QUALITY ANALYSIS OF PAPAYA (CARICA PAPAYA L.) VARIETIES AND PRODUCT DEVELOPMENT

By

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THESIS

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1999

DEDICATED TO

MY DAUGHTER PONNU

DECLARATION

I hereby declare that this thesis entitled "**QUALITY ANALYSIS OF PAPAYA (*Carica papaya* L.) VARIETIES AND PRODUCT DEVELOPMENT**" 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 to me 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 "**QUALITY ANALYSIS OF PAPAYA (*Carica papaya* L.) VARIETIES AND PRODUCT DEVELOPMENT**" is a record of research work done independently by **Mrs. ANITHA CHANDRAN, C.** 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

Papaya (*Carica papaya* L.) belonging to the family caricaceae is an unusually interesting plant of many uses in tropical and subtropical regions. This wonderful fruit of the tropics is gaining popularity as an industrial fruit because of its varied economic potential. The importance of papaya to agriculture and the world's economy is demonstrated by its wide distribution and substantial production in the tropical countries.

India is a major producer of papaya. India's production accounts for about 7.03 per cent of the world's papaya production, hence India is rated as the largest papaya producer of the world covering an area of 45,000 hectare with a production of about 0.81 million tonnes. In our state 13,157 hectares is under papaya cultivation with a production of about 58,155 tonnes.

Papaya is a popular fruit famous for its high nutritive and medical value. Vascodagama the famous explorer found virtue in the papaya and called it "The golden tree of life". Almost every part of the papaya plant has some medicinal value. The fruits are mainly used for the treatment of digestive diseases.

The papaya fruits are also important and economical source of certain vitamins and minerals. Ripe papaya fruits have been estimated to be very good sources of readily available beta carotene. Papaya is the only fruit where vitamin-C increases during ripening. It is also a store house of minerals consisting mainly of iron, calcium, phosphorus and potassium.

Papain the dried latex collected from the unripe fruit of papaya is used industrially in tenderising meat, in the manufacture of cosmetics, in textile industries etc. Papain is also used as an ingredients in many pharmaceutical drugs.

Papaya is one of the commonest Indian fruit and ranks first for luxuriousness and appearance. The unripe fruit is used as a vegetable and the fully ripe fruit is used as a dessert. Besides being consumed as a table fruit it goes in to the preparation of jam, jelly, nectar, ice-cream, flavours, tuty-fruty, crystallised fruits, etc. Pectin a compound present in unripe mature fruit is also used in food industries.

The search for alternative uses to maximise the utilization of this tropical fruit and to reduce losses is vitally important. Hence there is a felt need to chanalise more papaya varieties for table use and also for processing. At present there are vast number of papaya cultivars grown all

over the world. The characteristics of each variety vary widely and the ultimate quality of papaya products depend largely on the selection of suitable variety.

Arriola *et al.* (1980) had pointed out that even among fruits of the same kind there is a certain variation according to the variety and the climatic conditions occurring during development. In general the fruit composition varies with different cultivars, climate, soil and the stage of maturity.

Many high yielding varieties with good quality of fruits and desirable characteristics for special purpose have been evolved. In view of this, systematic work was started from many years for its improvement at several research centres. A large number of different genotypes of papaya varieties were developed in different research stations through out the world having desirable characters for varied utility.

Varieties with desirable physical characters and high nutritional values are suggested as promising interms of quality and their scope of utilization (Pal *et al.*, 1980).

Eventhough information regarding the processing techniques of papaya is available, only little information is available regarding its suitability for processing based on the physiological, chemical and nutritional aspects of the

different varieties. The characteristics and constituents of different papaya cultivars has not been studied systematically. With this in view the study was under taken to evaluate the quality aspects of different cultivars of papaya based on their physical, proximate composition, and organoleptic qualities, which will be beneficial for use by both farmers as well as end users for specific purpose. The study also looks into the suitability of the determined superior varieties for product development.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The relevant literature available on the study entitled "Analysis of papaya varieties and product development" have been briefly reviewed here.

2.1 Importance of fruit

Singh (1969) reported that fruits are undoubtedly man's oldest food, and the history of fruits is as old as that of Adam, Eve and the forbidden apple. Rao (1995) states that fruits has been a major food for mankind, from time immemorial, and even to the primitive man the food was based mainly on fruits and also tubers which were found wild in the forest.

Kumar *et al.* (1990) believes that fruits and vegetables can carry 20-23 tonnes higher foreign exchange per unit area than cereals. Sethi (1993) pointed out that India is one of the largest producer of fruits in the world. According to Chandha (1995) being a country having varied climatic conditions ranging from tropical to subtropical and to temperate. India has emerged as the largest producer of fruits in the world with the annual production of over 32 million tonnes.

Gill *et al.* (1991) states that considering the minimum per capita requirement of 95 g of fruits per day there is a short fall of 2.16 lakh tonnes of fruits per year for the existing population of this state. It is therefore essential to increase the production and yield of fruit crops for providing nutritional and protective food.

According to Inekoronye and Ngoddy (1985) fruits play an important role in human diet as the source of protein, calories, essential vitamins and minerals. Fruits are of dietetic importance for the variety, freshness and flavour they provide (Okieimen, 1985). Gill *et al.* (1991) states that fruits are rich in vitamins and are highly palatable in fresh as well as processed form and thus, indispensible part of human diet. According to Rao (1991) fruits and vegetables are the only sources of essential nutrients like vitamin-C and beta carotene whose intake for majority of our population are already below par.

George (1994) expressed that fruits are no longer considered as a luxury, since they belong to an important class of protective foods which provide adequate vitamins and minerals needed for the maintenance of health. Prasad and Singh (1996) states that fresh fruits are considered as an integral part of our dietary system since they are the rich sources of minerals, vitamins and dietary fibres.

Layne and Peterson (1996) pointed out that fruits are found to be a rich source of vitamins and minerals. According to them dietary needs of important minerals like iron, calcium, and phosphorus also is very well taken care of by the consumption of fruits. Sethi (1996) states that fruits and vegetables are the major source of important vitamins like A, C and B as well as good source of minerals such as calcium, iron, phosphorus, potash which are very essential part of our diet. The author also reported that in addition, fruits and vegetables provide variety, enjoyment, increase in appetite and a source of satisfaction with the diet because of their appealing colour, taste, flavour and texture.

2.2 Papaya-origin, geographical distribution and production

Papaya (*Carica papaya* L.) belonging to the family caricaceae is an unusually interesting plant of many uses in tropical and subtropical regions.

Considering the origin, Hofmeyr (1938) states that papaya a native of tropical America was introduced in India in the 16th century by the Portuguese travellers. However Purseglove (1968) had stated that the fruit indigenous to South Mexica and Cost Rica, was taken by Spaniards to Manila in mid sixteenth century and from there it was introduced in India. Kesavamurthy (1995) reported that West Indies is considered to the native of carica papaya. Jones and Lyne (1997) state that papaya is the largest edible fruit that is native to the United States.

Ram (1980) reported that papaya is grown in almost all tropical and subtropical countries of the world, among them the leading producer countries are Malaysia, India, China, Thailand, USA, Hawai, California, Florida, Srilanka, Nigeria, South Africa, Indonesia and Phillipines. He also states that on the globe 30° North and 30° South up to an elevation of about 1000 meters height, where the maximum temperature 4°C is best suited for papaya cultivation. Kesavamurthi (1995) reported that in India papaya grown in orchards and kitchen gardens and the states majoring include Karnataka, Maharashtra, Madhya Pradesh, Orissa, Assam, Kerala and Tamil Nadu.

A report published by Food and Agricultural Organisation (FAO, 1987) indicates that annual world production of papaya is 2914.47 metric tonnes and of this India produces

about 350 metric tonnes. According to Iyer (1987) in Kerala about 61.1 metric tonnes of papaya fruits is produced per annum. But a recent report of Horticultural Development Corporation (1992) revealed that Kerala's annual contribution in this context is 50.46 metric tonnes. India is a major producer of papaya and the production accounts for about 7.03 per cent of the world's papaya production. Hence India is rated as the largest papaya producer of the world, covering an area of 45,000 hectares with a production of about 0.81 million tonnes (FAO, 1991). The report also states that in Asia, papaya accounts for less than 1 per cent of the total fruit production and in India 3.09 per cent of the total fruit yield was covered by papaya.

2.3 Papaya - its importance as a promising fruit

Pal *et al.* (1980) reported that papaya the poor man's fruit of the tropics, emcompasses most of the desirable qualities of fruit is rich in nutritive values besides having medical properties, industrial utility and export potentialities. Ram (1980) states that papaya (*Carica papaya* L.) is an important fruit crop of our country covering almost all the tropical and subtropical states, excepting Kashmir and Himachal Pradesh. According to Rani and Veerannah (1996) papaya is considered as one of the most important fruits in the horticultural world.

Hayes (1960) reported that papaya is a wholesome fruit and is consumed primarily as table fruit or salad vegetables. The same author in (1953) pointed out that papaya is gaining popularity because of its easy cultivation under tropical conditions and its high potentiality for heavy yields under proper cultivation and its ability to yield fruit all round the year. Annon (1963) expressed that among the fruit crops papaya ranks first in producing the maximum calories per hectare and ranks second in carotene content and is also a fairly good source of ascorbic acid, thiamine, riboflavin, calcium, phosphorus and iron. According to Wenkam and Miller (1965) papaya assumes greater importance since papaya occupies an important position among the tropical and subtropical fruits and is a good source of vitamin-A, vitamin-C and minerals such as calcium and iron.

Studies conducted at NIN (1992) reveal that regular consumption of papaya will ensure a good supply of vitamin-A and vitamin-C. Kordylas (1990) states that papaya is rich in carotenoids and vitamin-C and is very low in fibre content. According to Rathinavel (1991) papaya (*Carica papaya* L.) variously called as a Papaw, Papita, Melon tree etc. is a tropical fruit which has gained immense popularity in the last five decades.

As per the report of Patil and Choudari (1994) papaya is an early bearing heavy yielding and a very remunerative crop

which is known for its high nutritive and medical values. According to Lavania and Jain (1995) fruit of papaya is known for its significant nutritive values, medical and industrial uses. Besides quick and easy growth of plant, the fruit is whole some and an excellent source of vitamin-A and good source of vitamin-C and fair source of vitamin-B and thus it deserves to be far more popular than any other fruits.

Kesavamurthi (1995) opined that among the various fruit crops grown in our country papaya is a highly nutritious and less expensive fruit. Auxcilia and Santhiamoorthy (1996) pointed out that papaya (*Carica papaya* L.) is highly nutritious, rich in vitamin and minerals, besides being delicious the fruits are consumed as fresh and processed forms.

2.3.1 Industrial significance of papaya

According to Chittiraichelvan (1975) several products like dental paste, face creams and several types of medicines can be prepared from papain, he also state that it can also be used as a meat tenderriser. Kordylas (1990) states that the enzyme prepared by drying the latex have protein digestion and mild clotting properties and is used in the manufacture of chewing gum, cosmetic industry for degumming natural silk for giving shrink resistance to wool and is also used as drugs for digestive ailments. He also states that leaves and young fruits are used to tenderize meat and, seeds are used to expel worms from the intestines.

Singh (1990) states that papaya is used for the extraction of papain and pectin as well as an alkaloid called carpaine. Ali and Mozumdar (1994) reported that the latex secreted by young fruits and plants of papaya is commercially important because of its content of proteolytic enzymes. They also state that the latex either in its dried form or after purification respectively termed "Crude papain" and "Pure papain" is used in several industries including silk production for degumming natural silk, in tanneries for curing leather in the wool industries, cosmetics, chewing gums and dental paste etc.

Bawasakar (1997) pointed out that papaya can be used for the preparation of jam, jellies, marmalades, tuti-fruity etc. Papain the latex obtained from papaya is used for making valuable medicines, chewing gum, in tanning and silk industries.

2.3.2 Therapeutic values

An extract of Indian papaya (*Carica papaya* L.) in water has proved well on male rats as an anti-fertility drug (Indian Food Industry, 1956). According to Jeans (1972) the milky juice taken from unripe fruit is so potent in affective break down and decay of muscular fibre.

Lokhande and Moghe (1991) reported that papaya fruit is well known for its medical use against chronic constipation

and digestive disorders in human beings. Ali and Mozumdar (1994) states that purified papain is used as an ingredient in drugs for digestion, dyspepsia, hyperacidity, gastro-intestinal ulcers, ring and round worms, acne, wound, scars, warts, piles and other ailments. Bawasakar (1997) pointed out that it is mostly useful for recovery from indigestion, skin diseases, piles constipation and acts as good laxative. He also emphasized that the alkaloid carpaine found in papaya incorporated to act as a heart stimulant, amoebicide and diuretic.

2.4 Chemical and nutritional characteristics of different papaya cultivars

Arriola *et al.* (1980) reported that the biochemical changes which occur in the fruit are an important factor in relation to its nutritive value.

2.4.1 Total sugar

One of the most important bio chemical changes which occur in the fruit during ontogeny is the appearance of sugar. Arriola *et al.* (1980) and Pal *et al.* (1980) reported that composition of sugars is of paramount importance in evaluating a variety for desert or for processing purposes and the palatability and taste in papaya are closely associated with the amount of sugars present.

Pal *et al.* (1980) further studied the composition of sugars of twelve different varieties of ripe papaya fruits and revealed that considerable variability existed among the cultivars. Arriola *et al.* (1980) pointed out that during ripening of fruit, the sugars generally tend to increase due to metabolism of the polysaccharides in the cell wall.

Arriola *et al.* (1975) opined that in papaya the sugar content is greater than the acidity and therefore a sweet flavour predominates. They also found that an increase in the level of total sugars during ripening of locally grown papaya in Guatemala. Chittiraichelvan (1975) investigated that the total sugar content and reducing sugar fraction increased with advancing maturity during growth and development of Co_2 papaya. Chan and Kwok (1976) reported that in ripe papaya the predominant sugar present is sucrose (48.3%) followed by glucose (29.0%) and fructose (21%). Chan (1979) reported that sucrose made up less than 18 per cent of the total sugar content 110 days after anthesis and increased rapidily to make up 80 per cent of the sugars in about 135 days after anthesis.

Arriola *et al.* (1980) pointed out that appearance of sugar during ripening of papaya is immense which vary a great deal in kind and quantity according to different cultivars and climate. Irulappan (1992) found that total sugar content varied between 5.91 per cent to 12.23 per cent among forty

types of papaya studied. Pal *et al.* (1980) reported that for Coorg Honeydew the sucrose, glucose and fructose content present in ripe papaya is equivalent to 1.49, 5.23 and 3.18 per cent respectively the authors also reported that for Washington it is 1.81, 5.24 and 2.90 per cent and for Thailand variety it is 1.82, 4.44 and 12.64 per cent respectively. Silva *et al.* (1980) states that glucose, fructose and sucrose were the main surgars per cent in papaya.

Selvaraj *et al.* (1982) observed that the concentration of sugars varies depending on the stage of ripening, with glucose predominating in all stages except that of full ripe stage where fructose accumulates in larger quantities. They also found that sucrose, glucose and fructose formed 7-50%, 14-78% and 13-50% respectively of total surgars in certain cultivars of papaya. Veerannah and Ratna Kumar (1988) reported that total and reducing sugars in ten cultivars studied showed a significant difference among all stages as well as genotypes.

Kordylas (1990) reported that ripe papaya consists of 10 per cent total sugar. Singh (1990) observed that the variety washington contains 13.0 per cent total sugar/100 g pulp. Chan and Teo (1992) assessed Exotica papaya and reported that fruit sugar content varied between 5·2 and 10·4 mg, per 100 g. Auxcilia and Sathiamoorthy (1996) stated that the variety

Washington, Coorg Honeydew and Waimanalo have a total sugar content of 10.77, 11.97 and 10.08 per cent respectively. The authors further reported that the varieties Exotic collections, Ec-100417, Ec-100612, Ec-100019, Ec-100011, Ec-100012, Ec-100015 and Ec-101 have a total sugar content of 10.08. 7.86, 9.05, 9.81, 10.08, 10.16 and 6.31 per cent respectively.

2.4.2 Reducing sugar

Veerannah and Selvaraj (1984) observed that the reducing sugar content increased gradually from the early stages and reached the highest at ripening stage, where as the non-reducing sugar did not show any particular trend. According to Singh (1990) the variety Washington contains 8.0 g of reducing sugar per 100 g of ripe papaya flesh.

Auxcilia and Sathiamoorthy (1997) screened twenty gynodioecious lines of papaya fruits and reported that the variety Washington, Coorg Honeydew and Waimanalo have a reducing sugar content of 9.78, 11.58 and 8.96% respectively. They also stated that the variety Ec-100417, Ec-100012, Ec-100019, Ec-100011, EC-100012, Ec-100015, Ec-101 have a reducing sugar content of 8.80, 6.51, 8.45, 9.46, 9.20, 9.05 and 5.30 respectively.

2.4.3 Non-reducing sugar

Auxcilia and Sathiamoorthy (1997) state that the non-reducing sugars for the variety Washington, Coorg Honeydew and

Waimanalo were found as 0.99, 0.32 and 1.12 per cent respectively. The authors also evaluated some exotic varieties of papaya fruits and found that the non-reducing sugar content for the varieties Ec-100417, Ec-100612, Ec-100019, Ec-100011, Ec-100012, Ec-100015 and Ec-101 were 1.28, 1.33, 0.60, 0.35, 0.88, 1.11, 1.01 respectively.

2.4.4 Total soluble solids

Akamine and Goo (1971) state that in order for the fruits to have a minimum percentage of soluble solids, 6 per cent of the outer surface should have an yellow colour. Pal *et al.* (1980) state that high t.s.s. is a positive attribute for desert quality. They evaluated different varieties of papaya fruit and reported that high total soluble solids was recorded for Coorg Honeydew (12 per cent) followed by pink flesh sweet (11.6 per cent). The open pollinated variety 'Solo' had lowest t.s.s. (7.2 per cent). Singh (1990) reported that the t.s.s. of the variety Washington was 10.6 g per 100 g pulp.

Sannigrahi *et al.* (1995) pointed out that the t.s.s. in Pusa Delicious ranges from 11.00 - 12.5 per cent. Auxcilia and Sathiamoorthy (1997) state that the variety Washington, Coorg Honeydew and Waimanalo have a total soluble solids content of 10.80, 14.02 and 13.12 per cent respectively. They

further states that the variety Ec-100417, Ec-100612, Ec-100019, Ec-100011, Ec-10012, Ec-100015 and Ec-101, have a total soluble solid content 9.12, 9.53, 9.24, 11.24, 10.50, 10.92 and 10.50 respectively.

2.4.5 Moisture

Munsell (1950) reported that papaya fruit contain 88.6 per cent, 89.3 per cent, moisture per 100 g.

Arriola *et al.* (1980) observed that the moisture content of ripe papaya fruit was 89.6 per cent/100 g pulp. Selvaraj *et al.* (1982) opined that the cultivar Coorg Honeydew, pink flesh and Washington have a moisture content of 87.94 per cent.

Kordylas (1990) reported that the edible portion of the fresh fruit of papaya contains about 88.00 per cent moisture. According to Rice *et al.* (1992) the moisture content in papaya is 89.00. Bose *et al.* (1993) state that ripe papaya consists of 92 per cent moisture. Srivastava and Kumar (1994) revealed that the moisture content inripe papaya is 90.8 per cent/100g.

2.4.6 Acidity

Chan and Coworkers (1971) identified the presence of ketoglutaric acid, citric, malic, tartaric, ascorbic and galacturonic acids in papaya of which malic, L keto-glutaric

and ascorbic acid represent 85% of the total acidity. Arriola *et al.* (1975) state that during the ripening of papaya at room temperature (24°C±1) titrable acidity increases and later, when the fruit become over ripe, this decreases. This trends in papaya has also been reported from Colombia by Civetta *et al.* (1965).

