DEVELOPMENT, DIVERSIFICATION AND SHELF LIFE OF JAMUN (EUGENIA JAMBOLANA L.) BASED PRODUCTS

BY

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DECLARATION

I hereby declare that this thesis entitled "Development, diversification and shelf life of jamun (Eugenia jambolana L.) based products" is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other university or soceity.

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CERTIFICATE

Certified that this thesis entitled **"Development, diversification, and shelf life of jamun (Eugenia jambolana L.) based products"** is a record of research work done independently by **HEMA S.R.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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MY FATHER

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INTRODUCTION

INTRODUCTION

Fruits ensure nutritional security, better land use, higher net return per unit area and help in improving the eco system and economic status (Pathak 1995). Perhaps the first food that prehistoric man ate was a fruit of some kind.

The total production of fruits in the world accounts for about 341.8 million tonnes (Eipeson and Bhowmik 1992). India is the largest producer of fruits and vegetables after Brazil (Indian Food Industry 1995). In addition to the major fruits, a large number of minor fruits, accounting for about 5.53 million tonnes are also produced in the country. But according to Sethi (1993), the current level of utilisation of fruit by the processing industry in only one per cent.

Sarain (1992) opined that apart from major fruits, the rare ones like pomegranate, custard apple, lychees, chikkoos, ber, plums Kinnows, lemon, jamun, strawberries etc. have tremendous marketing potential. Under exploited fruits may be defined as several less known fruit species which have the potential for commercial exploitation and are yet to be utilised for their potential. The commerical potential of these fruits are immense, but large quantities are going waste as no serious effort has been made to use the techniques available to convert them into value added products. These fruits lack proper post harvest processing, which leads to tremendous loss to our fruit wealth. So there is an urgent need to exploit the under exploited fruits.

Processing of these fruits could also help in the full capacity utilisation of the installed capacity for the processing industry, by spreading the raw material availability throughout the year (Eipeson and Bhowmik 1992).

Jamun is one such unconventional fruit having potentialities for making different types of products and need to be tried by the processing industry to promote its expansion (Chadha 1994). Jamun, considered as native of India, (Bajpai and Chaturvedi 1990) is an indigenous fruit having an attractive colour and is liked by people for its refreshing pink to greyish juicy flesh. Daulta et al (1980) and NIN (1992) have reported that jamun contain special kind of enzyme which besides being an important aid in the digestion, possess considerable therapeutic properties. Kumar et al (1993) and Mehrotra et al (1996) opined that fruits of this species are a good source of iron apart from minerals and proteins and can be used as an effective medium against diabetes, heart and liver troubles.

Jamun fruit has a sub-acid to sweet taste and pleasant flavour. It is highly perishable and cannot stay in good condition for more than two to three days. According to Khurdiya and Roy (1985), very little information is available on the processing of this fruit, except its use in making vinegar and spicy ready to serve beverages. Due to the ignorance in the technical know how of its processing, these fruits are not fully utilised during period of plenty. Therefore, to ensure production and minimise post harvest losses, there is dire need

for exploring the possiblities of utilising this fruit in the processing industry.

In most of the developed countries, there is a noticable shift from consumption of alcholic beverages (Varde 1991). The yearly per capita beverage consumption will increase with particular increase in alcohol free beverages, bottled water and fruit beverages (Armgart 1993). In a country with wide variety of fruit bearing trees, the production of beverages can be increased by introducing new variety of fruits that could be used for the preparation of interesting types of beverages (Vaidehi 1977). According to an anonymous estimate (1988) the industrial units in India have acquired capacity to produce 700 million fruit based beverages of 200 ml tetrapacks type only. The aseptic system has given a boost to the fruit beverage industry.

Hence, it was thought useful to make an attempt towards evaluating the processing qualities of jamun for production of beverages like squash, ready to serve beverage and wine. Several workers have reported the advantages of blending fruit juices in processing. Kalra et al (1991) opined that blending of fruit drinks could be done to supplement appearance, nutrition or flavour. It is also considered an economic requisite to utilise profitably some fruit varieties for processing, which may not have otherwise favourable characteristics. Thus the present investigation also envisages the suitability of jamun juice in melding with fruit juices of grapes, watermelon and West Indian cherry in developing diversified products.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The present study entitled "Development, diversification and shelf life of jamun (Eugenia jambolana L.) based products" is reviewed under the following headings.

2.1. Importance of fruits and its processing

2.2. Importance of fruit based beverages

2.3. Processing potential of under exploited fruits

2.4. Jamun fruit - its characteristics

2.5. Product development from under exploited fruits

2.6. Product diversification

2.7. Effect of storage on product quality

2.1. IMPORTANCE OF FRUITS AND ITS PROCESSING

According to Ghosh (1995) India has emerged as number one in the world map of fruit production putting Brazil behind.

Cook (1975) pointed out that high perishability of fruits lead to a high degree of wastage which is reported even in developed countries like USA with their well advanced and sophisticated techniques. In India also, inspite of this high production of fruits, 20 - 30 per cent of the produce are not utilised due to post harvest problems as reported by Sethi (1993). Poornia et al (1994) has also stressed that nearly 30 per cent of the fruits are lost due to spoilage during handling, transportation lack of storage and processing facilities. Though

there is high level of production of fruits in India, lack of post harvest technology and linkages result in a natiional loss of Rs.5000 crores per annum (Rajkumar 1995).

Kaushal (1987) had stressed on the rise in demand for processed fruits and vegetables because of the increased defence requirements and urbanisation trend. Das and jain (1989) opined that the processed food relevant to Indian context should be marketed in a manner, that would, benefit the consumer, the farmer and the society. According to Anvilla et al (1993) the consumption of processed foods is likely to increase in the future. Rajya (1995) reported that the production of processed fruits and vegetables increased by 30.28 per cent in the year 1992-93 and 23.66 per cent in the year 1993-94.

Swami et al (1977) pointed out that cultivation of new fruits and developement of products from many of the notable fruits could bring benefit nutritionally and economically.

2.1.1. Commercial Importance

Maini and Anand (1985) pointed out that development of fruit preservation industries can help generate employment, support growers, upgrade local nutrition and increase the gross national product. Kumar and Pramod (1990) reported that fruits and vegetables can carry 20-23 tonnes higher foreign exchange per unit area than cereals. The fruit and vegetable processing industry has been declared as a thrust area and is likely to

take of in the near future as a potential earner of foreign exchange through export of processed fruits and vegetables (Kapoor, 1993). According to Shaw et al (1993) the fruit and vegetable industry can play and important role in salvaging prices during glut sesons generating employment oppertunity meeting the requirements of defence forces in border area and earning foreign exchange for the country by development of exports. Poornia et al (1994) is of the view that fruit processing helps to imitigate the problems of underemployment during off-season in agriculture sector.

2.1.2. Nutritional Importance

According to Geetha (1982) cheapest fruits are also highly nutritive as they are large store house of essential vitamins and mineral salts ans comprise a rich dietary of essential nutrients like vitamin C and ß-carotene and minerals whose intake in a majority of our population is already below par (Rao, 1991). As per the report of Manson (1994), the people who eat more fruits and vegetables have a 54 per cent lower risk of getting heart stroke when compared to those who eat the least. George (1994) stated 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.

2.2. IMPORTANCE OF FRUIT BASED BEVERAGES:

According to Manay et al (1987) there has been a tremendous increase in the soft drinks/non alcoholic beverages such as fruit based drinks, synthetic drinks, sweetened aerated water or carbonated drinks because of rapid growth and development of beverage industry in India. Varde (1991) noticed that in most of the developed countries, there is a noticable shift from consumption of alcoholic beverages to natural fruit based beverages. Olsen (1991) pointed out that world trade in tropical fruit juice concentrates and pulps has expanded rapidly and would continue its upwards trend over the next several years. Armgart (1993) indicated that the yearly precapita beverage consumption will increase with particular increase in alcohol free beverages, bottled water and fruit beverages.

Khurdiya (1990) reported that dietetic value of real fruit based beverage is far greater than that of synthetic produce which are being produced in large quantities. According to Kalra et al (1991) fruit drinks are lately engulfing the domestic markets. They are rightly being encouraged as they provide much needed vitamins and minerals. Manan et al (1992) stated that fruit based ready to serve beverages and fruit juices are not only rich in enintial minerals, vitamins and other nutritive factors but also are delicious and have an universal appeal. Kaur and Khurdiya (1993) pointed out that fruit based beverages

are becoming increasingly popular in the market with the growing conscious of people in the nutritive value of fruits.

2.3. PROCESSING POTENTIAL OF UNDER EXPLOITED FRUITS

Durscheid (1984) reported the use of exotic fruits in the manufacture of soft drinks with reference to passion fruit, Kiwi fruit, mandarins, grape fruit, limes, pineapples, mangoes, guavas and papayas. Ambadan (1984) proclaimed that the fruit beverages of tomorrow may be based on fruits other than mango, orange, pineapple and also utilising passion fruit, guava and grape.

Leon (1976) has given description of the anatomy and morphology, physical chemical and organoleptic properties, principal constituents and nutritive value of fruits like avacado, banana, custard apple, cashew apple, guava, mango, papaya, passion fruit and West Indian cherry to encourage their use.

Purohit (1991) opined that in the developing countries, fruits of high nutritive value must get priority over those having attractive appearance. Vaidehi (1994) opined that it would be very useful, if the unconventional fruits are studied for their beverage value and used for the manufacture of acceptable fruit drinks for consumption.

Eipeson and Bhowmik (1992) expressed that there is a vast potential to tap the under exploited minor fruits in the country. Sarain (1992) advocated that apart from the major fruits like tomatoes, bananas, pineapples, apples mangoes, grapes etc, there are other rare ones like pomegranate, custard apple, litchis, chikkoos, ber, plums, Kinnows, lemon, jamun, straw berries etc which have tremendous marketing potential. Chadha (1994) suggested that fruits like ber and pomegranate are yet to be exploited.

Roy et al (1979) noticed that ripe bael fruit is not consumed freely because of eating difficulty, but it may become popular if properly processed. Studies on processing and utilisation of Kumkaut conducted by Bawa and Saini (1988) revealed that the high acidity of the juice (5.5 per cent), sweet nature of peel and consumer acceptance of various products indicated the potentiality of Kumkaut for processing. Ranote et al (1993) reported that the physico- chemical and sensory quality before and after thermal processing of Kinnow juice highlighted the potential for its conversion into quality ready to serve beverage. Saini and Baini (1994) stated that there is potential for commercial production and marketing of quality seed and vitaminised watermelon juice for processing. He also pointed out that other fruits like jack fruit, kokum, phalsa, jamun and custard apple need to be tried by the processing industry to promote their expansion. Vaidehi (1994) suggested that if we

make of several of our tropical fruits which are heavy yielding varieties, we may overcome the problem of deficiencies that are because of lack of fruits and vegetables in our diet and cauliflower, cabbage, banana, bringal, carrot, peas, beans, mushrooms, papaya, guava, jack fruit, litchi etc could be processed for domestic export markets.

Easwaran et al (1995) stated that preservation of surplus unexploited fruits can prevent the high wastage and make them available in the off season at renumerative pieces.

2.4. JAMUN FRUIT ITS CHARACTERISTICS

NIN (1992) reports that jamun tree is native to India, which thrives easily on hardy tropical regions is found in all parts of our subcontinent as well as countries of South East Asia and Eastern Africa. The same report reveals that the tree is botanically identified as "syzygium cuminii" and Known by several local names such as jambas, jamun, Rajaman, Kalajamun, Neredu, Naval, Nerale, jamali, Black plum and Black berry. Bajpai and Chaturvedi (1985) found that the average yield of fruit from full grown seedling jamun tree is about 80-100 kg and from a grafted one 60-70 Kg per year.

Generally two main types are distinguished based on the type of the fruit (Khurdiya and Roy 1985 and NIN 1992). The "Ra-jamun" fruit is big, oblong, deep purple or bluish in colour having pink to greyish juicy sweet flesh with small seeds. The

other types is known as "Kaatha" which has small fruits with comparatively big seeds and the flesh is acidic in taste. Improved varieties of jamun have also been developed, those bearing purple to violet or white, seedless fruits (NIN 1992).

Information of jamun fruit shows that from time immemorial, this fruit has been appreciated for its unusual taste, flavour and colour. According to Shukla et al (1990), the fruit is liked for its refreshing pink to greyish juicy flesh having a very balanced sugar, acid and tannin blend. NIN 1992 reports that the fruit has a sub acid to sweet taste.

According to Khurdiya (1985) the juice, recovery of jamun fruit was observed to be between 35-48 per cent. The edible portion in jamun fruit forms around 70 per cent of the whole fruit. NIN 1992 emphasised that glucose and fructose are the principal sugars in the ripe fruit.

Shukla et al (1990) estimated the constituents of jamun fruit and found them to be: TSS 12° brix, pH 3.15, Acidity (as citric acid) 1.06 per cent, Reducing sugars - 8.82 per cent, Total sugars - 9.22 per cent, pectin (as calcium pectate) 0.55 per cent, tannins (as tannic acid) - 302 mg/100g and anthocyanins - 157 (ml/100 g). As detected by NIN (1992), the nutrient value per 100g of fruit include energy - 62 (Kcal), Iron - 1.2 (mg) calcium - 15 (mg) phosphorous - 15 (mg), vitamin C - 18 (mg), folic acid - 3 (mg) carotene - 4.8 (mg) Fibre - 0.9 (g) potassium

- 55 (mg) magnesium - 35 (mg) and Sodium - 26.2 (mg). The jamun fruit is fairly good source of vitamin C and mineral salts as per the same report. According to sethi (1993) jamun fruits are rich in iron, calcium, phosphorous and caloriphic value.

According to Daulatabat et al (1988) Syzigum cuminii seed oil was found to contain lauric (2.8 per cent) myristic (31.7 per cent) Palmitic (4.7 per cent) stearic (1.8 per cent) and vernolic (3.0 per cent) acids.

Many people appriciate the fruit for its medicinal qualities especially its value in treatment of diabetes (Khurdiya & Roy 1985, Gopalan et al, 1971, Sheoti et al 1963 and NIN 1992).

NIN 1992 emphasised the medicinal/therapeutic value of various parts of jamun tree. As per the report, aqueous extract of the seeds is reported to cause marked prolonged decrease in blood sugar, when injected into dogs. Experiments carried out at central Drug Research Institute, Lucknow, showed that oral administration of dried alcoholic extracts of the seeds to diabetes patients reduces the level of blood sugar and glycosuria. Extracts from bark of jamun tree have a moderate antibiotic activity (NIN 1992). According to the same report, the bark is astingent and is used for gargles and mouth washes. Further, a decoction of the bark and powdered seeds is considered useful in the treatment of diarrhoea and dysentry.

2.5. PRODUCT DEVELOPMENT FROM UNDER EXPLOITED FRUITS

Highly acceptable nutritious products could be developed utilising under exploited fruits. Subhadra et al (1965) found out that wood apple could be preserved by converting it into RTS beverage. According to Jain et al (1970) a good quality RTS guava beverage can be prepared with fruit pulp content equivalent to 5-10 per cent peeled fruit, 12.5 per cent TSS and 0.25 per cent acidity. RTS beverage prepared from cucumis melo var momordica by Nalwadi (1970) remained for 4-5 months without spoilage. According to Khurdiya and Anand (1981), the acceptability of the RTS beverage prepared from phalsa fruit goes down, when stored at 20°C or at room temperature.

Khurdiya and Roy (1985) developed an acceptable quality RTS beverage from jamun. Standardisation of a method of juice extraction and preparation of RTS from Rhodopetals was carried out by Vyas et al (1989). RTS beverage with 10 per cent ber juice, 15 per cent TSS and 0.25 per cent acidity was found to be highly appreciable among the panel members as claimed by Kadam et al (1990).

RTS beverage from phalsa fruit was formulated and standardised by Waskar et al (1991). Studies by Teotia (1991) revealed that an RTS beverage which possessed excellent sensory quality could be prepared from fermented muskmelon juice. The formula for a carrot based RTS beverage was standardised with 15

per cent sugar, 0.15 per cent citric acid and 100 ppm sodium benzoate by Seralathan et al (1992). Ranote et al (1992) studied the suitability of Kinnow fruit/citrus reticulata for conversion into RTS beverage and its shelf life under ambient temperature conditions were evaluated.

Studies by Kaushik et al (1994) revealed that acceptable quality RTS beverage based on unripe Dashehari mangoes could be developed. Gowda and Jalali (1995) found that addition of spices was not found to be beneficial in improving the overall acceptability of RTS from watermelon.

The organoleptic evaluation of the RTS beverage prepared by utilising custard apple revealed that usage of 20 per cent juice made the product highly acceptable as revealed by the studies of Kotecha et al (1995). Saikia and Dutta (1995) reported that an RTS beverage having good consumer acceptability could be made from outenga (Dillenia indica) fruit.

Najunda swamy (1964) opined that plain guava juice required dilution with sugar syrup to make it a highly acceptable beverage. Studies by Muthu Krishnan and Palani swamy (1972) revealed the suitability of West Indian cherry for the preparation of clarified juice and squash. Roy and Singh (1979) noticed that by adjusting the amount of pulp, brix and acidity, good quality nectar and squash could be prepared from beal fruit. Jain et al (1986) studied the effect of different

storage conditions on the quality of squashes prepared from phalsa, Kaphal, and litchi fruits and found that products stored at low temperature were superior to other storage conditions. Investigations undertaken by Waskar and Khurdiya (1991) ended in the preparation of acceptable quality nectar and Squash from phalsa fruit. Tripathi et al (1988) developed a recipe for amla juice which was found organoleptically acceptable.

Okoli and Ezenweke (1990) found that papaya juice at pH 3.9 was highly acceptable. The juice from ripe fruits of Rangpur limes was found to yield good quality squashes and cordial as reported by Krishnamurthy et al (1990). According to Saini and Wani (1993) juice yield obtained from hot break pulp was higher than cold extracted pulps in all the three plum varieties evaluated. Studies conducted by Hayati and Dhawan (1992) revealed that guava pulp which was preserved and kept at low temperature can be utilised for beverage production.

Studies by Kaushik et al (1994) indicated that squash like beverage could be developed based on unripe Dushehari mangoes. Karakaya et al (1995) developed a beverage from melon seeds, which was highly acceptable to make a waste product available for human consumption.

Vyas et al (1989) noticed that a product containing 5-6 per cent alcohol, 3-4 percent sugar, 0.35 per cent acid can be prepared from litchi which can be served chilled as an appetizing

soft drink instead of intoxicating liquors. (Joshi et al (1990) noticed that wine producted from wild apricot in 1:2 (fruit pulp:water) dilutiion recorded higher scores compared to other proportions due to the balanced acid, alchol, sugar, taste, appealing colour and flavour.

Joshi et al (1990) found that the physico-chemical characteristics of plum vermouth compared well with those of mango and grape vermouths and the one with 15 per cent alcohol and sweet taste was adjudged the best. Studies conducted by Adsule et al (1992) to prepare an acceptable quality fermented beverage from ber fruits revealed that wine from ber juice was comparable to that from grape juice except slight astringent taste.

Adsule et al (1992) conducted a comparative study of pomegranate and grape wine. Sensory evaluation showed that pomegranate wine had better flavour and colour than grape wine. Lingappa et al (1993) conducted an experiment to utilise tamarind fruit pulp in fermentation to commercially acceptable vermouths and standardised the correct formula for the preparation of conmercially acceptable quality dry and sweet vermouths.

According to Attri et al (1993) a sweet vermouth having 15 per cent alcohol could be prepared from sand pear which was highly acceptable. Vyas and Kochar (1993) found that wine prepared from culled apple was acceptable. Trials were done to

prepare wine from over ripe banana fruits and the sensory evaluation revealed that wine from over ripe fruit was comparable to that from normal fruits (Kotecha et al 1994).

Muthu krishnan and Palani Swami (1972) reported that West Indian cherry was suitable for the preparation of jam, jelly and pickle. Studies by Roy et al (1979) revealed the possibility of preparing good quality fruit slab, toffee and fruit powder from bael fruit by adjusting the amount of pulp, brix abnd acidity. Tomar and Gawar (1985) standarised a procedure for Musk melon dehydration. Studies on pear candy processing by Rani and Bhatia (1985) resulted in products which elicited high consumer acceptability.

Kumar (1985) studied the probability of utilising peel from watermelon for pickle making and found that the pickle made with the outer green skin had little astringency in taste while the one without outer skin was of better taste. A good quality concentrate and crush which was acceptable upto 60 days at room temperature was prepared by Waskar and Khurdiya (1991).

The feasibility of fruit based carbonated drink from lime, phalsa, jamun, ber and apple was studied by Khurdiya (1990) and the author found that the sample having 30.9 per cent juice with 28.57 brix - acid ratio and carbonated at 80 psi CO_2 pressure was the best. Yousif et al (1990) revealed the possibility of processing date into good quality jelly. Trial was conducted on

the preparatiion of jam from watermelon rind by Bhatnagar (1991). He reported that though the jam was low in acid and pectin content, it was highly acceptable.

According to Aina and Aderina (1991) high solid jam from low usage topical fruits are composed of fruits (43-45 per cent) soluble solids (68 - 68.9) per cent), reducing sugar (35.6-40.6 per cent) showed good storage stability at ambient conditions. Grewal and Saini (1992) reported that heat treated fruit juice concentrates made from pear juice had higher acceptability.

2.6. PRODUCT DIVERSIFICATION

Reuniting flavour, eliminating undesirable component of the same of different juices becomes the basis for blending of a wide variety of flavour, colour and consistency (Annapurna, 1977).

According to wood roof (1974) the manufacture of blended juice of the traditional of popular juice has been used as a base, others are used to built up the beverage qualities. Rao et al (1979) reported that blends may go a long way in reducing cost of juice used in making beverages.

Muralikrishna et al (1969) reported that organoleptically acceptable blends could be prepared by utilising the prolific bearing grape variety "Bhokri" as a blend with the highly coloured and sweet juice of "Beauty seedless" to the extent of 50 per cent. Woodroof (1975) observed that the purees and juices of

orange, banana, papaya and guva can be successfully blended with passion fruit juice into tropical fruit drinks, punches and syrups.

Thorner and Herzberg (1978) opined that grape juice is an excellent blending agent. The authors also reported that blends of apple and concord grape juice with lemon or grape fruit juice are gaining wide acceptance. Nani et al (1993) found that all berries were not suitable for blending with apple juice. Good results in terms of sensory properties were achieved using apple/ black currant and apple/raspberry blends.

Najunda swamy et al (1964) reported that the plain juice of papaya has to be blended with the other fruit juices to make it a highly acceptable beverage. He further stated that plain guava juice should be blended with other fruit juice to make it an acceptable beverage. Pruthi and 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 quality and acceptability of mango beverage. Teotia et al (1992) tried to develop a musk melon - mango beverage blend and the beverage made from 50:50 blend was adjudged the best because of its balanced flavour. According to Chakraborthy et al (1993)

clarified watermelon juice blended with lime juice or pineapple juice yielded RTS beverage of acceptable quality.

