	0.032
	Chemical characters															
	Acidity	396.00**	-	-	72.00**	-	-	288.00**	-	-	2884.00**	-	-	2232.00**	-	-
	Reducing sugar	0.21**	0.004	0.018	1.01	0.083	0.023	1.08	0.084	0.018	1.03	0.081	0.017	38.75*	0.001	0.002

APPENDIX VI

Interaction effect of varieties and immersion time on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	6.41*	0.03	0.08	16.93**	0.031	0.085	16.15**	0.133	0.091	81.71**	0.033	0.092	159.60**	0.037	0.103
2	Flavour	32.86**	0.03	0.08	95.99**	0.029	0.081	49.40**	0.029	0.081	38.60**	0.035	0.097	46.47**	0.037	0.102
3	Colour	1.11	-	-	30.10**	0.030	0.083	8.04**	0.029	0.080	29.17**	0.031	0.088	72.11**	0.034	0.093
4	Taste	5.62*	0.037	0.103	16.66**	0.029	0.081	10.78**	0.033	0.093	5.28	0.035	0.096	48.29**	0.034	0.096
5	Texture	5.73*	0.037	0.103	20.55**	0.032	0.087	11.39**	0.028	0.079	12.02**	0.036	0.101	14.83**	0.034	0.093
6	Over all acceptability	32.96**	0.019	0.051	58.66**	0.015	0.042	45.81**	0.015	0.042	70.77**	0.016	0.045	218.34**	0.017	0.046
	Chemical characters Acidity	720.00**	-	-	127.38**	-	-	288.00**	-	-	3456.00**	-	-	3096.00**	-	-
	Reducing sugar	260.14**	0.005	0.015	2.00	0.010	0.028	1.85	0.091	0.025	6.35*	0.086	0.024	4724.70**	0.001	0.004

APPENDIX VII

Effect of Temperature on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	78.56**	0.03	0.08	217.45**	0.027	0.074	184.86**	0.28	0.079	169.51**	0.029	0.080	75.54**	0.032	0.089
2	Flavour	32.86**	0.03	0.08	85.65**	0.036	0.099	85.39**	0.025	0.070	53.03**	0.030	0.084	24.22**	0.032	0.088
3	Colour	1.11	-	-	30.10**	0.030	0.083	322.91**	0.025	0.070	211.64**	0.027	0.074	204.25**	0.029	0.081
4	Taste	5.82*	0.037	0.103	16.66**	0.029	0.081	35.15**	0.029	0.080	13.85**	0.030	0.083	47.67**	0.042	0.117
5	Texture	5.73*	0.037	0.103	3.09**	0.027	0.076	0.02	-	-	0.57	-	-	1.25**	-	-
6	Over all accepta-bility	210.97**	0.016	0.045	316.94**	0.013	0.036	45.81**	0.042	0.015	326.18**	0.014	0.039	157.85**	0.014	0.040
	Chemical characters															
	Acidity	180.00**	-	-	-	-	-	-13.09	-	-	288.00**	-	-	288.00**	-	-
	Reducing sugar	0.13	0.005	0.013	2.00	0.010	0.029	2.02	0.078	0.022	2.08	0.075	0.021	3.75*	0.001	0.0042

APPENDIX VIII

Interaction effect of varieties and temperature on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
		Months														
1	Appearance	0.02	-	-	281.63**	0.038	0.104	184.86**	0.028	0.078	223.55**	0.081	0.113	202.78**	0.046	0.127
2	Flavour	19.64**	0.03	0.07	85.65**	0.036	0.099	132.30**	0.036	0.099	104.34**	0.043	0.119	77.52**	0.045	0.125
3	Colour	6.48	0.04	0.12	284.10**	0.037	0.012	340.70**	0.035	0.098	257.83**	0.038	0.105	277.16**	0.041	0.114
4	Taste	34.65**	0.046	0.127	58.79**	0.036	0.099	49.61**	0.041	0.114	16.34**	0.043	0.118	47.67**	0.042	0.117
5	Texture	6.54**	0.046	0.128	21.43**	0.039	0.107	11.77**	0.035	0.096	9.07**	0.045	0.124	13.44**	0.041	0.114
6	Over all acceptability	210.97**	0.016	0.045	316.94**	0.013	0.036	340.59**	0.013	0.036	236.18**	0.014	0.039	157.95**	0.014	0.040
	Chemical characters Acidity	252.00**	-	-	72.00**	-	-	78.55**	-	-	1584.00**	-	-	1656.00**	-	-
	Reducing sugar	262.60**	0.006	0.019	4.06	0.014	0.040	3.90*	0.011	0.031	6.43**	0.010	0.029	4699.54**	0.002	0.005