Arriola *et al.* (1975) reported that acidity in papaya is very less compared to other fruits. Pal *et al.* (1980) opined that as compared to other fruits total titrable acidity was considerably low in papaya fruits. The open pollinated variety "Solo small" had maximum acidity and Washington had minimum acidity. The t.s.s. acidity ratio ranged from 7.2 to 1.94. Acidity for Coorg Honeydew and Washington was recorded to be 0.062 and 0.058 respectively. Arriola *et al.* (1980) observed that the acidity during the development of fruit varies according to the type of fruits.

Selvaraj *et al.* (1982) reported that concentration of total non-volatile acidity and citric and malic acids decreased to a minimum at the ripe stage. Singh (1990) states that papaya variety Washington contains 0.03 to 0.99 per cent of acidity. Auxcilia and Sathiamoorthy (1996) reported that the acidity of the varieties Washington, Coorg Honeydew and Waimanalo was 0.199, 0.102 and 0.179 per cent respectively. They further reported that the titrable acidity for the

varieties Ec-100417, Ec-100612, Ec-100019, Ec-100011, Ec-100012, Ec-100015 and Ec-107 were 0.128, 0.179, 0.153, 0.128, 0.179 and 0.153 respectively.

2.4.7 Vitamin-C

According to Orr *et al.* (1953), Civetta *et al.* (1965) and Arriola *et al.* (1975) the vitamin-C content during the development of the papaya fruit increases gradually reducing the maximum value at ripeness, 55 mg/100 g. Wood roof and Luh (1975) reported that papaya fruits are rich sources of vitamin-C. According to Arriola (1980) a single 100 g serving of papaya would be sufficient to cover the daily requirement of vitamin-C for one person. He also reported that the vitamin-C content in ripe papaya is 400 mg/100g.

Pal *et al.* (1980) reported that vitamin-C for Coorg Honeydew is 66.6 mg and that for Washington is 78.1 mg/100g of ripe fruit. According to Pal *et al.* (1980) the vitamin-C in Thailand variety is 46.6 mg/100g. Singh (1990) reported the variety Washington contains 45-55 mg vitamin-C/100g of pulp. Kordylas (1990) states that ripe papaya consists 52 mg vitamin C/100 g pulp.

Rice *et al.* (1992) reported that the vitamin-C in papaya is 50 mg/100g pulp. Bose *et al.* (1993) reported that ripe papaya contains 52 mg vitamin-C/100g. Srivastava and

Kumar (1994) reported that papaya contains 57 mg vitamin-C/100g pulp. Auxcilia and Sathiamoorthy (1996) evaluated twenty varieties of gynodioecious lines of papaya and concluded that the varieties Ec-100417, Ec-100612, Ec-100019, Ec-100011, Ec-100012, Ec-100015, Ec-101 have vitamin-C content of 70.31, 71.89, 62.41, 41.87, 41.87, 27.65 and 36.34 mg/100g respectively. They also reported that vitamin-C content for papaya varieties Washington, Coorg Honeydew and Waimanalo was recorded to be 65.67, 55.30 and 59.60 mg/100 g respectively.

2.4.8 Carotenoids

Howard *et al.* (1962) indicate that in the papaya variety whose flesh is a reddish salmon colour, considerable levels of carotenoids such as lycopene were found which is absent in the varieties of papaya whose flesh is yellow. Duck Worth (1966) reported that carotenoid pigments are the precursors for vitamin-A in the human diet that required a minimum of 5000 IU daily.

According to Good Win and Goo[illegible] (1970) the change of the outer colour in the fruit is an index of their ripeness. In general this change is considered due to an increase in the carotene content and to a decrease in chlorophyll. Akamine and Goo (1971) suggested that in order for the fruit to have a minimum percentage of soluble solids, 6 per cent of the outer

surface should have a yellow colour and this yellow colour is due to the development of carotenoids in the fruits.

Thomas and Janava (1975) stated that the change in outer colour has been employed as an index for determining the point at which to harvest the fruit. Arriola *et al.* (1975) pointed out that a progressive increase in carotene and xanthophyl from 0.3 to 2.0 mg/100g of flesh was observed during ripening of papaya. The similar increase was also mentioned by Munsell (1950). Wood roof and Luh (1975) state that papaya fruits are reported to be good source of vitamin-A.

Arriola *et al.* (1975) recorded a vitamin A content of 2020 IU/100 g for ripe papaya. Pal *et al.* (1980) studied 12 varieties of papaya fruits and concluded that vitamin-A content calculated from β carotene values ranges from 1600 to 6347 IU. Selvaraj *et al.* (1982) reported that colour break stage was characterised by an increase in vitamin-A.

Onayami and Badifu (1987) estimated that more than 75 per cent of vitamin-A present in papaya was lost during processing and they recommend eating fresh ripe papaya as the best method of avoid this great loss in this fruit. Vitamin-A report (1989) indicate that β-carotene is an important precursor of vitamin-A and low level of consumption of vitamin-A has been shown to be primary cause of night blindness. The report also pointed out that pre-school

children are more prone to vitamin-A deficiency symptoms, as the ratio of consumption of vitamin-A or β carotene rich food in their diet is low.

Kimura *et al.* (1991) indicates that climatic effects could have the same or even greater influence on the carotenoid composition than cultivar differences. He also states that fruits from hot regions have high carotenoid content. Similar results were obtained by Kimura *et al.* (1991) from CV Solo variety papaya and reported that the fruit obtained from hot Bahia region contained greater amounts of β-carotene, β-cryptoxanthin and lycopene, than papaya from cold sadpaulo region. Cinty *et al.* (1992) reported that β-carotene is said to have, protective role against cancers, and coronary heart diseases. Rice *et al.* (1992) estimated the vitamin-A in papaya and reported that it contain 1000 IU/100g.

Srivastava and Kumar (1994) states that papaya contain 666 µg carotenoids/100g. According to Auxcilia and Sathiamoorthy (1994) total carotenoid content of variety Washington is 4.33 mg, Coorg Honeydew is 6.85 mg and that for Waimanalo is 4.33 mg, Coorg Honeydew is 6.85 mg and that for Waimanalo is 5.85 mg/100g. According to them the variety Exotic collection - 100417, Ec-100612, Ec-100019, Ec-100011, Ec-100012, Ec-100015 and Ec-101 have carotenoid content of 5.63, 4.53, 3.35, 3.57, 4.63, 5.63 and 6.85 mg/100g of pulp.

Food digest (1997) high lighted that carotenoids found in fruits and vegetables has an antioxidant property which protect against cancer and cataracts and ever boost the immune system to fight against infection.

2.4.9 Fibre

Munsell (1950) reported that 100 g flesh of papaya contains 0.6 to 0.7 g crude fibre. Frederich and Nichols (1975) reported that papaya contains 0.9 g crude fibre. Rice *et al.* (1992) reported that the fibre content in ripe papaya fruit is 0.7 g/100 g edible portion. According to Srivastava and Kumar (1994) the fibre content in papaya is 0.8 per cent.

2.4.10 Pectin

Westerlund *et al.* (1991) reported that pectins exist in varying amounts in fruit cell walls and have important nutritional and technological properties mainly because of their ability to form gels. Sudhakar and Mani (1995) states pectin as an important constituent, widely distributed in various plant parts mainly in the middle lamella of cell walls as an insoluble form known as protopectin which acts as nature's cement in holding the adjacent cells together. The authors also reported that the pectin isolated from plant material play a significant role in the manufacture of fruit products like jam, jellies, marmalades, sauces, ketchups, flavoured syrups and as a texturising agent in fruit flavoured

milk deserts which are indispensable to the fruit processing industry. Food digest (1998) reports that pectin a purified carbohydrate that consists chiefly of partially methoxylated polygalacturonic acid is required as a thickening agent in the preparations of jams, jellies, marmalades and salad dressing and is also used in pharmaceutical preparations as a replacement of fat. Food digest (1998) again states that the requirement of pectin for Indian Food Industries is estimated to be around 300 tonnes per annum but indigeneous production is only about 25 tonnes that is currently being imported to meet the requirements.

Gee *et al.* (1958) reported that pectin substances has persisted because of their important role in maintaining the texture of fresh, processed fruits and vegetables. Deshpande *et al.* (1965); Shewfelt *et al.* (1971) and Somoyogy and Romani (1964) associated the loss of firmness in papaya fruit to the proportion and nature of the pectic materials. According to Arriola *et al.* (1980) an obvious change during the ripening of the fruit was the reduced firmness due to softening caused by the hydrolytic change of protopectin to pectin. Hayes (1980) reported that papaya contains a good amount of pectin.

Lassordiere (1969) in a study of papaya at different degrees of ripeness found that the variety of the fruit, the growth conditions and the state of development at the time of

harvest influence the chemical composition of pectins. Ihekoranye and Nagoddy (1985) state that papaya contain a pectin, content of above 1 per cent which has expected to produce good gels. Nwanekezi *et al.* (1994) reported that pectin from garden egg, pawpaw and mango have high methoxyl content. They also stated that pectin from mango, papaya, banana, lime and orange met the requirements for formation of thick gels.

Sudhakar and Mani (1995) state that with the rapid development of fruit growth in early stages of maturity a tremendous initial increase occurs in the total pectin followed by a gradual increase and this trend was observed during the maturity of many fruits like papaya, citrus, apple, mango, guava, etc. Sudhakar and Mani (1995) again stated that water soluble pectin of papaya was found to be 28 per cent of the total pectin at the over ripe stage as compared to 12.5 per cent at the green stage.

According to Kertesz (1951) pectin enzymes, poly galacturonase and pectin methyl esterase play an important role in textural change during the ripening of papaya. He also pointed out the enzymatic demethylation and depolymerization of the protopectin forms low molecular weight polymers with less methoxyl groups which are insufficient for maintaining the firmness of the fruit.

According to Lassoudiers (1969) the variety of the fruits, the growth conditions and the state of development at the time of harvest all influence the chemical composition of pectins. Arriola *et al.* (1980) showed an increase in the total pectin content in papaya which reached a maximum value two days after the fruit appeared to be ripe, similar trends have been reported in the same fruit by Shetty and Dubash (1975). According to Sudhakar and Mani (1995) the composition of pectic substances isolated from any plant materials varies with species, variety and stage of maturity. They also stated that commercial pectins are of high methoxyl content which range from 7 to 12 cent and can hold a high sugar content of 65 per cent and above to form gels.

Nwanekezi *et al.* (1994) reported that gels prepared from cashew, apple and guava at pH 32 with 70 per cent sugar had flowing characteristics, because of their low methoxyl ester content. They also reported that a avacado, pear, native mango, star apple and tomato could not gel, partly because their pectin contents, were less than 1 per cent and had low methoxyl ester content. Food digest (1998) also reports that the most important sources of pectin in advanced countries are the inner portion of the rind of citrus fruits and apple pomace and other good sources which they exploits for pectin are papaya, guava, peels of mango, orange and sunflower seeds.

2.4.11 Minerals

Munsell as early as in (1950) observed 0.025 and 0.030 mg of thiamin, 0.029 and 0.038 g of riboflavin and 0.238 and 0.399 mg of niacin per 100 g of fruit. He also states that 2 samples of papaya (per 100 g flesh) contains nitrogen 0.11 and 0.97 g, phosphorus 11.8 and 15.5 mg, calcium 18.3 and 17.5 mg, iron 0.25 mg and 0.42 mg and ash 0.46 mg and 0.57mg. Asenjo *et al.* (1950) found niacin content to range from 0.17 to 0.64 gm with an average of 0.320 mg/100 g of papaya fruit. According to Awada and Suchisa (1973) ripe papaya flesh contains nitrogen 0.12 per cent, phosphorus 0.01 per cent, calcium 0.03 per cent and magnesium 0.02 per cent.

Pal *et al.* (1980) state that varieties with maximum concentration of minerals were superior in their nutritional quality. They also reported that phosphorous, potassium and calcium content for Coorg Honeydew is 4.10 mg, 0.46 mg and 14.70 mg respectively. He also reported that for Washington it is 7.04 mg, 0.63 mg and 12.03 mg/100g respectively. The authors again reported that in Thailand variety papaya the phosphorus potassium and calcium is equivalent to 4.39, 0.33 and 8.4 per cent respectively. Arriola *et al.* (1980) recorded calcium content of 0.01 per cent, phosphorus 0.1 per cent iron 4.0 per cent vitamin B_2 0.4 mg, nicotinic acid 2.0 mg and riboflavin 0.250 mg/100 g in ripe papaya.

Rice *et al.* (1992) reported that calcium, iron, thiamine, riboflavin and nicotinamide is equivalent to 2.0, 0.5, 0.03, 0.03 and 0.2 mg/100 g respectively. Bose *et al.* (1993) pointed out that papaya consist of 0.01 mg thiamine, 28 mg calcium, 0.01 mg riboflavin, 28 mg calcium and 0.9 mg iron/100g pulp. According to Srivastava and Kumar (1994) the total mineral content in ripe papaya is 5 per cent. He also reported that calcium, phosphorus, iron, thiamine, riboflavin and niacin is equivalent to 17, 1.3, 0.5, 0.04, 0.25 and 0.2 mg respectively.

2.5 Physical characteristics of different papaya varieties

According to Wenkan and Miller (1965) fruit quality, such as shape of the fruit, weight, length, yield, varietal difference etc., keeps the quality of the fruits. Lokhanee and Moghe (1990) report that the shape, weight, size, t.s.s. and acidity of the papaya fruits are important qualities for market suitability transport and keeping quality of the fruits. Auxcilia and Sathiamoorthy (1997) stated that fruit characters such as fruit length, fruit weight, circumference of the fruit, flesh thickness, number and weight of seeds are influence the quality of the papaya fruits.

2.5.1 Fruit weight

Arriola *et al.* (1980) state that Washington is round to ovate in shape, medium to large in size. The weight of the

fruit is about 1 kg. whereas the weight for Pusa Giant and Pusa Dwarf range from 2.5 to 3.5 kg and 1.00 to 2.00 kg. Pal *et al.* (1980) evaluated twelve papaya varieties to study the physical characteristics and reported that the variety Thailand gave large sized fruits followed by Coorg Honeydew. They further stated that the Thailand variety recorded maximum weight of 1.92 kg, Coorg Honeydew 1.37 kg and the variety Washington recorded 1.09 kg per fruits.

Singh (1980) reported that the weight for the variety Washington is recorded to be 2.5 kg. Singh (1990) again states that the variety Washington is recorded to have a weight ranging from 1.050-2.075kg. Ghanta (1994) evaluated different characteristics of CV Ranchi varieties of papaya and found that the fruit weight was 2.132kg.

Sannigrahi *et al.* (1995) indicate that the fruit weight of the variety Pusa Delicious is 1.2 - 2.4 kg. Auxcilia *et al.* (1996) observed that the fruit weight for the varieties Pusa Dwarf, Pusa Giant, Pusa Delicious, Pusa Majesty, Washington, Coorg Honeydew and Waimanalo are 1.457, 3.253, 2.525, 2.176, 2.312, 1.100 and 0.820kg respectively. They also studied the weight of some exotic varieties of papaya and reported that the fruit weight of these varieties range from 996 g to 1.42 kg. Sannigrahi *et al.* (1995) stated that the edible portion of Pusa Delicious ranges from 80.0 - 85.7 per cent.

2.5.2 Fruit length

Arriola *et al.* (1980) states that the variety Washington is round to ovale in shape, medium to large in size, over 20 cm long and 40 cm circumference at its maximum bulge. They also stated that the variety Pusa Delicious and Pusa Majesty are gynodiocious lines with fruits of medium in size and round in shape. They further reported that the Pusa Giant and Pusa Dwarf are two dioecious cultivar having fruits size of medium to big and oval shape.

Singh (1980) reported that size of the Washington is medium to large and round to ovate having 20 cm long with circumference of over 50 cm at its maximum bulge. He further states that Coorg Honeydew is almost oblong, nearly of the same size as that of Washington but only less elongated. According to Pal *et al.* (1980) length of single fruit of Coorg Honeydew and Washington were 18.8 cm and 18.8 cm respectively. They also stated that the breadth for Coorg Honeydew is 12.6 cm and that of Washington 13.3 cm.

Auxcillia *et al.* (1996) studied the length of different varieties of papaya fruit and reported that the length of the varieties Pusa Dwarf, Pusa Giant, Pusa Delicious, Pusa Majesty, Washington, Coorg Honeydew and Waimanalo were 18.73, 24.66, 26.36, 22.20, 22.33, 22.33 and 19.73 cm respectively.

2.5.3 Cavity width

Pal *et al.* (1980) reported that the cavity width of Coorg Honeydew was found to be 7.1 cm and of Washington the same was recorded as 7.5 cm. Kordylas (1990) state that papaya has a central five angled cavity, with many seeds attached in five rows to the interior walls.

2.5.4 Seed/Peel weight

Auckland (1961) opinions that the seed weight, size of the seed have often been quoted as messures for quality of fruits. Pal *et al.* (1980) reported that besides the varietal differences the seed content in papaya fruits depend on cropping season and the type of pollination. In a further study the authors report that the peel percentage for Coorg Honeydew is 6.7 and that for Washington 8.5. According to Selvaraj *et al.* (1982) an increasing pulp/peel ratio was observed with increased age of fruit. They further stated that this ratio decreased at ripe stage in cultivars like Coorg Honeydew, Pink Flesh sweet, Sunrise Solo, Thailand and Washington.

Kordylas (1990) pointed out that papaya is covered with a think skin which is smooth and green turning yellow or organe when ripe. He also stated that shape of papaya seeds are spherical about 5 mm in diameter, black or greenish and

wrinkled which is enclosed in a gelatinous fluid which forms the outer seed coat. Auxcilia *et al.* (1997) found that the seed weight for the varieties Pusa Dwarf, Pusa Giant, Pusa Delicious, Pusa Majesty, Washington, Coorg Honeydew and Waimanalo as 45.16, 49.93, 64.96g respectively.

2.6 Organoleptic qualities of different varieties of papaya

Arriola *et al.* (1980) opined that the variety Washington is good for its desirable flavour and sweetness. They further observed that the cultivar Honey dew have less number of seeds with good flavour and taste, in addition to this Coorg Honeydew have thick and good flavoured flesh. Arriola *et al.* (1980) stressed that the variety Pusa Delicious is a cultivar with deep orange flesh and the fruits are also reported to have excellent flavour. The authors revealed that the variety Pusa Majesty is a cultivar with soft textured flesh and yellow colour having good keeping quality and is less prone to the spoilage during transportation and storage.

According to Singh (1980) the variety Washington is sweet and good flavoured. He also reported that the variety Coorg Honeydew is very sweet with equally good flavour. Kordylas (1990) states that the flavour of papaya is mild and pleasant. Singh (1990) reported that the variety Washington contains a purplish colour. Observations made by Sannigrahi *et al.* (1995) revealed that the variety Pusa Delicious with

orange coloured pulp and excellent flavour is becoming quite popular among the north-eastern region.

Auxcilia and Sathiamoorthy (1997) reported that Coorg Honeydew is a delicious papaya variety with red-fleshed fruits. Food digest (1997) indicated that papaya has natural colour and flavour and hence requires no artificial flavouring and colouring.

According to Kordylas (1990) the fleshing edible parts of papaya has a consistency of butter and varies in colour from yellow to red or orange.

2.7 Processing potential of fruits

Cook (1975) states that high perishability of fruits lead to a high degree of wastage. Sethi (1993) pointed out that inspite of high production of fruits 20-30 per cent of the produce are not utilised due to post harvest problems.

Bourne (1986) defined the causes for post harvest loss of perishable crops as primary losses due to insects, microbes and mechanical damages and secondary losses due to poor storage and inadequate transport facilities. Nwanekezi *et al.* (1994) pointed out that the search for alternative use of these tropical fruits to maximise their utilization and reduce losses is therefore vitally important.