Kalra and Tandon (1984) observed that blends of guava and mango nectar was found to be inferior to guava or mango nectar. Kaur and Khurdiya (1993) observed that overall acceptability was highest for the blended nectar of mango with pineapple, orange and plum in the ratios 2:2, 3:1, 3:1 and 1:3.

Studies by Muthu Krishnan and Palaniswami (1972) resulted in acceptable quality squash by blending lime and pineapple juices with West Indian cherry at 1:1 ratio. Begum et al (1983) have tried pineapple and mango pulp mixtures in the ratio of 25:75, 50:50 and 75:25 for squash and they have claimed good consumer acceptance.

Rao et al (1979) found that beverages could be prepared by blending Rangapur lime and acid lime in the ratio of 15:10 or 20:5. Investigations have been carried out to combine Maharaji apples that has poor marketing due to its tart taste with the juice of more sweet varieties of apple. Results revealed that blends of harmonised flavour were obtained by mixing the juices of Red delicious, American and Maharaji in the ratio of 30:30:40, 20:40:40 and 15:45:40 which are economically viable. Shresta and Bhatia (1982) recommended that best blend could be prepared from the juices of American and Maharaji apples in the ratio of 1:2

with 2 per cent added sugar which was better than any of the market products.

Khurdiya (1993) noticed that the nectar prepared from the pulps of Totapuri and Amrapali mangoes at the ratio of 50:50 was superior to the nectars prepared from either Totapuri pulp alone or the blend with Amrapali in the ratio of 75:25. Saini and Wani (1993) opined that overall scoring improved when plum juices from three varieties were blended uniformly prior to the preparation of RTS drinks.

Wines prepared from the combinatiion of more than two varieties were found to be quite acceptable in apple. (Dang et al 1979).

Peeled watermelon rind was processed alone and in combination with pink berries of grape cultivar by Bhatnagar (1991) and the study resulted in a mixed jam with high acid and pectin content, better consistency, colour and flavou. Kaur and Bains (1992) reported that tomato juice canned Okra was rated superior to the one in brine and it showed the typical blend of Okra and tomato flavour which elicited high consumer acceptability.

2.7. EFFECT OF STORAGE ON PRODUCT QUALITY

2.7.1. Nutritional and chemical changes

Zee et al (1991) reported that nearly 90 per cent of vitamin C in human diet is obtained from fruits and vegetables as

ascorbic acid and dehydro ascerbic acids. He further stated that these acids are sensitive to light and oxygen and may decompose under normal transport and storage conditions resulting in reduction of nutritional value.

Ranote et al (1992) stated that exposure to sunlight was a significant factor that affects the ascorbic acid retention in bottled juice. Geetha and Shivaleela (1982) reported that maximum loss of ascorbic acid occured in products subjected to continuous boiling, steaming etc. Jellinik (1985) stated that there was a loss of ascorbic acid in the processed food products under the influence of atmosperic oxygen. Pruthi (1985) studied the role of vitamin C in the discolouration of processed products and has reported that there was 10-15 per cent loss of ascorbic acid during storage period.

Analysis of citrus juice stored during a period of 7 months showed an ascorbic acid loss of 24.77 mg/100 g juice (Palani swami and Muthukrishnan 1974). Smoot and Nagg (1980) noticed that the loss of ascorbic plus dehydro ascorbic acid in canned grape fruit juice stored at 10°C to 50°C for 12 weeks increased with increasing temperature. Storage studies of Kinnow mandarin juice by Ranote et al (1992) indicated that the loss of ascorbic acid was rapid at the initial perioid of storage but slowed down after 6 weeks of storage at room temperature. Sandhu et al reported that the rate of loss of ascorbic acid in Kinnow orange

juice and concentrate was directly proportional to storage temperature.

Achienewhu and Hart (1994) revealed that processing the juice by pasteurisation reduced ascorbic acid to between 28-46 per cent, while storage in plastic bottles for two months further reduced the ascorbic acid content to between 10-21 per cent. Storage evaluation of processed tomato juice by Agarwal et al (1995) revealed that about 53 per cent of ascorbic acid was lost during 6 months of storage. Saini and Grewal (1995) reported that loss of ascorbic acid was more pronounced during concentration of unblanched pear juice (60.7 per cent) than that of blanched pear juice (49.3 per cent).

Sethi et al (1980) found that kinnow orange juice preserved by canning, bottling and sulphur dioxide and stored for 9 months at room temperature had an ascorbic acid content of 17.64, 3.53 and 23.53 mg/100ml respectively.Studies conducted by Ranote et al (1992) indicated that the retention of ascorbic acid was better in So_2 preserved juice than heat processed bottled juice of Kinnow mandarin. Mehta and Bajaj (1983) noticed that comparatively lower losses were observed in juice samples preserved with KMS than those preserved by pasteurisation and sodium benzoate.

According to Mehta and Bajaj (1983) comminuted squashes of Kinnow and Blood red orange contained more ascorbic acid and the

ascorbic acid retention was 78 and 55 per cent respectively during the 9 week storage at 37°C.

Seralathan and Thirumaran (1990) reported that the decrease in ascorbic acid was 28.73 per cent in tomato concentrate stored in glass bottles. Agarwal et al (1995) noticed that the ascorbic acid decreased significantly (26-48 per cent) during the 6 months storage of tomato concentrate.

Mokady et al (1984) observed a rapid decrease in ascorbic acid in banana, apple, guava samples and in blends consisting of orange juice - banana - apple or banana - apple blends.

Nichabouri et al (1993) reported that there was no significant loss of ascorbic acid from the 11 commercial fruit juices kept in a clored container at 4° & 25°.

Chemical analysis of Jack fruit squash by Bhatia et al (1956) showed that the pH did not change during storage. Khurdiya and Anand (1981) noted that the pH remained stable in the RTS beverage from phalsa fruits during storage at different temperature. Kulwal et al (1985) indicated no change in canned papaya products during storage. In fruit juice concentrates there was practically no change in pH showing the stability towards storage and temperature (Sandhu et al 1985). The pH remained constant during storage of sand pear juice concentrate as reported by Saini and Grewal (1995). The result of the studies done by Khurdiya et al (1995) indicated that there was

not much changes observed as pH was concerned. Storage studies by Gupta and Jayaraman (1995) indicated no change in pH during the entire period of storage.

Tripathi et al (1988) observed that only little change in pH occured during storage of amla juice. Evaluation of pH in Kinnow RTS showed that only negligible changes occured during storage. This was reported by Renote et al (1992). This is in accordance with the study done by Renote et al (1993) in Kinnow juice.

The analysis of pH in citrus juice by Bawa and Saini (1988) indicated an increase in pH from 4.2 - 4.5 at higher temperature. Mehta and Bajaj (1983) reported that the three varieties of citrus juices showed a slight increase in pH during storage pf 8 months.

Seralathan and Thirumaran (1990) observed that the tomato concentrate stored in glass bottles showed a decreasing trend in pH and it was to the tune of 4.9 per cent. Kaushik et al (1993) found out that the declinatiion of pH was from 4.1 to 3.7 during the storage of honey upto 6 months. Chakraborthy et al (1993) also found similar results in RTS beverages prepared from watermelon.

Sethi et al (1980) reported that Kinnow juice preserved by canning, bottling and SO_2 and stored for 9 months at room

temperature showed 2.35, 2.0 and 2.10 per cent acidity respectively.

Kalra et al (1991) noticed that beverages made from the blend of four commercial mango cultivars and papaya blends showed negligible changes in titrable acidity. Similar results were also observed by Renote et al (1992) and Shah and Bains (1992) in Kinnow RTS and Canned apricot and peach pulps respectively.

Saini and Bains (1994) reported that during storage of watermelon juice there was no change in the acidity of the product.

Palani Swami and Muthu Krishnan (1974) noted a decrease of titriable acidity in lemon juices and squashes. Mehta and Bajaj (1983) found out that the loss of acidity in citrus juices ranged from 13.83 - 51.70 per cent. Sandhu et al (1983) also noticed a reduction in acidity of Kinnow mandarin irrespective of the temperature during 3 months storage. Similar results were also observed in comminuted kinnow and blood red orange squashes and citrus squash by Mehta and Bajaj (1983) and Muhammad et al (1986) respectively. Sandhu et al (1985) also observed a reduction in acidity of orange juice concentrate at all temperature of storage while in pineapple juice the acidity increased maximum, at 37°C and minimum at refrigeration temperature. The storage studies on Bhadri lemon juice and teinturies grape hybrids by Bansal and

Dhawan (1993) and Khurdiya et al (1995) indicated that the acidity decreased during the period.

Adsule and Roy (1975) reported an increase in the acidity of stored mango pulp. Kalra et al (1984) observed that during storage of fruit nectars the titrable acidity increased by 0.02 - 0.04 per cent. Seralathan and Thirumaran (1990) observed that the increase in acidity was 4.46 per cent in the tomato concentrate. Mir and Nath (1993) also reported a significant increase of acidity in mango bars during storage. According to Kaushik et al (1993) the acidity increased from 2.47 - 3.05 ml/100g during the 4 month storage of honey. Sethi (1994) also noticed a increase of 2.08 per cent in titrable acidity on whole tomato concentrate stored for 8 months.

Singh and Mathur (1953) observed an increase in TSS in cashewapple under cold storage at different temperature, the increase being greater at higher storage temperature. But Kaushik et al (1993) opined that heating at 60°C, addition of KMS and temperature of storage did not affect the TSS, pH and acidity of honey and the increase in TSS value was from 81.51 to 82. 26 per cent.

Saini and Grewal (1995) opined that as TSS increased, total solids also increased parallel to the soluble solids during concentration process.

Not much change in TSS was observed in the phalsa beverage during storage at all the three temperatures as reported by Khurdiya and Anand (1981). Practically no change was observed by Sandhu et al (1985) on TSS in Kinnow and pineapple concentration during storage. Khurdiya and Roy (1985) and Saini and Bains (1994) also observed similar results in Jamun beverage and watermelon juice respectively.

During storage of fruit nectars, the decrease in TSS was of the order of 0.5 - 10 per cent. Seralathan and Thirumaran (1990) observed that the deccrease in TSS was to the extent of 3.6 per cent in tomato concentrates stored in glass bottles. In RTS beverages preapared from watermelon, the decrease in TSS was from 15 to 14.5 after storage of 5 months (Chakraborthy et al 1993).

The Kinnow juice preserved by canning, bottling and SO_2 after 9 months of storage at room temperature contained 10.11, 12.68 and 9.50 per cent total invert sugars respectively. This was reported by Sethi et al (1980).

Khurdiya and Anand (1981) opined that not much change in total sugar was observed in the phalsa beverage during storage at three different temperature. Sandhu et al (1985) reported that no change was observed in Kinnow and pineapple concentrates as far as Total sugar was concerned. Similar results were obtained

for water melon juice in the study done by Saini and Bains (1994).

In RTS beverages prepared from watermelon, the decrease in total sugar was from 12.2 to 12.1 after 5 months of storage. This is in accordance with the study done in pear juices by Saini and Grewal (1995).

Palani Swami and Muthukrishnan (1974) observed an increase in total sugar content during 7 months storage of lemon juices. Mehta and Bajaj (1983) stated that an increase in the range of 5.89 - 12.11 per cent in total sugar was observed in citrus juices stored for 8 months at room temperature.

2.7.2. Organoleptic Changes

Apricot pulp preserved with 547 ppm SO_2 has shown that the quality was satisfactory upto 9 months at room temperature (Manan et al (1982). Squashes prepared from the pulp was also found to be acceptable upto 8 months as reported by same authors. Sethi (1985) had reported that pulp from litchi fruit was found acceptable for 6 months at room temperature and upto 12 months at low temperature. Angela et al (1987) reported that dehydrated blue berry products had a good texture, flavour and overall acceptability and had a shelf life of 16 - 64 months. Sethi and Malini (1991) had found that mango pulp mixed with 1000 ppm SO_2 and stored at ambient condition and 1 to 3°C for 1 year was

acceptable. Kalra et al (1991) had concluded that the mango-papaya blended beverage showed a shelf life of one year under ambient conditions. Bhatnagar, (1991) found that keeping quality of watermelon jam was good under ambient storage conditon for a period of 6 months. Pal (1995) reported that passion fruit RTS was acceptable during its 5 weeks of storage. Majeed (1995) reported the organoleptic stability of karonda products during its storage.

2.7.3. Microbial Changes

Allen et al (1986) reported that spore forming bacilli is the most revelant one among the bacilli species identified in the food product. Bhatnagar (1991) found that there was no activity of microorganisms upto six months of storage of watermelon jam. Kadam et al (1991) observed complete absence of microorganisms in pomegranate wine during storage period of eight months. Majeed (1995) reported that there was complete absence of microorganisms in karonda candy, jelly, canned karonda and wine during storage. Oommen (1995) reported that osmotically dehydrated jackfruit products of soft and firm flesh varieties had a stability of five months.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study entitled "Development,diversification and shelf life of jamun (Eugenia jambolana. L) based products" was under taken to envisage the suitability of jamun fruit in processing into acceptable beverages. Product diversification through blending with suitable fruits was also attempted in the study.

3.1. SELECTION OF THE FRUIT

Jamun is a tasty, but highly perishable fruit that cannot stay in good condition for more than three days (NIN 1992). Hence a considerable amount of this seasonal fruit is wasted during its peak harvest . According to Shukla et al (1991)the Jambal fruit (Eugenia jambolana.L)is liked for its refreshing pink to greyish juicy flesh having a very balanced sugar, acid and tannin blend. Venkateswarlu (1952) and Khurdiya and Roy (1985) have opined that the attractive colour due to anthocyanin pigment is a major quality attribute in jamun for the preparation of beverages and this with other characters can be used in making various products. However the potential of this fruit for processing has not received much attention. Sarain (1992) and Chadha (1994) opined that apart from the major fruit, there are rare ones like jamun having tremendous marketing potential, need to be tried by the processing industry to promote their expansion. According to Khurdiya and Roy (1985), jamun, an indigenous fruit having an attractive colour and excellent taste with some therapeutic value can be profitably

utilized by beverage industry. For this popularisation of the fruit is necessary.

Eventhough this fruit is remarked for preparation of certain products, very, little information in available on the processing of jamun. Based on these factors, jamun was selected in the present study to disclose its suitability for processing into acceptable beverages and thus salvage this under exploited fruit. Jamun fruit needed in the study was collected from local homesteads during the months of June to August which falls as the season of this fruit.

3.2. FRUITS SELECTED FOR BLENDING

According to Navani (1965), berry juices are best when used in blends with other juices or with syrup rather than used alone. Hence attempts were also undertaken to formulate mixed beverages with jamun as comparison against the plain beverages. Fruits selected for blending were grapes, watermelon and west Indian cherry.

3.2.1. Grapes

Thorner and Herzberg (1978) reported that grape juice is an excellent blending agent. The utilisation of grapes juice in grape drinks and in blends of juice has expanded considerably and these blends are very pleasing as reported by Pederson and Luh (1971). Jamun and grapes have similar colour, proving them ideal for mixing. Besides, the ready availability of this

conventional fruit was also considered, while selection of fruit for blending with jamun in the preparation of beverages identified for the present study.

3.2.2. Watermelon

Watermelon is a summer fruit generally grown for its juicy flesh, which is very sweet. (Gowda and Jalali 1995). The flesh of watermelon is relished as a dessert. However, this soft fruit cannot be used for canning, dehydration and jam and jelly making. Therefore, there is need to find alternative uses of melon fruits during the period of plenty. So an attempt was made to blend this fruit with jamun in the preparation of soft beverages.

3.2.3. West Indian cherry

West Indian cherry, popularly known as Barbados cherry or puertorican cherry is acidic and not popular as a table fruit. Nevertheless, Muthukrishnan and Palaniswamy (1972) reported that west Indian cherry is suitable for the preparation of clarified juice, squash, jam, jelly and pickle in oil. They further reported that blending of west Indian cherry with pineapple and lime juice in the ratio of 1:1 resulted in products of acceptable quality. The availability of the fruit in the instructional farm, Vellayani, added with its underutilisation for processing, accounted for favouring its selection for blending with jamun in the production of fermented beverage in the present investigation.

3.3. SELECTION OF PRODUCTS

In todays market, innumerable new products appear. Among these, beverages are the easiest new fruit products for introduction (Vaidehi 1977). Khurdiya (1988) reported that fruit beverages are able to offer more variety of nutrient flavour and other physiological benefits with a greater margin of safety in a drink with lower inherant cost. Thus as an initial attempt, beverage items were choosen in the study. Ambadan (1984) pointed out that it is necessary to introduce new fruit beverages by utilising unfamiliar fruits because of their exotic aroma and excellent colour. Jamun is such an unfamiliar fruit with attractive colour and blend of chemical components suitable for preparation of beverages. Hence three beverages were selected for development with jamun viz squash, ready to serve beverage (RTS) and wine.

3.3.1. Squash

Kalra (1991) highlighted that fruit based beverages are rightly being encouraged as they provide much needed vitamins and minerals. There is a noticeable shift from consumption of alocoholic beverages to natural fruit based beverages (Varde 1991). Squash is one of the products which is familiar among different strata of families in our country. However, the preparation of squashes from lesser known fruits have not received much attention.) According to Ambadan (1984), the fruit beverage of tomorrow may be based on fruits other than the

present popular varieties. Therefore, in this attempt of product development, jamun based plain and mixed squashes combining grapes and watermelon were included.

3.3.2. Ready to serve beverage (RTS)

RTS is a fruit beverage which is considerably altered in composition with sugar and water during preparation. No amount of dilution in necessary prior to serving, as it is in the ready to serve form. Ready to serve beverages are increasingly gaining popularity throughout the country, which is evident from its boosting production figures (Chakraborthy et al (1993). However, the RTS from unconventional fruits have yet to pick up the impetus (Manan et al 1992). Hence with an aim of bringing popularity to low cost nutritious drinks, preparation and evaluation of RTS beverage from jamun alone and in combination with grapes and watermelon was considered.

3.3.3. Wine

Wine is a natural, nontoxic, healthful fermented beverage from fruits rich in calories, vitamins and minerals (Adsule 1992). They serve as an important adjunct to the human diet, by increasing satisfaction and contribute to the relaxation necessary for proper digestion and absorption of food. (Delin and Lee 1992). According to Vyas (1993), wines of pleasing flavour could be made from fruits containing tannin. Jamun is a fruit rich in tannin content and so this fruit was considered for

its feasibility in fermenting into wine and also for diversifying the product by blending with grapes and west Indian cherry.

3.4. STANDARDISATION OF JAMUN BEVERAGES

According to Pruthi (1969), standardisation is the yardstick which when properly used, lead to considerable improvement in quality, enhancement of productivity, reduction of costs and in optimum utilisatiion of available resources. Bhagwan (1968) stated that standardisation should bring about harmony and not uniformity. This harmony of the added substances and the composition can be achieved only by trial and error method.

In the present trial, standardisation of jamun based beverage viz, squash, RTS and wine was carried out at the laboratory in two steps.

a. Standardisation of straight beverages using jamun alone.
b. Standardisation of mixed beverages by combining jamun juice and other fruit juices in three different proportions.

3.4.1. Preparation of squash

The steps followed in the preparation of squash are as follows.

Selection of fruit

Fully ripe jamun fruits without blemishes and injury were used. The fruits were washed thoroughly in running water to

remove the adhering dirt and other extraneous matter and was drained. Two kg of fruit was utilized for the preparation of eight bottles of plain jamun squash.

Extraction of juice

Though mechanical extraction can be employed, jamun juice was extracted manually in the present study. The method of juice extraction will differ with the structure and composition of the fruit (Lal et al 1986). Therefore, the methods employed for extraction of juice with respect to jamun were the "cold break" and "hot break" method. In the "cold break" method, the juice was extracted by washing the fruit manually and filtering with a double layered muslin cloth. The "hot break" method differed from "cold break" method in that, the berries were crushed and heated upto 60±5°C for 5 minutes before pressing out the liquid portion using a sterile muslin cloth. During extraction, care was taken so that the juice was not unduly exposed to air.

Clarification of the juice

Fruit juice after extraction contain varying amounts of suspended matters. Chakraborthy (1962) described a method of removing astringent principles in cashew apple juice by precipitation with gelatin followed by filteration. The presence of these constituents causes deterioration in the quality of final product. Complete removal of all suspension is effected by the process of clarification. Clarification of the extracted jamun juice was necessary to separate the astringent particles.

Therefore, two practices were adopted here for clarification (i) addition of gelatin and (ii) heating the juice to 80°C.

Gelatin, which is considered an excellent fining material (Lal et al 1986) was added at the rate of 0.2 per cent to the fruit juice and it was stirred well to make it homogeneous. This mixture was allowed to stand undisturbed for five hours so that the precipitated matter formed clots and settled down. The other clarification step was accomplished by keeping aside the heated fruit juice for sedimentation upto five hours. Lal et al (1986) have pointed out that the colloidal material in fruit juices coagulates and settles down readily when the juice is heated.

Preparation of syrup

Syrup was prepared by observing 1:1:2 ratio for juice, water and sugar respectively. In a prior trial, various ingredients were also tested for quantity to be added in the formula. 5 g of citric acid was added per litre of fruit juice taken for the preparation of squash.

Mixing

After the syrup was cooled, the melding of the juice with syrup was done. The ratio maintained for juice:water:sugar was 1:1:2. Essence and colour was added as they improves the overall acceptability of the product. Preservative at the prescribed level was also used.

Bottling

The prepared squash was filled in glass bottles that were thoroughly sterilised leaving 5 cm head space and was sealed using a cap sealing machine.

3.4.2. Preparation of Ready to Serve beverage

The initial steps at extraction and clarification of jamun juice for the preparation of RTS was carried out following the procedure as in the case of squash.

Syrup preparation

RTS beverage differs from squash in the proportion of sugar, water and juice taken for its preparation and do not dilute at serving. According to Jain and Borker (1970), Ready to serve beverages are prepared by mixing appropriate quantities of fruit juices or pulps, sugars, citric acid, and water, with or without flavour fortification. In the present investigation, standardisation of RTS beverage was done by trying different levels of jamun juices (15,20 and 25 per cent) with the specified amount of water, sugar and acid. In the standardisation trial of RTS beverage from custard apple juice Kotecha et al (1995) used different levels of juice to formulate an acceptable product. According to Ashurt (1986), sugar is a principal component for the formulation of the beverage. Sugar contributes flavour, sweetness, mouthfeel, nutrition and facilitates water absorption. Water contributes bulk and mass to the beverage and is a solvent

carrier and thirst quencher. 5g of citric acid per kg of jamun juice was also added to the syrup. Sugar syrup for jamun RTS was prepared by taking sugar and water in the ratio 1:3. These proportion of sugar and water were melded and heated.

Mixing and Bottling

Preservatives, essence and colour within the permissible limits were added and mixed thoroughly. The RTS beverage prepared was filled in thoroughly sterilized glass bottles leaving 5 cm head space. The bottles were sealed using crown corking procedure.