APPENDIX IX

Effect of sugar concentration on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	Months I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	21.41**	0.02	0.06	46.23**	0.022	0.060	33.34**	0.023	0.064	64.70**	0.023	0.065	69.69**	0.026	0.073
2	Flavour	6.14*	0.02	0.06	6.14*	0.021	0.057	8.71**	0.021	0.057	29.18**	0.025	0.069	16.67**	0.026	0.072
3	Colour	5.75	0.02	0.06	31.86**	0.021	0.058	5.75**	0.025	0.057	0.81**	-	-	0.11	-	-
4	Taste	7.99**	0.026	0.073	0.01	-	-	1.55	-	-	10.23**	0.025	0.065	2.10	-	-
5	Texture	0.56	-	-	0.01	-	-	0.61	-	-	0.47**	-	-	1.54	-	-
6	Over all accepta-bility	16.78**	0.013	0.036	35.57**	0.011	0.030	22.97**	0.011	0.030	48.65**	0.012	0.032	19.69**	0.012	0.032
	Chemical characters															
	Acidity	287208.00**	-	-	44407.39**	-	-	52049.66**	-	-	571.968**	-	-	5650.56**	-	-
	Reducing sugar	44.55**	0.004	0.011	2.27	0.083	0.023	-	0.064	0.018	4.20*	0.061	0.017	3920.12**	0.001	0.003

APPENDIX X

Effect of sugar concentration on Organoleptic/Chemical characteristics in jack fruit

Sl. No.	Organoleptic qualities Character	Months I F	I SE	I CD	II F	II SE	II CD	III F	III SE	III CD	IV F	IV SE	IV CD	V F	V SE	V CD
1	Appearance	11.60**	0.03	0.09	50.86**	0.031	0.085	45.92**	0.033	0.091	198.58**	0.037	0.103	118.22**	0.033	0.092
2	Flavour	17.56*	0.03	0.08	52.15**	0.029	0.081	48.82**	0.029	0.081	73.57**	0.037	0.102	83.54**	0.033	0.097
3	Colour	27.81**	0.03	0.08	39.76**	0.021	0.059	38.41**	0.029	0.080	88.12**	0.034	0.093	82.13**	0.031	0.086
4	Taste	10.76**	0.037	0.103	11.21**	0.029	0.081	12.16**	0.093	0.033	34.81**	0.034	0.096	10.74**	0.035	0.096
5	Texture	4.57	0.037	0.103	16.65**	0.032	0.087	11.70**	0.028	0.079	14.22**	0.034	0.093	7.25**	0.036	0.101
6	Over all accepta-bility	27.34**	0.017	0.051	56.12**	0.015	0.042	82.04**	0.015	0.042	158.76**	0.016	0.045	245.10**	0.017	0.046
	Chemical characters															
	Acidity	288396.00**	-	-	44579.08**	-	-	52258.91**	-	-	5740.56**	-	-	567072.00**	-	-
	Reducing sugar	3961.21**	0.005	0.015	2.81	0.011	0.034	1.00	0.090	0.025	9.77**	0.086	0.024	8627.42**	0.001	0.004

ABSTRACT

SUITABILITY OF OSMOTIC DRYING TECHNIQUE FOR PRODUCT DEVELOPMENT IN JACK FRUIT *(Artocarpus herterophyllus Lam)*

by

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ABSTRACT OF THE THESIS

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ABSTRACT

The study entitled "Suitability of Osmotic drying technique for product development in Jackfruit *Artocarpus hetrophyllus lam*" is a comprehensive study aimed at standardisation of Osmotic drying technique for product development in Jackfruit varieties namely soft flesh type and firm flesh type and its evaluation on organoleptic and shelf-life qualities.