According to Rao (1991) processing of fruits can be derived as adding value to conventional and innovative food item through various formation and combination providing protection, preservation, packing, convenience, carriage and disposability. Roy (1993) stated that surplus production of perishable fruits and vegetables during the seasonal glut could be converted into durable products inorder to avoid wastage. Shaw *et al.* (1993) proclaimed that owning to rich horticultural potential that exist in our country fruit processing industry can play an important role in salvaging prices during glut seasons, generating employment opportunity, meeting the requirements of defence forces and earning foreign exchange for our country.

Siddappa (1967) opined that it has become necessary to preserve fruits in different forms so that they could be made available to a large number of people during seasons when they are not available reading in fresh condition. Anvilla (1993) reported that consumption of processed foods is likely to increase in future. Subrahmanyan (1993) stated that, for increasing the export of products there is a need to develop new products for export based on the large international demand.

Yadav (1995) revealed that there is a big potential for fruit processing, since commercial processing plays a very

important role in marketing of fruits and vegetables. Sethi (1996) emphasised that all future thrusts in research should be aimed at devleoping simple technologies which could be easily adopted to conserve and preserve perishable commodities and minimise both their qualitative and quantitative losses, so tha the gap between the production and availability of horticultural crops is slowed down.

2.7.1 Processed fruit products

Hayes (1960) opined that the rind of fruits contains a good amount of pectin for making jelly. According to Mukherjee (1963) jelly can be prepared from peel and leaves of pear fruit. Peel of orange can be utilized in the production of jelly (Pareek, 1965) Pruthi (1971) reported that mandarin orange waste constitutes good source of pectin for the preparation of jelly. According to Jackson (1973) best quality pectin jelly can be prepared with glucose fruit syrup ratio 102:58.

Extraction of pectin from mango peel has been well studied and good quality jelly grade pectin could be extracted (Kinsella, 1974) Sweetmaker (1983) reported that higher amount of gelatin and glucose makes the jelly tough when stored for a long time. Ramdas conducted studies on the preparation of jelly from passion fruit rind and the product was good.

Bhatnagar (1991) opined that jelly made from peeled water melon rind in combination with grapes are highly acceptable than plain water melon rind jelly. Joshy (1993) prepared jelly from Karonda fruits with 13.5 brix tss, 2.8 per cent acidity and 3.2 pH. He also reported that the product was organoleptically acceptable. Sanjeev and Srivastava (1994) opined that papaya, Guava, sour apple, plum, Goosberrry are generally used for the preparation of jelly.

Teotia *et al.* (1992) prepared a blended RTS with muskmelon and mango and was found to be highly acceptable. Srivastava and Kumar (1994) reported that blended juice can give a well behaved right flavoured highly palatable and refreshing drink. Khurdiya *et al.* (1984) developed a receipe for wine using jack which was organloptically acceptable. Kandan *et al.* (1991) has standardised the formula for the preparation fo wine from ber which was organoleptically acceptable.

Danchenko and his colleagues (1983) observed that the pectin/sugar solution prepared in the rate of 1:5 with water at 30 volume per weight of pectin and pH in range of 2.5 to 6.0 was observed to result in increased jam strength. Mango sauce prepared by Kumar and Khurdiya (1993) from mature unripe mango scored maximum results with 2:1 ratio of mango and cane sugar. Sharma and Kumar (1995) standardised ketchup using four

flakes, baby foods and toffee and raw papaya was suggested for pickle tuty-fruty and candy. Singh (1990) suggested the need for formulating new papaya products due to its year round availability, quick and heavy bearing and also its high pulp content. Erulappan (1992) also emphasised the need for standardising new papaya products. He also stated that good pulp content, appreciable colour and high nutrition are the main characters which gives papaya priority for processing.

Pal (1995) opined that good quality jelly can be prepared by utilizing papaya and passion fruit. She also reported that orangoleptic evaluation of blended jelly was found to be highly acceptable than plain passion fruit jelly.

Krishnamurthy and Varma (1978) reported that mixed fruit slabs were found to be quite delicious than plain papaya slabs. Thirumaran *et al.* (1985) standardised a simple processing technique for papaya candy making use of fully matured but unripe papaya. Jayaraman and Gupta (1991) reported that good quality fruit bars can be prepared by drying papaya and jack fruit. Jyothi (1997) reported that fruit bar prepared from mango and papaya blend was organoleptically more acceptable than plain mango bars.

Nanjundaswamy *et al.* (1964) stated that the plain juice of papaya can be blended with other fruit juices to make it a highly acceptable beverage. The author's also reported

varieties of pumpkin and the product was organoleptically assessed in comparison with tomato ketchup and vegetable ketchup.

Nanjundaswamy *et al.* (1976) revealed that mango bar prepared from different varieties of fruits had high organoleptic qualities than the product prepared from only one variety fruit. CFTRI (1978) reported that variety of the fruit, and consistency of the pulp have definite impact on the quality of fruit bar.

Ronald (1956) developed candy from figs, pears and peaches and observed considerable decrease in weight of the fruit. Beerh *et al.* (1965) standardised a method for candy from pear. The candy had good colour, taste and acceptability. Razarathnam (1992) standardised a processing techniques for canned mushroom in brine reported that the product was organoleptically acceptable.

2.7.2 Papaya based products

Papaya is marketed chiefly as fresh fruit, however its processed products are becoming increasingly popular (Nath and Ranganna, 1981). Findings of CFTRI (1987) suggested that the mature papaya fruit at various stages of ripening was suitable for the preparation of jam jelly, canned papaya, beverage, nectar, puree, concetrates, slab, powder, cereal

that good quality beverage can be prepared by blending papaya juice with guava juice. Wood roof (1975) observed that the purees and juices of orange, banana, papaya and guava can be successfully blended with passion fruit juice into tropical fruit drinks, punches and syrups. Annapurna (1977) reported that good quality beverages can be prepared by bledning fruit juices like guava, papaya and passion fruit.

Sondhi (1978) reported the development of interesting products like cashew apple RTS, beverage from blends with carotene rich fruit pulps of mango and papaya. Studies by Kalra *et al.* (1991) revealed that 25-33 per cent papaya pulp could be incorporated in mango without affecting the quantity and acceptability of mango beverage. Manimeghalai (1995) conducted studies on mango papaya blended quashes and revealed that organoleptic evaluation indicated that blends with ratio 50:50 and 75:25 had high consumer acceptability than 25:25 ratio of mango and papaya blends. Purushothaman (1996) formulated wine from papaya after removing the latex and skin of the papaya through a process standardised by them and wine with 7.9 per cent alcohol could be obtained.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study entitled "Quality analysis of papaya (*Carica papaya* L.) varieties and product development" is a comprehensive study carried out with an objective to evaluate the quality of different varieties of papaya based on physical characteristics, proximate composition and organoleptic qualities so as to identify the most suitable variety for the development of papaya based products.

The methodology followed in the study is presented under the following headings.

3.1 Selection of varieties

3.2 Assessemnt ofquality parameters of selected papaya varieties

3.3 Identification of superior varieties

3.4 Product development

3.5 Cost analysis

3.6 Quality assessment of jelly

3.7 Confirmation with FPO requirements

3.8 Statistical analysis

3.1 Selection of varieties

Papaya (*Carica papaya* L.) the wonder fruit of the tropics is gaining popularity as an industrial fruit due to its high productivity and diverse uses.

At present the fruit is catching more fancy by the public and consequently papaya cultivation is also becoming more and more popular. The characteristics of each variety of papaya both traditional and hybrid vary widely.

Ram *et al.* (1992) have pointed out that selection of suitable varieties for specific purposes will result not only in better utilization but also in the production of value added products and gainful employment opportunities for farm families.

Hence ideal varieties for both table purpose and product development is to be found out in order to promote wider use especially for processing industry.

In order to identify varieties that possess ultimate quality parameters suitable for product preparation. Ten dessert varieties of papaya fruit were selected. Inclusion of most of these varieties in the study were based on their general use in the country for various purpose.

Papaya is a notoriously difficult crop to maintain as a pure cultivar and so selection of papaya varieties from local farms will not provide a pure cultivar for reasearch purpose. Tamil Nadu Agricultural University, Coimbatore has done pioneering work in the development of different varieties of papaya and is a leading papaya breeding station. Hence for the

present study papaya fruits were collected from the above institute in order to obtain pure cultivar. The varieties selected are presented in Table 1.

Table 1

Varieties selected for the study

Sl.No.	Name of the variety
1.	Waimanalo
2.	Pusa Dwarf
3.	Pusa Giant
4.	Pusa Majesty
5.	Pusa Delicious
6.	Coorg Honeydew
7.	Washington
8.	Malayasian Long
9.	Exotic collection - 100091
10.	Exotic collection - 100060

3.2 Assessment of quality parameters of selected papaya varieties

In India more than 55 per cent of papaya fruits are sold as fresh fruits in the market (Ahamad *et al.* 1995). The qualitative indices of any edible fruit are its physio chemical characteristics. The shape, size, weight, t.s.s., acidity and keeping quality are important Bhugan *et al.* (1991).

Physical and organoleptic characteristic of the fruits influence the immediate consumer appeal and the popularity of the varieties among consumers while chemical composition has a major role in its practical utility especially for processing industries.

Detailed study on different quality parameters of the selected varieties of papaya fruits were ascertained. The parameters studied included. Physical characteristics, chemical characteristics and organoleptic qualities.

Different indicators are reported to influence the quality of papaya fruit under each parameters. The various indicators analysed with respective quality parameters are given below:

3.2.1 Physical characteristics

According to Sharma (1988) the physical characteristics are found to be major determinent of quality and acceptability of different varieties of papaya fruits. Thus to pick out the superior genotypes in physical aspects the following observations were carried out as per the procedures mentioned.

Fruit weight, weight of edible protion, skin waste and seed waste were observed using an electronic balance.

Length of fruit, fruit thickness and cavity width were measured using thread and a measuring scale and expressed in centimeters.

Skin thickness was measured using screwguage.

3.2.2 Chemical and nutritioncomposition

Chemical composition is a major parameter influencing the quality of fruits (Ranjit, 1969).

In the present experiment different chemical aspects were studied using the method specified below. The different indicators ascertained under nutritional composition are:

Moisture

Moisture was determined according to the procedure outlined by the A.O.A.C. (1970).

Total soluble solids

Total soluble solids was estimated using a hand refractometer and expressed in °B/%.

Total sugars

Total sugar content was determined by using the procedure suggested by the A.O.A.C. (1960).

Reducing sugars

Reducing sugar content was estimated using the procedure suggested by A.O.A.C. (1960).

pH

pH was measured using a digital pH meter.

Vitaminc C

Vitamin C was determined by the method outlined by the A.O.A.C. (1970).

Acidity

Acidity was measured by the procedure given by the A.O.A.C. (1960).

β - Carotene

β-Carotene was estimated calorimetrically by the method suggested by Srivastava *et al.* (1994).

Pectin

Pectin was estimated by the procedure suggested by Srivastava and Kumar (1994).

Crude fibre

Crude fibre was analysed by method suggested by Reghuramulu *et al.* (1983).

Calcium

Calcium was estimated by dry ashing followed by reading in A.A.S. (Piper, 1966).

Potassium

Potassium in the ash extract was analysed using a flame photometer (Piper, 1966).

Phosphorus

Phosphorus in the ash extract estimates by measuring the yellow colour of Vanado-molybdate in Spectrometer (Piper, 1966).

Sodium

Sodium in the ash extract was analysed using a flame photometer (Piper, 1966).

Total minerals

Total minerals was estimated by applying the procedure suggested by Srivastava and Kumar (1994).

3.2.3 Organoleptic qualities

It has been recognized that enjoyment of food is a major aspect in its popularity and use.

Johns (1993) stated that for consumers the perceivable, sensory attributes, colour, appearance, feel, aroma, taste and texture are the deciding factors in food acceptance. Acceptability trials on the ten variety papaya fruits under study were carried out at the laboratory by a panel of ten judges. Panel members were selected after initial screening through a simple triangle test suggested by Jellineck (1985). Studies have indicated that a small highly sensitive panel would usually give more reliable results than a large less sensitive group (Amerine *et al.*, 1965).

From the twenty members who participated in the triangle test, ten members were selected. The selected panel members were between the age group of 20 to 25 years. Evaluation card used for the triangle test is presented in (Appendix-I). Sensory analysis of the different varieties of papaya fruits were carried out in the laboratory.

Scoring test was used for quality evaluation as suggested by Swaminathan (1974). A four point rating scale was applied for each quality. The major quality attributes includes for scoring were acceptance, colour, flavour, texture, taste and sweetness

Judges were requested to taste the ten samples and mark their respective scores. Score card on these lines were prepared and distributed among the judges. Details of the score card is presented in (Appendix-II).

Water was given in between for the removal of any after taste carried over from sample to sample. Judges were permitted to take enough time to score the samples. Scoring was conducted in the afternoon between 3 pm and 4 pm, since this time is considered as the ideal time for conducting the quality evaluationstudies (Swaminathan, 1974). The overall acceptability was also computed based on the scores for quality attributes. Organoleptic attributes of both fresh fruits as well as of the jelly prepared from the two identified varieties were studied.

3.3 Identification of superior varieties

Yadav (1997) stated that even if the variety is suitable for table purpose it may not be suitable for processing and therefore selection of suitable variety for processing will increase the ultimate quality of the product and hence by giving high returns. So identification of best varieties is utmost important in the manufacturing of any fruit based products.

The data pertaining to physical, chemical and organoleptic attributes of 10 varieties of papaya under study were subjected to discriminant function analysis. Based on the discriminant functiion analysis two superior varieties of papaya were selected.

3.4 Product development

According to Sethi (1996) most fruits are seasonal and the post harvest losses of fruits are very high mainly due to its perishable nature, she also expressed that this can be over come by developing value added fruit products. So development of fruit based recepies is very important to reduce the bulk loss of valuable fruits.

From the 10 varieties selected for the study, the two superior varieties of papaya selected based on quality evaluation were used for the development of papaya selected based on quality evaluation were used for the development of papaya based fruit product.

3.4.1 Selection of the product

Papaya fruits are used for the extraction of pectin and preparation of good quality jelly (Bawasakar, 1997 and Singh, 1990).

Nwanekezi *et al.* (1994) reported that papaya which explain a pectin content of 1 per cent and above are expected to produce good gel. Esselen (1973) pointed out that the papaya is based for making jams, jellies and marmalades.

Based on the above facts, jelly was chosen for product development from the selected superior varieties of papaya.

3.4.2 Standardisation of jelly

Ericson *et al.* (1983) states that efforts in product development and testing cover a broad spectrum. Any product that is new should be first tested insmall quantity before being used in regular production.

According to Pruthi (1977) standardisation is the yard stick which when properly used, lead to considerable improvement in quality, enhancement of productivity, reduction of costs and in optimum utilisation of available resources.

Srivastava and Kumar (1994) states that jelly is a semi solid product prepared by boiling a clear strained solution of pectin containing fruit extract free from pulp after the addition of sugar and acid.

According to Lal *et al.* (1986) the amount of sugar required for proper setting of jelly depends on the quality of pectin and acid present.

In the present trial, test papaya jellie's were prepared from the papaya extract of the selected superior varieties with three varying proportions of sugar.

To standardise jelly from the superior varieties, fruit extract sugar ratio indifferent proportions tried out were the following.

Table 2

Proportions selected for the development of jelly

Treatments	Fruit extract	Sugar	Ratio
T_1	1	1	1 : 1
T_2	1	3/4	4 : 3
T_3	1	1/2	2 : 1

The techniques followed in standardisation of jelly using papaya is detailed below.

Fruit maturity

Lal *et al.* (1986) pointed out that slightly under ripe firm fruits yields more pectin than over ripe fruits does, because as the fruits ripens the pectin present in it decomposes to pectic acid which does not form jelly with acid and sugar. Thus fruits of firm ripe stage was used for jelly preparation. In order to prevent degradation of pectin, fruits are to be processed soon after harvest. Hence jelly was prepared one to two days after harvest of papaya.

Preparation of fruit

The fruits after removing the skin and seeds are washed throughly. Fruits were then cut into small pieces, so that the acid and pectin in them could be extracted easily.

Extraction of pectin

Successful preparation of a jelly depends largely on the extent to which pectin is separated from the cell of the fruit Siddappa *et al.* (1986).

For pectin extraction small papaya pieces were boiled with water and citric acid. Citric acid was added to adjust the pH, large quantities of water for extraction was avoided. Excessive dilution of pectin would necessitate prolonged boiling which in turn would reduce the jelly strength Siddappa (1986).

To one kg of fruit one liter of water and 4 g of citric acid were added while boiling. The above were boiled for 20 minutes till all the pectin in the fruit leached out into the water. A second extract was taken using minimum water and it was combined with the first extract. Extraction was done in a stainless steel container.

Straining and clarification

The pectin extract was clarified by passing through a muslin cloth folded several times. The cloth containing the fruit extract was not squeezed because other wise the pectin would not be clear due to partic les passing through the pores in the cloth. The pectin extract was clarified by allowing the filtrate to settle overnight and the supernate liquid was drained off.

Pectin test

Following the procedure of Srivastava and Kumar (1994) and Lal *et al.* (1986) a teaspoon full of the extract was taken in a test tube and cooled. Three teaspoon full of methylated spirit was added gently along the sides of the test tube and was mixed with the extract by rotating the test tube. The mixture was then kept undisturbed for few minutes and the clot formed was observed for pectin quality.

Boiling

Three samples of jelly each were prepared from the two superior varieties by boiling the fruit extract and the specified proportions of sugar. Four g of citric acid was added per kg extract and the samples were boiled to attain desired jelly consistancy.

End point determination

End point was determined by sheet/flake test. In this test a small portion of the jelly was taken in a wooden laddle, cooled slightly and then allowed to drop off. Dripping of jelly like a syrup required further concentration, but when it fall in the form of flakes or sheet, the end point had been spotted. The temperature at which proper jellying took place was noted with the help of a thermometer.

Bottling

When the jelly was ready it was poured into clean sterile glass bottles. Care was taken not to entrap air in the jelly mass while pouring. Bottle was sealed when the product was cool.

3.5 Cost analysis

Product cost analysis of jelly samples standardised were worked out by estimating the cost of the ingredients purchased, cost of fuel, cost of bottles etc. From the total cost, cost of production per bottle of papaya jelly was calculated.

3.6 Quality assessment of jelly

Chemical characteristics and organoleptic qualities are the two main quality parameters carried out for the prepared jelly.

3.6.1 Assessment of organoleptic parameters of jelly

According to Mehony (1986) sensory quality is one of the criteria of the acceptability of any food product by the consumer. An overall quality of a product in addition to quantity and nutritional attributes also depends on the sensory quality.

Jelly prepared using the superior papaya varieties with three different fruit extract sugar ratios were assessed for their organoleptic qualities.

Sensory evaluation of the different samples of jelly prepared was done with the help of the same panel of judges mentioned for organoleptic evaluation of fresh papaya fruits. The main quality attributes evaluated on scoring of papaya jelly were appearance, taste, flavour, colour, clarity and textures. A five point scale was used for assessing each quality. The score card used for the quality evaluation of jelly is presented in (Appendix-III).

3.6.2 Assessment of chemical parameters of jelly

Chemical composition is an index generally selected to ascertain the product suitability for consumer use and to assess the processing quality are chemical tests like acidity, pH, total soluble solids, reducing sugars and total sugars. Hence these chemical components in jelly formulated were analysed as per the procedures mentioned earlier.

3.7 Confirmation with FPO requirements

Food standards for ensuring the quality and safety of natural and processed foods for human consumption have been formulated and enforced by law in different parts of the world by past several years Swaminathan (1974). The quality of the

preserved product is controlled by the government through the fruit product control order (FPO) 1955 and later modified in 1961 as fruit products (Amendment) order 1961. In the present study papaya jelly standardised using three different fruit extract sugar proportions were checked for agreement with the FPO requirements in order to identify the jelly samples that satisfy the standards.