Pasteurisation

The bottles were heat processed for 30 minutes in boiling water and kept aside for periodic observations.

3.4.3 Preparation of wine

Availability of technology is the most important factor determining the production of fruit based alcoholic beverages (Sandhu *et al* 1995). Apart from grapes for which the technology has been advanced, other fruits can also be fermented into wine. Few reports are available on the preparation of wine from many of the unconventional fruits (Joshi and Attri 1990, Adsule *et al* 1992). Accordingly, a procedure for the preparation of jamun wine was formulated. The different steps undertaken in the standardisation of wine from jamun fruit is given below.

Selection of fruits

Fully matured and ripe fruits of jamun were used for the preparation of wine

Preparation of must

Fruits were washed in water and crushed with hand without damaging the seeds. For standardising the procedure for jamun wine, trials in two aspects were undertaken.

a. Pulp water ratio of 1:1 and 1:2
b. Must preparation using hot water and cold water.

Shukla et al (1991) have reported standardisation trials of wine using different proportions of fruit, pulp and water Similarly for karonda wine standardisation, must preparation using hot water and cold water was also tried by Majeed (1995). Hence these two aspects have been experimented in the standardisation procedure of jamun wine.

Fruit pulp and water in the two different proportion and temperature were kept separately in ceramic pots. Sugar was added at the rate of 1kg/kg pulp to all the samples of wine. Half the quantity of sugar was added initially and the other half after five days of fermentation. Sandhu et al (1995) has suggested the amelioration of the must with sugar as the alcohol content of wine is more than cider.

Fermentation

A culture of pure wine yeast (5gms/kg pulp) was added as inoculum to start the fermentation process and the jar was kept closed.

To the hot water treated samples, the wine yeast was added when the must attained lukewarm temperature. The must was stirred every day with a wooden laddle by opening the jar. Stirring process was continued for 10 days.

Filtration

When the fermentation ceased, the juice was filtered using a double layered muslin cloth and transfered to clean, dry ceramic jars.

Sedimentation and Ageing

Fining or clarification of wine is one of the stabilization process which are carried out in cellars after the fermentation is finished (Revilla 1993). The jars having the filtered wine were kept airtight and undisturbed at room temperature for a period of one month for aging and settling of haze. According to sandhu et al (1995), aging is a complex process in which precipitation of the undesirable suspended material takes place besides the formation of esters.

Siphoning and bottling

The clear wine samples after sedimentation process were siphoned off using a plastic tube and was filled in clean sterilised bottles for further assessment.

3.4.4. Selection of fruit combination and proportion for blended products.

Navani (1965) has aptly stated that chemical composition of many fruit juices may not be balanced from an organoleptic point of view and to avoid chemical alteratious, juices of varying composition may be blended together so that it will bring about the standardisation of acid constituents. Thus in order to serve a balance of chemical constituents and to bring about taste alterations, jamun products were standardized using combinations of selected fruits. For standardising each product viz, squash, RTS and wine, two different fruit juices were blended with jamun at there different proportion. Apart from these mixed formulas, straight or plain beverages utilising the corresponding blending juice were also included in the study for assessing comparative acceptability performance in coalition with jamun juice and viceversa. Different straight beverages and their blends and proportions attempted in this study are given in Table 1.

Table 1

Plain beverages and their blends attempted in the study

Product	Fruit/combinations of fruits	Proportion selected for mixed products		
		P_1	P_2	P_3
Squash	Jamun alone	-	-	-
	Jamun and grapes	1:1	2:1	3:1
	Jamun and watermelon	1:1	2:1	3:1
	Grapes alone	-	-	-
	Watermelon alone	-	-	-
RTS	Jamun alone	-	-	-
	Jamun and grapes	1:1	2:1	3:1
	Jamun & watermelon	1:1	2:1	3:1
	Grapes alone	-	-	-
	Watermelon alone	-	-	-
Wine	Jamun alone	-	-	-
	Jamun and grapes	1:1	2:1	3:1
	Jamun and west Indian cherry	1:1	2:1	3:1
	Grapes alone	-	-	-
	West Indian Cheery alone	-	-	-

3.5. ORGANOLEPTIC QUALITY AND ACCEPTABILITY OF PRODUCTS DEVELOPED

Quality is the ultimate criterion of the desirability of any food product to the consumer. Overall quality depends on quantity, nutritional and others hidden attributes and sensory quality (Ranganna 1977).

Sensory quality is of great importance to both processor and consumer. The organoleptic qualities of the products developed were evaluated by a panel of judges. This panel members for acceptability trials at the laboratory level were selected by employing the triangle test as suggested by Jellinik

(1985). Under this test, three sets of sugar solutions of different concentrations were used. Of these sets, two solutions were of identical concentration. The members were asked to identify the third sample which differed in the concentration. A small highly sensitive panel would give more reliable results than a large less sensitive group (Mahony 1986). Thus ten members were selected as judges for the sensory evaluation. Evaluation card used for triangle test is given in Appendix I.

Assessment of organoleptic qualities of the fresh products were carried out at two levels. The score card used for evaluation is given in the Appendices II and III.

i) Selection of ideal blend

ii) Comparative acceptability performance.

3.5.1. Selection of ideal blend from different proportion tried

Screening of the blended beverages to identify the best proportion of fruits in each category of mixed beverage was carried out by sensory evaluation. The acceptability of the products was evaluated by the panel members on a five point numerical scale. The attributes tested for evaluating sensory quality of the beverages under study were appearance, taste, colour, flavour and clarity. Strength of wine was also scored. The tests were conducted as per standardised procedure. prescribed by Swaminathan (1974). The judges were requested to record the scores based on the quality attributes. Three

proportions were tried out in each blend of the different products. Grapes and west Indian cherry were the fruits used for preparation of blended jamun wine. In the case of squash and RTS the fruits mixed were grapes and watermelon. The most acceptable blend in each group was identified by organoleptic assessment. Based on the mean scores obtained for the various attributes, the overall acceptability for each blend was worked out. The blend which secured the highest overall acceptability score among each product was selected for the detailed comparative study along with plain beverages of jamun and other fruits included in the investigation.

3.5.2. Comparative acceptability performance of different samples.

According to Beekley and Krall (1996) the standard must be a physical representation of the users concept of the product and should be readily available for examination by the panel members. The suitability of jamun for production of straight beverages and blended beverages were evaluated by comparing with similar plain products of commercially outstanding and accepted fruits like grapes and also with other unconventional fruits like watermelon and west Indian cherry. These five samples in each beverage (including plain and their blends) were studied in detail for their comparative acceptability performance and desirability in quality attributes. They were tested for their beverage values based on sensory evaluation by the selected test group.

3.6. ANALYTICAL OBSERVATIONS MADE ON STANDARDISED PRODUCTS

3.6.1. Assessment of chemical and nutritional components

Various chemical parameters such as acidity, total sugar, pH and total soluble solids were analysed on freshly prepared RTS and wine. In addition to the above, wine was analysed for its alcohol percentage also.

10 ml of the samples were drawn for each analysis. Duplicate analysis was carried out for each constituent. The procedure followed for the analysis are detailed below.

The acid content of the products were determined using the titration method (Ranganna, 1987).

Total sugar was estimated by following the method suggested by AOAC (1975).

TSS was recorded using a hand refractometer callibrated at 20°C. The room temperature was also recorded and the necessary corrections were made in the reading.

The pH of the products was noted using a digital pH meter.

3.6.2. Assessment for FPO requirements

Food standards are made to ensure the quality and safety of natural and processed food for human consumption (Swaminathan 1988). According to Ranganna (1977) as the consumer is unable to judge them easily, he is protected by stringent government

controls in the shape of food laws. The standards are meant to provide a uniform and consistently good quality of food products to the consumers. Fruit product order (1995) has specified certain standards for fruit products (Siddappa. 1967). Specifications are indicated for squash, fruit based RTS beverage and wine. The three beverages developed based on jamun were tested for conformity to FPO standards.

3.6.3. Assessment of cost benefit of the products

The price of the product is an important factor determining the commercial introduction of the products developed. Obtaining detailed information on production costs of commodities in relevant to its economic viability.

Cost benefit analysis of beverages under study was worked out based on the prices of different raw materials at the time of preparation of the product. The cost calculated also include the price of bottles, labour and fuel charges.

3.6.4. Fruit product yield ratio

Yield of finished product from a specific unit of raw ingredient is a necessary information to people involved in the production of fruit products. Fruit product yield ratio was calculated by taking into account the quantity of fruit used and the final produce obtained. Obtaining such information of these commodities is especially challenging because they widely fluctuate in different products and fruits (How 1990).

3.6.5. Consumer acceptance and consumer preference

Consumer groups are the major determiners of acceptance or preference for a product. These people are selected specifically because they are untrained and represent the potential consuming population. Caveletto (1970) reported that acceptance must really be tested in the population for whom the product is intended.

Consumer acceptance survey of the products was carried out among 50 subjects drawn at random who represented various socio-economic categories. The test was conducted by the similar procedure followed earlier through administrating score card to assess quality characteristics that were judged at the laboratory level.

Preference test was also conducted at the field level simultaneously to find the order of liking for jamun products by the population group. The members were instructed to rank the different types of squash (5 types) based on their preference. Similar ranking were made for RTS and wine also. Apart trom analysing the product wise preference level, preference of consumers between the three beverages (Squash, RTS and wine) was also studied. From this, the best scored product under each item was selected.

3.7. CONDUCT OF STORAGE STUDY FOR ASSESSMENT OF SHELF LIFE QUALITIES

The beverages processed were bottled, sealed and stored at ambient condition for further detailed study. Squashes and RTS beverages were stored in bottles having 200 ml capacity, while wine in bottles of 250 ml capacity. Adequate number of bottles were stored in the case of each product required for periodical examination upto 8 months.

3.7.1. Assessment of changes in the nutritional and chemical qualities

According to woodroof and Luh (1975) nutrients are destroyed during processing and storage of fruit products because of sensitivity to pH, oxygen, light, heat or a combination of these. Monthly analysis was done for assessing the changes that occurred in the nutritional and chemical qualities in the nutritional and chemical qualities of the products under study during storage. Changes in the constituents viz acidity, pH total sugar and Total soluble solids and alcohol percentage (wine) were assessed during storage drawing samples in duplicate.

3.7.2. Assessment for microbial contamination

The products stored were assessed for any occurrance of microbial contamination during storage. Nutrient agar, malt extract agar and peptone dextrose agar were used as media for the

detection of bacteria, yeast and fungi respectively. Serial dilution method was followed.

3.7.3. Assessment of changes in the organoleptic quality

Organoleptic quality is of great importance in the acceptability of any product. Changes that occurred in the organoleptic quality was also analysed by evaluating monthly/weekly by the panel members.

3.7.4. Statistical analysis of the data

The data observed was treated to statistical analysis. CRD was used as the programme for statistical analysis. CD values were computed at one per cent level of significance for comparing the means of effects.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The results of the present study entitled "**Development diversification and shelf life of jamun (Eugenia jambolana L.) based products**" are presented and discussed under the following headings.

4.1. Physico - Chemical characteristics of Jamun fruit

4.2. Development of plain and blended jamun beverages

4.3. Indepth studies on selected jamun based products

4.4. Assessment of shelf life

4.1. PHYSICO - CHEMICAL CHARACTERISTICS OF JAMUN FRUIT

A detailed study was made with regard to the physico-chemical characters of jamun fruit so as to provide full background information regarding its suitability for processing. The major characters analysed include, size of the fruit, average weight, moisture, acidity, pH, Total sugar, Total Soluble Solids and vitamin C, the results of which are presented in Table 2.

Table 2

Physico-chemical characteristics of jamun fruit

Particulars	Fruits
Shape	oblong
colour	deep bluish purple
Average size (l x d cm)	3.02 x 1.9 cm
Average weight(g)	3.33
waste/stone (per cent)	30
Moisture (per cent)	80.2
Acidity (per cent)	0.7
pH	3.1
Total soluble solids (° brix)	9.0
Total sugar (per cent)	8.82
Vitamin C (mg/100g)	16.0

Jamun is a berry which is also known as black plum or black berry. It was evident from visual examination,that the fruit is highly perishable due to the soft nature of the skin and was found to be bestowed with an attractive purple colour. As detailed in Table 3, the fruits are oblong shaped. The average weight of the fruit was found to be 3.33 g, when worked out by weighing randomly selected fruits. Polar and transverse diameters of the fruits were measured in cm by using vernier callipers and the average size of the fruit (l x d cm) was recorded as 3.02 x 19 cm. The edible portion in jamun fruit form about 70 per cent of the whole fruit. Juice yield was in the


JAMUN FRUIT

range of 38 to 40 per cent and the percentage of pomace was observed in the range 52 to 58. The percentage of juice recovery is in accordance with the range observed for jamun by Khurdiya (1990) which was 35-42 per cent.

The chemical composition of fresh fruit from Table 3 reveals that jamun is a juicy fruit having a moisture content of 80.2 per cent. The fruit bears an acidic sweet taste. The total sugar and soluble solids were observed as 8.82 per cent and 9° brix respectively. The pH and acidity of the fruit was recorded as 3.1 and 0.7 per cent. Vitamin C content of the fruit was observed fairly good,having 16mg/100g. According to Shukla et al (1990) chemical constituents present in jamun fruit include TSS 12°brix, pH, 3.15 and Total sugar 9.22 per cent. The vitamin C content of the jamun fruit was reported as 18 mg/100g (NIN 1993).

Analysis of the physico-chemical characteristics revealed that jamun is an oblong berry with attractive purple colour. The fair juice percentage recovery and the well balanced sugar, acid ratio of this unconventional fruit, highlights its feasibility in the preparation of attractive beverages. Thakur et al (1995) have aptly opined that from processing angle, varieties with high juice yield is the character of prime importance for economic consideration.

4.2. DEVELOPMENT OF PLAIN AND BLENDED JAMUN BASED BEVERAGES

Vaidehi et al (1977) opined that for proper utilisation of food products available in our country, necessary study for utilisatiion of any product should be conducted. Beverages from certain unfamiliar fruits have been developed successfully by earlier workers (Masoodi et al. 1992) Renote et al. 1993 Chakraborthy et al. 1993; Neog et al. 1992 and Saikia and Das, 1993). Therefore as an effort towards utilisation and popularisation of jamun fruit, beverages using plain jamun juice and also in combination with other fruit juices were standardised. Accordingly the beverages developed in the present study are

1. Squash
2. RTS beverage and
3. Wine

4.2.1. Assesment of standaridisation procedures

The seasonally available jamun fruits are not utilised for processing due to the ignorance in the technological knowhow. Recipes were formulated for jamun squash, RTS and wine by conducting systematic trials at the laboratory following varied procedures and quality assessment by experts at each trial.

4.2.1.1. Squash

Initially procedure for the extraction and clarification of juice for squash was standardised. For the extraction of the

juice, the "hot break" and "cold break" methods were applied. The "hot break" method of heating the crushed juice to 60°C and pressing the mass while hot, helped in the maximum juice yield retention, compared to the "cold break" method. Pigment leaching was also observed to be the best in the "hot break" method and hence this was confirmed to be the ideal juice extraction procedure for jamun in this investigation. Khurdiya and Roy (1985) in their trial have advocated the heating of the jamun juice to about 50°C for the extraction of maximum juice.

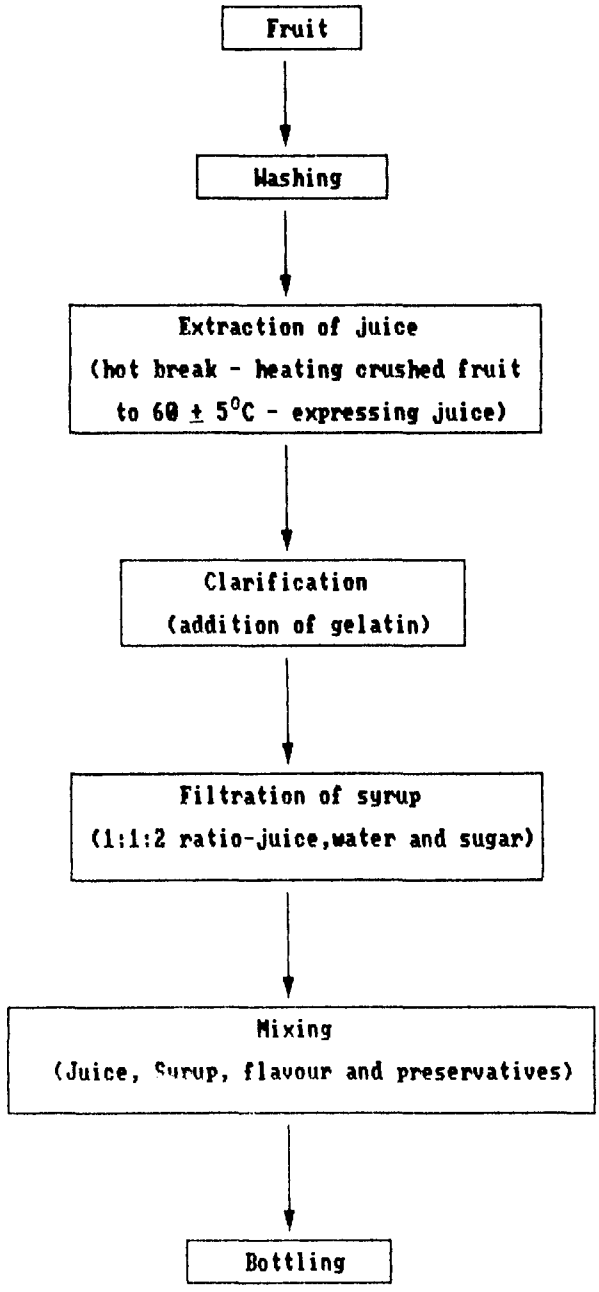
As far as the experiment on clarification of the juice was concerned, the standardisation procedure undertaken were

1) the addition of gelatin and
2) heating the juice to about 80°C and keeping it undisturbed.

Of these two methods tried, the one in which maximum clarity and moderate sediment formation observed was the sample treated with gelatin. The beneficial effects of gelatin have been reported by Manda (1992). He noticed that addition of gelatin solution to the expressed juice reduced the astringent principle in cashew apple juice. Thermal processing caused over-sedimentation leaving watery juice at the top in watermelon juice (Chakraborthy et al 1993). The steps followed in the preparation of squash is given in figure 1.

FIG. 1

FLOW CHART FOR PREPARATION OF JAMUN SQUASH




JAMUN SQUASH


GRAPES SQUASH

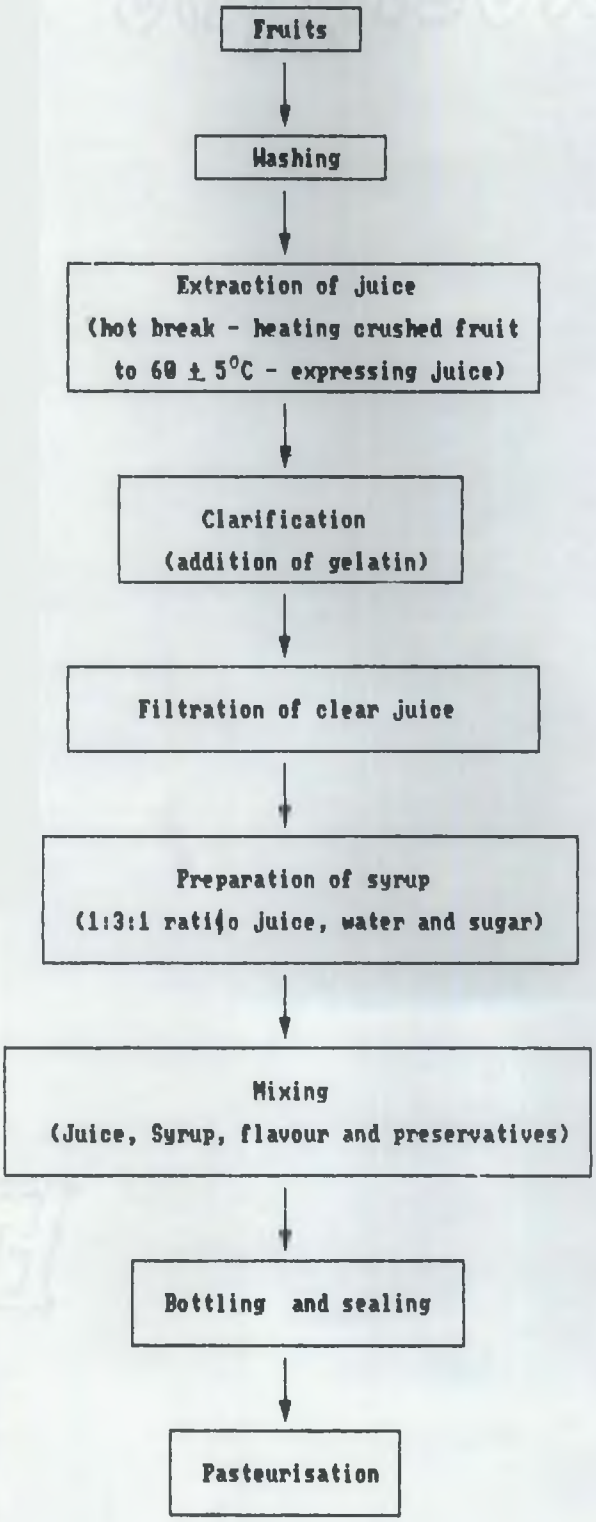

WATERMELON SQUASH

4.2.1.2. RTS beverage

Standardisation of the RTS beverage was done by using different levels of jamun juice (15,20 and 25 per cent). The organoleptic evaluation indicated that the colour, taste, appearance, flavour and overall acceptability increased with increase in the proportion of fruit juice. The beverage prepared from 25 per cent juice was liked most by the judges, as it contributed a pleasing flavour of jamun to the beverage. The higher quality performance of custard apple RTS beverage composed of 25 percent fruit juice in a standardisation work was reported by Kotecha *et al* (1995). A flow chart showing steps in the preparation of RTS is given in figure 2.