Results of the study indicated that weightloss of the products were found to be 7.0 to 15.7 per cent in firm and in soft flesh varieties of jack fruit and moisture loss was accounted to be 9.0 to 9.6 per cent in soft flesh variety and 8.7 to 9.6 per cent in firm flesh variety.

The effect of pretreatment on weightloss and on moisture ~~loss~~ Content indicated that pre treatments like preservative sucrose concentration, temperature and immersion time positively influence the percentage of weightloss, but not found to influence the moisture levels in the final product. It was also observed that there was no significant difference in the moisture content and weight loss between the two varieties of jack fruit.

The time taken for drying the differently treated products of both varieties ranged between 42 to 58 hours. It was also noted that preservative used had no effect on drying time but the samples treated with highest of sugar concentration and temperature used were found to take the least time for drying.

Assessment of chemical components indicated that in fresh Jack fruit the acidity was 2.34g in soft flesh samples and 2.32g in firm fresh samples, and it was reduced to 0.48g and 0.43g respectively in dried samples.

Reducing sugar of fresh jack fruit was 4.39 g in soft flesh samples and 4.40 in firm flesh samples and was reduced to 1.52 and 1.54 respectively in dried samples. The vitamin C content of fresh Jack fruit was 7mg in both varieties where as in dried products, vitamin C was reduced to traces.

It was also noted that firm flesh samples were less acidic than soft flesh samples, but there was no significant difference between the two varieties in acidity content. During storage, acidity was found to decrease in the dried Jack fruit products.

Firm flesh samples had more reducing Sugar content than soft flesh samples. Storage was found to positively influence the reducing sugar level of the dried Jack fruit products.

Assessment of the organoleptic qualities of the dried Jack fruit products revealed that samples treated with the preservative sodium metabisulphate along with 20 per cent glycerol showed highest acceptability with respect to appearance, flavour, colour, taste and texture. Firm flesh samples showed higher scores than soft fresh samples at different preservative levels and it was observed that samples immersed for 30 minutes secured better scores in quality attributes than the samples immersed for 60 minutes.

Effect of the temperature on the quality of products indicated that a temperature of 70°C is more suitable than the lower temperature for pretreatments in two varieties of Jackfruits before drying.

Impact of different sugar concentration tried (60°Brix and 70°Brix) in the study revealed that samples treated with 60°Brix sugar concentration retained better appearance, colour and texture.

The products showed a shelf stability of five months after which microbial infestation was detected in the sample.

Impact of pretreatments on changes in the quality parameters indicated a significant difference in samples treated at different preservative levels through out the storage period in all quality attributes.

Immersion time was not found to affect the quality attributes during storage however temperature influenced the quality attributes during storage. Samples treated with 60°Brix sugar solution retained better organoleptic qualities than the samples treated with 70°Brix sugar solution.

Among the various pretreatments applied in the present study, the pretreatment 60 minute immersion time, 70° temperature, 60°Brix sugar concentration and a preservative (sodium metabisilphate (0.4 per cent) along with 20 per cent glycerol) proved to the best treatment for the quality retention in the stored jackfruit products though storage decreased the overall acceptability.

Consumer acceptance of the products revealed that among the thirty-six treatments tried in the study in the soft flesh variety, the samples treated with 70 per cent sugar solution heated to 50°C and immersed for 30 minutes with preservative level 20 per cent glycerol was adjudged to be the best product but in the firm flesh variety, samples given same treatment but without having any glycerol was proved to be the most acceptable product.

Cost of the products of firm flesh samples ranged from Rs.16.30 to 18.10 per kg and in soft flesh samples, it ranged between 12.30 to 14.10 per kg. Thus dried jack fruit products utilising soft and firm flesh varieties, which are nutritious, affordable and acceptable to the consumer can be prepared for consumption.