3.8 Statistical analysis

The following statistical analysis was done for the interpretation of data collected.

ANOVA for the comparison of different varieties of papaya with respect to various quality attributes (Snedecor and Cochran, 1967).

Discriminant function analysis was employed out to determine the superior variety (Fisher, 1936).

Organoleptic characteristics of different papaya varieties were assessed using the non parametric kruskal walli's test.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The results and discussion of the study entitled "Quality analysis of papaya (*Carica papaya* L.) varieties and product development" are presented under the following headings.

4.1 Assessment of physical characteristics of different papaya varieties.

4.2 Assessment of chemical and nutritional composition of different papaya cultivars.

4.3 Organoleptic assessment of different cultivars of papaya

4.4 Discriminant function for selection of superior varieties

4.5 Determination of superior varieties for product development

4.6 Product development (jelly)

4.7 Quality assessment of papaya jelly

4.8 Cost analysis of jelly

4.9 Confirmation with FPO requirements

4.1 Assessment of Physical characteristics of different papaya varieties

Physical characteristics of papaya fruits vary widely according to the variation in cultivars and will help in easy identification of specific varieties without conducting any chemical analysis (Callaway, 1988). It has been reported that

form, size and colour of the fruit afford useful information for varietal identification. Physical parameters impose great influence on the popularity of papaya varieties among consumers.

The physical quality attributes of ten papaya cultivars selected in this study were analysed in order to learn the morphological characteristics which in turn could help in identification of the suitable varieties. The major physical characteristics assessed on ripe fruits were fruit weight, fruit length, fruit thickness, skin thickness, cavity width, skin waste, seed waste and weight of edible portion.

The physical characteristics of the ten varieties of papaya cultivars understudy are presented in Tables 3, 4 and 5.

Table 3 indicates the average fruit weight and fruit length of the selected ten papaya cultivars.

Among the fruit characteristics, physical characters differ according to the particular cultivar (Bhugan *et al.*, 1992). On analysing the average fruit weight of different varieties it was observed that the variety Coorg Honeydew recorded the maximum fruit weight (3416.00 g) and this variety was significantly different from all other varieties studied. This was followed by Pusa Delicious (2768.00 g). Waimanalo (2114.00 g) and Malaysian Long (2078.00 g) which were

significantly not different but had higher fruit weight than the remaining varieties except Pusa Majesty (2042.00 g). The lowest weight was recorded for the variety Exotic Collection-100060 (597.00g). No significant difference was observed between the varieties Malaysian Long (V_8) and Pusa Majesty (V_4) and also Washington (V_7) and Exotic Collection-100091 (V_9).

Table 3

Fruit weight and fruit length of different papaya cultivars

Treatment No.	Name of cultivar	Fruit weight (g)	Fruit length (cm)
V_1	Waimanalo	2114.00	33.33
V_2	Pusa Dwarf	989.00	26.67
V_3	Pusa Giant	1606.00	23.77
V_4	Pusa Majesty	2042.00	23.83
V_5	Pusa Delicious	2768.00	32.33
V_6	Coorg Honeydew	3416.00	26.77
V_7	Washington	1499.00	32.00
V_8	Malaysian Long	2078.00	34.67
V_9	Exotic Collection-100091	1476.00	26.50
V_10	Exotic Collection-100060	597.00	19.67
F		1612.71**	26.53**
SE		20.48	0.913
CD		60.42	2.69

**Significant at 1% level

It was observed that fruit length was more or less similar in the varieties Malaysian Long (34.67 cm), Waimanalo (33.33 cm), Pusa Delicious (32.33 cm) and Washington (32.00 cm). Length of fruit was least for Exotic Collection-100060 (19.67 cm). There was also no significant difference in fruit length among the varieties Pusa Majesty (V_4), Coorg Honeydew (V_6), Pusa Dwarf (V_2) and Exotic Collection-100091 (V_9).

Maximum fruit weight was recorded for Coorg Honeydew but its length was less. However V_1, V_5 and V_8 are better varieties both in fruit weight and fruit length. Mean while both the exotic varieties exhibited the minimum fruit weight and length. Large fruit weight and fruit size is a positive attribute for processing purpose. Auxcillia *et al.* (1996) observed the mean fruit weight of the variety Coorg Honeydew as 1100.00 g. In the present study a higher fruit weight was recorded for Coorg Honeydew. Iyer (1997), Pal *et al.* (1980) and Callaway (1988) reported that quality parameters of fruits differ due to difference in cultivars, cultivation practices and geographic conditions. According to Pal *et al.* (1980) length of a single fruit of Washingtonis 18.8 cm. Observations on fruit length for Washington in the present study was also higher.

Data on the fruit thickness, skin thickness and cavity width of different papaya cultivars are presented in Table-4.

Table-4 elucidates that fruit thickness was markedly high in Waimanalo (4.97 cm) and significantly low in Exotic Collection-100091 (1.5 cm). Fruit thickness of the remaining varieties ranged from 2.47 cm (V_{10}) to 3.93 cm (V_5). No significant difference was observed between the varieties Washington (3.53) and Malaysian Long (3.50) and also Pusa Dwarf (2.67 cm), Coorg Honeydew (2.53 cm) and Exotic collection-100060 (2.47 cm).

Waimanalo recorded the highest fruit thickness followed by Pusa Delicious and Washington. Increased fruit thickness yields a high pulp content.

Observations on the skin thickness of the papaya fruits under study (Table-4) indicate that lowest skin thickness was recorded for the variety Pusa Dwarf (0.34 mm). Varieties Waimanalo (0.59 mm), Coorg Honeydew (0.58 mm) and Pusa Delicious (0.58 mm) were on par but significantly high in comparison to the other varieties. Among the remaining varieties skin thickness ranged between 0.42 mm (V_4) to 0.53 mm (V_{10}).

Kordylas (1990) reported that papaya is covered with a thin skin ranging between 0.75 to 0.7 mm. The lowest skin thickness was noted for the variety Pusa Dwarf and higher for the variety Waimanalo. However regarding the thickness of fruit skin, there is positive and negative factors attached to

Table 4

Fruit thickness, skin thickness and cavity width of different papaya cultivars

Treatment No.	Name of cultivar	Fruit thickness (cm)	Skin thickness (mm)	Cavity width (cm)
V_1	Waimanalo	4.97	0.587	11.67
V_2	Pusa Dwarf	2.67	0.340	7.67
V_3	Pusa Giant	3.10	0.477	9.53
V_4	Pusa Majesty	3.00	0.417	9.97
V_5	Pusa Delicious	3.93	0.577	9.77
V_6	Coorg Honeydew	2.53	0.583	7.23
V_7	Washington	3.53	0.453	5.00
V_8	Malaysian Long	3.50	0.433	4.53
V_9	Exotic Collection-100091	1.50	0.477	6.53
V_10	Exotic Collection-100060	2.47	0.533	4.47
F		333.44**	334.40**	425.37**
SE		0.052	0.0045	0.124
CD		0.152	0.0132	0.365

**Significant at 1% level

the less thickness. On the positive side it shows that the thin skinned varieties are better suited for processing as they enable to minimise the total wastage on fruit, thus making thin skin of Pusa Dwarf to be advantageous. Mean while damage due to transportation and handling could be maximum for the varieties having thin skin, which turns to be disadvantageous.

On analysing the fruit cavity width of ten different varieties of papaya it was observed that the variety Exotic Collection-100060 recorded the lowest cavity width (4.47 cm) and Waimanalo (11.67 cm) recorded the highest cavity width. In the remaining varieties the cavity width ranged from 4.5 cm (V_3) to 9.57 cm (V_4). On observing the remaining data, it was found that the cavity width of Pusa Majesty (V_4) and Pusa Delicious (V_5) and also Exotic Collection-100060 (V_{10}) and Malaysian Long (V_8) were statistically on par.

Large cavity width minimises the flesh thickness and is a negative attribute for economic prospects as the pulp yield for fruit could be low. The lesser cavity size observed in Exotic Collection-100060 in the present study can be attributed to its comparative smaller size also.

Data obtained on skin waste, seed waste and weight of edible portion of ten different varieties of selected papaya cultivars are depicted in Table-5.

Table 5

Skin waste, seed waste and weight of edible portion of papaya cultivars

Treatment No.	Name of cultivar	Skin waste (g)	Seed waste (g)	Weight of edible portion(g)
V_1	Waimanalo	311.00	121.00	1681.67
V_2	Pusa Dwarf	41.00	57.33	904.33
V_3	Pusa Giant	34.33	45.33	1526.00
V_4	Pusa Majesty	162.00	104.33	1776.00
V_5	Pusa Delicious	224.33	17.33	2526.67
V_6	Coorg Honeydew	61.00	108.67	3246.33
V_7	Washington	133.33	23.67	1349.00
V_8	Malaysian Long	141.67	26.00	1910.00
V_9	Exotic Collection-100091	54.00	64.00	1357.67
V_10	Exotic Collection-100060	24.33	65.47	506.67
F		859.17**	160.18**	1963.62**
SE		3.22	2.94	17.55
CD		9.50	8.69	51.79

**Significant at 1% level

The data obtained for skin waste (Table-5) shows that skin waste was low in the varieties Exotic Collection-100060 (24.33 g) followed by Pusa Giant (34.33 g), Pusa Dwarf (41.00 g). Exotic Collection-100091 (54.00 g) and Coorg Honeydew (61.00 g). In the remaining varieties wastage by skin ranged from 133.33 g to 311.00 g. Higher skin wastage was observed for the variety Waimanalo.

Pal *et al.* (1980) reported that the peel percentage for Coorg Honeydew was 6.7 g and that for Washington as 8.5 g. Lesser wastage from skin observed in varieties V_{10}, V_3, V_2 and V_9 is a welcome quality of papaya fruit for both table as well as for processing requirements. Where as the higher skin wastage present in variety Waimanalo makes it less preferable for industrial purpose with regard to the economic advantage.

Results of the data presented in (Table-5) reveals that seed wastage was low in the variety Pusa Delicious (17.33g) followed by Washington (23.67g) and Malaysian Long (26.00g) which were on par. The maximum seed waste was recorded for the variety Waimanalo (121.00 g) followed by Coorg Honeydew (108.69g) and Pusa Majesty (104.33g). There was also no significant difference between the varieties V_2, V_9 and V_{10}.

Auxcilia *et al.* (1996) reported that Pusa Delicious and Washington exhibited a seed wastage of 64.96 and 76.23 g

respectively. Pusa Delicious recorded the least seed wastage which is more beneficial for processing as well as for table purpose. Observations also reveal that both seed and skin wastage was high for the variety Waimanalo.

Knowledge on the extent of edible quality present in various fruits is of utmost important for a processor. Data regarding the weight of edible portion studied among 10 varieties (Table-5) highlighted that variety Coorg Honeydew was significantly superior (3246.33g) to the other varieties followed by Pusa Delicious (2526.7g). The least edible portion weight was recorded by Exotic Collection-100060 (506.67g). In the remaining varieties the weight ranged from 904.33 to 1910.00 g. There were significant difference between the varieties except Washington (V_7) and Exotic Collection-100091 (V_9).

Sannigrahi *et al.* (1995) reported that weight of edible portion was high for the variety Coorg Honeydew. The least wastage was accounted to this particular cultivar which in turn resulted in maximum edible portion yield. Decreased wastage increases the pulp yield percentage. It was also observed from the above data that fruit weight was high for this variety. It was found that increased fruit weight contributed higher quantity in the edible portion as well.

From the above details on physical characteristics of the selected papaya varieties it could be stated that Coorg Honeydew was the comparatively heavier fruit followed by Pusa Delicious. The appreciably large fruited varieties identified were Malaysian Long, Waimanalo, Pusa Delicious and Washington. Waimanalo posessed a remarkably thicker pericarp. The varieties Exotic Collection-100091, Exotic Collection-100060, Pusa Delicious and Pusa Dwarf showed better position with regard to less cavity size and also minimum wastages from seed volume and skin volume. Skin thickness was also found thinner in the above varieties. Coorg Honeydew revealed to be the excellent variety for its relative merit in relation to edible portion. While Exotic Collection-100060 showed a poor grade regarding the weight of edible portion, weight and length of the fruit. Observation also reveal that cavity width, skin wastage, seed wastage and skin thickness were higher in the variety Waimanalo. Skin thickness was comparatively more in cultivars, viz. Coorg Honeydew and Pusa Delicious. This aspect even though contributes to wastage, it has been identified as a positive quality for shelf life and minimising damage while handling.

From the above observations, it may be concluded that the Pusa Delicious is the best variety for processing based on its superior position in qualities like higher fruit weight, maximum edible portion, better fruit length and low seed and

skin wastages. For any fruit minimum wastage is a mark of higher per cent pulp yield. The variety Coorg Honeydew stands close to Pusa Delicious with remarkably good position in fruit weight, weight of edible portion, and satisfactory in its qualities viz. fruit length, cavity width and skin wastage. Malaysian Long and Waimanalo are the next two varieties that possessed good physical qualities. Among these Malaysian Long exhibited appreciable fruit length, higher edible portion along with having lesser cavity width, seed waste and skin thickness. The fruits of Waimanalo recorded, good weight better length and thick pericarp. For consideration of a papaya variety for processing, Washington stands a fair chance.

4.2 Assessment of chemical and nutritional composition of different papaya cultivars

Chemical composition is a major parameter influencing the quality of fruits (Rejit, 1969). Bose (1990) ascertained that the chemical composition of the fruit in general differs with the cultivar and the stage of maturity. In the present observation on papaya varieties, fruit qualities were determined by analysing the various chemical components of fully ripened fruits. The fruits were analysed for determination of acidity, pH, moisture, total sugar, reducing and non-reducing sugars, total soluble solids, β-carotene, fibre, pectin and mineral consistuents.

The proximate value obtained for total sugar, reducing sugar and non-reducing sugar of selected varieties of papaya are depicted in Table-6.

Presence of total sugar is an indication of sweetness. The total sugar content of the ripe papaya fruit was highest in the variety Washington (11.84%) followed by Pusa Delicious (10.77%) and Coorg Honeydew (10.53%). In the remaining varieties the percentage of total sugar ranged from 8.42 to 10.14 per cent and the lowest value was recorded for the variety Pusa Dwarf (7.27%). The variety Pusa Delicious and Coorg Honeydew and also Pusa Majesty and Malaysian Long were on par.

Pal *et al.* (1980) reported that composition of sugars present in papaya is important in evaluating a variety for special purpose. Among the ten cultivars Washington was recorded to have maximum amount of total sugars. Pusa Delicious and Coorg Honeydew were also graded as sweet varieties. Hence these varieties can be suggested for product development and so also for table use considering the total sugar content. Auxcilia *et al.* (1994) observed that the total sugar content for the papaya varieties Washington. Pusa Delicious and Coorg Honeydew were 9.56, 10.24 and 11.97 per cent respectively. The presence of higher per cent total sugar is an indication of more sweetness in papaya fruit. An increase in total sugar content may also elevate the shelf life period of the product.

Table 6

Total sugar, reducing sugar and non-reducing sugar of papaya cultivars

Treatment No.	Name of cultivar	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
V_1	Waimanalo	9.21	8.04	1.18
V_2	Pusa Dwarf	7.27	6.57	0.69
V_3	Pusa Giant	8.43	8.27	0.16
V_4	Pusa Majesty	8.83	8.19	0.65
V_5	Pusa Delicious	10.77	9.85	0.95
V_6	Coorg Honeydew	10.53	8.69	1.84
V_7	Washington	11.84	11.34	0.50
V_8	Malaysian Long	8.73	8.42	0.31
V_9	Exotic Collection-100091	10.14	9.58	0.56
V_{10}	Exotic Collection-100060	9.81	9.35	0.46
F		184.45**	220.06**	165.58**
SE		0.098	0.087	0.038
CD		0.289	0.255	0.112

**Significant at 1% level

Estimation of the reducing sugar content of different varieties of papaya (Table-6) reveals that lowest reducing sugar was recorded for the variety Pusa Dwarf (6.5%) followed by the varieties Waimanalo and Pusa Majesty. The highest reducing sugar was recorded for the variety Washington (11.34%). In the other samples, reducing sugar level ranged from 8.27 to 9.85 per cent. Statistical analysis of the data revealed that the varieties Malaysian Long, Pusa Giant and Pusa Majesty were on similar levels with respect to reducing sugars.

It was noted that the variety Pusa Dwarf possessed the lowest reducing sugar level among the ten cultivars. A report by Singh (1990) states that the variety Pusa Dwarf contains (6.3%) of reducing sugar per 100 g. Generally, the low reducing sugar content denotes a stability in the sweetness of ripe fruits. Waimanalo and Pusa Majesty were also low in reducing sugar while Washington existed to be the variety containing highest reducing sugar level.

Considering the non-reducing sugar, it was evident from the data that the amount ranged from 0.63 to 1.84% among the varieties under study. Non-reducing sugar was found maximum in the variety Coorg Honeydew (1.84%) and minimum for the variety Pusa Giant (0.63%). It was observed that the non-reducing sugar level of Exotic Collection-100091 (V_9); Washington (V_7) and Exotic Collection-100060 (V_{10}) were on par.

Arriola *et al.* (1980) opined that more sweetness in papaya is due to the presence of increased level of sugar. Coorg Honeydew being of the highest composition of non reducing sugar among the ten varieties, could retain its sweetness throughout the shelf period. However in a report by Auxcilia and Sathiamoorthy (1997) the non-reducing sugar for the variety Coorg Honeydew was found to be at a level of only 0.32 per cent. Waimanalo and Pusa Delicious are the other varieties containing more share of stable sugar. Higher amount of non-reducing sugar is indicative of minimum fluctuations in sweetness of its products and also helps to increase the storage life of the product.

The values on total soluble solids content among ten papaya varieties ranged from 8.23 to 13.73 per cent. Significant difference in total soluble solids were observed between the varieties selected. The highest value was obtained for the variety Washington (13.73%) followed by Pusa Delicious (13.03%) and Coorg Honeydew (12.73%), while Pusa Dwarf remained to be the lowest with 8.23 per cent total solids. Statistical analysis of the data proved that the variety Pusa Majesty (V_4) was on par with the variety Malaysian Long (V_8).

The comparatively high total solids present in Washington, Pusa Delicious and Coorg Honeydew is a favourable quality for exploitation of these varieties for product

Table 7

Total soluble solids and moisture of different papaya cultivars

Treatment No.	Name of cultivar	Total soluble solid (Per cent)	Moisture (Per cent)
V_1	Waimanalo	10.37	90.23
V_2	Pusa Dwarf	8.23	88.63
V_3	Pusa Giant	8.77	89.37
V_4	Pusa Majesty	9.33	89.07
V_5	Pusa Delicious	13.03	87.33
V_6	Coorg Honeydew	12.73	89.17
V_7	Washington	13.73	88.43
V_8	Malaysian Long	9.27	89.23
V_9	Exotic Collection-100091	11.78	89.33
V_10	Exotic Collection-100060	10.42	89.47
F		562.97**	69.41**
SE		0.082	0.101
CD		0.241	0.297

**Significant at 1% level

development. According to Singh (1990) and Auxcilia *et al.* (1997) the total solid content of Washington is 10.6 per cent and Pusa Delicious is 10.8 per cent respectively. Pal *et al.* (1980) opined that high total soluble solids in fruit is a positive attribute for the quality of desert prepared from it. Increase in total soluble solids again improves the overall quality of the fruit.

Analysis of the moisture content of the different papaya cultivars included in the study (Table-7) gives a percentage value ranging from 87.33 to 90.23. The variety Waimanalo recorded maximum juiciness as per its moisture level (90.23%) and the minimum water content was recorded in the variety Pusa Delicious (87.33%). It was found that the varieties V_3, V_4, V_7, V_6, V_9 and V_8 were on par.