FIG. 2

FLOW CHART FOR PREPARATION OF JAMUN RTS




JAMUN RTS


GRAPES RTS


WATER MELON RTS

4.2.1.3. Wine

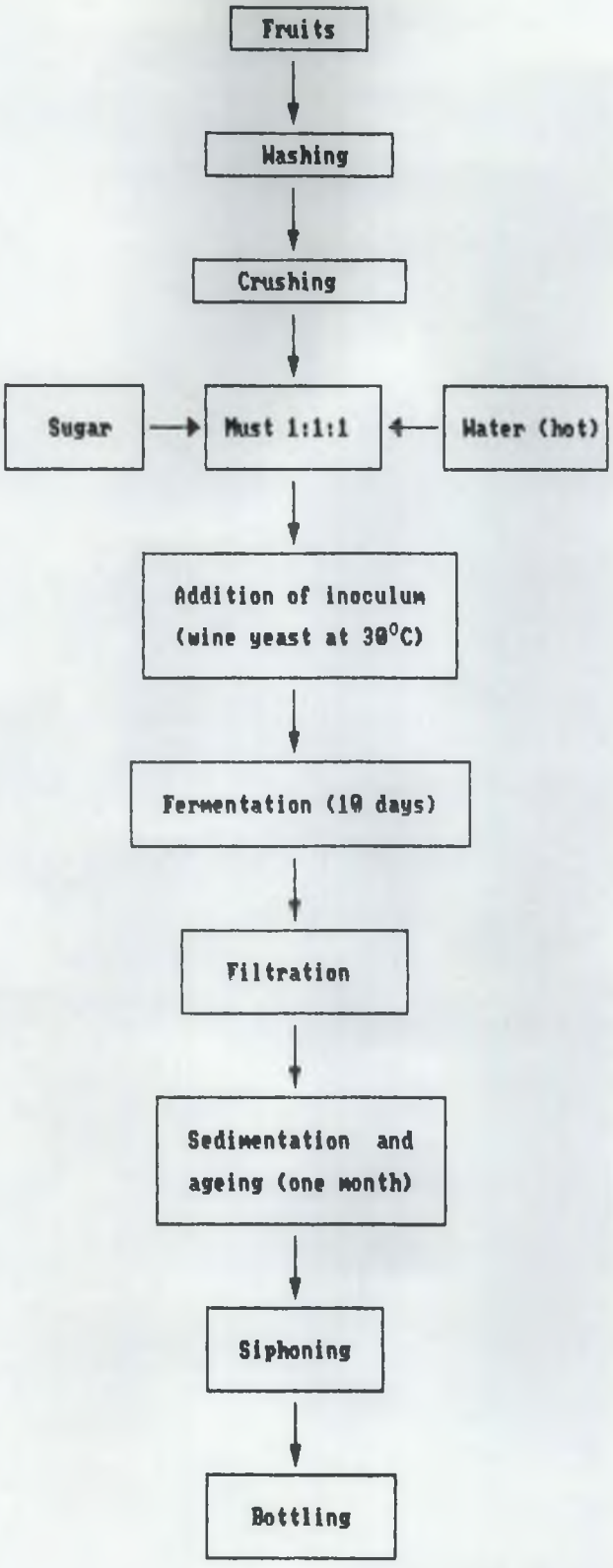
While carrying out the standardisation of methodology for jamun wine, trials were undertaken with respect to two aspects.

1. Pulp, water ratio of 1:1 and 1:2 levels.
2. Preparation of wine with hot water and cold water.

Results of the trial indicated that procedure with 1:1 pulp and water ratio and addition of hot water produced jamun wine with better quality than a higher dilution and cold water treatment. Shukla et al (1991) also observed that 1:1 dilution of pulp and water was adjudged superior, compared to the 1:2 dilution of wine prepared from jamun. Similarly, Majeed (1995) tried the standardisation of karonda wine by 1) adding cold water 2) by adding boiled water to the crushed fruit and 3) by boiling the fruit along with water. In that experiment best wine was obtained when boiled water was used. The results of the present study was also in favour of adding boiled water to the fruit. The samples prepared with boiled water contributed better aroma, clarity and colour to the product. Figure 3 depicts the steps followed in the preparation of wine.

FIG. 3

FLOW CHART FOR PREPARATION OF JAMUN WINE




JAMUN WINE


GRAPES WINE


WEST INDIAN CHERRY WINE

4.2.2. Selection of ideal ratios for the blended products

The chemical composition of many fruit juices is not balanced from an organoleptic point of view. In order to avoid chemical alterations such as neutralising or increasing the acidity, juices of varying composition may be blended together to provide the desired balance of sweetness and sourness (Navani, 1965). This brings about the standardisation of acid constituents. Almost all fruit juices have some aroma and in some, the quality may be pronounced and pleasing, and are therefore useful in building bouquet in blend. Marked improvements may be realised by giving attention to the aromatic qualities of different fruit juices . To this effect, jamun was blended with fruits like grapes, watermelon and West Indian Cherry in the preparation of squash, RTS and wine at ratios 1:1, 2:1, and 3:1.

The beverages prepared were assessed organoleptically for its sensory parameters to identify those blends which are most desirable in their quality characteristics. According to kordylas (1990), the overall acceptability depends on concentration of amount of particular components, the nutritional and other hidden attributes of food and its palatability or sensory quality. Based on the overall acceptability, the selection of the best acceptable ratio in each combination of the different beverages under study was made.

4.2.2.1. Acceptability of blended squashes

Navani (1965) and Kalra et al (1991) have stated that blending of juices supplement appearance, nutrition and flavour. It is also possible to bring out the latent flavours of the ingredient juices and the resultant blend due to multiplicity of the flavours and bewitching colour is outstanding and unique.

In the attempt for the identification of most acceptable proportion of mixed jamun squashes, the selected fruits ie, grapes and watermelon were blended in three different proportions. (jamun : grapes and jamun : watermelon at 1:1, 2:1 and 3:1 proportions). The details of the acceptability levels of blended squashes is given in Table 3.

Table 3

Acceptability levels of blended Squashes (Mean scores)

Squash Blends	Quality parameters					
	appea-rance	Taste	Colour	flavour	Clarity	Overall accept-ability
Jamun - Grapes						
P_1	4.5	5.0	4.6	4.8	4.4	4.66
P_2	4.6	4.1	4.7	4.0	4.5	4.38
P_3	4.7	3.9	4.8	3.8	4.6	4.36
Jamun - Watermelon						
P_1	4.3	2.0	4.6	4.4	3.8	3.82
P_2	4.5	3.1	4.7	4.5	4.0	4.16
P_3	4.9	4.5	4.9	4.7	4.5	4.70

P_1-1:1

P_2-2:1

P_3-3:1

As indicated in Table 3, regarding jamun-grape blended squash, the overall acceptability mean score of P_1(1:1) was highest with 93.2 percent, while P_2 and P_3 obtained mean score of 87.6 per cent and 87.2 per cent respectively. The taste and flavour attributes of P_1 was highly appreciated by the panel members than the other two combinations. P_1 secured 100 percent score for taste, while the scores obtained by P_2 and P_3 were 82 per cent and 78 per cent respectively. The mean score obtained for the sensory characteristic flavour was maximum in the 1:1 combination. Experiment conducted by Teotia et al (1992) revealed

JAMUN+GRAPES SQUASH

JAMUN+WATERMELON SQUASH

that the beverage made from 50:50 blend of muskmelon and mango was the best because of its balanced flavour. The preferences of the judges on colour, appearance and clarity showed a narrow increase with the increase in the quantity of jamun juice. The increased score of P_3 for colour could be attributed to the highly appreciated deep coloured pigments present in jamun fruit.The maximum score on appearance (P_3) could be related to its good clarity. The higher percentage of clarified jamun juice in P_3 might have contributed to the best clarity effect. However the widely accepted taste and aroma of grapes when mixed at equal proportions with jamun having an unfamiliar flavour balanced the taste to appreciable level (P_1) with the best overall rating.

The second combination of jamun blended squash, where jamun and watermelon were mixed, the overall acceptability score for P_3 was highest bagging 94 per cent score followed by P_2 with 82.4 per cent and P_1 with 77.2 percent. Begum et al (1983) have tried pineapple-mango pulp mixture in the ratio of 75:25 for squash and had claimed good consumer acceptance. Unlike for the combination with grapes, here, when a soft fruit like watermelon was melded with jamun having a very balanced blend of sugar, acid and tannin along with an attractive colour, it was found that the acceptability of the squash increased with the increased proportion of jamun juice in the beverage. The combination 3:1 (P_3), obtained best scores for all sensory parameters assessed namely appearance, taste, colour, flavour, clarity and overall acceptability. The higher mean scores obtained for P_3 indicated the superiority of jamun over watermelon for preparation of

squash. It was a welcome observation that the combination P_3 which constituted the highest share of jamun juice performed best among jamun-watermelon mixed squashes.

Thus from the jamun-grape blend, the ratio identified for preparation of squash was 1:1, where equal quantity of juices was mixed and for jamun-watermelon blend the ratio selected was 3:1, where 75 percent of jamun juice was melded with 25 percent watermelon juice.

4.2.2.2. Acceptability of blended RTS

Kalra et al (1991) suggested that one could simply think of new product development through blending. The same fruits and ratios as in the case of blended squashes were chosen for the preparation of blended jamun RTS beverage. The combinations were (1) jamun:grapes and (2) jamun: watermelon at 1:1, 2:1 and 3:1 ratios each. The results of the acceptability trial of different blends are summarised in Table 4.

Table 4

Acceptability levels of blended RTS (Mean scores)

RTS Blends	Quality parameters					
	appea-rance	Taste	Colour	flavour	Clarity	Overall accept-ability
Jamun - Grapes						
P_1	5.0	5.0	4.9	4.5	4.8	4.84
P_2	5.0	4.1	4.9	4.0	4.9	4.58
P_3	5.0	3.0	4.9	3.9	4.9	4.34
Jamun - Watermelon						
P_1	3.9	2.7	4.0	3.4	3.0	3.60
P_2	3.9	3.5	4.4	3.5	4.2	3.90
P_3	4.4	5.0	4.6	3.7	4.5	4.44

P_1-1:1

P_2-2:1

P_3-3:1

As indicated in Table 4, for the first combination, jamun-grape blend, the highest overall acceptability score with 96.8 per cent was recorded for P_1 (jamun:grapes at 1:1 ratio) followed by P_2 (2:1) and P_3 (3:1) with 91.6 per cent and 86.8 per cent respectively. High mean scores were obtained for the taste and flavour attributes for P_1 compared to P_2 and P_3. The reason for the best preference of P_1 may be accounted to the same fact as the case for maximum acceptance observed by 1:1 proportion of jamun-grape blended squash. According to Lowenberg (1970), food habits of human beings are hard to change especially where


JAMUN + GRAPES RTS


JAMUN + WATERMELON RTS

unconventional ingredients are used in food items. Hence new tastes are only gradually appreciated. The mean scores recorded for colour attribute and appearance of all the three ratios of blends were equal and for clarity, the mean scores were slightly higher for P_2 and P_3 compared to P_1. However the overall acceptability was in favour of P_1 (1:1 ratio),.

Results of the acceptability trial of the second combination revealed that palatability rating was highest for proportion 3:1 of jamun-watermelon blended RTS (P_3). Likewise for squash, the scores obtained for different proportions were found to increase with higher percent of jamun juice mixed with watermelon in all the attributes assessed. The higher clarity level in P_3 resulted in the consequent increase in the score for appearance too, since appearance and clarity are interrelated. The proportion P_3 in which the jamun and watermelon ratio was 3:1, obtained highest per cent of 88.8 proving it to be best compared to P_1 and P_2. In a trial for blended nectar, Kaur and Khurdiya (1993) observed that the overall acceptability was highest for the blended mango and orange nectar in the ratio 3:1.

From the foregoing discussion, it may be concluded that a similar trend of acceptability level pertinent to squash regarding the same fruit combinations was found in RTS also. Therefore in this study the ratios identified for jamun - grape blend and jamun-watermelon blend were 1:1 and 3:1 respectively for production of mixed jamun RTS.

4.2.2.3. Acceptability of blended wines

Dang (1979) prepared wine from combinations of different varieties of apple and was found highly beneficial. Selected fruits viz grapes and West Indian cherry were blended with jamun in three different proportions. Three proportions each were tried in both combination viz jamun:grapes and jamun:West Indian cherry at 1:1, 2:1 and 3:1 ratios respectively. The mixed wines were evaluated and the data obtained is given in Table 5.

Table 5

Acceptability levels of blended Wines (Mean scores)

Wine Blends	Quality parameters						
	appea-rance	Taste	Colour	flavour	Clarity	Strength	Overall accept-ability
Jamun-Grapes							
P_1	4.3	5.0	4.8	5.0	4.7	5.0	4.76
P_2	4.2	4.8	4.8	4.5	4.5	4.3	4.52
P_3	4.2	4.2	4.9	3.8	4.5	3.9	4.25
Jamun-West Indian cherry							
P_1	3.1	2.3	2.8	3.7	2.1	3.2	2.87
P_2	4.0	3.3	3.1	4.2	2.9	3.4	3.48
P_3	4.7	4.4	4.6	4.6	4.1	4.3	4.45

P_1-1:1

P_2-2:1

P_3-3:1

JAMUN + GRAPES WINE

JAMUN + WEST INDIAN CHERRY WINE

For the blended wine of jamun and grapes, best quality rating was observed in all the sensory parameters except for colour in P_1 in which jamun:grapes ratio was 1:1. It is also worthy to note that taste, flavour and strength characters secured cent per cent score due to an equal blending of jamun and grapes to achieve a proper balance of the required criteria to wine. However the judges prefered P_3 for its colour appeal in which jamun contribution was highest, while clarity of wine was equally rated. Though there was not much variation in scores among the combinations, highest overall acceptability per cent of 95.2 was recorded for P_1, where the jamun - grapes ratio was 1:1 followed by 2:1 and 3:1 with 90.4 per cent and 85.0 per cent respectively.

Organoleptic assessment on the next blend, where jamun and West Indian cherry were used in combination for the preparation of blended jamun wine, the overall acceptability was observed to be highest for the proportion that composed of jamun: West Indian cherry at the ratio 3:1. The score value on all the six quality characteristics viz, appearance, taste, colour, flavour, clarity and strength reflected an increasing pattern with an increase in the amount of jamun juice in the product and was significantly superior to P_1 and P_2. This enlightens the beneficial aspects of jamun fruit for beverage production. On the otherhand, wine prepared with the increased percentage of west Indian cherry gave the lowest score in all the sensory characteristics. The overall

acceptability of P_3 was double fold higher than P_1 followed by P_2.

After the standardisation and assessment of the blended wines of jamun and grapes and jamun and West Indian cherry, the ratios identified for further studies in this particular blended products were 1:1 and 3:1 respectively based on the sensory evaluation by panel members.

4.2.3. Identification of the best blend among mixed products

The most liked blend among each mixed jamun beverages, was worked out by computing the mean scores obtained in the sensory attributes. Among each type of mixed beverage, the sample which secured the highest mean score for over all acceptability was identified as the ideal blend. The proportions thus identified for the preparation of different blended beverages in the present study are presented in Table 6.

Table 6

Proportion identified for the blended products

Products	Fruit Combinations	Proportions selected
Squash	Jamun-grapes	1:1
	Jamun-watermelon	3:1
RTS	Jamun-grapes	1:1
	Jamun-watermelon	3:1
Wine	Jamun-grapes	1:1
	Jamun-watermelon	3:1

From the Table, it is clear that for the preparation of blended squash, RTS and wine with combination viz jamun - watermelon and jamun-West Indian cherry, the products consisting of increased quantity jamun juice was found more appreciated. This results are evident for proving jamun to be superior over the fruits like watermelon and West Indian cherry in the preparation of these beverages. At the same time, in the case of jamun-grapes combination, an equal proportion contributed good result which leads to the assumption that jamun fruit possess similar qualities with grapes, a highly acceptable and commercially valuable fruit, both for processing and for table use.

4.3. INDEPTH STUDIES ON SELECTED JAMUN BASED PRODUCTS

Five samples in each product (beverages) under study viz, squash, RTS and wine were standardised for detailed investigation. This included plain beverages with jamun, the selected blended beverages of jamun with two selected fruits each and plain beverages of the fruits selected for blending. Indepth comparative observation of chemical and organoleptic qualities and storage performance of the above jamun products were also undertaken.

For assessing the nutritional, chemical and shelf life qualities of the products viz squash, RTS and wine, the beverages were prepared in required quantities following standardised

recipes. The products were filled in suitable sterilised bottles, sealed and kept at room temperature.

4.3.1. Nutritional and chemical composition of standardised products

It is always considered better to observe the nutrient quality of fruit products, and necessary measures to maintain them at optimum possible levels are also important. With this aim, the freshly prepared products (Squash, RTS and wine) were analysed for its nutritional and chemical composition. The major parameters analysed were acidity, pH, Total sugar, Total soluble solids and alcohol percentage.

4.3.1.1. Assessment of chemical constituents in squash

Chemical constituents of the five samples of fresh squash were assessed and the results are depicted in Table 7.

Table 7

Chemical constituents of fresh squashes

Parameters	S_1	S_2	S_3	S_4	S_5	CD value
Acidity(per cent)	1.85	1.54	1.34	1.64	1.57	0.06
pH	2.50	2.80	3.20	2.77	2.90	0.23
Total Sugar (per cent)	66.87	71.67	63.89	68.34	64.31	4.50
TSS (° Brix)	55.20	56.80	52.40	55.90	54.60	0.41

S_1 - Jamun alone

S_2 - grapes alone

S_3 - watermelon alone

S_4 - Jamun and grapes

S_5 - Jamun and watermelon

The acidity of products can be attributed to many organic acids which occur in fruits and also to the citic acid added while processing. A careful observation of the data obtained revealed that the acidity of the five squashes were found to range from 1.34 to 1.85 percent expressed as percentage citric acid. The variation in acidity was due to the difference in the acidity of the fruit juices of jamun, grapes and watermelon. Muthukrishnan and Palaniswamy (1972) reported that the percentage of acidity was 1.5 in squash prepared from West Indian cherry. Squash prepared from apricot was found to have 1.2 per cent acidity as observed by Manan et al (1992). In this experiment the squashes made from individual fruits of grapes and watermelon (S_2 and S_3) exhibited an acid content of 1.54 and 1.34

respectively, while that of jamun was 1.85. However, it was found that the jamun blended grape squashes attained a relatively higher acid percentage than the individual products from grapes and watermelon. However, the acidity of jamun-watermelon mix squash possessed more or less the same level of acidity with grapes. This could be achieved due to the high acid level contributed by jamun as observed in plain jamun squash.

According to Ranganna (1977) p^H is a measure of active acidity which influences the flavour or palatability of a product and affect the processing requirements. The analysis on p^H of fresh squashes revealed that S_1 (Plain jamun squash) recorded the lowest value of 2.5 followed by S_4 and S_2 (Jamun and grapes blend and plain grapes squash).Comparitively higher pH was observed in S_3 and S_5 (watermelon alone and jamun blended watermelon squash) Jain et al (1984) observed that squash made from orange, lemon and bael had a pH of 2.8, 2.9 and 3.7 respectively. The variation in pH is in relation with the acidity of the products. The lowest value observed in jamun squash indicates the relatively high acid content of the products. From the results (Table 6) it is also evident that pH values of jamun blended squash (S_4 and S_5) were lower than the values obtained with plain grapes and watermelon squashes, where the later possesed the highest pH (3.2) indicating the low acid content of the fruit Statistical analysis revealed that significant difference in pH was observed only between S_3 and S_5 and S_4 and S_1. However, the pH level was on par in S_4, S_2 and S_5.

The sugar present in fruits consists mainly of sucrose, fructose, and glucose, and the percentage of total sugar is subjected to variation with respect to the particular fruit. Swaminathan (1979) reported that total sugar content of fruits varied from 3 to 18 per cent. In this experiment, the total sugar of squashes varied from 64.31 to 71.67 percent in the five samples.Jain et al (1984) has recorded a total sugar percentage of 51.15, 54.85 and 57.42 in squashes prepared from orange,lemon and bael. Sheeja (1994) observed a total sugar percentage of 71.03 in papaya squash. The total sugar percentage did not significantly differ with S_3 and S_5; also S_4 and S_2 recorded same sugar percentage. However, total sugar was high in S_2 and S_4 in comparison with S_3 and S_5 also the sugar content of S_1 (Jamun) was on par with S_4 and S_5.

Total soluble solids (TSS) consist essentially of the sugars and soluble minerals present in the fruit products. The TSS of the squashes prepared which is expressed as °Brix ranged between 52.40 to 56.80. Muthukrishnan and Palaniswamy (1972) reported that the accepted sample of squash prepared from west Indian cherry had a TSS of 50 percent. Manan et al (1992) observed a TSS of 45°brix in squash prepared from apricot. Critically analysing the soluble solids level of squashes made from plain fruits and their combinations, it was observed that the grapes registered the highest °brix of 56.80, closely followed by jamun (55.20), and plain watermelon observed the lowest value (52.40) among the five samples. It could be safely

stated that jamun squash was comparable to that prepared from grapes as far as the brix level is considered and could improve this parameter when jamun was added to watermelon.

There existed significant difference with respect to TSS content of squashes on statistical interpretation.

From the above results, it is clear that the chemical constituents of jamun squashes developed is in accordance with the squashes prepared from other conventional fruits. By blending jamun, the qualitative aspects of watermelon was improved substantially. Similarly, the jamun-grape mixture was almost comparable to grapes squash in composition. Thus it may be stated that jamun could be very well utilised for the preparation of good chemical and nutritional quality squashes when used alone, so also when mixed with other fruits.

4.3.1.2. Assessment of chemical constituents in RTS

The data obtained on the chemcial parameters of fresh ready to serve beverages (RTS) are summarised in Table 8.

Table 8

Chemical constituents of fresh RTS beverages

Parameters	R_1	R_2	R_3	R_4	R_5	CD value
Acidity(per cent)	0.51	0.45	0.37	0.48	0.40	0.11
pH	2.90	3.17	3.50	2.93	3.32	0.27
Total Sugar (per cent)	12.35	13.11	10.75	12.45	11.36	0.40
TSS (° Brix)	14.77	16.03	13.10	15.33	14.00	0.40

R_1 - Jamun alone

R_2 - grapes alone

R_3 - watermelon alone

R_4 - Jamun and grapes

R_5 - Jamun and watermelon

The acidity of the ready to serve beverages ranged from 0.37 to 0.51 per cent. Wasker (1991) noted that the RTS beverage from phalsa fruit showed an acidity of 0.42 per cent. Ranote et al (1992) observed an acid percentage of 0.45 in kinnow RTS. Acidity level of R_3 did not possess any variation between the bleded RTS. The acidity percentage of S_1 did not differ significantly when blended with watermelon (R_5) and grapes (R_4). The blended squashes also recorded the same acidity level as that of the same product prepared from the conventional fruit, grapes.

pH is an indication of the acidity or alkalinity of the product. The range that was observed for the pH of various RTS was between 2.9 and 3.5. Physico-chemical analysis of RTS beverage prepared from passion fruit showed a pH of 3.5 (Khurdiya 1994). Plain jamun, plain grapes and jamun-grapes blend observed the low pH values, indicating the high acid content in the RTS. The products which contained watermelon recorded the least values for pH, which were on par. The blended RTS R_4 and R_5 were on par with R_2. Hence, it could be stated that advantage could be taken of the differences in acidity found amongst fruit juices to produce a blend of more constant acidity.

On analysis of the total sugar percentage of RTS, it was observed that the highest value was recorded for grapes, immediately followed by jamun-grape blend and plain jamun RTS, which possessed the same level. Similarly no significant difference was observed between S_1 and S_4. The range observed in various RTS were between 10.75 and 13.11. S_3 and S_5 which were on par exhibited the lowest value, which may be due to the lower amount of sugar present in the fruit. Manan et al (1992) noted that the total sugar percentage in the RTS beverages prepared from two varieties of apricot were 13.6 and 13.4 respectively. Ranote et al (1992) observed that the RTS beverage prepared from kinnow mandarin secured a total sugar percentage of 9.95.