Observation on the moisture content proved that all the varieties exhibited almost good moisture level. Srivastava and Kumar (1994) opined that the moisture content in ripe papaya is 90.8 per cent. Higher moisture content is reported to reduce the pulp percentage in fruits. However, higher amount of moisture content establishes it suitability for the preparation of fresh juice and many other beverages.

The acidity and pH of the different papaya varieties are presented in the Table-8.

Table 8

Acidity and pH of different papaya cultivars

Treatment No.	Name of cultivar	Acidity (%)	pH
V_1	Waimanalo	0.133	5.51
V_2	Pusa Dwarf	0.207	5.07
V_3	Pusa Giant	0.183	5.44
V_4	Pusa Majesty	0.143	5.50
V_5	Pusa Delicious	0.063	5.85
V_6	Coorg Honeydew	0.077	5.73
V_7	Washington	0.073	5.04
V_8	Malaysian Long	0.213	5.04
V_9	Exotic Collection-100091	0.093	5.67
V_10	Exotic Collection-100060	0.123	5.60
F		5.95**	298.66**
SE		0.023	0.016
CD		0.067	0.047

**Significant at 1% level

The acidity level was almost similar in most of the varieties. The value was noted slightly higher in Malaysian Long (0.213%) followed by Pusa Dwarf (0.207%) and Pusa Giant (0.183%) and found statistically on par. Acid content of the remaining varieties also were more or less closer to the above levels.

Higher acidity in fruits lowers its perishability. A good acid sugar blend also enables the fruit to be tastier. According to Arriola *et al.* (1975) acidity in papaya is very low compared to other fruits and suggested that this low acid fruit can be blended with high acid fruits for preparation of products from it. From the varieties studied it was found that the acid content of the ten varieties do not vary widely, however the fruits of Malaysian Long, Pusa Dwarf and Pusa Giant have comparably better acid per cent than the other varieties.

pH is a measure of the extent of acidity or alkalinity of the product. The data on pH of different papaya varieties evidenced that there was significant variation in pH and the values ranged from 5.04 (V_8) to 5.85 (V_5). pH values were lower in Malaysian Long (5.04) and Pusa Dwarf (5.07). Varieties Pusa Giant (5.44), Pusa Majesty (5.50) and Waimanalo (5.51) remained on par. Slightly higher pH values were observed in the varieties Pusa Delicious (5.85), Washington (5.79), Coorg Honeydew (5.73), Exotic Collection-100091 (5.67) and Exotic Collection-100060 (5.60).

Vitamin-C and β-carotene content of different varieties of papaya are presented in Table-9.

Vitamin-C content of different papaya fruits ranged from 49.13 to 69.06 mg (Table-9). The comparative data indicated that the highest vitamin-C level was found in the variety Pusa Delicious (69.06 mg) followed by Pusa Majesty (67.29 mg), Exotic Collection-100091 (63.68 mg) and Washington (61.73 mg). The Vitamin-C level of Pusa Giant was the lowest (49.13 mg). Statistical analysis of the data revealed that significant difference exist between the varieties.

Wood Roof and Luck (1975) stated that papaya fruits are rich sources of vitamin-C. According to Arriola *et al.* (1980) papaya is the only fruit that shows increase in vitamin-C during ripening. High level of vitamin-C enriches the nutritive value of this fruit and thereby its products. The high vitamin-C composition of Pusa Delicious and Pusa Majesty makes these varieties distinguishly superior to the others. Study conducted by Auxcilia *et al.* (1994) also reported a vitamin-C content of 66.70 mg in Pusa Delicious and this result is in accordance with the present study.

Observations on the β-carotene status of papaya in the present study indicated that a significantly high level of carotene present in Pusa Delicious (2488.76 µg) followed by the varieties V_{10}, V_9, V_8, V_6 and V_3. Among the cultivars studied

Table 9

Vitamin-C and β carotene of different papaya cultivars

Treatment No.	Name of cultivar	Vitamin-C (mg)	β carotene (µg)
V_1	Waimanalo	56.14	1866.57
V_2	Pusa Dwarf	57.37	1312.23
V_3	Pusa Giant	49.13	1896.36
V_4	Pusa Majesty	67.27	1249.35
V_5	Pusa Delicious	69.06	2488.76
V_6	Coorg Honeydew	59.03	1969.17
V_7	Washington	61.73	1098.76
V_8	Malaysian Long	54.13	1989.02
V_9	Exotic Collection-100091	63.68	2015.50
V_{10}	Exotic Collection-100060	56.12	2161.12
F		9450.90**	287.90**
SE		0.199	2.608
CD		0.588	7.693

**Significant at 1% level

the comparatively lower value was found in Washington (1098.76 µg). The amount of β-carotene in the remaining varieties ranged from 1249.35 ug (V_4) to 1866.57 ug (V_{10}). Statistically there existed a significant difference between the varieties in β-carotene composition.

Rice *et al.* (1992) found that β-carotene in papaya is 1000 IU per 100 ug meanwhile the deep yellow coloured varieties possess even higher amount of β-carotene. In the present evaluation Pusa Delicious was highly pigmented and existed to be superior in its β-carotene composition. Varieties like Exotic collections, Malaysian Long and Coorg Honeydew also have appreciably higher content of this important nutrient factor. Therefore these varieties besides their significance as table fruits cam be use especially as a supplementary food for vitamin-A, are worthly enough to recommend for processing purpose as they impart an attractive colour to products even without adding artificial colour as required in the case of most of the fruits.

Fibre and pectin content of ten different cultivars of papaya are presented in Table-10.

Analysis of the fibre content disclose that statistically there was a variation in fibre levels of the fruits and the values in different varieties ranged from

Table 10

Fibre and pectin content of different papaya cultivars

Treatment No.	Name of cultivar	Fibre (%)	Pectin (%)
V_1	Waimanalo	0.673	1.123
V_2	Pusa Dwarf	0.713	0.967
V_3	Pusa Giant	0.813	1.377
V_4	Pusa Majesty	0.645	1.132
V_5	Pusa Delicious	0.697	1.823
V_6	Coorg Honeydew	0.777	1.603
V_7	Washington	0.727	1.619
V_8	Malaysian Long	1.093	1.753
V_9	Exotic Collection-100091	0.544	1.077
V_{10}	Exotic Collection-100060	0.547	1.347
F		19.336**	163.396**
SE		0.036	0.024
CD		0.105	0.070

**Significant at 1% level

0.544 to 1.093 per cent. Exotic Collection-100091 (V_9) and Exotic Collection-100060 (V_{10}) were the varieties with minimal fibre content. The varieties V_4, V_1, V_5, V_2 and V_7 also remained to be low fibre varieties and were on par. Malaysian Long (V_8) recorded the maximum fibre content among the varieties under study.

ICAR (1967) emphasised that the fibre content is a determining determining factor in the fruit quality which may vary from 0.02 to 0.2 per cent. Studies conducted in papaya by Srivastava and Kumar (1994) revealed that fibre content of papaya is 0.8 per cent. Varieties with low fibre composition are suitable for processing into jellies, marmalales, syrups, juices, nectars etc. Most of the varieties evaluated were low fibre types and therefore could be utilized in fibre free recipes. At the same time papaya varieties with more fibre constituents are particularly suitable for the preparation of fruit bar/leather etc. Malaysian Long which contained more fibre among the ten varieties could be identified for formulation of the above products.

As indicated in the Table-10 the pectin content was maximum in the variety Pusa Delicious (1.823%) followed by Malaysian Long (1.753%). The pectin composition of Washington (1.619%) and Coorg Honeydew (1.603%) were also comparatively

high. The lowest share of pectin was found in Exotic Collection-100091 (1.077%) and Pusa Dwarf (0.967%). Percentage of pectin in the other varieties ranged from 1.123 to 1.377 per cent.

Nwanekezi *et al* (1994) observed that pectin content in papaya is 1.0 per cent and above. Increased pectin content in fruits is a positive attribute for making jam, jellies and marmalades. Results of the present study highlighted that the variety Pusa Delicious, Malaysian Long, Washington and Coorg Honeydew could be wisely utilized for the preparation of jam, jellies etc. in view of their high pectin content. The superior quality and good texture of jelly depend on its balanced pectin, sugar and acid ratio.

4.2.1 Mineral composition of different papaya samples

Pal *et al*. (1980) stressed that varieties with maximum concentration of minerals are superior in their nutritional quality. Bose *et al.* (1993) pointed out that the principal minerals in papaya are calcium, thiamine, riboflavin, iron, potassium, sodium and phosphorus.

In the present study mineral constituents in different varieties of papaya were assessed with regard to their calcium, sodium, potassium, phosphorus and total ash content. The data obtained is presented in Table-11.

Table 11

Mineral constituents of different varieties of papaya (mg/100g)

Treatment No.	Name of cultivar	Calcium (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Total mineral (mg)
V_1	Waimanalo	25.20	8.37	210.83	13.27	0.53
V_2	Pusa Dwarf	17.53	11.87	214.30	12.34	0.46
V_3	Pusa Giant	25.53	6.47	213.20	13.30	0.51
V_4	Pusa Majesty	19.41	12.83	207.07	14.17	0.64
V_5	Pusa Delicious	18.43	7.53	217.00	17.07	0.52
V_6	Coorg Honeydew	24.20	9.94	211.10	13.47	0.53
V_7	Washington	25.33	8.33	218.23	16.90	0.63
V_8	Malaysian long	23.12	9.74	215.40	14.73	0.49
V_9	Exotic Collection-100091	25.30	8.83	219.67	15.55	0.65
V_{10}	Exotic Collection-100060	24.30	9.23	219.10	16.11	0.54
F		423.23**	97.40**	365.45**	53.49**	12.55**
SE		0.146	0.193	0.214	0.226	0.018
CD		0.431	0.569	0.632	0.66	0.055

**Significant at 1% level

The values indicate that the high calcium containing varieties were Pusa Giant (25.53 mg), Washington (25.33 mg), Exotic Collection-100091 (25.30 mg) and Waimanalo (25.20 mg) and these existed statistically on par. Exotic Collection-100060 and Coorg Honeydew were also found to be varieties with partly high calcium level. Composition of other varieties remained at a range from 17.53 mg (V_3) to 23.13 mg (V_8). Base *et al.* (1993) pointed out that calcium content in Pusa Delicious is 28 mg per 100 g pulp.

With regard to sodium content Pusa Majesty recorded maximum value (12.83 mg) followed by Pusa Dwarf (11.87 mg). Sodium level in Coorg Honeydew, Malaysian Long and Exotic Collection-100060 were also good. A variation of 8.83 mg to 6.47 mg of sodium was recorded in the other papaya fruits. Pusa Giant being the lowest in this mineral level.

Potassium is reported to be the most abundant mineral in fruits (Arriola *et al.*, 1980). Considering the value of the potassium content of different varieties (Table-11) it can be assumed that Exotic Collection-100091 (V_9) and Exotic Collection-100060 (V_{10}) represent the maximum levels (above 219.00 mg) which were on par and closely followed by Washington and Pusa Delicious. Lower values were recorded for the varieties Pusa Majesty (207.07 mg) and Waimanalo (210.83 mg). Studies by Pal *et al.* (1980) showed that the potassium content of variety Coorg Honeydew is 209.00 mg and a reasonably higher value was obtained in the present experiment.

The phosphorus content of the different papaya fruits analysed (Table-11) proved that Pusa Delicious (V_5) possessed a distinguishly high phosphorus composition (17.00 mg). The Exotic varieties and Washington were comparably high in this mineral concentration (16.11 to 15.55 per cent). Phosphorus content was lowest in Pusa Dwarf (12.34 mg). In the remaining varieties phosphorus content was obtained in the range 16.11 to 13.27 mg.

Pal *et al.* (1980) reported that in Thailand variety papaya the phosphorus content is as low as 4.39 per cent. However phosphorus levels in cultivars included in this investigation were found to be above 13 mg except Pusa Dwarf.

Focussing on the data on total mineral level (Table-11) it could be learnt that the varieties Exotic Collection-100091 (V_9), Pusa Majesty (V_4) and Washington (V_7) carried higher per cent (0.63 to 0.65) mineral concentration. The varieties Pusa Dwarf (V_2) and Malaysian Long (V_8) were observed to be low (0.46 to 0.49 per cent). While Pusa Giant, Coorg Honeydew, Pusa Delicious, Waimanalo and Exotic Collection-100060 were found to be at a fairly good mineral level ranging between 0.51 to 0.54 per cent. The varieties that are higher in mineral percentage have better index as health promoting agent.

Bose (1990) ascertained that the composition of the fruit in general differs with the cultivar and stage of maturity. On critically analysing the pooled data on chemical constituents the information proves that the variety Pusa Delicious possess the top position with regard to total sugar, total soluble solids, non-reducing sugar, vitamin-C, B-carotene pectin and phosphorous. The variety Coorg Honeydew carried a remarkably high total soluble solid; total sugar, Non-reducing sugar, pH, fibre, vitamin-C, pectin and B carotene levels. A good perentage of total sugar, total soluble solids and phosphorus was noted in the variety Washington. Pusa Majesty exhibited a better level of sodium. The two Exotic Collections of papaya were noted for appreciable amounts of B-carotene and potassium. It was noted that appreciable levels of calcium was recorded for the varieties Washington, Exotic Collection-100091 and Waimanalo. Acidity was comparatively high for the variety Malaysian Long and accordingly pH was low for this variety. It was found that acidity and moisture was low for the variety Pusa Delicious. Observations also revealed that the total sugars, pH, pectin, B-carotene, calcium, phosphorus and total minerals were low for the variety Pusa Dwarf.

To arrive at conclusion it could be stated that Pusa Delicious was ranked as the best variety for processing based on its superior chemical qualities like higher total sugar, non reducing sugar, total soluble solids, vitamin-C, pH, pectin,

β-carotene and phosphorus. The variety Coorg Honeydew was next to Pusa Delicious with its appreciable qualities like high total sugar, non reducing sugar, total soluble solids, pH, fibre, moisture, vitamin-C, pectin, β-carotene and calcium. A remarkably good total sugar, total soluble solids, pH, pectin, calcium, potassium and phosphorus, was noted for the variety Washington, Exotic Collection-100060 and Exotic Collection-100091 are also good varieties for processing when assessed for its chemical parameters.

4.3 Assessment of organoleptic qualities of different papaya cultivars

Among the different parameters organoleptic qualities and physical parameters influence the consumers appeal immediately. Almedia and Noguiria (1995) stated that organoleptic properties determine acceptance of food by the consumer with appearance being the first factor that determine the acceptance or rejection of a food and colour is a fundamental characteristics of appearance.

Acceptability trials were carried out on the ten different varieties of papaya fruit in order to study their sensory qualities. Sensory evaluation was carried out by a panel of ten judges applying a four point scale on each quality parameters. The attributes judged were appearances, taste, colour, flavour, texture and sweetness. The results

highlighted in Table 12 are based on the rank means obtained for each quality parameters evaluated organoleptically by the ten judges.

According to Manay and Sudhakaraswamy (1987) first impression of a food is usually visual and a major part of our willingness to accept a food depends on its appearance. Birch (1977) stated that appearance is the compound of all, information about the product and its environment which reaches the eye.

The results given in Table-12 indicate that rank means obtained for appearance ranged between 21.00 and 5.67. The varieties Pusa Dwarf, Pusa Majesty and Washington obtained a higher rank mean of 21.00. These varieties were more attractive in appearance than the variety Waimanalo and were on par with other varieties. The least preference in appearance as per the score of judges was for the variety Waimanalo.

The varieties Pusa Dwarf, Pusa Majesty and Washington ranked superior in appearance. It was also noted that these varieties possessed an attractive colour. Therefore it could be assumed that colour appeal may be the main parameter that influenced appearance. The Waimanalo having light orange colour ranged low in this quality.

Table 12

Organoleptic assessment of different cultivars of papaya
(Rank means for quality attributes)

Treatment No.	Name of cultivar	Appearance	Flavour	Taste	Colour	Texture	Sweetness
V_1	Waimanalo	5.67^{a}	10.50^{a}	13.00^{ab}	8.00^{a}	11.50^{ab}	11.50^{ab}
V_2	Pusa Dwarf	23.00^{b}	10.50^{a}	13.00^{ab}	26.00	5.17^{a}	8.99^{a}
V_3	Pusa Giant	15.00^{ab}	10.50^{a}	5.67^{a}	11.50^{a}	11.50^{ab}	8.99^{a}
V_4	Pusa Majesty	23.00^{b}	10.50^{a}	14.00^{ab}	26.00	10.50^{ab}	11.50^{ab}
V_5	Pusa Delicious	16.50^{ab}	25.50^{b}	25.33^{b}	11.50^{a}	26.50^{b}	26.50^{b}
V_6	Coor Honeydew	16.50^{ab}	15.50^{ab}	21.00^{b}	11.50^{a}	25.17^{b}	26.83^{b}
V_7	Washington	23.00^{b}	25.50^{b}	25.00^{b}	26.00	26.50^{b}	26.50^{b}
V_8	Malaysian Long	12.00^{ab}	10.50^{a}	13.00^{ab}	11.50^{a}	10.50^{ab}	11.50^{ab}
V_9	Exotic Collection-100091	12.00^{ab}	20.50^{ab}	13.00^{ab}	11.50^{a}	11.50^{ab}	11.50^{ab}
V_{10}	Exotic Collection-100060	8.33^{ab}	15.50^{ab}	13.00^{ab}	11.50^{a}	16.17^{ab}	11.50^{ab}
	χ^2_a	17.8^{*}	20.3^{*}	23.4^{*}	27.6^{*}	22.6^{*}	23.5^{*}
	Critical value	14.09	14.09	14.09	14.09	14.09	14.09

* Significant at 5% level
Rank means followed by common letter are not significantly different

Flavour is a complex sensation comprising mainly of colour, taste and odour being more important (Sharma and Wani (1995). Regarding the flavour component of different papaya varieties (Table 12) Pusa Delicious and Washington were superior to Waimanalo, Pusa Dwarf, Pusa Giant, Pusa Majesty, Malaysian Long and on par with Coorg Honeydew, Exotic collection - 100060 and Exotic collection - 100091.

Sannigrahi *et al.* (1995) hypothesised that the variety Pusa Delicious with excellent flavour is becoming popular among the north eastern regions. Singh (1980) proclaimed that the variety Washington is sweet and have good flavoured. Generally papaya is an almost neglected fruit for the purpose of processing mainly due to its unacceptable odour. But at present there are many varieties that are not only devoid of the characteristic papaya odour but also possess an appealing flavour. Pusa Delicious, Washington, Coorg Honeydew and Exotic varieties were found to be such varieties that have excelled in their flavour attribute. Hence these varieties could be better utilised for preparation of acceptable papaya products and propagated in a wider scale.

According to Krammer and Twigg (1970) taste is the primary and most important quality among various attributes. When different papaya varieties were scored for judging its taste, the varieties Pusa Delicious, Washington and Coorg Honeydew were found superior to Pusa Giant and on par with the

varieties V_2, V_4, V_1, V_8, V_9 and V_{10}, showing good taste appeal. Among the ten different varieties studied least taste appeal was found for the variety Pusa Giant (V_3). However no significant difference was found among the varieties in taste except V_3.

Arriola *et al.* (1980) reported that the variety Pusa Delicious, Washington and Coorg Honeydew have good taste and flavour. Taste is a combination of sweetness and flavour. The results of the prresent study also indicate that taste of Pusa Delicious and Washington were excellent in taste and flavour.