Observation on the total soluble solids of the fresh RTS revealed that a range of 13.10 per cent to 16.03 per cent

soluble solible were present in the beverage. The TSS of jamun RTS was quite comparable with that of grapes RTS. A similar TSS level of 15° brix was observed by kadam (1991) in RTS prepared from ber fruit. Total soluble solids of RTS prepared from Kinnow mandarin was found to be 15.00, as reported by Ranote (1993). The results of the present study revealed that, the TSS level of jamun RTS was improved by mixing grapes juice so also that of watermelon RTS by way of blending with jamun. This again is an indication to the advantage of blending fruits in improving its nutritional quality.

On observation of the chemical parameters of jamun based RTS, the results were worthy enough to state that jamun could profitability be exploited to prepare plain and blended RTS with good nutritional qualities. Chemical parameters viz acidity, pH, total sugar, and TSS of grapes, jamun and jamun - grapes blended RTS were almost equal in composition and on par with other fruit based ready to serve beverages. Watermelon RTS and its blend also exhibited more or less similar quality.

4.3.1.3. Assessment of chemical constituents of fresh wine

A number of factors which includes yeast strains, fermentation conditions, mineral contents, treatments adopted and composition of the must are known to influence the quality of wines as reported by Sandhu et al (1995). Chemical parameters of fresh wine analysed are presented in Table 9.

Table 9

Chemical constituents of fresh wines

Parameters	W_1	W_2	W_3	W_4	W_5	CD value
Acidity (per cent)	0.38	0.69	0.59	0.61	0.45	0.06
pH	3.50	2.90	3.33	3.13	3.37	0.28
Total Sugar (per cent)	9.42	11.63	6.17	10.42	8.47	0.34
TSS (° Brix)	20.10	24.23	18.50	23.63	19.20	0.32
Alcohol (per cent)	8.63	10.00	5.85	9.55	6.55	0.15

W_1 - Jamun alone

W_2 - grapes alone

W_3 - West Indian cheryy alone

W_4 - Jamun and grapes

W_5 - Jamun and West Indian Cherry

It could be clearly noted from the Table that the acid content of the wine developed in present study of the wine ranged between 0.38 to 0.69 percent. According to Sandhu et al (1995), the wine contains acids which are dependent upon the type of fruit used. similarly, acetic acid constitutes the volatile acidity of wine (Amerine et al, 1980). Studies by Vyas (1982) indicated an acid content of 0.62 in wine made from plum. Wine made from wild apricot observed an acidity value of 0.75 (Joshi 1990) and that from Golden apple was found to be 0.50 (Vyas 1993). Plain grapes wine recorded the highest acidity, followed by its blend with jamun (W_4) and plain West Indian cherry which were at the same level. Acidity of S_3 remained same when blended

with jamun (S_5). Acidity of S_4 was also at the same level with S_3. Low value of acidity observed in jamun wine might be due to the lesser days of fermentation applied in the case of this particular fruit. An increase in acidity corresponding to the fermentation duration of apple wine had been reported by Vyas and Kochar (1993). Jamun must was subjected to active fermentation only to a duration of 10 days as against 21 days in grape wine and other wines in the present trial. Hence a higher acidity was recorded in these wines.

Evaluation of the data observed for the pH of fresh wines indicated that the pH values ranged between 2.9 and 3.5. The pH level observed for wine in this experiment agrees with the data reported by other workers. Vyas (1982) observed that the plum wine showed a pH of 3.9. Joshi (1990) reported that wild apricot wine had a pH of 2.58, while the wine from undiluted pulp of apricot had a pH of 3.80. Wine from Golden apple showed a pH of 4.5 (Vyas, 1993). The variation in the pH of wine observed in the experiment is in accordance with the acidity level of the products. High pH was recorded for S_1, S_5 and S_3 which were on par and low for S_2 and S_4. S_3 recorded more or less similar pH with S_4 and S_5.

Total sugar percentage of wine samples under study varied between 6.17 to 11.63. Reports on Total Sugar content of wines published by earlier workers fall at similar levels as obtained in this study. Vyas et al (1982) reported a total sugar percent of 5.0 in wine prepared from plum. Mean while, the total sugar at a

higher percentage was observed for plain jamun wine in the study (9.43). Total sugar was high in W_2 and low in W_3 which was on par with W_5. However, W_4 recorded more total sugar than W_1. The highest total sugar content recorded for plain grapes wine (11.63) could be attributed to the high sugar content of the fruit.

The Total soluble solids (TSS) of the wines prepared ranged from 19.20 to 24.23. These value agrees with the findings reported in other studies. In the present study, significant difference was observed between the wines with respect to TSS content. Vyas (1982) reported a brix of 18.00 in plum wine. Wild apricot wine recorded a TSS of 12.00 in a study conducted by Joshi (1990). The percentage of soluble solids observed for jamun wine was 20.10 and for the blended wine of jamun and grapes, the value recorded was 23.63. Comparatively low TSS was recorded for W_3 and melding of jamun with West Indian cherry improved the TSS content resulting in a more stable product with a better level of soluble solids.

Considering the alcohol content of wine, the value ranged between 5.85 to 10.00 per cent. Among the wine samples prepared, the highest alcohol percentage was recorded for grapes wine (10.00). Comparable alcohol level was observed in grape blended jamun wine (9.58), followed by plain jamun wine (8.63). According to Sandhu et al (1995) deamination and decarboxylation of aminoacids result in the formation of alcohol. Studies conducted by Vyas et al (1982) reported an alcohol value

of 6.50 in plum wine, while Golden apple wine was observed to have an alcohol percentage of 8.04 (Vyas 1993). The low alcohol percentage of West Indian cherry wine (5.84) in this experiment could be increased to 6.55 percent by blending with jamun.

There existed significant difference between the wines on its alcohol content as evidenced by statistical interpretation.

Results of the analysis of chemical and nutritional characters of wines studied were found within the range observed for fruit wines. The blend of grapes and jamun attained almost same quality as that of grapes with respect to chemical and nutritional character followed by plain jamun. The acidity, pH, total sugar, TSS and alcohol content could definitely be improved by the addition of jamun for West indian cherry for wine making. This shows that jamun could be an effective substitute for partially replacing expensive fruits like grapes and for improving chemical qualities of fruit products with West Indian cherry which showed comparatively low quality.

4.3.2. Organoleptic assessment of fresh products

Sensory evaluation of food refer to their scientific evaluation through the application of human senses (Jellinick, 1985). Assuring the sensory attributes of a product is of prime importance as this provides a significant information which could be utilised for the development of the product. Sharma et al (1995) is of the opinion that subjective quality evaluation relies on physical senses of the panelists.

According to winter (1990) the overall impression and taste of a food product can be properly assessed only by human sensory perception. Among the various quality attributes taste is the primary and most important one (Kramer, 1970).

Appearance is one of the important factors which influences consumers inclination while buying fresh as well as processed products. It is basically the recognition and assessment of properties such as colour, surface structure etc associated with the product (Sharma and Wani, 1995). Smulder (1986) opined that absolute colour scores cannot be provided through visual assessment since it is extremely difficult for humans to develop a colour memory.

Flavour is a complex sensation comprising mainly of odour and taste, odour being more important (Sharma and Wani, 1995). According to Ranganna (1986) flavour is an important factor which enriches the consumers preference to a particular food. According to Stillman (1993), the sensory attribute flavour is very important and lacking an appreciable flavour would often result in unpalatability of the product.

Comparative acceptability of the five samples in each group of beverage under study namely squash, RTS and wine was carried out in the laboratory with the selected panel members by scoring test. The qualities assessed were appearance, taste, colour, flavour and clarity. The strength of the product was also assessed in the case of wine. preference of a product depends

not only on a particular character examined, but on every quality involved in the evaluation. Thus the over all aaceptability of each product was also ascertained by computing the total score obtained for various quality parameters mentioned above.

4.3.2.1. Organoleptic assessment of fresh squash

Khurdiya (1990) reported that fruit based beverages like squashes are gaining popularity than that of the synthetic products. The details on sensory quality of jamun based and other squashes studied under the present experiment are depicted in Table 10.

Table 10

Organoleptic characteristic of fresh squashes

Squashes	Mean scores for quality attrubutes					
	Appearance	Taste	Colour	flavour	clarity	overall acceptability
S_1	4.9	4.8	5.0	5.0	4.3	4.8
S_2	5.0	5.0	5.0	5.0	4.4	4.9
S_3	3.8	3.7	3.3	3.5	2.9	3.5
S_4	5.0	5.0	5.0	5.0	4.6	4.9
S_5	4.9	4.4	4.9	5.0	4.6	4.8
CD values	0.25	0.33	0.23	0.21	0.43	0.19

It is evident from Table 10 that among the five types of squashes prepared, appearance attribute score of S_2 (grapes alone) and S_4 (jamun grape blend) obtained cent percent score

(5.00). S_1 (jamun alone) and S_5 (Jamun-watermelon blend) were with only tinge of difference in scores (4.9), but statistically on par. The squash prepared from watermelon (S_3) obtained the lowest score of 3.8. This may be due to the poor clarity and colour observed in this particular squash. Although the plain beverage from watermelon obtained the lowest score, when it was blended withjamun, there was an appreciable increase in the score value for this attribute, which was comparable to S_1, S_2 and S_4.

Regarding the taste of squashes, the samples S_2 (grapes alone) and S_4 (jamun-grapes blend) obtained the maximum score of 5.0 and the plain jamun squash (S_1) could also record a very appreciable mean score in taste (4.8), which was on par with S_2 and S_4, while plain watermelon performed the least in score level. The same scores obtained by S_2 and S_4 indicated that jamun could be blended with grapes in the ratio 1:1 with the same taste value of squash from grapes alone. It was also noticed that when jamun was mixed with watermelon, the mean scores obtained increased to 4.4 from 3.7, ie. the taste of the squash is increased.

The samples S_1, S_2 and S_4 obtained the maximum score (5.0) for colour evaluation. Though the mean score obtained for colour attribute in S_3 was very low (3.3), blending with jamun lifted the mean score to 4.9, which was at the same level as that of S_1, S_2 and S_4. The data discloses that the rich colour of jamun is attractive and at the same time provide better appeal to watermelon juice when mixed together. According to Sharma et al

(1995) colour scores were significantly related with acceptability. This fact is evident in the present study with squashes since the richer coloured jamun and grapes were found to be more acceptable.

All the samples secured maximum score in flavour except plain watermelon squash (S_3) which attained a mean score of only 3.5. This could be due to the characteristic nature of the fruit which is not worthy to provide good flavour when processed into squash as reflected by the opinion of panel members. A noteworthy result obtained in this study was that the flavour profile of jamun squash and grape squash was found equal and the same quality was retained, when these two were blended also.

The mixed squashes S_4 and S_5 secured the highest score of 4.6 for clarity, which was on par with S_1 and S_2. S_3 (Plain watermelon) obtained the least score of 2.96 for this particular attribute. To the surprise, the clarity of the mixed squashes were better than its component plain fruit products, for which the reason is not clear although it was statistically non significant.

When the overall acceptability was computed based on sensory qualities, the squash prepared from grapes, jamun, jamun-grape blend and jamun-watermelon blend showed high acceptance among the panel members with mean scores recording 4.8 to 4.9. The lowest overall acceptability was recorded by watermelon squash with an average score of 3.5 which could be improved to

an appreciable level of 4.8 by melding with jamun, which was at the same level as that of S_1, S_2 and S_4.

The results of the present trial suggested that a highly appreciable squash comparable to the subjective quality parameters of grapes could be prepared from jamun. Its utility could be successfully extended for making blended squashes with grapes having equal preference to grape squash and also with watermelon observing better feasibility to the straight beverage from watermelon.

4.3.2.2. Organoleptic assessment of fresh RTS

Ready to serve beverage using jamun and its blend was another product selected for study in this experiment. According to Manan et al, (1992) fruit based RTS beverages are not only rich in essential minerals, vitamins and other nutritional factors, but also are delicious and have an universal appeal. The acceptability performance of RTS beverages was tested and the data on their sensory qualities are presented in Table 11.

Table 11

Organoleptic characteristic of fresh Ready to serve beverages

RTS beverages	Mean scores for quality attrubutes					
	Appearance	Taste	Colour	flavour	clarity	overall acceptability
R_1	4.3	4.4	4.8	4.5	3.8	4.4
R_2	4.6	5.0	4.9	4.7	3.9	4.6
R_3	3.0	2.9	3.1	2.9	3.3	3.1
R_4	4.0	4.5	4.9	4.6	3.8	4.4
R_5	4.0	4.1	4.7	4.6	3.7	4.2
CD values	0.28	0.39	0.34	0.43	0.39	0.25

Table 11 indicated that for eyeappeal, grapes RTS and jamun RTS scored high securing scores of 4.6 and 4.3 respectively. Both the blended RTS (R4 and R5) were similar in this aspect, while the watermelon RTS remained lower in appearance showing mean score of 3.0. The colour and clarity of the beverages might have influenced its appearance too. In total the appearance of the RTS samples were rather well appreciated, except that of watermelon RTS.

Regarding the taste of ready to serve beverage with jamun and other fruits developed, the beverage made from grapes,a highly valued fruit for processing, remained superior with a maximum score. The taste value contributed by jamun-grape blend, plain jamun RTS and jamun-watermelon blend remained same. The taste preference for the watermelon RTS was rather very low

(2.9). However, the same was increased to an appreciable level of 4.1, when its juice was combined with jamun in the ratio 1:3 for the preparation of RTS, which was on par with S_1 and S_4.

Data showed that all samples of RTS prepared secured good acceptability with regard to its colour having scored in the range 4.7 to 4.9, which were on par, except for plain watermelon RTS. But it was evident that it even could be blended with the unconventional fruit jamun to obtain a product bearing rich colour.

The mean score for flavour in RTS samples were high and was on par which ranged between 4.7 to 4.9 except for R_3. The lowest flavour appreciation was observed for RTS prepared from watermelon due to its characteristic mild flavour which might not have felt appealing to the panel members. The difference in flavour between R_3 and other samples was found to be significant on statistical interpretation.

The clarity attribute scores of the RTS developed was in the range 3.3 to 3.9, the highest being recorded for grapes RTS, which was on par with R_1, R_4 and R_5 and lowest for RTS made from watermelon. The analysis revealed that watermelon blended jamun RTS was acceptable the same level as that of R_1, R_4 and R_2.

The overall acceptability values obtained for RTS beverages presented in Table 11 indicated that R_2, R_1, R_5 and R_4 were highly acceptable with a range of scores from 4.6 to 4.2. performance of R_5 also could secure 4.2. Meanwhile R_3 was

downgraded with a low score (3.1). It is evidenced from the data that the overall acceptability of blended RTS was on par with that of grapes RTS and Jamun RTS while R_3 attained lower score with respect to overall acceptability.

Results of the organoleptic evaluation of RTS clearly indicated that jamun fruit has a potential for processing into plain RTS and blended RTS beverages bearing an overall acceptability value comparable with qualities of similar product from grapes a very popular and important horticultural crop.

4.3.2.3. Organoleptic assessment of fresh wine

Four basic tastes viz, acidic, sweet, saltish and bitter could be identified in wine and their harmony determines the final quality as reported by Sandhu et al (1995). The quality testing of fresh wines through selected judges on parameters like taste, flavour, strength, clarity etc was carried out and the data are summarised in Table 12.

Table 12

Organoleptic characteristic of fresh wines

Wines	Mean scores for quality attributes						
	Appearance	Taste	Colour	Flavour	Clarity	Strength	overall acceptability
W_1	4.6	4.0	4.6	4.4	4.1	3.8	4.3
W_2	4.3	4.4	4.3	4.6	4.0	4.1	4.3
W_3	3.4	3.3	3.0	3.3	2.9	3.0	3.2
W_4	4.4	4.3	4.5	4.4	4.0	3.9	4.3
W_5	3.6	3.6	3.2	3.5	2.9	3.2	3.4
CD values	0.46	0.40	0.39	0.46	0.22	0.28	0.42

According to Singleton (1969) appearance is the important feature of wine and the colour, along with its clarity is a good indicator of its past, present and future quality. Table 12 indicates that among the five types of wines prepared, the eye appeal and body of jamun wine (W_1) was superior with mean score of 4.6 and its blend with grapes and plain grapes was on par with respect to this quality. Plain west Indian cherry performed the lowest appearance quality,which was at the same level as that of jamun-West Indian cherry blend. The pigments and tannin content of jamun contributed a very attractive appearance and body texture upon alcoholic fermentation.

According to Gayon (1978), taste and aroma of wines are very complex and are dependent upon a number of factors such as variety of fruit, practices adopted, fermentation and maturation. The taste attribute scores in the wines ranged from 4.4 to 3.3.

The wine prepared from grapes was observed to have a highest score of 4.4. The taste of jamun-grapes blended wine and Jamun wine also performed more or less equal and was on par with W_2. This advocates that grapes can be blended with jamun to prepare wine without degrading its taste and aroma. The experiment showed that when jamun was blended with west Indian cherry, the taste attribute score increased to 3.6 from 3.3, but was at the same level as evidenced by the statistical analysis.

According to Sethi and Malhan (1993), colour is a major characteristic that determine the wine quality. Like appearance, the colour of wine was also adjudged to be the best for jamun wine (4.6). Jamun-grapes blend was closely attractive in colour (4.5), followed by plain grapes and this was at the same level as W_1 . According to stefana and Cravero (1991), colour in young grapes wine was due to anthocyanins. When West Indian cherry was utilised for the preparation of wine the mean score recorded for colour was 3.0, where as mixing with jamun slightly improved this parameter and was on par with W_3. The deep purple colour of jamun fruit after fermentation contributed a highly appealing characteristic natural colour in wine which was found comparable to that of the characteristic hue from grapes.

Singleton and Ough (1962) stated that the single characteristic most important in making wine an attractive beverage is the complexity of flavour. According to Moulin (1986), the fermentation temperature of lower than 15°C, produced a grossy aroma while at more than this temperature, the wines

lacked in fineness. In the present study, three wine samples developed (W_2, W_1 and W_4) exhibited high scores for the flavour and was on par with respect to this attribute. In tune with its performance in other quality characters, the wine samples W_5 and W_3 was considered lower by the judges in flavour too. The flavour intensity of jamun wine as per the laboratory evaluation was appreciable like grapes wine and blending jamun with grape did not alter this quality to any noticable level.

The clarity attribute scores of the wines prepared, ranged from 4.1 to 2.9. Jamun gave the most clear wine and thus the highest score (4.1). Grapes and jamun-grape blend were also more or less equal in clarity with a mean score of 4.0, which was on par with W_1, while the clarity of W_3 and W_5 was poor. The scores obtained for appearance had an impact on this quality since appearance is linked with clarity of any beverage. The pectic enzymes present in jamun fruit was able to sediment the particles and improve clarity scores.

Strength of wines in the experiment varied from 4.1 to 3.2. The Strength of W_4 was on par with W_1 and W_2. Similarly the strength of W_3 and W_5 possessed the same level, although a slight increase was noticed in W_5. According to Amerine (1972), the strength of the wine depends upon the alcohol percentage. The alcohol percentage was highest in grapes wine and this reflected in the panel judgement for strength. Comparatively strong wine was produced from jamun-grapes blend and from jamun fruit alone. Strength of West Indian cherry was lower than

grapes or jamun and was found enhanced by the mixing of jamun and was found to be on par with W_5.

On comparison of various quality attributes to evaluate the overall acceptability, the results revealed that W_1, W_2 and W_4 were ranked high with equal appreciation and mean score of 4.3. When jamun was combined with West Indian cherry for preparing wine, the overall acceptability scores increased to 3.4 from 3.2, which was on par with W_3, indicating that jamun fruit can be utilised to improve the processing quality of certain fruits if mixed with such fruits viz, West Indian cherry.

The present data on preparation of wine using jamun gave promising results. Highly attractive and superior quality wine was prepared from the indigenous and neglected fruit jamun. The apperance, colour and clarity were preferable than grapes wine and was comparable in other qualities like taste flavour and strength. The quality of wine when mixed with grapes at 1:1 ratio was not found inferior to grapes wine and at the same time excelled in few qualities. Another observation was that the less appreciated West Indian cherry wine could be prepared more attractive by combining with jamun.

4.3.3. Confirmation with FPO requirements

Food standards are made to ensure the quality and safety of natural and processed foods for human consumption (Swaminathan, (1988). These standards are meant to provide a uniform and

consistently good quality of food products to the consumers. The products developed in the present study were thus compared with FPO specifications in its requirements for particular items. The data is presented in Table 13.

Table 13

Comparision of products with FPO standards

Particulars	Products				
	Squash		RTS		Wine
	% of TSS	% of Fruit juice	% of TSS	% of Fruit juice	Alcohol content (%) W/W
FPO Values	40.00	25.00	10.00	10.00	7 - 16
Analysed values					
Sample 1	55.20	25.00	14.80	25.00	8.63
Sample 2	56.80	25.00	16.00	25.00	10.00
Sample 3	52.40	25.00	13.10	25.00	5.85
Sample 4	53.90	25.00	15.30	25.00	9.55
Sample 5	54.60	25.00	14.00	25.00	6.55

As per FPO specifications, 1955, the product squash should contain a minimum of 40 per cent total soluble solids and composed of a minimum of 25 per cent fruit juice. In the present study, all the squashes developed, possessed a TSS per cent, well above the specifications prescribed as minimum. Plain grapes and plain jamun squash consisted of more than 15 per cent soluble solids additional to the minimum specified in Food products order. The watermelon blended and grape blended squashes also stood far above the standards in TSS content with

54.6 and 53.9 per cent respectively, followed by plain beverage from watermelon (52.40). The minimum percent of fruit juice observed in all the developed products was 25. Squashes maintained good flavour and was free from objectionable taints. Thus it could be confirmed that the squashes detailed in the present study are well competent with a standard squash.

With relevant to RTS beverages, FPO prescribes a minimum of 10 per cent total soluble solids and 10 per cent fruit juice as requirements for this drink to be considered upto the mark. On analysis, all the samples exceeded this level in soluble solids per cent. Plain grape and jamun grape RTS were on top with 16.0 and 15.3 per cent in this constituent. Plain jamun contained 14.8, followed by jamun-watermelon blend and plain watermelon. The other criteria specified by the FPO for an ideal RTS beverage is the minimum per cent of fruit juice in the final product. All the RTS developed in this investigation, were composed of 25 per cent fruit juice that is one fold more than the minimum requirement. The finished RTS also maintained an appreciable flavour. Therefore, all the RTS beverages prepared confirmed its standard since agreed with the FPO levels.

According to Srivastava and Kumar (1994) fermented fruit beverage which contain 7-16 percent alcohol can be considered as sweet wines or table wines. In this experiment, wines prepared from jamun and its blend with grapes were found to have an alcohol percentage of 8.63 and 9.55 respectively, which was within the limits specified. Grapes wine exhibited an alcohol

percent of 10 per cent where as the West Indian cherry wine possessed an alcohol percent that was slightly below the maximum level required when analysed at termination of fermentation process. The percentage of alcohol possessed by W_5 and W_3 were 6.55 and 5.85 respectively. Ageing is a process during which the sensory as well as chemical quality of the wine invariably improves. Hence during storage these wines also attained satisfactory alcohol level.

Thus it could be concluded that in this experiment, recipes for jamun based squash, RTS and wine have been properly adjusted and procedures were well formulated during standardisation process in the production of beverages. This scientific approach followed, resulted in products agreeing the standards prescribed by FPO.

4.3.4. Cost analysis of the products

The cost analysis of the products was worked out to assess the extent of expense effected to obtain different beverages from the fruits exploited in this experiment. Prices of many fruits exhibit faily regular seasonal variations, although at times the the seasonal pattern may be obscured by other factors. Hence cost analysis is utmost importance in product development.

The cost was worked out based on the price of various commodities needed for the preparation of different products such as cost of fruit, sugar, chemicals, bottles and overhead charges.

The expense incurred for the production of each beverage for its preparation with three individual fruits is shown in Table 14.

Table 14

Cost analysis of the products

Particulars	Cost/litre
Squash	
S_1	33.30
S_2	34.70
S_3	39.50
RTS beverage	
R_1	13.25
R_2	14.50
R_3	16.50
Wine	
W_1	12.85
W_2	20.00
W_3	18.40

The Table indicates that cost of one litre of the squashes prepared from the three fruits viz. jamun, grapes and watermelon ranged from 33.30 to 39.50. The expense for production of jamun squash was observed to be lowest. Grape squash stood next costing Rs 34.70. It is to be highlighted that even though the juice yield of grapes was better than Jamun, the cost of squash production could be made lesser with jamun, due to the

indigenousity of the fruit and thus its availability at a lower price. The squash of watermelon squash was observed to be highest. This may because of the higher wastage occured during its processing.

The cost analysis of the RTS beverage indicated that the cost per litre of RTS beverage from jamun fruit was Rs 13.25 and that observed for grapes squash was 14.50. The RTS beverage prepared from watermelon was found to have a price of Rs 16.50/litre. The fluctuation in prices may be related with the juice recovery and market price of the particular fruit.

Cost benefit analysis of RTS beverages throws light to the possibility of production of nutritious soft drink with jamun at a lesser cost compared to other common fruit based RTS beverages available in the market.

The cost of production of wines ranged from 14.85 to 20.00. The maximum cost was recorded for grapes wine. Jamun wine was observed to have the lowest price when fermented into wine (Rs 14.85/litre), while West Indian cherry wine stood in between with respect to cost. When compared from the angle of acceptability, jamun wine excelled grapes wine as per the judgment of both consumers and scientific panel members. In this context it is to be highlighted that on comparision of cost, jamun wine was the least expense bearing. Thus exploiting its two way benefit, jamun fruit could be recommended for the development of highly acceptable nutritious low cost fermented

beverage as a replacement to grapes wine which required higher production cost.

While comparing the different products prepared from jamun alone, it may be stated that wine was the cheapest item among the three beverages viz, squash, RTS and wine. RTS was found to have the second place in cost benefit parameters. Squash was the most expensive product. Since squash remains in a concentrated form and needed dilution before serving, its net yield has to be taken three fold compared to other products. Hence the preparation of squash may also be considered economical when prepared with jamun fruit. According to Harold (1992) though processed convenient foods has been found attractive, the price of the product was one of the factors for which the consumers were found to be choosy. Considering this aspect, beverages with lesser expense produced from jamun, compared to grapes and watermelon could increase the "likelihood to buy" these products.

4.3.5. Fruit product yield ratio

Yield ratio of products with respect to the beverages developed in the present investigation was worked out as this is considered to be one of the factors which determine the utilisation of fruits by processing industry and their economic feasibility. The yield of the products from fruit is dependent upon its juice recovery. This information is particularly important and challenging when unfamiliar fruits are introduced.

Table 15 gives the data on the yield ratio of different straight beverages illuminated in this study.

Table 15

Fruit product yield ratio

Product	Quantity		Ratio
	Fresh fruit (g)	product yield (g)	
Squash			
Jamun	1000	900	1:0.9
Grapes	1000	1240	1:1.2
Watermelon	1000	860	1:0.8
RTS beverage			
Jamun	1000	1600	1:1.6
Grapes	1000	2480	1:2.4
Watermelon	1000	1520	1:1.5
Wine			
Jamun	1000	1400	1:1.4
Grapes	1000	1720	1:1.7
West Indian Cherry	1000	1100	1:1.1

Table 15 elucidates that when beverages like squash, RTS and wine were attempted using grapes, jamun, watermelon/ West Indian cherry, the best yield ratio was presented by grapes, followed by jamun. Water melon /West Indian cherry yielded lowest for all the three beverages. This difference in yield ratio could be explained by the particular character of the fruit. Grape varieties are characterised with smaller seeds and

higher flesh content and hence wastage was less during its processing. Jamun resembles grapes in its colour and juice quality, while its seed weight is more. Also jamun contains certain astringent principles which needs to be separated in the course of processing. A difference of 340 ml (squash), 880 ml (RTS) and 320 ml (wine) was noted between the beverages prepared from grapes and jamun. In the case of watermelon, although its flesh contains high amount of juice, the very thick rind resulted in higher percentage of wastage. Squash and RTS from watermelon fruit and West Indian cherry wine recorded comparatively low yield than its similar products from jamun and grapes. Thus the variation in product yield ratio of differnt fruits was directly influenced by its juice yield.

Yield ratio of fruits to a particular beverage was also studied to find out which beverage is welcome in terms of quantity. It was observed that jamun and other fruits tried yielded highest, when they were processed into RTS. Next yield ratio was in favour of wine and lowest was for squash.

Higher yield ratio was obtained for RTS from all fruits tried, compared to squash and wine. It is to be stated here that RTS beverage is in a reconstituted form compared to squash, since it is composed of higher proportion of water. Mean while, squash remains in the concentrated form, which can be diluted as and when required. Hence it is not worthy to arrive at a conclusion that RTS is more econnomical among the beverages attempted. Considering wine, it can be served either diluted or in the

undiluted state. However this product exhibited a comparable yield with RTS especially with relevant to jamun fruit. At the same time jamun showed comparatively less product yield ratio to grapes in the preparation of squash, RTS and wine.

Even bearing comparatively bigger seeds among the fruits experimented here, the juice yield of jamun was well satisfactory, yielding at a slightly lesser ratio than that of grapes. When considering the state of under exploitation of jamun, which is a major thrust in the present look out, this fact should not restrict the commercials from identifying this fruit for processing and marketing its products in various forms. Besides it carries high nutritive and therapeutic value and hence the slightly low value observed in product yield ratio compared to grapes should be overlooked.

4.3.6. Consumer acceptance of the products

According to Land (1983) most consumers have fairly fixed ideas and know what to expect in terms of sensory quality of a given processed food. Potter (1986) stated that a difference of opinion is expected while judging a product since people differ in their sensitivity to detect different taste and colours and even when they can detect them, people differ in their preference. On preferences, the relevance of consumer preceptions alone is even more marked. This is indeed acknowledged by sensory testers who would not employ an expert panel to measure preferences. Olsen (1981) reported that Food

Scientists probably possess a memory schemata for foods that are dramatically different from those of ordinary consumers. Results of the study conducted by Gao et al (1983) indicate that education, sex, race, urbanisation and household size are important determinants. The beverages in the present study which underwent a scientific panel testing were thus subjected to evaluation by untrained consumer group also to study the trend in acceptability by common population. Products developed were exposed to common people of different socio-economic status as an attempt to find out the scope for popularisation by testing acceptability. To select the most promising product among the jamun beverages developed, preferential ranking was also conducted. Fifty untrained consumers who visited an agricultural fair at Thiruvananthapuram city participated in the test. They expressed their acceptability level by marking values in the score cards. They also ranked the various jamun based products based on their priority of liking the items at a numerical basis.

4.3.6.1. Consumer acceptance of squashes

The mean scores of the consumer testing by a group of fifty unscientific members on the various quality attributes of squashes is given in Table 16.

Table 16

Consumer acceptance of squashes

Squashes	Quality attributes					
	appearance	taste	colour	flavour	clarity	overall acceptability
S_1	3.20	3.23	4.07	3.09	3.55	3.43
S_2	3.51	4.36	3.03	3.99	3.74	3.73
S_3	1.09	1.14	1.00	1.02	1.01	1.05
S_4	3.40	3.60	3.64	3.52	3.29	3.49
S_5	2.14	2.05	2.16	2.13	2.09	2.11

On critically analysing the data (Table 16) pooled on acceptance of squashes by general consumers, the scores proved that S_1, S_2 and S_4 were well accepted by them bagging above 60 per cent scores in each criteria evaluated with respect to these three samples. Grapes squash was liked best in most of the characters by the consumers, followed by jamun-grape blend and jamun squash. For colour, jamun squash was the most preferred sample by the consumer group too. The apperance, flavour and clarity, score of these three squashes were not much varied ranging between 3.51 to 3.20, 3.99 to 3.09 and 3.74 to 3.29 respectively. With reference to taste, S_2 stood ahead of S_4 and S_1 with 4.36 mean score while the others recorded 3.60 and 3.23 respectively. The taste of grape fruit and its products have been marked as a relished choice by consumers mainly due to its high status and unavailability from the local orchards and hence the high cost. Since jamun which is available in the rural

homesteads are not utilised for processing and thus the taste also unfamiliar to them. Colour acceptability scores of jamun squashes was much higher than grapes being 4.07 and 3.03 respectively for jamun and grape squashes. Consumers liked the colour better when grape was mixed with jamun (3.64). It is a fact that the attraction to any food product by the common people primarily rests on its colour and taste. The range for overall accepatability of three acceptable squashes ranged between 3.73 to 3.43 showing a well satisfactory acceptance to squashes S_1, S_2 and S_4.

At the same time consumers were not adequately appreciated with the organoleptic parameter of watermelon squash since score given was much lower. This product could attain a mean score level of only 1.14 to 1.00 out of 5 in the different quality parameters. Colour was the least prefered character in watermelon squash. At the same time score value of jamun blended watermelon squash was found better in all the aspects. Even then the values stood below a mid point of 2.5, thus grading this item also to an unacceptable status by the consumers.

A glance to the consumer acceptability of squashes evidenced that jamun squash, grapes squash and blended squash from these two fruits were highly accepted by them, where as watermelon was not acceptable to them for squash. Owing to the higher value provided to grapes squash from this fruit was appreciated best.

4.3.6.2. Consumer acceptance of RTS beverages

The mean values of acceptability scores given by 50 consumers by testing various quality parameters of ready to serve beverages is summarised in Table 17.

Table 17

Consumer acceptance of RTS beverages

RTS beverages	Quality attributes					
	appearance	taste	colour	flavour	clarity	overall acceptability
R_1	3.60	3.30	3.90	3.21	3.82	3.57
R_2	3.61	4.57	2.95	3.92	3.63	3.74
R_3	1.02	1.10	1.01	1.00	1.11	1.05
R_4	3.41	3.55	3.51	3.24	3.11	3.36
R_5	2.08	1.99	2.27	2.23	2.03	2.12

Perusal of the data obtained revealed that the jamun (R_1), grapes (R_2) and its blended RTS (R_4) was highly acceptable among common people compared to other products. The scores secured by these products for all characteristics were well above 60 per cent. Jamun RTS ws highly preferred by the consumers for its colour and clarity compared to grapes RTS and thus blending of jamun with grapes increased the acceptance of the product regarding the colour attribute. Clarity of the plain RTS beverages from jamun and grapes was highly acceptable, while when these fruit juices were blended (mixed RTS) the clarity value was slightly less according to consumer's view. The consumer scores recorded for appearance and flavour of R_1, R_2 and R_4 were also

high and almost similar varying between 3.41 to 3.61 and 3.21 to 3.92 respectively. The familiar taste of grapes was easily detected by them and the blending of grapes with jamun increased the acceptance of the products as far as taste was concerned. The overall acceptability expressed by consumers for R_1, R_2 and R_4 was at a high level. Grapes RTS scored 74 per cent and jamun RTS, 71 per cent. Overall acceptability of grapes-jamun blended RTS was 67 per cent. Unlike the consumer opinion expressed for squashes, plain jamun RTS was more appreciated than its blend with grapes.

While considering the consumer opinion of RTS beverages, R_3 and R_5, these failed to catch the appreciation in all the parameters including overall acceptabilty. Eventhough the taste of watermelon was quite familar compared to jamun, the RTS beverage prepared was not accepted by consumers. The scores obtained for all the sensory qualities evaluated was at a very low range of 1.00 to 1.11 mean scores showing the least acceptance. However the level of acceptance could be slightly increased when blended with jamun (R_5) compared to R_3. But this product also was not judged with a good score by consumers. The maximum score obtained for R_5 among all the quality parameters tested was 2.27 (45 per cent) indicating less acceptability among the consumers. This findings give support to the general approach of common people that they are attracted mainly by the colour and flavour of soft drinks. Watermelon, when prossed into RTS gave a faded pink tinch and its flavour too was not intense

compared to jamun and grapes. However while blending with jamun, these characters were partly improved and the acceptance of consumers was also much more than plain watermelon RTS.

It could be remarked that RTS from jamun, grapes and their blends were liked by the consumers giving the third preference to blended RTS and best preference to grapes. When the acceptabilityof the RTS beverages were considered, it could be stated that although jamun RTS, grapes RTS and their blend were satisfactory to the consumers, the plain beverages were highly appreciated compared to their blend. This indicated that unlike squash, for RTS these two beverages were prefered more than its blended forms by consumers. Similar to squash the watermelon products were not attractive to the consumers.

4.3.6.3. Consumer acceptance of wines

Results of the acceptance testing of the wines conducted at the consumers level on fifty people are presented in Table 18.

Table 18

Consumer acceptance of Wines

Wines	Quality attributes						
	appea-rance	taste	colour	flavour	clarity	strength	overall accept-ability
W_1	4.38	3.64	4.71	3.79	3.89	3.41	3.97
W_2	3.41	4.36	3.25	4.00	3.77	4.45	3.87
W_3	1.30	1.30	1.30	1.53	1.21	1.25	1.32
W_4	3.86	3.49	3.88	3.72	3.58	3.86	3.73
W_5	1.72	1.73	1.74	1.48	1.79	1.76	1.70

Analysis of the data obtained revealed that among the five wines, W_1, W_2 and W_4 proved high acceptance among the consumers as evidence from the scores. Jamun wine was more acceptable to consumers than grapes wine, regarding the sensory parameters appearance, colour and clarity with mean score values of 4.38, 4.71 and 3.89 respectively. However grapes stood ahead of jamun in the sensory characteristics, taste, flavour and strength. The wines prepared from individual fruits of jamun and grapes gained greater appreciation by the common people for taste flavour and clarity than its blended product. This suggests that from consumer's point of view blending of these two fruits was not found beneficial with regard to these three quality attributes. At the same time the blended product of jamun and grapes excelled jamun wine in its strength, recording a score of 3.86 against 3.41 in the later. The overall acceptability score indicated the highest liking for plain jamun wine among consumers when comparing the five wines evaluated obtaining a mean score of 3.97 out of 5 in

overall acceptability. Grapes wine catched the next place followed by jamun-grapes blend where the acceptability level stood at 75 per cent. West Indian Cherry wine and its blend with jamun were the wines found to be least acceptable among the consumers.

As in the case of other beverages the lowest score in all characters were obtained by West Indian cherry wine with a slight improvement in its blend. Like wise the trend shown in other beverages the blending of jamun with West Indian Cherry increased the acceptability scores with wine also, yet, was not observed up to a satisfactory level. Thus these two wines can be graded as less acceptable according to the judgement of the consumers. This is indicated by the scores obtained which were much below a mid point of 2.5.

Consumer remarks on wines evidenced that jamun wine was more appealing than grapes wine. Like RTS beverage, plain wines of these two fruits were found more relishing to them compared to its mix. West Indian cherry wine was judged to be less satisfactory while mixing jamun with it showed slight improvement in liking.

4.3.6.4. Consumer preference of the jamun products

Preference order of the jamun products viz. squash, RTS and wine among consumers was also assessed along with their acceptability test at the field level, as an attempt to find the most promising and acceptable product that could be made from the fruit, jamun.

The results of the consumer preference based on ranking the three products are presented in Table 19.

Table 19

Consumer preference level of jamun products (percentage)

Products	Preference level		
	I(%)	II (%)	III (%)
Wine	76.00	24.00	0.00
RTS	18.00	72.00	10.00
Squash	6.00	4.00	90.00

When the first preference of beverage item from jamun was taken into consideration, it was found that 76 per cent of the consumers gave their choice to wine, 18 per cent of the consumers favoured RTS for their first choice while squash was prefered only by 6 per cent of consumers as their best liked jamun beverage.

While taking into account, the second preference of consumers on jamun products like wine, squash and RTS, the highest per cent (72) liked RTS as their second choice. Wine was marked by 25 per cent of consumers against a second prefered product while just a small portion of 4 per cent liked squash as their second preference.

Coming to the third preference it was found that majority of the consumers (90 per cent) liked squash as their third prefered item. The same rank was given by 10 per cent of

consumers to RTS while none of the consumers accepted wine down to a third preference.

Preference study conducted for jamun beverages like squash RTS and wine clearly indicated the best preference order to wine. Wine is a fermented beverage which is universaly enjoyed and is gaining popularity rapidly. The same trend was observed in the present study also. More over the high level sutability of jamun fruit to ferment into wine was also evident from this information. The colour, aroma and mouthfeel of jamun wine was proved excellent in this study. RTS beverage was the next drink choiced by the consumers to be made out of jamun. While majority of the RTS beverages available in the market at present are synthetic drinks, it will be highly beneficial both for consumers and processors to produce and popularise RTS drinks based on jamun which is now wasted for want of an outlet. Squash was identified as the last choice among the three items according to consumers. This is quite normal since the present consumers are exposed to the taste of many delicious fruit squashes. Hence comparison with an unpopular fruit would largely reflect their opinion.

4.4. ASSESSMENT OF SHELF LIFE

Product qualilty is judged from the degree of difference from the standard (Beekley and Roll 1996). Monitoring the storage behaviour is as important as its acceptability testing with respect to any new product. Shelf life quality of the beverages was assessed on the basis of their changes in nutritional and chemical components, overall organoleptic qualities, microbial status and spoilage of periodical assessment.

4.4.1. Assessment of changes in the chemical constituents of products during storage

Potter (1986) considered that the knowledge of the constituents of foods and their proportions is the basis of the understanding of food science. The chemical components present in the fruits are sugars, acids, total soluble solids (TSS), vitamins, minerals, pigments, polyphenols and enzymes. These components undergo various changes when processed and kept for a longer period. According to Bansal and Dhawan(1993), the main quality attributes like sugar content, ascorbic acid, acidity, tannins,and browning are affected by the storage. These variations may be detrimental is assessing the shelf life of the beverages prepared. The stability of the product is depended upon the changes occurring in these products with the progression of time. Hence the three beverages developed in this experiment (squash, RTS and wine) were assessed periodically to study the

changes in its chemical components like TSS, pH, acidity, total sugar and alcohol percentage on storage.

4.4.1.1. Assessment of changes in the chemical constituents of squashes

The results obtained concerning the changes in the various chemical parameters like TSS, pH, acidity and total sugar of squashes developed are discussed below.

4.4.1.1.1. Changes in the acidity of squashes during storage

According to Ashurst (1986),acidity gives flavour and offer antimicrobial activity to beverages. Results of evaluation of the acidity of squashes during the storage period of eight months are presented in Table 20.

Table 20

Effect of storage on acidity (% citric acid) of squashes

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	1.85	1.85	1.85	1.89	1.91	1.92	1.93	1.94	1.89
S_2	1.54	1.54	1.54	1.54	1.57	1.66	1.70	1.76	1.61
S_3	1.34	1.34	1.34	1.34	1.38	1.39	1.44	1.48	1.38
S_4	1.66	1.66	1.66	1.66	1.73	1.76	1.87	1.93	1.74
S_5	1.57	1.57	1.57	1.67	1.70	1.73	1.77	1.79	1.67
Mean M	1.59	1.59	1.59	1.62	1.66	1.69	1.74	1.78	
M CD	0.024								
S CD	0.019								
MS CD	0.054								

The data indicated that there was no change in the acid content of squashes during the initial months of storage. The

increase in acidity observed during the later months of storage was gradual and steady. This increase in acidity may be due to the interaction of organic acids present in the beverage. Increase in acidity was lowest (0.06 per cent) for jamun squash. Acidity increase in other squashes were slightly higher and varied from 0.10 to 0.27. Storage studies conducted by Vilasachandran et al (1984) had revealed similar findings in cashew apple juice. They reported that acidity increased corresponding to the increase in storage days. Palaniswamy et al, (1974) observed an increase in acidity in lime- ginger cocktail and ginger ale during storage. A slight increase in acidity was noticed after 15 days of storage in canned papaya products like juice and nectar (Kulwal et al, 1985). Sethi observed an increase in acidity in mango pulp squash and litchi juice during storage. Studies conducted by Tripathi et al, (1988) in amla juice exhibited an increase of 0.86 per cent in acidity during storage. Thirumaran et al, (1990) also noticed similar trend in tomato juice concentrate. Shelf life studies of whole tomato concentrate showed an increase in acidity by 2.08 per cent as reported by Sethi (1994). In the present study the increase in acidity noticed coincides with its parallel decrease in pH.

The acidity of squashes remained inconsistant over the storage period with respect to the squashes. During the fourth, fifth and sixth months, the acidity level of S_4 and S_5 was on par. In seventh month, the acidity level of all the squashes differed significantly and in the eigth month, S_1 and S_4 kept the same level followed by S_5 and S_2. The results show that S_3

maintained the least acidity level during all the eight months of observation and S_1 the highest level during the said period. In S_1, the acidity for the last five months of storage was observed to be on par. Similarly, the increase noticed in the fifth month and seventh month in S_2, S_3 and S_5, sixth month in S_3, S_4 and S_5 and eighth month in S_3 and S_5 was insignificant.

Increase in acidity upon storage of squashes was noted only from the mid months of observation and the increase was very low in jamun squash, compared to other squashes.

4.4.1.1.2. Changes in the pH of squashes during storage

Woodroof and Luh (1995) reported that the stability of processed fruits and juices may be extended by lowering its pH. The variation observed in the pH of squashes due to storage in the present study is presented in Table 21.