Sharma *et al.* (1995) stated that colour scores were significantly related with acceptability when the colour attributes was taken in to consideration. It is inferred that colour of Pusa Dwarf, Pusa Majesty and Washington were more attractive than the other varieties. These varieties obtained a rank mean of 26.00, while the remaining varieties except Waimanalo (V_1) attained a rank mean of 11.50. The least rank mean was obtained for the variety (V_1).

Food digest (1997) indicate that papaya has natural colour and requires no artificial colouring for product preparation. Colour of food always contribute immeasurably to ones appreciation. The varieties, Pusa Dwarf, Pusa Majesty and Washington were found to be more attractive due to their dark reddish and purplish colour while the light orange colour found

in other cultivars was less appealing to judges. Singh (1990) reported that the variety Washington has a purplish colour. The colour of Waimanalo had a comparatively lesser preference in evaluation.

According to Matzl (1962) texture has long been recognised as an important element in the total sensory impression obtained during the consumption of a food. It is evident from the results (Table-12) that the texture of the varieties Pusa Delicious, Coorg Honeydew and Washington were superior to Pusa Dwarf. Texture of remaining varieties were also good except Pusa Giant (V_1). Statistically no significant difference was observed between varieties except (V_1).

Texture is the property of food which is associated with the sense of feel or touch experienced by the finger or the mouth. Kordylas (1990) reported that fleshy edible parts of papaya has better consistency and its soft texture reduces the harness of the flesh. Coorg Honeydew, Washington and Pusa Delicious being soft textured varieties could be well utilized for making jam, juice and other beverages.

Regarding the sweetness of ten different varieties of papaya, the varieties Pusa Delicious, Coorg Honeydew and Washington were more sweeter varieties than Pusa Dwarf and Pusa Giant and were on par with other varieties. Sweetness was

comparatively less in papaya varieties Pusa Dwarf (V_2) and Pusa Giant (V_3).

Arriola *et al.* (1980) reported that the varieties Pusa Delicious, Coorg Honeydew and Washington are good for their desirable sweetness and taste. Results of the present study is in tune with the above statement. It was also noted that the varieties having high total sugar content were forced to be higher in sweetness also.

What ever be the difference we observe in rank means are merely due to sampling variation but not due to varietal difference except for those explained above.

The results on organoleptic evaluation indicated that the variety Washington is a promising variety for processing when organoleptic aspects alone were considered. This variety performed maximum rank for all characteristics tested like appearance, flavour, taste, colour, texture and sweetness, which are highly contributing factors for table use and for processing purposes. The variety Pusa Delicious was also remarkably good which received highest sensory appeal for flavour, taste, texture and sweetness along with its fairly good performance in appearance. The statement by Singh (1990) in support of the present results who found that the varieties Washington and Pusa Delicious are very suitable for

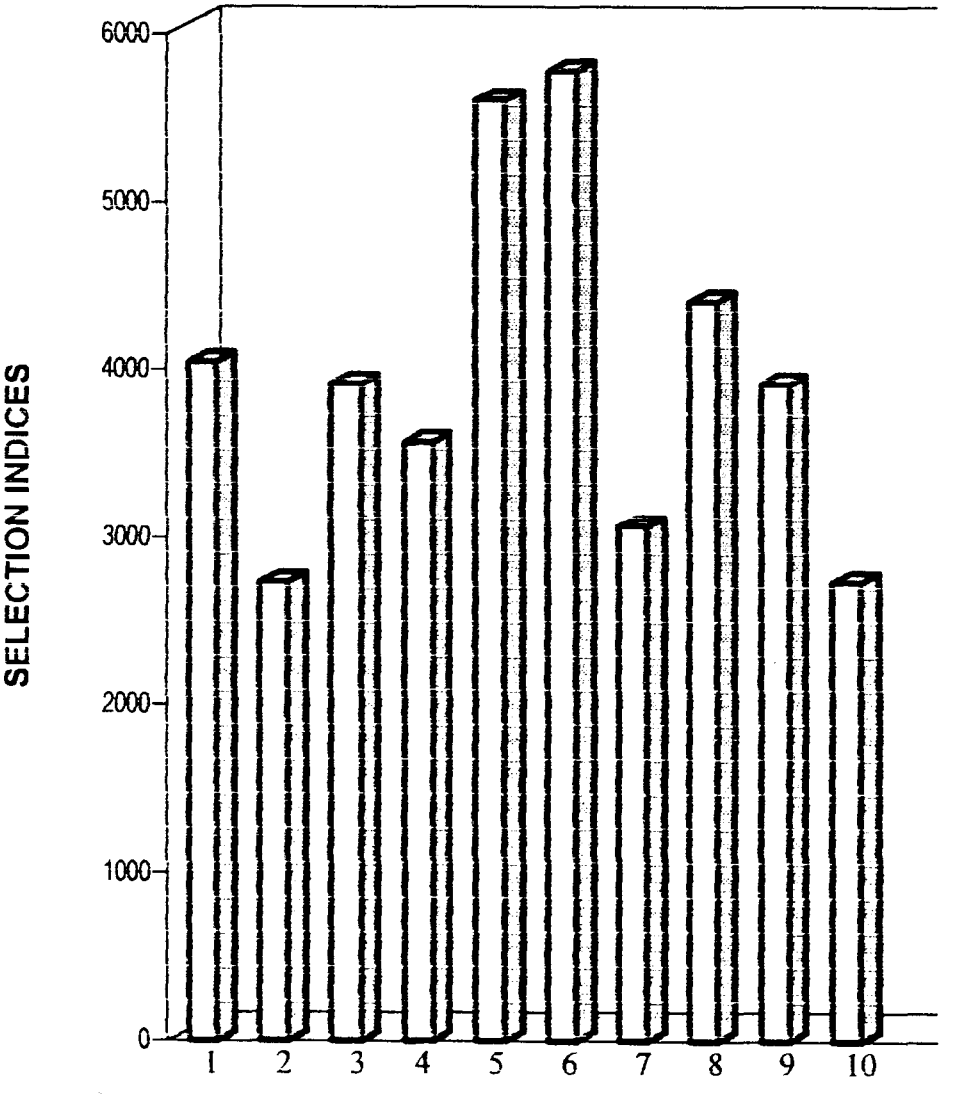
processing due to their superior qualities. The fruits of Coorg Honeydew and Pusa Majesty remained closer to Pusa Delicious in the various organoleptic attributes and over all performance.

4.4 Discriminant function for selection of superior varieties

Polovynov (1985) reported that variations exists in bio chemical constituents within and between species and this may be due to difference in genotypes, cultural practices and ecological conditions. According to Pal *et al.* (1980) varieties with desirable characters are said to be promising for a particular purpose. Therefore selection of superior varieties that are suitable for processing becomes necessary. Discriminant function analysis was applied for identifying superior varieties for this purpose.

The physico-chemical and sensory attributes of the ten papaya cultivars served as the independent variables for carrying out discriminant function analysis. Based on their performance in the above qualities an index was developed to determine the superiority of the varieties. The relative position of merit for the varieties were known from their ranks. Figure·1 represents the selection indices of different papaya varieties. The selection indices based on discriminant function analysis along with their rank performance have been presented in Table-13.

Fig. 1 SELECTION INDICES OF DIFFERENT PAPAYA VARIETIES



VARIETIES

1. Waimanalo
2. Pusa Dwarf
3. Pusa Giant
4. Pusa Majesty
5. Pusa Delicious
6. Coorg Honeydew
7. Washington
8. Malayasian Long
9. Exotic Collection - 100091
10. Exotic Collection - 100060

Table 13

Selection Indices on physico-chemical and organoleptic characteristics of different cultivars of papaya

	Cultivars	Index	Rank
V_1	Waimanalo	-445201.0	4
V_2	Pusa Dwarf	-449408.0	10
V_3	Pusa Giant	-445714.0	6
V_4	Pusa Majesty	-446766.0	7
V_5	Pusa Delicious	-442650.0	2
V_6	Coorg Honeydew	-440344.0	1
V_7	Washington	-448671.0	9
V_8	Malaysian Long	-444154.0	3
V_9	Exotic Collection-100091	-445666.0	5
V_{10}	Exotic Collection-100060	-447696.0	8

All the indices were obtained on negative, which were ranked from highest to lowest. Coorg Honeydew (Plate 1) is found to be the most outstanding variety among the ten papaya cultivars. The variety Pusa Delicious (Plate 2) was ranked as the next immediate variety that predominated in merit for their physico-chemical and sensory parameters. The papaya varieties in the descending rank order for their quality performance were

PLATE - 1

PLATE - 2

Malaysian Long, Waimanalo and Exotic Collection-100091 (ranks 3, 4 and 5 respectively). Based on the index obtained rank 6, 7 and 8 were attained by Pusa Giant, Pusa Majesty and Exotic Collection-100060 respectively. Washington and Pusa Dwarf which were positioned at rank orders 9 and 10 respectively.

4.5 Determination of superior varieties for product development

The quality of product is highly related with quality of raw materials. However not all varieties grown are suitable for processing into various products. Therefore screening of suitable cultivars for production of quality products is highly important for processing industry.

Based on discriminant function analysis two superior varieties were identified for product development from the ten papaya varieties included in this experiment. Rank order shown in Table-13 indicated that papaya fruits of Coorg Honeydew and Pusa Delicious excelled in their desirable fruit characteristics with respect to physico-chemical and organoleptic qualities. Hence these two varieties were suggested for their probable utilisation for processing. Findings of Ghanta (1994) also advocated that Pusa Delicious and Coorg Honeydew are suitable varieties for processing especially for jams, jellies and marmalades. Therefore further studies on product development was undertaken on these identified varieties viz. Coorg Honeydew and Pusa Delicious.

4.6 Product development (Jelly)

Mature papaya fruit at various stages of ripening was suggested for the preparation of jelly (CFTRI, 1987). Nwanekezi *et al.* (1994) proposed that papaya which contain a pectin content of 1 per cent and above are expected to produce good gel. Same reports were made by Singh (1990) and Bawasakar (1997) papaya which contains enough pectin for making good jelly. Hence it was considered to standardise jelly using the selected superior varieties.

Jelly is prepared by boiling fruits with or without water, expressing and straining the juice, adding sugar and concentrating to such consistency that gelatinisation takes place on cooling (Siddappa, 1986). According to Lal *et al.* (1986) the amount of sugar required for proper setting of jelly depends on the quantity of sugar, pectin and acid per cent.

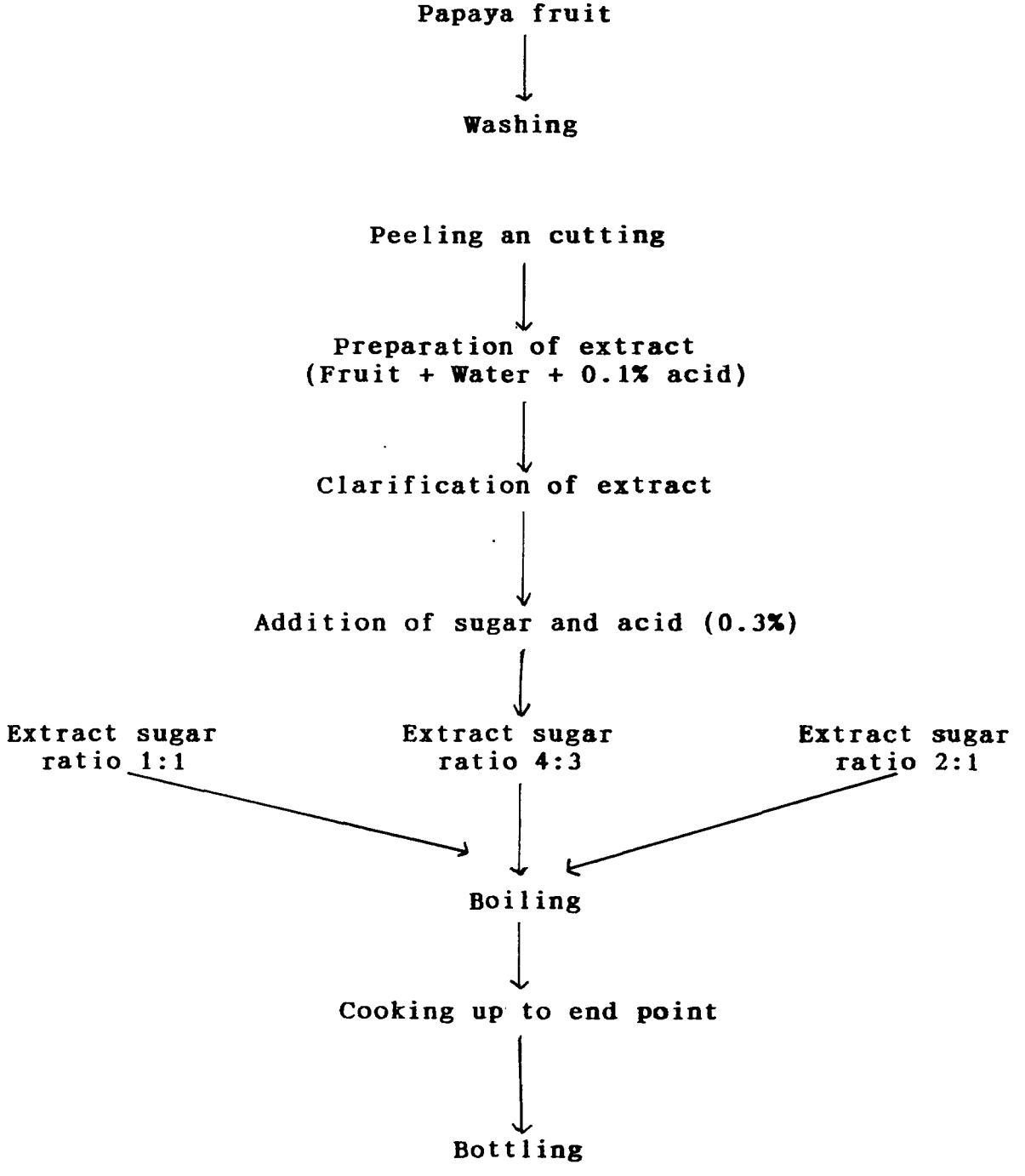
Therefore to standardise jelly from papaya fruits of Coorg Honeydew and Pusa Delicious fruit extract ratios in three different proportions viz. 1:1, 4:3 and 2:1 were experimented. The flow chart for the preparation of papaya jelly is presented in Fig. 1. The jelly samples were tested to their sensory qualities and nutritional requirements.

4.7 Quality assessment of papaya jelly

According to Kalia and Sood (1996) quality is the combination of attributes or characteristics of a product that

FIGURE - 1

Flow chart for the preparation of papaya jelly



have significance in determining the degree of acceptability of the product to a user. Siddappa (1980) opined that the quality of jelly mainly depends on the amount of pectin, sugar and acid present.

Jelly standardised in the present experiment from the two selected superior varieties of papaya viz. Coorg Honeydew and Pusa Delicious using three different ratios of fruit extract and sugar were assessed for their organoleptic and nutritional requirements in order to determine the appropriate and balanced proportion.

4.7.1 Assessment of organoleptic characteristics of the jelly

According to Herrington (1991) sensory evaluation technology is a method using skilled management and trained panallists to provide confirmation on the acceptability of the product in terms of product profile, consumer acceptability and consistancy.

The organoleptic parameters evaluated on jelly at a five point scale were appearance, taste, flavour, colour, clarity and texture. The maximum score that could be attained for each attribute was 5. For scoring test the procedure followed for fresh fruit samples was adopted. The mean values of evaluation by judges on the above attributes are presented in Table 14, 15, 16, 17, 18 and 19.

The score values obtained for appearance of jelly is given in the Table-14.

Table 14

Appearance of papaya jelly (mean score)

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	4.93	4.63	2.77	4.12
2.	Pusa Delicious	4.93	4.53	2.90	4.11

CD (between cultivar) = 0.178
CD (between:ratios within cultivars) = 0.217

Christianson (1985) emphasised that consumer preference to appearance is one of the major factors leading to the increasing demand of the product. The author further stated that it is very essential to keep the appearance of the product quite attractive. The data summarised in Table 14 revealed that there existed no significant difference in the appearance of jelly made with Coorg Honeydew and Pusa Delicious. But the appearance differed according to the fruit extract - sugar ratio for both the cultivars. When the ratio of fruit extract - sugar was increased to 1:1 the appearance was found good in both the cultivars. When the ratio was kept as 4:3 there was a reduction in the appearance score. Significantly low score was obtained at 2:1 ratio for both the cultivars. 1:1 ratio is found to be superior for the appearance of jelly.

According to Kalia and Sood (1996) jelly of excellent quality can be obtained by combining pectin, acid and sugar in definite proportion. Papaya is a fruit having high pectin content and hence requires a high proportion of sugar for proper setting of jelly compared to low pectin fruits. Siddappa (1986) detected that a perfect jelly is clear, sparking, transparant and of attractive colour. Results of the present trail on jelly proved that the ratio P_1 where equal quantity of sugar and extract was used contributed the best eye appeal for jelly due to its high clarity, transparency and well set. An almost similar performance was claimed by P_2. However treatment P_3 in which the sugar concentration was low exhibited a low position in this quality mainly because the jelly sample was not properly set due to inadequacy of sugar to bind the pectin present.

Table 15 depicts the mean score obtained for taste of papaya jelly prepared with three different fruit extract, sugar proportions.

Table 15

Taste of papaya jelly (mean score)

Sl. No.	Cultivar	Fruit - extract sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	5.00	4.60	2.70	4.11
2.	Pusa Delicious	5.00	4.50	2.90	4.13

CD (between ratios within cultivars) = 0.209
CD (between cultivar) = 0.171

Regarding taste of jelly (Table 15) the proportion 1:1 secured the highest and cent per cent score (5.0) in both the varieties and remained statistically at par. There was variations in taste of jelly among treatments tested in both the varieties. The treatment P_3 was significantly different from P_1 and P_2. Jelly made from Coorg Honeydew and Pusa Delicious presented rather good taste having scores 4.60 and 4.50 when prepared using extract and sugar proportion 4:3. But when the sugar was reduced to half share of extract (2:1) the taste score of both jelly samples were downgraded (2.70 and 2.90).

Results highlight that increased quantity of sugar benifitted the taste of jelly in both the varieties as indicated from the superior score of proportion 1:1. This data also revealed that sweetness and acidity of papaya jelly was well balanced when extract and sugar were equal in quantity. It could be also learnt that when extract used was double the amount of sugar, the taste was inferior. This can be accounted to the higher acidity of jelly as the sugar added was less for the correct blend. However the 4:3 ratio had not formed a conspicous inbalance between sugar and acid thus contributing an appreciable taste.

The score values obtained for flavour of jelly made from the two superior varieties are shown in Table-16.

Table 16

Flavour of papaya jelly (mean score)

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	4.80	4.40	2.90	4.03
2.	Pusa Delicious	4.93	4.60	3.00	4.18

CD (between ratios within cultivars) = 0.215
CD (between cultivars) = 0.176

Table 16 elucidates that as detected in other qualities there was no significant difference in flavour profile also among the varieties. While the score values for flavour showed significant difference with respect to the three treatments. The score value of P_1 was highest since Coorg Honeydew recorded 4.8 and Pusa Delicious 4.9. Similarly flavour scores were good in both the varieties for the proportion P_2 (4.4 and 4.6). Whereas P_3 (2:1) was assessed to be having a lower score in flavour for both varieties (2.9 and 3.0).