Table 21

Effect of storage on pH of squashes

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	2.50	2.50	2.47	2.43	2.30	2.27	2.23	2.23	2.37
S_2	2.30	2.80	2.77	2.63	2.50	2.47	2.43	2.30	2.59
S_3	3.20	3.20	3.20	3.10	3.03	2.90	2.90	2.83	3.05
S_4	2.77	2.73	2.73	2.73	2.70	2.67	2.67	2.63	2.70
S_5	2.90	2.90	2.83	2.83	2.83	2.73	2.67	2.67	2.80
Mean M	2.83	2.83	2.80	2.75	2.67	2.60	2.58	2.53	

M CD 0.071
S CD 0.056

The value revealed that pH of squashes remained steady in the beginning months of storage. Fall in pH was noticed only at a variation of 0.14 to 0.50 in different squashes. More stability and less pH variation existed in S4 (jamun-grapes blend). The decrease in pH value of squashes in directly related to the increase in acid content of the product. The results are in accordance with the findings of Palaniswamy (1971), who recorded a decrease in pH of lime ginger cooktail and ginger ale during storage. Chakraborthy (1993) pointed out that clarified watermelon juice stored for five months at room temperature showed a decrease in pH. Similar trend in pH was noticed in tomato concentrate by Sethi (1994). Contradictory to the above results, Mehta and Bajaj (1983) observed an increase in pH of comminuted kinnow and blood red orange squashes.

When interpreted statistically, it was found that significant difference prevailed among different types of

squashes. However the values obtained for pH kept the same trend during the eight months of storage ie, the variation in pH was consistent over the months of storage with respect to various squashes, although the values decreased with the advancement of storage period. The decrease observed in the last three and first three months was on par. Similar results was also observed for the change noticed in fourth and sixth months of storage. Low pH which indicated the higher acidity of the products was noticed for S_1, while high pH was noticed for S_3 throughout the storage period. The blended product stood intermediate to the products prepared from individual fruits with respect to pH value.

The unnoticeable decrease in pH of squash found after the first quarter of storage duration was in agreement with the change in acidity. S4, S5 and S1 were the samples that were observed to be more stable.

4.4.1.1.3. Changes in the total sugar content of squash during storage

The total sugar content of squash upto eight months was studied and are detailed in Table 22.

Table 22

Effect of storage on Total Sugar (percentage) of squashes

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	66.87	66.87	66.87	66.87	68.26	68.51	69.48	70.28	68.00
S_2	71.67	71.67	71.67	73.38	73.03	73.90	74.31	74.85	73.06
S_3	63.89	63.89	64.51	65.70	65.98	66.32	67.81	68.65	65.84
S_4	68.34	68.34	69.48	70.35	71.48	72.28	72.59	73.02	70.74
S_5	64.51	64.51	65.70	65.98	67.09	68.34	68.65	69.48	68.78
Mean M	67.06	67.06	67.65	68.45	69.17	69.87	70.57	71.26	

M CD 1.691
S CD 1.337

A small rise in total sugar per cent of the squashes have been observed at the end of storage period (Table 22). Increase was noticed only after four months in S1, after three months in S2 and from third month onwards in S3, S4 and S5. The increase was sequential and the lowest percentage of increase was observed in S2 followed by S1. The range of increase in sugar content was from 3.18 to 4.97 per cent as observed in various squashes. Increase of total sugar in squash during storage have been observed earlier by many workers. Bhatia et al, (1950) have reported an increase in total sugar content in jack fruit squash during storage. Jain et al, (1984) has observed a gradual increase in the total sugar during the entire storage period in fruit squashes. In the present study, with respect to the variation noticed in the total sugar content, it could be inferred that the straight squashes prepared from jamun (S_1) and grapes (S_2) was more consistent to the other squashes developed.

The results obtained in this study with regard to this particular parameter is in conformity with the findings of Dhawan et al (1980), who mentioned that the increase in total sugars could be due to partial hydrolysis of complex carbohydrates.

Significant difference were observed in the total sugar content of squash with respect to various squashes, except S_5 and S_4 which were found to be on par. However the variation in the sugar content was consistent over the months of storage with respect to various squashes, though its amount increased with the progression of storage period. Maximum total sugar was recorded for S_2 followed by S_4. The sugar content of S_1 was also found to be higher than S_3. From the results, it is revealed that total sugar content was high in squashes which contained grapes. The change that was observed in the first four and last three months of storage was found to be on par. Similarly, the values recorded in the fifth and sixth month was on par with that of fourth and seventh month.

The sugar content of squashes increased at a similar rate upon storage.

4.4.1.1.4. Changes in the Total Soluble Solids of the squashes during storage

Total Soluble Solids is the amount of sugar and soluble fruit particles present in the juice, which is an important parameter that decide the quality of the squash. The values obtained on periodical analysis of squashes for TSS is depicted in Table 23.

Table 23

Effect of storage on TSS (°brix) of squashes

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	55.20	55.20	55.20	55.27	55.40	55.40	55.40	55.60	55.33
S_2	56.80	56.83	56.90	56.90	57.00	57.00	57.00	57.20	56.95
S_3	52.40	52.40	52.53	52.40	52.53	52.73	52.73	52.73	52.56
S_4	53.90	53.93	53.90	53.93	53.97	54.07	54.03	54.07	53.98
S_5	54.60	54.60	54.70	54.70	54.77	54.77	54.83	54.83	54.73
Mean M	54.58	54.59	54.65	54.64	54.73	54.79	54.80	54.89	

M CD 0.158
S CD 0.125

As observed in the other chemical parameters, TSS also did not undergo conspicuous change during eight months. The minute variation occured was not steadily progressive. The TSS of the plain jamun squash (S_1) remained constant for the first three months of storage. Similarly the values obtained for TSS of S_3 and S_5 remained same for the first two months. The range of increase observed for various squashes was very marginal (0.17-0.33). From the variation observed, the highest value of 0.40 was found for grapes squash and jamun squash. Very low increase was recorded for jamun blended squashes. This small change in TSS can be correlated with the increase in total sugar. Jain et al, (1984) reported a rise in TSS of orange, lemon and bael squashes during storage. However the same authors in another experiment (1987) found that there was no appreciable change in TSS values during storage of phalsa, kaphal and litchi squashes. According

to Jawanda et al (1978), the increase in TSS on storage of juice might be due to hydrolysis of polysaccharides and concentration due to dehydration.

Significant difference prevailed in the TSS content of squash with respect to the various squashes. Though the TSS was found to increase through out the storage period, the variation was observed to be consistent. The increase noticed for the first five months and last three months of storage was on par. Similar results was observed for the third, fourth, fifth, sixth, and seventh months of storage.

From the above data, it is clear that the TSS of squashes exhibit a slight elevation with storage of 8 months and rate of increase was similar in grape squash and jamun squash.

Periodical evaluation of the chemical parameters of squashes observed only minor changes upon 8 months of storage. Chemical constituents like TSS, total sugar and acidity were found to increase and pH decreased with the corresponding increase in acidity. Jamun squash and jamun blended squashes were comparable to grapes squash in their compositional change during storage.

4.4.1.2. Assessment of changes in the chemical constituents of Ready to serve beverage during storage:

RTS beverages are rather considered as a refreshing drink than its nutritional significance. According to Saikia and Dutta (1995), nutrient quality of RTS beverages is not considered important. However it is always considered better if nutrient quality is maintained at optimum possible level. Being kept in the reconstituted form, RTS drinks maintain a shorter shelf life compared to other beverages. The compositional changes in RTS beverages under study was assessed for a period of five weeks at regular intervals.

4.4.1.2.1. Changes in the acid content of RTS during storage

Acid content is of great importance in fruit juice as it concerns flavour in combination with sugar (Adsule, 1992). Results of the weekly analysis of the acidic content of the stored RTS is given in Table 24.

Table 24

Effect of storage on acidity (% citric acid) of RTS beverages

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	0.51	0.51	0.51	0.50	0.50	0.51
R_2	0.45	0.45	0.45	0.45	0.45	0.45
R_3	0.37	0.37	0.36	0.36	0.36	0.37
R_4	0.48	0.48	0.48	0.48	0.48	0.48
R_5	0.39	0.39	0.38	0.38	0.38	0.39
Mean W	0.44	0.44	0.44	0.44	0.44	

R CD 0.046

The Table indicated that the acidity of RTS remained constant during the observation period in all the samples. The constant acidity is an indication of successful shelf performance, where no deteriorative changes as to fermentation has occured in the beverage. The acid content of R_4 was observed to be at the same level as that of R_2 and R_1. The beverages R_3 and R_5 was also found to be on par with respect to their acid content. In line with the present observation, Vyas (1989) reported no appreciable change in acidity of Rhodopetal RTS beverage during two months storage. However a decreasing trend in acidity was reported by Shreshta (1982) in apple juice. Khurdiya (1984) reported a decreasing trend in acidity of jamun beverages. Musk melon-mango beverage and grape juice also recorded a decreasing trend in acidity as reported by Teotia (1992) and Masoodi et al (1992). The acidity of the bhadri lemon juice showed a downward trend during storage as reported by Bansal and Dhawan (1993).

It was a worth while observation that no fluctuation in the acidic content of RTS was noted in the present investigation.

4.4.1.2.2. Changes in the pH of RTS during storage

Data concerning the effect of storage in the pH of RTS is depicted in Table 25.

Table 25

Effect of storage on pH of RTS beverages

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	2.90	2.90	2.93	2.97	2.97	2.93
R_2	3.17	3.17	3.17	3.17	3.17	3.17
R_3	3.50	3.53	3.53	3.57	3.57	3.54
R_4	2.93	2.93	2.97	2.97	2.97	2.95
R_5	3.37	3.37	3.37	3.43	3.43	3.39
Mean W	3.17	3.18	3.19	3.22	3.22	

R CD 0.103

The Table revealed that generally there was not much difference in the pH of RTS during storage. The analysis of the data revealed the significant difference that existance between the beverages except R_1 and R_4 which was found to be on par. Least values was recorded for R_1 and R_4 which kept the same level for pH. Most of the samples gave constant values upto three weeks, except S_3. In S_2 (grapes RTS), no change was recorded during the entire storage period. There was no marked increase in the other samples. The non fluctuating acidity level of RTS had reflected in the pH level of the product also. This is

an assurance on the absence of fermentative changes. Similar to this results, Mehta and Bajaj (1983) reported that there was no appreciable change in the pH of citrus juices. Vyas et al. (1989) also observed no change in the pH of rhodopetal RTS during its storage of 2 months. However certain workers have found an increase in pH levels. Tripathi et al. (1988) revealed that due to chemical changes, a slight change in pH was noticed in amla juices. A gradual increase in pH of Bhadri lemon juice was observed through out the storage period by Bansal and Dhawan(1993). The pH of RTS during the first week ranged between 2.83 to 3.62 (Annapoorna, 1977). This value is in agreement with the present study.

pH of RTS beverages were rather constant proving no sign of deteriorative changes upon 5 weeks storage.

4.4.1.2.3. Changes in the total sugar content of RTS during storage

The effect of storage on the total sugar value of RTS is depicted in Table 26.

Table 26

Effect of storage on Total sugar (%) of RTS beverages

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	12.35	12.45	12.50	12.66	12.82	12.56
R_2	13.11	13.16	13.22	13.46	13.52	13.29
R_3	10.75	10.91	11.24	11.36	11.45	11.14
R_4	12.45	12.66	12.88	12.99	13.16	12.83
R_5	11.36	11.49	11.63	11.76	11.71	11.59
Mean W	12.00	12.14	12.29	12.45	12.54	

W CD 0.167
R CD 0.167

The change observed during storage in all the five types of RTS prepared is narrow and not accountable as far as total sugar is in concerned. Altogether there was only an ascending fluctuation of 0.1 per cent within five weeks. The total sugar content of RTS beverages was observed to differ significantly. Considering the slight increase observed in all beverages it could be stated that the sugar level of second week was of the same level as that of first period and third period. Similarly, the sugar content of fourth period was on par with that of third and fifth week. The results are in evidence to state that either no enzyme activity or inversion of non reducing sugars have taken place to raise the total sugar content of RTS upon storage. The results obtained in this study is in conformity with the work done by Palaniswamy and Muthukrishnan (1974) and Mehta and Bajaj (1983), who noticed a slight increase in total sugar in lemon juice and citrus juice respectively on storage.

Ranote and Bains (1982) noticed that the sugar contents increased in bottled kinnow juice stored under ambient condition. According to Jain et al (1988), the increase in total sugar could be attributed to the gradual inversion of non-reducing sugars. During storage, the TSS content of Bhadri lemon juice also increased as per the report by Bansal and Dhawan (1993). Mean while Khurdiya and Anand (1981) stated that not much change in total sugar was observed in phalsa beverage.

Weekly evaluation showed that the small difference in total sugar level of RTS cannot be taken as an indication to any storage change.

4.4.1.2.4. Changes in the Total soluble solids of RTS during storage

The data observed in the TSS content of RTS during storage is summarised in Table 27.

Table 27

Effect of storage on TSS (°brix) of RTS beverages

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	14.77	14.77	14.87	14.87	14.87	14.83
R_2	16.03	16.03	16.07	16.07	16.07	16.05
R_3	15.10	15.10	15.13	15.13	15.13	15.12
R_4	15.33	15.33	15.33	15.33	15.33	15.33
R_5	15.80	15.80	15.80	15.87	15.87	15.84
Mean W	15.41	15.41	15.45	15.45	15.45	

R CD 0.166

TSS value of RTS beverages on storage upto 5 weeks showed the stabililty of the product with respect to this component. However, there was significant difference in the TSS content with respect to various RTS beverages. Our findings agrees with the results of Khurdiya and Anand (1981). They reported that not much change was recorded in the TSS content of phalsa RTS beverages. But Khurdiya et al. (1985) reported an increase in TSS content of grape juice upon six months of storage. It could be noted that the extent of increase in the TSS content coincides with the corresponding increase observed in the total sugar content.

It was noteworthy to observe that the fluctuation of TSS in RTS beverages was un noticable.

From the above findings, the successful stability of RTS beverages developed can be highlighted. The changes occured in the chemical parameters viz. acidity, pH, Total sugar and TSS were very narrow and not worthy of explanation. The storage behaviour of jamun RTS and jamun blended RTS were in comparison with the product prepared from grapes in its compositional behaviour on storage as per the data.

4.4.1.3. Assessment of changes in the chemical constituents of wine

Mohini and Surjeet (1993) reported that on aesthetic appeal of wine depends upon the balance of chemical components that arise from extraction, fermentation and ageing. According to Amerine et al. (1980), a typical wine contains ethyl alcohol,

sugars, acids, higher alcohols, tannins, aldehydes, anthocyanins and minor constituents like flavouring compounds etc. Fermented products undergo more changes in chemical constituents during storage. In the present investigation, monthly analysis was carried out in various wine samples with respect to changes in chemical components.

4.4.1.3.1. Changes in the acidity of wine during storage

The wines also contains acids, which are dependent upon the type of fruit used such as grapes which contain tartaric acid and apples, maleic as the major acids (Sandhu et al, 1995) Acetic acid constitute the volatile acidity of wine as reported by Amerine et al (1980). The data pertaining to the acidity of wines under study during storage is depicted in Table 28.

Table 28

Effect of storage on acidity (% citric acid) of wines

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	0.38	0.38	0.40	0.41	0.42	0.43	0.44	0.46	0.41
W_2	0.69	0.70	0.71	0.73	0.74	0.74	0.76	0.77	0.73
W_3	0.59	0.59	0.60	0.62	0.64	0.65	0.66	0.68	0.63
W_4	0.61	0.61	0.62	0.64	0.65	0.66	0.69	0.70	0.65
W_5	0.45	0.46	0.47	0.49	0.51	0.50	0.52	0.53	0.49
Mean M	0.54	0.55	0.56	0.56	0.59	0.60	0.61	0.63	

M CD 0.026
W CD 0.020

Perusal of the recorded data indicated a slow and linear increase in the acid component of different wines. The rate of increase was almost similar which was accounted to be 0.08 and 0.09 per cent acidity. W_3 and W_4 was observed to be on par with respect to their acid content. The fluctuation noticed in the first four months was observed to be at the same level. Similarly the values obtained in fifth, sixth and seventh months and sixth, seventh and eighth months kept the same level as interpreted in the statistical analysis. The variation in the acid content was consistent over the months of storage with respect to various wines though its amount increased with the advancement of storage period. This increase in acidity is an indication of increase in alcochol content during storage. These findings on acidity variation of wine during storage is exactly in tune with that reported by Kadam et al (1992) in pomegranate wine. He found that acidity of wine increased from 0.71 to 0.75 during storage.

A very negligible increase in acidity of either 0.08 or 0.09 was recorded in the five types of during storage.

4.4.1.3.2. Changes in pH of wine during storage

The results of the observation on pH of wine during storage in depicted in Table 29.

Table 29

Effect of storage on pH of wines

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	3.50	3.47	3.47	3.40	3.40	3.40	3.30	3.30	3.40
W_2	2.90	2.90	2.90	2.70	2.70	2.63	2.60	2.60	2.74
W_3	3.33	3.33	3.30	3.17	3.17	3.10	3.10	3.10	3.20
W_4	3.13	3.13	3.13	3.00	3.00	2.93	2.93	2.93	2.03
W_5	3.37	3.37	3.33	3.33	3.30	3.30	3.17	3.17	3.29
Mean M	3.25	3.24	3.23	3.12	3.11	3.07	3.02	3.02	

M CD 0.099
W CD 0.078

From the data, it was found that the pH of wines varied with respect to the pH value. The value was observed to be descending with the advancement of storage period and the variation was consistant through out the period of storage. The observations for the first three months was found to be on par as far as pH was concerned. Similarly the pH of fourth, fifth and sixth months; and last four months of storage was of the same level as evidenced by analysis of the data. The pH value of jamun wine after a storage period of 6 months observed by Shukla et al (1992) and Vyas et al (1982) also observed a slight decrease in pH in pomegranate and plum wine respectively. The decrease noted in pomegranate wine was from 3.50 to 3.48. The decrease in pH observed during storage in this study could be subscribed to the consequent increase in the acidity observed in wines.

A narrow decline within the range of 0.20 to 0.30 was recorded in pH level and the variation was comparatively less in jamun based wines.

4.4.1.3.3. Changes in the total sugar of wines during storage

The changes noted in the total sugar content of wines during storage in presented in Table 30.

Table 30

Effect of storage on Total sugar (%) of wines

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	9.43	9.09	8.62	8.33	7.81	7.35	7.25	7.04	8.12
W_2	11.63	11.49	11.19	10.75	10.13	9.63	9.09	8.60	10.32
W_3	6.17	5.90	5.49	5.21	4.64	4.27	4.00	3.82	4.94
W_4	10.42	10.21	10.00	9.62	8.93	8.47	8.33	8.20	9.27
W_5	8.47	8.20	7.81	7.35	6.94	6.67	6.33	6.10	7.23
Mean M	9.23	8.98	8.62	8.25	7.69	7.28	7.00	6.75	

M CD 0.099
W CD 0.078
MW CD 0.220

Significant difference was observed in the total sugar content with respect to various wines during the entire period. A marginal decrease was observed in total sugar content of wine during storage. The range of decrease observed iun different wines varied only within a percent level of 2.22 to 3.03. This slight reduction in total sugar may be explained with convertion in unfermented residue left in the wine at the time of storage.

These findings corroborate with the results on chemical analysis of fermented canot based RTS which indicated a decline in total sugar with storage Vyas et al (1982) also reported a decline in total sugar in plum wine during storage.

The level of total sugar percentage with respect to types did not remain consistent over the period. In W_1 and W_4 the total sugar content of the seventh month was at the same level as that of sixth and eighth months. The change observed in the second month was on par with that of first month for W_2 and W_4. The total sugar content of third month was also on par with that of second month in W_4. The total sugar content of last two months of storage kept the same level in W_3.

The total sugar content of wines reduced at a minimum rate on storage upto 8 months.

4.4.1.3.4. Changes in the total soluble solids of wine during storage

Periodical testing of wine for its TSS content was carried out and the data obtained in given in Table 31.

Table 31

Effect of storage on TSS (° brix) of wines

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	20.10	16.53	12.47	10.33	8.70	7.73	7.10	6.83	11.23
W_2	24.23	20.30	15.67	13.35	11.77	10.50	9.20	8.53	14.22
W_3	18.50	16.47	14.33	12.53	10.50	9.20	8.80	7.57	12.24
W_4	23.63	19.60	15.40	13.03	12.53	11.37	10.00	9.97	14.44
W_5	19.20	17.60	15.67	13.30	11.77	10.43	9.03	8.07	13.13
Mean M	21.13	18.10	14.71	12.55	11.05	9.85	8.83	8.19	

M CD 0.142
W CD 0.113
MW CD 0.319

The Table revealed a tangible decrease in the TSS content with increase in storage period. It could be noticed that eventhough the parameter was found to decrease during the storage period, the reduction was much less in the later months. Among the samples, there was decline of 10.93 to 15.70 per cent TSS. Grapes wine showed the maximum TSS decrease followed by jamun wine and jamun-grapes blend. The cause of this decrease could be substantiated by the commensurated increase in alcohol content. Such downward trend in TSS of wine was observed by Vyas and Kochhar (1993). The authors reported that the TSS content of wines prepared from different varieties of apples were around 9.0 after six months of storage. A decrease in TSS content was reported in pomagranates wine by Kadam *et al* (1992). According to this worker, the unfermented sugar present in wine gets converted to alcohol and this results in the changes in TSS.

The TSS of the wines remained inconsistent thoughout the storage period with respect to the wines. During the secoud month, the TSS content of W_1 and W_3 was on par. In the third month the wines W_2, W_4 and W_5 was at the same level with respect ot TSS content. W_2 and W_5 also possessed the same level for TSS content during fourth, fifth and sixth months of storage. In seventh month, W_5 was on par with W_3 and W_2 with respect ot TSS content. In W_1 the change occured in the eight month alone was on par with that of preceding month.

The range of decrease for TSS was highest for grapes wine indicating convertion of more sugar to alcohol during storage. This in turn develops better aroma and flavour. Alcoholic conversion upon storage of wine prepared from jamun and grape blend was similar as indicated by TSS decrease and was comparable to grape wine.

4.4.1.3.5. Changes in the alcohol content of wine during storage

Among the biochemical characteristics of wines, alcohols constitute an important component (Sandhu et al 1995). The alcohol content of wine was evaluated at regular intervals during its storage period of eight months and the data is summarised in Table 32.

Table 32

Effect of storage on alcohol content (%) of wines

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	8.63	9.10	9.68	10.47	10.99	11.13	11.70	11.80	10.44
W_2	10.00	10.75	11.23	11.57	12.13	12.43	12.90	13.68	11.84
W_3	5.85	6.50	6.80	7.28	8.22	8.68	9.22	9.30	7.73
W_4	9.55	10.18	10.73	11.12	11.42	12.30	12.30	12.88	11.31
W_5	6.55	7.22	7.92	8.07	8.63	9.33	9.97	10.17	8.48
Mean M	8.12	8.75	9.27	9.70	10.28	10.78	11.22	11.57	

M CD 0.066
W CD 0.052

It is clearly evident from the Table value that upon storage the alcohol level of wines increased considerably. Alcohol increase in different wine showed a range from 3.17 per cent to 3.68 per cent and found that the variation among the samples were not striking. Ageing is a process which the wine undergoes after the completion of fermentation, and during this process the unfermented sugar gets converted to alcohol which accounts for the increased alcohol content as observed inthe present investigation during storage. Several workers have reported improvement in alcohol content during storage of fruit wines. During a storage period of 8 months Kadam et al (1992) noticed an increase of alcohol content in pomegranate wine. Ber wine also observed the same trend during storage as reported by Kadam et al (1992). An increase in alcohol content of 3.45 was reported by Majeed (1995) in karonda wine during 8 months.