Malathi *et al.* (1980) reported that papaya has not caught the fancy of our people as much as it deserves mainly because the odour of papaya is not highly appealing. Kalra and Sood (1996) opined that good jelly should be free from any undesirable flavour. On considering flavour evaluation of papaya jelly the present study indicated that jelly made from

papaya fruits of Pusa Delicious and Coorg Honeydew registered a highly acceptable flavour. This result is in accordance with superior flavour performance of the fresh fruits of these particular varieties. In general, the flavour of jelly prepared from local varieties of papaya could not catch good acceptance as the characteristic fresh fruit odour predominates even after processing, Contrary to this established view, papaya jelly prepared in the present investigation using P_1 and P_2 formula were superior in flavour quality showing the maximum acceptance by 1:1 proportion and making a close position to this by 4:3 proportion. Added to the pleasing flavour constituted by the selected superior varieties of papaya fruits. the accuracy in fruit extract sugar and acid blend of the jelly might also have contributed to this notably good results. However jelly composition in which the proportion was 2:1 (P_3) was least preferred in flavour. The surplus quantity of papaya extract might have created an inferior flavour in jelly made from this combination.

The score values obtained for colour of papaya jelly is summarised in Table-17.

Table 17

Colour of papaya jelly (mean score)

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	3.43	4.60	4.93	4.32
2.	Pusa Delicious	3.23	4.57	4.93	4.24

CD (between ratios within cultivar) = 0.173
CD (between cultivar) = 0.141

The colour attribute scores of jelly from Coorg Honeydew and Pusa Delicious recorded the same trend. But a significant difference was observed with respect to proportion in both the varieties. Results indicate that maximum scores were maintained by P_3 (4.93) for colour perception of jelly in both the varieties. The proportion 4:3 (P_2) also attained a rather good score, 4.60 and 4.57 for both the varieties of Coorg Honeydew and Pusa Delicious. Slightly low scores among the three proportions were attained by P_1 for colour of jelly, the value being 3.43 and 3.23.

It appears from the above data that unlike other qualities studied, the most attractive colour was found in the combination 2:1 fruit extract - sugar ratio. Kalia and Sood (1996) reported that colour of the jelly should be sparkling and typical as the colour of the fruit. Colour attribute of jelly prepared from the two superior varieties of papaya was attractive even without the addition of colouring substance.

The rich carotene pigments present in the fruit imparted a natural pleasing colour to the product. Therefore the ratio that was composed of sugar level twice the amount of fruit extract could be benefitted more for colour contribution to the jelly as there was less dilution by sugar in this treatment compared to other proportions. Jelly from proportion P_2 (4:3) obtained an almost equal intensity in colour. Colour supply in P_1 (1:2) was lower even though not found that inferior in attraction.

Score values obtained for clarity of papaya jelly is presented in Table-18.

Table 18

Clarity of papaya jelly (mean score)

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	4.93	4.43	2.80	4.05
2.	Pusa Delicious	5.00	4.50	3.00	4.17

CD (between ratios within cultivar) = 0.210
CD (between cultivars) = 0.172

Data presented in Table-18 on the clarity of jelly elucidated that there was no significantly difference between the varieties Coorg Honeydew and Pusa Delicious concerning the clarity of the jelly. Similar to the other results a decrease

in score was found with lower sugar levels. It was noted that P_1 claimed to have the highest clarity with scores of 5.0 and 4.9 in varieties Pusa Delicious and Coorg Honeydew. The proportion 4:3 (P_2) also recorded a good clarity level (4.5 and 4.4). While clarity scores in proportion 2:1 (P_3) was low in both the varieties.

Clarity is an important criteria that determine the quality of jelly. Kalia and Sood (1996) reported that clarity of jelly should be transparent and should not be opaque. Siddappa (1986) also opined that a perfect jelly is clear, sparkling, transparent and of attractive colour. In the present work jelly standardised from equal amount of fruit extract and sugar was judged to be superior presenting a very clear and transparent product. Jelly made out of 4:3 fruit extract sugar ratio was almost comparable to P_1 in transparency and for clear appearance. It appears from the above results that jelly from Coorg Honeydew and Pusa Delicious could be the best clarity wise when prepared from equal quantity fruit extract and sugar. At the same time observations also claimed that quality was not noticeably altered even with a proportion of 4:3.

The data presented for texture of papaya jelly is presented in Table-19.

Table 19

Texture of papaya jelly (mean score)

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	4.93	4.50	3.0	4.1
2.	Pusa Delicious	5.00	4.50	3.0	4.1

CD (between ratios within cultivar) = 0.192
CD (between cultivars) = 0.16

According to Renganna (1991) texture is the property of which is associated with the sense of feel or touch experienced by the fingers or the mouth which requires trained personnel. Persual of the score values obtained for texture of jelly disclosed that there was no significant difference with in the varieties. However a significant difference was found between treatments in both the varieties. Raising the proportion of sugar resulted in increase of scores for texture attribute of jelly. Jelly standardised with 1:1 proportion using Pusa Delicious presented the highest score of 5.0 and Coorg Honeydew 4.93. The jelly made using 4:3 proportion of extract and sugar could also produce a good textured product attaining a score 4.50 each in the two selected superior varieties. Lowest score was recorded for the jelly prepared with 2:1 proportion for both the varieties.

It may be concluded from the results that fruit extract - sugar ratio of 1:1 (P_1) is the most ideal combination

for the proper setting and formulation of jelly having the best structure from papaya fruits Coorg Honeydew and Pusa Delicious. This data corroborates with the findings of Singh *et al.* (1980). The study revealed that jelly prepared from different varieties of guava fruits with a fruit extract-sugar proportion 1:1 was the best. Kordylas (1990) pointed out that a smaller percentage of sugar gives a lower jelly strength at all acidity levels, and may require the addition of more sugar to produce a high jelly strength. Fruits which contains large amount of pectin requires a significantly high portion of sugar. Papaya being a fruit with high amount of pectin, therefore requires an equal amount of extract and sugar for production of jelly with a sound texture. Texture quality of P_2 was rather good even though not up to the level of treatment P_1. Whereas this aspect in P_3, the ratio composed of the lowest quantity of sugar was not satisfactory due to its loose structure and weak gel frame.

The pooled data on the sensory evaluation of the jelly proved that both Coorg Honeydew and Pusa Delicious varieties presented no much variation in sensory aspects of jelly. Discussing on the organoleptic evaluation for jelly standardised with three different fruit extract - sugar proportions it was highlighted that the proportion with equal amount of fruit extract sugar (1:1) performed remarkably well in qualities viz. appearance, taste, flavour, clarity and

texture. Just for colour intensity this treatment stood behind the other two.

Sensory evaluation also manifested that when proportion of sugar was slightly lowered as in P_2 (4:3). All the quality attributes of jelly were slightly affected in application compared to 1:1 proportion (P_1) except colour. Present experiment clearly proved that a fruit extract sugar ratio 2:1 could not form a judicious combination for preparing good quality jelly from fruits of papaya variety Coorg Honeydew and Pusa Delicious. Appearance, taste, flavour, clarity and also texture of this sample (P_3) was much inferior compared to these aspects judged in the other two combinations in which the amount of sugar incorporated was higher. However P_3 could provide the best colour. To conclude, it can be proclaimed that papaya jelly of the best grade could be formulated from 1:1 ratio of extract and sugar combination.

4.7.2 Assessment of chemical characteristics of the jelly

Analysis of the chemical components provide valuable information on the nature and quality of the product. Therefore the jelly samples were subjected to analysis for its chemical compositions like acidity, pH, total sugar, total soluble solids and reducing sugar.

The results obtained on the chemical parameters of jelly are summarised in the forth coming tables.

Acidity values of jelly are furnished in Table 20.

Table 20

Acidity of papaya jelly

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	0.560	0.597	0.677	0.611
2.	Pusa Delicious	0.523	0.573	0.667	0.589

CD (between ratios within cultivar) = 0.0127
CD (between cultivar) = 0.0217

On an average the jelly made of Pusa Delicious was less acidic than Coorg Honeydew. But significant difference was not observed with in the varieties. Considering the different treatments there was significant different in both the varieties. It was observed that the acidity increased when the level of sugar decreased. Jelly samples of treatment P_1 had an acidity value of 0.560 and 0.523 per cent for the varieties Coorg Honeydew and Pusa Delicious. At the same time in P_2 the acid level was increased to 0.597 and 0.573 per cent. Acid content of of jelly was higher in treatment P_3 in which the lowest amount of sugar was used (0.677 and 0.667 per cent).

Siddappa (1986) reported that acidity is essential for pectin gel formation and without it jelly of good taste cannot be made. Pal (1995) detected that jelly made from

passion fruit contained an acidity of 0.55%. Majeed (1995) also pointed out that a good quality jelly can be prepared from Karonda fruits with a acid content of 0.50%. Jelly made with equal amount of fruit extract and sugar (P_1) in the present trial was found exactly in tune with the above results which in turn produced a good jelly structure. The acid content in P_2 and P_3 showed a corresponding increase due to the lower amount of sugar used to balance the acidity. Increase in acidity results in the formation of loose structure in jellies. Kalia and Sood (1996) reported that addition of excess of acid results in the break down of jelly structure owning to the hydrolysis of pectin and this can be rectified by adding more sugar. Hence it could be highlighted that 1:1 proportion of fruit extract and sugar is the most suitable to formulate papaya jelly with an optimum acidity level compared to that of 4:3 or 2:1 ratios.

pH of papaya jelly prepared following these treatments are shown in Table-21.

Table 21

pH of papaya jelly

Sl. No.	Cultivar	Fruit extract sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	3.43	3.39	3.35	3.39
2.	Pusa Delicious	3.60	3.52	3.41	3.51

CD (between ratios with in cultivar) = 0.112
CD (between cultivar) = 0.0917

According to Ranganna (1997) pH is a measure of active acidity which influence the flavour or palatability of a product and affect the processing requirement. Values indicated a higher level of pH in jelly from variety Pusa Delicious than Coorg Honeydew. The result on pH values of jelly imposing different treatments revealed that pH of jelly decreased with a decrease in sugar concentration in both the varieties. The treatment P_1 (1:1) remained to possess a higher pH content (3.43 and 3.60) for the varieties Coorg Honeydew and Pusa Delicious. Mean while the same values in the treatment P_2 (4:3) were 3.39 and 3.52. Lowest level of pH was recorded for the proportion P_3 (3.35 and 3.41).

Majeed (1995) observed a pH of 3.55 for jelly made with Karonda fruits. Papaya jelly standardised with 1:1 and 4:3 extract sugar proportions more or less agrees with the above value. The ratio with equal amount of fruit extract sugar was found to be have a maximum pH level. The most adequate pH level could be maintained by P_1 mainly because of its appropriate sugar concentration compared to the other proportions.

Total soluble solid content of jelly is furnished in Table-22.

Table 22

Total soluble solid content of jelly (%)

Sl. No.	Cultivar	Fruit extract sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	65.69	64.78	60.72	63.73
2.	Pusa Delicious	65.36	64.87	61.53	64.09

CD (between ratios with in cultivar) = 0.644
CD (between cultivar) = 0.53

Data presented in Table 22 revealed no statistical difference between the two superior varieties in the total soluble solids of jelly. But on an average significant difference with respect to treatments was observed and the t.s.s. content was highest with jelly composed of 1:1 proportion (65.69 and 65.36%) followed by P_2. Lowest total soluble solids content was noted for the proportion 2:1 in the two varieties and the difference was significantly different.

Increase in t.s.s. content is an indication to quality of product. Kalia and Sood (1996) stated that jelly should contain a total soluble solid content of 65%. In the present study it was noted that t.s.s. level of P_1 was highest and well satisfied the requirement followed by P_2 where as the t.s.s. level in P_3 was low. Therefore it could be recommended

that the treatment with 1:1 ratio of extract and sugar resulted in papaya jelly of desired composition in t.s.s. content compared to jelly made with the other two proportions.

Table 23 depicts the total sugar content of papaya jelly samples.

Table 23

Total sugar content of jelly (%)

Sl. No.	Cultivar	Fruit extract sugar protection			Mean
		P_1	P_2	P_3	
1.	Coorg Honeydew	40.81	39.85	34.93	38.53
2.	Pusa Delicious	43.17	41.10	36.24	40.17

CD (between ratios with in cultivar) = 2.767
CD (between cultivars) = 2.26

Total sugar content of jelly presented in Table 23 elucidates that the variety Pusa Delicious recorded a higher total sugar content than Coorg Honeydew. When the treatments were considered, there was no significant difference in total sugar in the jelly prepared with 1:1 and 4:3 ratios in both the varieties. But a significant difference was recorded in 2:1 ratio.

Sugar is an essential component in formulation of jelly. The addition of the higher amount of sugar made P_1 possible to attain the top value in total sugar content. The

sugar level recorded in treatment P_1 was 40.81 and 43.17 per cent and the same in P_2 was 39.48 and 40.10 per cent whereas in P_3 the sugar value remained at a low level of 34.93 and 36.24 in the two varieties. Decrease in total sugar content causes the network of pectin to hold more liquid and this causes syneresis in jellies. According to Pal (1995) the total sugar content of jelly made with passion fruit was 42.60 per cent. Majeed (1995) emphasised that jelly prepared from Karonda have a total sugar content of 38.35 per cent. While the total sugar values observed in P_1 and P_2 were with in the range reported by the above workers, the total sugar of P_3 was at a low position.

The data pertaining to the reducing sugar content of papaya jelly is presented in Table 24.

Table 24

Reducing sugar content of jelly (%)

Sl. No.	Cultivar	Fruit extract sugar ratio			Mean
		P_1 (1:1)	P_2 (4:3)	P_3 (2:1)	
1.	Coorg Honeydew	32.22	28.14	26.37	28.91
2.	Pusa Delicious	32.71	28.86	27.20	29.59

CD (between ratios within cultivars) = 0.349
CD (between cultivars) = 0.285

Estimation of reducing sugar of papaya jelly (Table 24) from the two varieties of papaya indicated that reducing sugar level in jelly made from Coorg Honeydew maintained a significantly lower level than Pusa Delicious. The difference was also significant between proportions in both the varieties and the difference was higher in P_3 (2:1 proportion) when the reducing sugar level in P_1 was at a level of 32.22 and 32.71 the same in P_2 was decreased to 28.14 and 28.86. Treatment P_3 (2:1) remained to possess the lowest reducing sugar content (26.37 and 27.20%).

The presence of higher amount of reducing sugar in jelly samples of Coorg Honeydew could be in turn accountable to the high amount of sugar present in this particular papaya variety. Among treatments, the more quantity of sugar used in P_1 resulted in a variation with reducing sugar level followed by P_2 and P_3.

The chemical characteristics evaluated in jelly standardised from two superior varieties of papaya viz., Coorg Honeydew and Pusa Delicious imposing three different fruit extract - sugar proportions highlighted that varietal wise difference existed in chemical components except in acidity and total soluble solids. Higher values were recorded in jelly prepared from Coorg Honeydew compared to Pusa Delicious. Considering the different extract sugar proportions 1:1, 4:3

and 2:1, the combination 1:1 was proposed to be the optimum ratio. Parameters like acidity, pH, total sugar and total soluble solids in 1:1 ratio were found to influence the quality of this jelly sample as the best grade. The ratio 4:3 was found more or less agreeable with the requirements in the above mentioned characteristics. Where as jelly made with half amount of sugar to pulp (2:1) recorded a poor grade with respect to chemical parameters due to its imbalance between sugar, acid and pectin. It was emphasised that the optimum amount of sugar required to maintain the composition, wise quality standards of papaya jelly was disclosed to be an equal proportion to that of the extract used. This formula gave the highest t.s.s., total sugar, reducing sugar, pH and the optimum acidity level.

4.7.3 Setting temperature of papaya jelly

Besides other factors, the strength of a jelly depends also on the temperature of which the mixture gels The jelly setting temperature of the two superior variety of papaya were detected and the values are presented in Table 25.

Table 25

Setting temperature of papaya jelly

Sl. No.	Cultivar	Fruit extract - sugar ratio			Mean
		P_1(1:1)	P_2(4:3)	P_3(2:1)	
1.	Coorg Honeydew	104.9	104.0	102.6	104.0
2.	Pusa Delicious	105.0	104.3	102.7	104.0

Data given in Table-25 indicated that there was no variation in end point temperature between varieties. While considering the end point temperature for the different treatment it was noted that the temperature required for the precise setting of jelly in the case of P_1 was highest. (104.9 and 105.0°C respectively for Coorg Honeydew and Pusa Delicious). While the temperature at which the mixture formed a good gel in the case of proportion 4:3 was at a slightly lower level showing a variation of 0.9°C and 0.7°C. A much lower temperature was recorded for the porportion 2:1 (102.6 and 102.7°C).

Results of jelly forming temperature indicated that jelly made with equal amount of fruit extract - sugar required more temperature than the other treatments that were composed of lesser sugar levels. With higher sugar levels the end point temperature was also higher. However the gel structure of P_1

was best followed by P_2. When the sugar used was low it took lesser temperature to set, but presented a low texture quality. Korydylas (1991) reported that a properly proportioned jelly mixture is 'done' when it reaches a boiling point of 104° to 105°C. Siddappa (1986) also stated that exact setting of jelly takes place at a temperature of 105°C. Results on temperature requirement for jellying, observed in treatments P_1 and P_2 were in accordance with the above report and therefore identified to be the appropriate temperature. Whereas P_3 set in a lesser temperature than this standard temperature requirement. It can be pointed out that increase in concentration of sugar extends the setting temperature of the jelly and at the same time this delay favoures the formation of fine structured gel as the indications of this investigations. This may be possibly due to the variation in composition of total soluble solids and invert sugar thereby elevating its boiling point.

4.8 Cost analysis of jelly

Keeping up prices is one of the most challenging and difficult tasks facing marketers of fruit products (Potter, 1986). Cost analysis was carried out to assess the extent of expense incurred to prepare papaya jelly using the selected superior varieties at three different, fruit extract - sugar combinations.

Cost analysis was carried out based on the price of various commodities used for the preparation of jelly. This included the cost of fresh papaya, sugar, chemicals, bottles and over head charges including labour and fuel.

Table 26 depicts the expenses incurred for the production of papaya jelly with three proportions of fruit extract - sugar ratio.

Table 26

Cost of jelly

Sl. No.	Treatments (Fruit extract sugar ratio)	Cost per kg of standardised jelly (Rs.)	Market price of Jelly (Rs./kg)
1.	1:1	25	
2.	4:3	21	70
3.	2:1	17	

Cost for production of one kilogram of papaya jelly constituted with an equal proportion of fruit extract sugar combination came to Rs.25.00 while papaya jelly prepared from extract sugar ratio of 4:3 costed Rs.21.00 The lowest expense was worked out for the proportion 2:1 having a cost of only Rs.17.00/kg. It is clearly known that the raw materials included directly influences the cost of products. Therefore jelly prepared with equal amount of extract - sugar was

observed to have the comparatively high cost. It could be remarked that cost of sugar is a major expense to bear in production of jelly and therefore the fluctuation in the amount of sugar used led to the variation in price. The current market price for one kilogram of jelly is Rs.70.00 and above. Meanwhile the cost for the production of one kg. of papaya jelly remained in a range of only Rs.17 to 25. This is a positive indication for a large scale production and commercial exploitation of jelly from this fruit as the price of similar product from other fruits or synthetic materials available in the market was invariably much higher. The year round availability of this indigenous fruit at a low cost discloses the potentiality of these superior quality papaya fruits Coorg Honeydew and Pusa Delicious for utilisation by processing industry.

4.9 Confirmation with FPO requirements

According to Kapoor (1993) food laws are essential for food safety. Kalia and Sood (1996) emphasised that the development of grades and standards of quality depends upon the definition of the quality characteristics to be measured.

The papaya jelly samples standardised in this study were thus subjected to analysis for FPO specifications in its requirements viz. total soluble solids and pH.

As per FPO specifications (1955) the jelly should contain a minimum total soluble solids content of 65 per cent. In the present study, jelly developed using fruit extract sugar proportion 1:1 attained well above the specifications prescribed as minimum in both the varieties, Coorg Honeydew and Pusa Delicious. A total soluble solid of 65.69 and 65.86 was attained by jelly from the two varieties standardised at a proportion of 1:1. Srivastava and Kumar (1994) Kalia and Sood (1996) have reported that jelly should contain a t.s.s. of 65 per cent. The proportion 4:3 have almost fulfilled the requirement in t.s.s.s level having a percentage of 64.78 and 64.87 whereas 2:1 ratio (P_3) remains far below the specified standard level (60.72 and 61.53 per cent). This result is indicative of the fact that the treatment P_1 (1:1) proportion) could be considered as the standard ratio of fruit extract and sugar for preparation of papaya jelly with satisfactory FPO requirements in t.s.s. content.

Discussing on FPO values on pH of jelly, it speficies a minimum level of 3.4. Kordylas (1990) also reported that jelly should not have a pH less than 3.4. Comparison of the values obtained by papaya jelly for pH in the present trial, it proved that all the three treatments have more or less satisfied the optimum level. Since the pH varied between 3.35 and 3.60 in the different samples. However, comparitively lower values were found in P_3.

SUMMARY

SUMMARY AND CONCLUSION

The present study entitled "Quality analysis of papaya (*Carica papaya* L.) varieties and product development was undertaken with an objective to evaluate the quality of papaya based on physical, chemical and organoleptic characteristics, so as to identify the most suitable papaya varieties for the development of papaya based products. The study also aimed at selecting the best proportion for papaya jelly by standardising at three different fruit extract - sugar ratio's viz. 1:1, 4:3 and 2:1 from the two superior varieties of papaya selected through discriminant function analysis.

Ten desert varieties of papaya fruits were selected for the study. The varieties selected were Waimanalo, Pusa Dwarf, Pusa Giant, Pusa Majesty, Pusa Delicious, Coorg Honeydew, Washington, Malaysian Long, Exotic Collection-100091 and Exotic Collection-100060. These papaya varieties were collected from the Tamil Nadu Agricultural University, Coimbatore.

A detailed study on the different qualitative indices of papaya varieties like physical characteristics, proximate composition and organoleptic qualities were envisaged, so as to identify most suitable cultivars of papaya for the development of papaya based products.

Physical characteristics of papaya varieties were assessed in order to learn their suitability for processing with respect to the nature of fruit. The major physical characteristics assessed in the ten papaya cultivars were fruit weight, fruit length, edible portion weight, peel seed and skin waste, fruit thickness, skin thickness and cavity width.

On analysing the fruit characteristics Malaysian Long was identified to have the first place for fruit length followed by the varieties Waimanalo, Pusa Delicious and Washington. Of these papaya varieties Coorg Honeydew remained as the heaviest fruit followed by Pusa Delicious. Meanwhile the minimum fruit weight and length was noticed in the Exotic varieties.

Data proved that the papaya variety Waimanalo possessed the thicker pericarp followed by the varieties Pusa Delicious and Washington. It was recorded that the varieties Pusa Dwarf, Pusa Majesty, Malaysian Long and Washington were thin skinned fruits. It was evidenced that the variety Exotic Collection - 100060 occupied the least cavity width followed by the varieties Malaysian Long, Washington and Exotic collection - 100091.

Papaya fruits of Exotic collection - 100060 was identified to be having the minimum skin wastage followed by Pusa Giant, Pusa Dwarf and Coorg Honeydew. Pusa Delicious,

Washington and Malaysian Long were varieties showing lower seed wastage among. It was clearly observed that among the ten varieties Coorg Honeydew possessed a remarkably high flesh weight followed by the variety Pusa Delicious while the Exotic variety - 100060 was recorded to have the lowest edible portion weight.

The physical quality assessment proved that Pusa Delicious was the best variety due to its superior position in most of the parameters followed by Coorg Honeydew. Malaysian Long and Waimanalo were the next preferred varieties in this aspect.

Chemical composition of the ten different varieties of papaya fruits were analysed, with regard to their total soluble solid, total sugar, reducing sugar, non-reducing sugar, moisture, pH, acidity, vitamin-C, B-carotene, pectin, fibre and mineral constituents.

The study on the chemical aspects revealed that the variety Washington exhibited a superior position for total sugar content followed by Pusa Delicious and Coorg Honeydew. It was found that the variety Pusa Dwarf occupied a lower level of reducing sugar followed by the varieties Waimanalo and Pusa Majesty while the highest content was recorded for the variety Washington. Papaya fruits of Coorg Honeydew and Waimanalo were identified to be having the highest non-reducing sugar content.

It was evidenced that fruits of Washington, Pusa Delicious and Coorg Honeydew recorded the higher level of total soluble solid content. While Pusa Dwarf remained at the lowest position in total soluble solid content. Of these papaya varieties Waimanalo possessed the maximum moisture content and the minimum level of water content was found in the variety Pusa Delicious. Papaya fruits of Malaysian Long, Pusa Dwarf and Pusa Giant possessed higher acidity level and at the same time the pH correspondingly lower.

Among the ten varieties analysed the highest vitamin-C level was observed in Pusa Delicious followed by the varieties Pusa Majesty, Exotic collection - 100091 and Washington. The variety Pusa Delicious exhibited a high level of β-carotene followed by the varieties Exotic collection - 100060 and Exotic collection - 100091. Data showed that the composition of β-carotene was lowest in Washington.

Among the ten different papaya varieties studied the fruits of Exotic collection - 100091 and Exotic collection - 100060 were the varieties with minimal fibre content followed by the varieties Pusa Majesty, Waimanalo and Pusa Delicious. Malaysian Long recorded the maximum fibre content among the varieties under study. Papaya fruits of Pusa Delicious was proved to be superior in pectin content followed by Malaysian Long, Washington and Coorg Honeydew. Data also revealed that

Exotic collection - 100091 and Pusa Dwarf were the varieties that recorded a lower level of pectin content among the ten cultivars studied.

Analytical data of mineral composition of the ten selected papaya varieties indicated that fruits of Pusa Giant, Washington, Exotic collection - 100091 and Waimanalo were high calciumm varieties. Sodium level was maximum in Pusa Majety followed by the varieties Coorg Honeydew and Malaysian Long. Among the varieties studied Exotic collection - 100091 and Exotic collection - 100060 were identified with higher potassium level and was closely followed by Washington and Pusa Delicious. It was found that the variety Pusa Delicious possessed a distinguishly high phosphorus content followed by the Exotic varieties and Washington. Considering the total mineral content of fruits Exotic collection - 100091, Pusa Majesty and Washington carried the higher per cent of total mineral composition. While the lowest total mineral level was observed in the varieties Pusa Dwarf and Malaysian Long.

A critical analysis on the chemical composition suggested Pusa Delicious as the best variety for processing based on its high total sugar content, soluble solids, vitamin-C level, pH, pectin, B carotene and phosphorus composition followed by Coorg Honeydew, Washington and Exotic varieties were also graded to be good in their chemical parameters.

Sensory evaluation studies on various quality parameters evidenced that the varieties Washington, Pusa Dwarf and Pusa Majesty carried the best eye appeal. It was clearly observed that the papaya varieties Pusa Delicious and Washington were superior for their flavour profile, so also in their taste performance along with Coorg Honeydew. Among the varieties studied Pusa Dwarf, Pusa Majesty and Washington were more attractive in colour than the other varieties. Considering the texture of the fruit Pusa Delicious, Coorg Honeydew and Washington were the varieties that were highly preferred. The ten varieties when ranked for their sweetness proved that the varieties Pusa Delicious, Coorg Honeydew and Washington were highly appreciated than the rest of varieties studied. Study also revealed that sweetness was comparatively low in varieties Pusa Dwarf and Pusa Giant.

Observations on organoleptic evaluation highlighted that the varieties Washington, Pusa Delicious and Coorg Honeydew were the promising varieties for processing and table use based on their superior performance in the sensory appeal. Pusa Majesty was also identified as a good variety in the above observations.

Data pertaining to the chemical, organoleptic and the most important physical charactor viz., edible portion weight were then subjected to discriminant function analysis in order to select the superior varieties. Based on the over all performance inthese parameters, the varieties Coorg Honeydew and Pusa Delicious were identified as the two best varieties for product development from papaya fruits.

Considering the high pectin value of papaya fruits, jelly was chosen for product development using the two identified superior varieties - Coorg Honeydew and Pusa Delicious imposing three treatments of different sugar ratios. The fruit extract sugar combination tried were 1:1, 4:3 and 2:1. The jelly samples standardised were then subjected to quality analysis with respect to organoleptic and chemical attributes.

The organoleptic qualities like appearance, taste, flavour, colour, clarity and texture of the jelly were envisaged. Data clearly indicated that in general there was no significant difference in the organoleptic qualities of jelly among the varieties Coorg Honeydew and Pusa Delicious. Studying the acceptability of jelly made using different treatments, it was observed that the best sensory quality attributes were performed by the jelly prepared with equal

amount of extract - sugar ratio (1:1). All the qualities viz, appearance, taste, flavour, clarity and texture maintained remarkably high in this treatment. Colour was the only character that showed a comparatively lesser preference by the 1:1 extract-sugar ratio. The organoleptic attributes of jelly with proportion 4:3 also showed good acceptability and occupied the next position. At the same time when the quantity of sugar was reduced to half the amount of fruit extract (2:1) all the sensory qualities of the jelly except colour was downgraded. Therefore it could be proved from the experiment that fruit extract - sugar proportion 1:1 is the judicous combination for the formulation of papaya jelly from Coorg Honeydew and Pusa Delicious with best organoleptic qualities.

The jelly standardised with three varied proportion of sugar were then analysed for their chemical characteristics like acidity, pH, total soluble solid, total sugar and reducing sugar. The analytical evaluation of papaya jelly revealed that varietal wise difference was observed for the characters like pH, total sugar and reducing sugar content. The treatment P_1 prepared with equal amount of extract and sugar was found to possess well satisfied level in all the chemical parameters. The proportion 4:3 was also more or less agreeable with the requirements. However, the proportion in which half the quantity of sugar was used (2:1) recorded a lower level in all

the above mentioned chemical aspects. It was observed that pH, total soluble solids, total sugar and reducing sugar increased with increase in sugar proportion. But acidity level decreased with the rise in sugar proportion.

Data on the setting temperature of jelly indicated that the sample made with an equal amount of extract - sugar (1:1) required more temperature followed by the treatment composed of 4:3 ratio. However the lowest end point level with regard to temperature was recorded by the fruit extract - sugar combination 2:1 in both the varieties.

The jelly samples in the present study were compared with FPO specification for ensuring their quality standards. Total soluble solid content of the jelly standardised using fruit extract sugar ratio 1:1 (P_1) agreed the requirements and was positioned well above the specifications mentioned by the FPO. Proportion 4:3 (P_2) also attained an almost satisfactory level specified by the FPO. Whereas the t.s.s. content of jelly with the proportion 2:1 (P_3) remained below the specified levels. On verifying the pH values of jelly formulated with the three different fruit extract - sugar proportions, it was found that all the three proportions satisfied the minimum levels of pH specified by the FPO.

Cost analysis of the jelly standardised with three different sugar proportions highlighted that the expenses for

production of 1 kg of papaya jelly ranged from Rs.17 to 25. The cost of papaya jelly standardised with equal amount of extract sugar ratio (1:1) was higher than the other two combinations because of variation in the quantity of sugar. However a comparison of the price of jelly available in the market with the cost of papaya jelly standardised in this study revealed that the market price for jelly was found to be nearly three fold higher than that incurred for the production of papaya jelly in this study.

It was realised that screening suitable papaya varieties for processing not only enhance the quality of the product but also results in better commercial utilization of this under utilised fruit. Such effort may also provide sound recommendations for growers for channelising their production to enable high returns.

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* Original not seen

APPENDICES

APPENDIX - I

EVALUATION CARD FOR TRIANGLE TEST

In the triangle test three sets of sugar solution of different concentration were used. Of the three sets two solutions were of identical concentrations and the members were asked to identify the third sample which was of different concentration.

Name of the product : Sugar solution

Note : Two of the three samples were identical, identify the odd sample.

Sl. No.	Code No. of the samples	Code No. of the identical samples	Code No. of the odd sample
1.	X, Y, Z		
2.	A, B, C		

APPENDIX - II

SCORE CARD FOR THE ASSESSMENT OF ORGANOLEPTIC QUALITIES OF PAPAYA FRUIT

		Score 1 2 3 4 5 6 7 8 9 10
Appearance		
	Very good	4
	Good	3
	Fair	2
	Poor	1
Colour		
	Very good	4
	Good	3
	Fair	2
	Poor	1
Flavour		
	Very pleasant	4
	Pleasant	3
	Moderately pleasant	2
	Unpleasant	1
Taste		
	Very good	4
	Good	3
	Fair	2
	Poor	1
Texture		
	Very good	4
	Good	3
	Fair	2
	Poor	1
Sweetness		
	Very good	4
	Good	3
	Fair	2
	Poor	1

APPENDIX - III

SCORE CARD FOR THE ASSESSMENT OF ORGANOLEPTIC QUALITIES OF PAPAYA JELLY SAMPLES

		1	2	3
Appearance				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Taste				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Flavour				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Colour				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Clarity				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Texture				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			

ABSTRACT

QUALITY ANALYSIS OF PAPAYA (CARICA PAPAYA L.) VARIETIES AND PRODUCT DEVELOPMENT

By

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ABSTRACT OF THE THESIS

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ABSTRACT

The present study entitled "Quality analysis of papaya (*Carica papaya* L.) varieties and product development" was undertaken with an objective to evaluate the quality of papaya based on physical, chemical and organoleptic characteristics, so as to identify the most suitable papaya varieties for the development of papaya based products. The study also aimed at selecting the best proportion for papaya jelly by standardising at three different fruit extract - sugar proportions viz. 1:1, 4:3 and 2:1 using the selected superior varieties of papaya.

Ten desert varieties of papaya fruits viz., Waimanalo, Pusa Dwarf, Pusa Giant, Pusa Majesty, Pusa Delicious, Coorg Honeydew, Washington, Malaysian Long, Exotic collection - 100091 and Exotic collection - 100060 were selected for the study.

Study on the physical characteristics of the fruits revealed that Malaysian Long occupied the superior position for fruit length followed by the varieties Waimanalo, Pusa Delicious and Washington. Coorg Honeydew was recorded as the heaviest fruit followed by Pusa Delicious. Mean while both fruit weight and fruit length was minimum for the two exotic varieties. It was identified that the papaya variety

Waimanalo was the best fruit in thickness of pericarp followed by the varieties Pusa Delicious and Washington. Papaya fruits of Pusa Dwarf, Pusa Majesty, Malaysian Long and Washington were thin skinned fruits. The variety Exotic collection - 100060 was noticed to be having the least cavity width followed by the varieties Malaysian Long, Washington and Exotic collection - 100091.

Data proved that Exotic collection - 100060 was the fruit carrying the minimum skin wastage followed by Pusa Giant, Pusa Dwarf and Coorg Honeydew. In the case of seed wastage Pusa Delicious, Washington and Malaysian Long were varieties that observed the minimum levels. Among the ten varieties studied Coorg Honeydew possessed a remarkably high flesh weight followed by the variety Pusa Delicious.

Chemical analysis revealed that the variety Washington exhibited a superior position for total sugar content followed by Pusa Delicious and Coorg Honeydew. It was found that the variety Pusa Dwarf occupied a lower level of reducing sugar followed by the varieties Waimanalo and Pusa Majesty while the highest content was for the variety Washington. The fruits of Coorg Honeydew and Waimanalo were identified to have the highest non reducing sugar content.

Among the ten varieties analysed fruits of Washington, Pusa Delicious and Coorg Honeydew recorded the

higher levels of total soluble solid content. Of the varieties studied Waimanalo was found to have the maximum moisture content and the minimum level of water content was recorded by variety Pusa Delicious. Papaya fruits of Malaysian Long, Pusa Dwarf and Pusa Giant possessed higher acidity level and showed a correspondingly lower pH value.

It was evidenced that, highest vitamin-C level was observed in the variety Pusa Delicious followed by the varieties Pusa Majesty, Exotic collection - 100091 and Washington. The variety Pusa Delicious exhibited a high level of β-carotene followed by the varieties Exotic collection - 100060 and Exotic collection - 100091. Observation on fibre content of different papaya varieties showed that the two Exotic varieties were having the minimum fibre level followed by the varieties Pusa Majesty, Waimanalo and Pusa Delicious, while Malaysian Long recorded the maximum fibre content. Papaya fruits of Pusa Delicious was found superior in pectin content followed by Malaysian Long, Washington and Coorg Honeydew.

Analytical data of mineral composition indicated that fruits of Pusa Giant, Washington, Exotic collection - 100091 and Waimanalo were high calcium varieties. Pusa Majesty recorded maximum sodium content followed by the varieties Coorg Honeydew and Malaysian Long. Among the varieties studied both

the Exotic varieties were identified for its higher potassium level and was closely followed by Washington and Pusa Delicious. It was found that the variety Pusa Delicious possessed a distinguishly high phosphorus content followed by the Exotic varieties and Washington. Fruits of Exotic collection - 100091, Pusa Majesty and Washington were composed of the higher per cent total mineral composition.

Sensory evaluation studies on various quality parameters evidenced that the varieties Washington, Pusa Dwarf and Pusa Majesty carried the best eye appeal. It is clearly observed that the papaya fruits of Pusa Delicious and Washington were superior for their flavour profile, so also in their taste performance along with Coorg Honeydew. The varieties Pusa Dwarf, Pusa Majesty and Washington were more attractive in colour than the other varieties. Considering the texture of the fruit Pusa Delicious, Coorg Honeydew and Washington were the varieties that were highly preferred. Sweetness of the varieties Pusa Delicious, Coorg Honeydew and Washington were highly appreciated than the rest of the varieties studied.

Based on the chemical organoleptic and the most important physical characteristic viz, edible portion weight were subjected to discriminant function analysis for the selection of two superior fruits for product development. The screened varieties Coorg Honeydew and Pusa Delicious were used

for the development of jelly using different fruit extract - sugar ratios viz. 1:1, 4:3 and 2:1.

Organoleptic evaluation of jelly disclosed that there was no significant difference in sensory quality of jelly between the two varieties Coorg Honeydew and Pusa Delicious. All the quality parameters except colour maintained remarkably superior for the jelly sample standardised with equal amount of extract - sugar ratio (1:1). The organoleptic qualities of jelly prepared with 4:3 (P_2) ratio remained satisfactory while the sample with fruit extract sugar ratio 2:1 (P_3) could not form a judicious combination for the formulation of good quality jelly except for its good performance in colour.

Chemical analysis of the jelly revealed that a varietal variation was observed in jelly samples with respect to chemical characters like pH, total sugar and reducing sugar content. The jelly prepared with an equal amount of extract and sugar 1:1 (P_1) remained at a higher level in most of the chemical attributes, the ratio 4:3 (P_2) was found more or less agreeable in chemical composition, whereas the 2:1 ratio (P_3) presented the comparably lower grade with respect to chemical parameters tested. It was observed that pH, total soluble solids, total sugar and reducing sugar increased with an

increase in the sugar proportion. But acidity level decreased with a rise in the proportion of sugar.)

Data on the end point temperature of jelly indicated that the sample prepared with an equal amount of extract and sugar (1:1) recorded a higher temperature for setting than the other treatments (4:3 and 2:1).

The jelly developed using 1:1 proportion of extract and sugar was positioned well above the FPO specifications. Proportion 4:3 (P_2) could attain an almost satisfactory level specified by the FPO, whereas the total soluble solid content of jelly with the proportion 2:1 (P_3) remained below the level specified by the FPO.

The cost of papaya jelly standardised with equal amount of extract - sugar ratio (1:1) was slightly higher than the other two combinations. A comparison of the price of jelly available in the market with the cost of papaya jelly standardised in this study revealed that the market price was three fold higher compared to the cost incurred for the production of papaya jelly in this study.

The study highlighted that screening suitable papaya varieties for product development not only enhance the quality of the product but also results in better commercial utilization of this fruits.