Significant difference was observed in the alcohol content with respect to various wines. However the alcohol content kept the same trend during 8 months of storage. ie. the variation in alcohol content was consistent over the months of storage though its amount increased with the progression of storage period.

The increase observed in the alcohol content of wines was observed to have not much variation with respect to different wine and the range recorded was between 3.17 to 3.68 per cent.

From the result obtained, it can be concluded that the chemical constituent of all the wines during storage exhbited a positive change. A narrow increase in acidity and rise in alcohol percentage resulted. pH, TSS and total sugar was reduced in tune with the rise in alcohol and acidity. The changes in chemical constituents of jamun wine and grape wine were more or less in the same range.

4.4.2. Assessment of microbial contamination of the stored products

The shelf life quality of the processed product is one of much importance because the need for improving different processing techniques is influenced by shelf life quality (Tandon 1986). The storage life of any product is dependent on the absence of harmful microorganisms. The microbial growth or microbial damage of a product is dependent upon certain factors both chemical and physical, which are favourable for their growth and among this pH is one of the important factor that determine

the survival and growth of microorganisms during processing and storage (Frazier 1994) Therefore routine analysis of the product is necessary to find out whether the product has any quality deterioration.

The beverages developed in this investigation were subjected to test for the microbial infestation such as yeast, fungus or bacteria. In the present study,RTS beverage was analysed weekly to test any presence of deteriorative organism while the other products squash and wine were examined monthly.

The microbiological examination of the squashes at regular intervals of storage failed to show the presence of microorganisms even at the end of eighth month. This is a positive indication for the safe use of squashes over 8 months under ambient storage. According to Srivastava and Kumar (1994) the sugar based products are considered "high sugar " level items if it contains a sugar content of 50 per cent and above. As per this criteria squashes studied here possessed high value which also acts as a presevative by binding the water content. Further the maintanance of acidity level of squashes at the optimum level during the storage period have also contributed to its keeping quality. Thus it could be highlighted that the jamun based squashes behaved equivalent to grapes and other fruits generally processed into squash.

The weekly examination of RTS beverages prepared showed no visible changes of spoilage upto 5 weeks except watermelon RTS. RTS prepared from watermelon showed onset of infestation with

yeast by the fifth week of storage. This may be due to comparatively lesser acidity level of this sample that had resulted in spoilage much earlier than the other RTS beverages. Generally RTS beverages are meant only for a ready and quick use. Since its water content is high, the shelf stability is also very less compared to squash. The safe storage span of RTS at ambient conditions observed in this study coincides with results by others. RTS beverages prepared based on passion fruit by Pal (1995) had detected pencillium species after a shelf life of 6 weeks. Better keeping period for RTS may be accomplished if stored at lower temperattures.

The stored samples of wine failed to show any deterioration even after 12 months of storage. Rebereau and Gayon (1978) stated that the wine owes its microbiological stability to its acidity and alcohol content which permits certain conservation without the use of highly specific techniques. Complete absence of microflora was observed in wine during its storage of 8 months by Adsule et al.(1992). This results offer a good outlet for jamun to be converted into a shelf stable and relishing beverage.

Squash remained unaffected by microorganisms even at eighth month, while wine exhibited successful storage even after 12 months. Similarly the RTS beverage that is generally known for shorter span was safe at ambient temperature upto 5 months.

It could be inferred from the results of microbial testing that utmost care with high standards of quality control and ideal methodology were followed during processing the products in this

study. The nutritional and chemical composition were also proved to be at satisfactory levels which is evident from the quality standards maintained by products. These are necessary factors that enables any product to face the international market competition where quality is of utmost importance.

4.4.3. Change in the organoleptic qualities of products during storage.

Sensory quality may be defined as those attributes of quality which are perceived through the senses (Williams and Atkin, 1983). Among numerous factors which influence quality of products, sensory attributes may be considered as a major factor, and these are susceptible to change during storage. Sensory quality is thus an essential prerequisite for nutrition. According to Thakur et al (1995), like chemical changes sensory changes are also influenced by its storage period. Winter (1990) opined that instruments usually analyse only a single component at a time, where as the overall impression and taste of a food product can be properly assessed only by human sensory perception. The sensory quality analysis of the products under investigation were carried out periodically through the selected panel members during the entire storage period. The data is presented and discussed.

4.4.3.1. Changes in the organoleptic qualities of squash during storage

The maintenance of the organoleptic qualities of squash during storage is very important as it influences the

acceptability of this beverage. The products prepared are susceptible to changes in its storage due to various factors like temperature, packaging system etc.In order to check whether storage had any negative influence in the acceptability, the squashes prepared were assessed monthly for variation in sensory qualities like appearance, taste, colour, flavour and clarity.

4.4.3.1.1. Appearance attribute

The data obtained on monthly observation related to the appearance of squash on storage is presented in Table 33.

Table 33

Effect of storage on appearance of squashes (Mean Scores)

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	4.97	4.97	4.83	4.83	4.73	4.70	4.60	4.53	4.77
S_2	5.00	5.00	4.93	4.90	4.83	4.77	4.73	4.60	4.85
S_3	3.83	3.80	3.63	3.43	3.30	3.23	3.13	3.10	3.43
S_4	5.00	4.93	4.90	4.83	4.70	4.63	4.60	4.60	4.78
S_5	4.97	4.97	4.93	4.83	4.80	4.70	4.67	4.60	4.81
Mean M	4.75	4.75	4.65	4.57	4.47	4.41	4.35	4.29	

M CD 0.032
S CD 0.025
MS CD 0.071

The results revealed (Table 34) a gradual and steady decrease in the visual quality of squashes during storage. However, the values remained constant for first two months in certain squashes. The squashes made from jamun, grapes and their blend recorded the decrease of 8 per cent in mean score for

appearance during storage. The lowest decrease of 6 per cent was recorded by jamun-watermelon blend, while squash made from watermelon alone observed a percentage decrease of 13. Stability of anthocyanins is an important factor that retains the colour of the product which inturn has a direct impact on the appearance of squash. Waskar and Khurdiya (1987) noted that the squashes prepared from phalsa beverages was acceptable upto 180 days, considering the appearance of the product, as there was maximum retention of anthocyanins in phalsa beverages kept in cool store. Jamun squash in the present study exhibited no colour deterioration that affected its acceptability even at ambient temperature and performed similar to grapes.

The appearance score was observed to be inconsistent throughout the storage period. But the scores was found to be decreasing throughout the storage period for all the five squashes developed. In the first, second, fourth and eight month, all the squashes were on par except S_3. S_3 observed the least score for all the months of storage. In the third month of storage, S_4 alone was found to be on par with S_1 as well as S_5 and S_2. Similarly S_1 was on par with S_4 and S_5 with respect to appearance and S_5 was also found to be similar to S_2 in this organoleptic character in the fifth month of observation. S_4, S_5 and S_1 was similar in the sixth and seventh month of storage. In S_2 and S_5 the first three months of storage did not show any remarkable difference with respect to appearance whereas significant decrease in appearance was observed in the third, fifth and seventh month in S_1, eighth month in S_2 , third,

fourth, fifth and seventh month in S_3 and fourth and sixth month in S_5.

The eye appeal performance of the squashes were not degraded considerably on storage which maintained above 90 per cent, except in watermelon squash. This attribute in jamun and its blended products were comparable with that of grapes.

4.4.3.1.2. Taste attribute

The results of periodical examination of squash pertaining to the most important sensory characteristic, taste is depicted in Table 34.

Table 34

Effect of storage on taste of squashes (Mean scores)

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	4.47	4.20	4.17	4.13	4.00	3.73	3.70	3.60	4.00
S_2	5.00	5.00	4.90	4.73	4.63	4.60	4.60	4.53	4.75
S_3	3.83	3.80	3.63	3.43	3.30	3.23	3.13	3.10	3.50
S_4	5.00	5.00	4.83	4.73	4.70	4.63	4.60	4.50	4.75
S_5	4.83	4.83	4.73	4.73	4.50	4.50	4.43	4.43	4.63
Mean M	4.61	4.55	4.45	4.39	4.27	4.19	4.11	4.03	

M CD 0.029
S CD 0.023
MS CD 0.065

The mean score value on taste of squash remained unchanged for two months in grapes squash and jamun blended squashes. However the taste value decreased in general with the progression

of time in all squashes. Taste reduction as per score level of judges varied only from 8 to 17 per cent. Blended squashes were better in taste retention and performed at a more or less equal status to grape squash when stored. Study conducted by Jain et al (1980) revealed that reductiion in scores for taste of phalsa and Kaphal squash in its storage period of six months was negligible. Another report by the same authors showed that twelve months storage of litchi squash could not develop any off taste in the product. Similarly, in the present study no perceptible off taste was found in the squashes even after eight months, while a slight fading in the taste appreciation has occured which is quite natural when fruit products are stored. Jamun blended squashes were equally comparable to grapes squash in its taste performance during storage, and plain jamun squash was rated next. The high astringency of jamun fruit was outstanding when the juice was used alone in squash making. When blended with other fruit juices like grapes and watermelon, this aspect was not found pronouncing even at storage.

The taste of the squashes developed was found to be inconsistent throughout the storage period. S_2 and S_4 ie. grape squash and jamun-grape mix was at the same level in all months except in the third and fifth month. In the fourth month S_2,S_4 and S_5 was on par with respect to taste. In all squashes except S_1, the scores obtained for first two months was comparable. In S_1, the taste in the third month was not found to differ significantly from that of second and fourth month. The sixth month and seventh month scores was also on par in S_1 and S_4 and

was similar to that of fifth month in S_2. The taste of last two months of storage also kept the same level in S_3 and S_5.

Taste of squash was rather appreciable even after eight months, watermelon squash showing comparatively lesser appreciation on storage.

4.4.3.1.3. Colour attribute

Variation in score for the colour intensity of the squashes during storage are summarised in Table 35.

Table 35

Effect of storage on colour of squashes (Mean scores)

Squashes	Storage period (months) 1	2	3	4	5	6	7	8	Mean S
S_1	5.00	5.00	5.00	4.83	4.80	4.73	4.70	4.70	4.85
S_2	5.00	5.00	5.00	4.93	4.90	4.83	4.80	4.70	4.90
S_3	3.30	3.30	3.20	3.20	3.13	2.97	2.93	2.93	3.12
S_4	5.00	5.00	4.90	4.90	4.83	4.73	4.70	4.60	4.83
S_5	4.97	4.97	4.93	4.93	4.73	4.70	4.63	4.60	4.81
Mean M	4.65	4.65	4.61	4.56	4.48	4.39	4.35	4.31	

M CD 0.027
S CD 0.021
MS CD 0.059

A perusal of the data given in Table 35 revealed that colour of squashes retained well during storage. Colour value was constant during first two months. The score level at the end of 8 months was 92 to 94 per cent, except in S_3 where only 59 per cent was scored. The perentage of decline observed for jamun

squash and grapes squash was found to be minimal with 6 per cent. But the decrease observed was more pronounced in the initial stages in jamun squash and in the later stage in grapes squash. This may be due to the high anthocyanin content of the jamun and hence, disintegration was more from the beginning of storage period itself. The decrease in percentage observed for other squashes were slightly higher and was within the range of 7 to 8 per cent. According to Skrede et al, (1992), colour stability was dependent upon anthocyanin concentration and the degradation of anthocyanin pigments Findings of Jain et al. agrees with present data, where no appreciable colour loss was recorded in phalsa and Kaphal squashes for a period of 6 months. Purushotham et al (1992) advocated that colour deterioration due to passage of light through the walls of the container can be reduced by storing in coloured glass jars. Shah and Bains (1992) found that tintometric colour did not change much during prolonged storage of mango pulp where as that of apricot pulp was observed to decrease during storage.

The colour of the squashes did not remain consistent throughout the storage period. For the first two months of obervation, all the squashes was observed to be on par with respect to colour except S_3, which was observed to be low. In the fifth, sixth and seventh months of storage, S_2 observed the highest value while in the last observation S_2 and S_1 remained on par. The blended squashes S_4 and S_5 was at the same level in the third and last month of storage and was found to be on par with S_2 in the fourth month and S_1 in the sixth month. In S_5, the

value remained at the same level for the first four months of observation and was unchanged for first three months in S_1 and S_2. The second, fourth and seventh months of observation was on par with that of preceding month in S_3 and S_4 and in S_3, the observations made for last three months remained at the same level.

To conclude, it may be stated that all the squashes except watermelon had an attractive colour even after the storage period of 8 months and the decrease that observed was just minimal, which may be due to colour bleaching by light rays that had passed through colourless glass containers.

4.4.3.1.4. Flavour attribute

Table 36 depicts the data obtained for the flavour profile of squashes during storage.

Table 36

Effect of storage on flavour of squashes (Mean Scores)

Squashes	Storage period (months) 1	2	3	4	5	6	7	8	Mean S
S_1	5.00	5.00	4.83	4.73	4.53	4.80	4.43	4.40	4.68
S_2	5.00	5.00	4.90	4.83	4.73	4.70	4.63	4.53	4.79
S_3	3.50	3.43	3.40	3.37	3.33	3.20	3.13	3.10	3.31
S_4	5.00	4.93	4.90	4.73	4.70	4.53	4.33	4.30	4.68
S_5	5.00	4.97	4.90	4.73	4.70	4.50	4.33	4.30	4.68
Mean M	4.70	4.67	4.59	4.48	4.40	4.29	4.17	4.13	

M CD 0.029
S CD 0.023
MS CD 0.065

It is evident from the Table that flavour scores for the plain squashes prepared from jamun and grapes were constant in the first month and a slow decrease was observed in scores at the end of storage in all squashes. The lowest percentage of decrease was observed for grapes and watermelon squash, followed by jamun squash. The percentage of decline observed for jamun blended squashes were slightly higher. Even then, these squashes recorded a highly appreciable value for flavour at the termination of storage observation, compared to watermelon squash that secured very low score of 62 per cent. While storing for a period of 8 months, the flavour of jamun squash was almost equal with that of flavour appreciation for grapes squash. According to Shukla et al (1992), browning reaction was a major reason for the impairment of flavour in fruit products. This might be the case in the present study also. Jain et al (1980) reported no

change in flavour for a period of 6 months in phalsa and Kaphal squashes and for 12 months in case of litchi squash, where as apple beverages stored at higher temperature were rated higher in chemcial off odour and low intensity aroma as reported by Daniel et al (1980). However no such development of off odour was noted in the present study except for a slight progressive loss of flavour.

The squashes developed was observed to have an inconsistent score with respect to flavour. Apart from S_3, all the other squashes were at the same level in the first month of storage. S_3 observed the least score for flavour in all the periods of storage. S_4, S_5 and S_2 were on par with respect to flavour in the third and fifth months of storage. $S_4$and S_5 ie. the blended squashes possessed the same level of flavour in the last three months of storage and was on par with S_1 also in the fourth month. The first two and last two months of storage observed the same level for flavour in S_1 and S_5. The second and sixth months scores obtained for flavour attribute was observed to be on par with scores obtained for the previous months in S_2. As far as S_3 and S_4 is concerned, the third, fifth and eighth month score for flavour was at the same level as that of previous month.

All the products except watermelon plain squash possesed good flavour after storage. In this particular sample, flavour score was less even for the fresh product. Although a decrease was found in general,scores obtained for jamun and blended product at the end of storage period was comparable to that of grapes.

4.4.3.1.5. Clarity attribute

Score pertaining to the clarity performance of squash with storage is presented in Table 37.

Table 37

Effect of storage on clarity of squashes (Mean scores)

Squashes	Storage period (months) 1	2	3	4	5	6	7	8	Mean S
S_1	4.33	4.30	4.30	4.40	4.40	4.47	4.47	4.50	4.40
S_2	4.43	4.40	4.50	4.53	4.57	4.60	4.70	4.70	4.55
S_3	2.97	3.00	3.27	3.30	3.37	3.47	3.57	3.60	3.32
S_4	4.60	4.67	4.77	4.77	4.80	4.90	4.93	4.93	4.80
S_5	4.67	4.70	4.77	4.80	4.80	4.87	4.87	4.87	4.79
Mean M	4.20	4.21	4.32	4.36	4.39	4.46	4.51	4.52	

M CD 0.030
S CD 0.024
MS CD 0.068

Contrary to the other characters, the Table values denoted that the squashes became more clear upon storage. Considering S_1 (Jamun squash) and S_2 (grapes squash), a slight decrease in score observed during the initial months, become steady and then increased with the advancing storage period. Clarity of all other squashes increased steadily. Jamun squash was observed to have the lowest percentage of increase for its clarity during storage. The low clarification process at storage can be assigned to the fact that clarity in this particular fruit juice had been attained by applying specific agents, prior to product preparation. Due to the same reason, eventhough there was less

clarity improvement at storage, the score on this aspect for jamun squash was very high (90 per cent) and comparable to grapes squash (94 per cent). Although,plain watermelon squash observed the highest increase in percentage value for clarity, the score obtained even at the end of storage period was only 72 per cent. Natural clouds were found in comminuted orange and lime squash (Verma and Sastry, 1969), where as in jamun squash clouds were less due to removal by clarification of fresh juice. Khurdiya (1994) observed that during storage of lime drinks, the clouds were found to decrease drastically.

The clarity of the squashes was found to be inconsistent throughout the storage period with respect to the squashes. During the first period of storage, all the five squashes was observed to be at different levels with respect to clarity. But during all the other periods of storage, the clarity level of S_4 and S_5 was observed to be at the same level. In S_1, the changes noticed in the first and last three months of storage was insignificant, apart from the fourth and fifth months of storage which also kept the same level. The last three months as well as the thrid, fourth and fifth months of storage kept the same level within themselves for S_4 and S_5. The clarity levels of first and last two months as well as the third and fourth months possessed the same level for S_2 and S_3.

Squashes were observed to be more clear on storage due to setting of clouds. Clarification and cloud setting was lowest in jamun squash and highest in watermelon during storage. This suggests that jamun juice was adequately clear before storage.

4.4.3.1.6. Overall acceptability

The over all acceptability of the squashes worked out on averaging the values for different sensory characters are depicted in Table 38.

Table 38

Effect of storage on overall acceptability of squashes (Mean Scores)

Squashes	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean S
S_1	4.75	4.69	4.63	4.59	4.49	4.43	4.38	4.35	4.54
S_2	4.89	4.88	4.85	4.79	4.73	4.70	4.69	4.61	4.77
S_3	3.47	3.45	3.43	3.39	3.33	3.27	3.20	3.17	3.34
S_4	4.92	4.91	4.86	4.79	4.75	4.69	4.63	4.59	4.77
S_5	4.89	4.89	4.85	4.81	4.71	4.65	4.59	4.56	4.74
Mean M	4.58	4.56	4.52	4.47	4.40	4.35	4.30	4.26	

M CD 1.40
S CD 1.11
MS CD 0.031

Overall acceptability of squashes marked a slight decreasing change with storage upto 8 months as revealed by scores in Table 38. The percentage of decrease in the overall acceptability scores was merely to an extent from 6 to 8 per cent. On perusal of the scores obtained at the end of storage period, it was clear that all the products were acceptable. Although watermelon squashes recorded a comparatively less value, the percentage decrease was less. Phalsa squash prepared by Waskar and Khurdiya (1987) was found to be highly acceptable upto 180 days, while in the present study overall acceptability at a

score level above 85 per cent was observed at the eight month in jamun, grapes and the blended squashes and watermelon squash at a level of 63 per cent, when stored at room temperature. Fruit squashes of lemon, orange and bael stored at low temperature maintained the overall organoleptic qualities for a period of 12 months as noted by the above workers in 1987.

The overall acceptability of squashes was found to be inconsistent with respect to the squashes. For the first four period of storage, squashes S_2, S_5 and S_4 was observed to be on par with respect to overall acceptability. S_2 alone was found to have the same level as that of S_5 and S_4 regarding the overall acceptability during the fifth period. S_4 and S_2 was at the same level during the sixth month, while S_4 alone was observed to be on par with S_5 and S_2 in the last period of storage. The overall acceptability for the last two months kept the same level for S_1, S_3 and and S_5. The scores obtained for overall acceptability also kept the same level for all squashes except S_1.

Storage exhibited a small degrading influence in the overall acceptability of squashes. The change occured in the score value of all the squashes revealed a similar range within 8 months.

The organoleptic performance of all the squashes were adequately preserved even with an observation of slight decrease with reference to the decrease in colour, taste, flavour and appearance,whereas clarity of squashes improved. Storage results

confirmed that the squashes were well acceptable after 8 months, watermelon with comparably low overall preference to the panel judges.

4.4.3.2. Changes in the organoleptic qualities of RTS during storage

4.4.3.2.1. Appearance attribute

Appearance is one of the important factors which influence consumers inclination, while buying fresh as well as processed products (Sharma and Wani 1995). According to Hicks (1990), for maximum acceptability, the drink must look fresh and should have good fruit appearance.

The scores obtained for the apperance attribute of the different RTS at weekly intervals is presented in Table 39.

Table 39

Effect of storage on appearance of RTS (Mean Scores)

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	4.33	4.30	3.97	3.97	3.97	4.11
R_2	4.57	4.57	4.57	4.40	4.40	4.50
R_3	3.06	3.06	3.00	3.00	3.00	3.03
R_4	3.93	3.93	3.93	3.90	3.90	3.92
R_5	4.00	3.97	3.87	3.87	3.87	3.91
Mean W	3.98	3.97	3.87	3.83	3.83	

W CD 0.031
R CD 0.031
WR CD 0.068

The Table reveals that there was only a slight decrease in the appearance attribute scores obtained by various Ready to serve beverages. The range of decline in appearance value in the RTS samples was from 1 to 8 per cent. In R_1 and R_4, a change was observed only in the fourth week, which then remained constant with storage of five weeks. Jamun RTS was next to grapes RTS in the scores secured for sensory characteristic appearance. Eventhough the reduction in score was more for plain jamun RTS, the mean score even at the end of storage period remained high, which maintained a level of 80 per cent. It could be stated that appearance and colour of a product are interrelated. The loss of colour in jamun RTS due to the oxidation-reduction reaction of anthocyanins might have influenced the appearance of the product. Sedimentation of fruit particles at the bottom is a very important factor that affects the appearance of RTS drinks, especially when such beverages are not mechanically blenderised. In the present trial, RTS beverages were not subjected to blenderisation. As per the opinion of Shamel (1993), appearance is an important property of certain soft drinks, since it gives a natural appeal to the fruit drink. At the same time Teotia (1992) noted that the RTS beverage made from muskmelon-mango blend resumed attractive appearance upon shaking the bottle prior to serving.

The stastical analysis of the data revealed that the appearance of the RTS remained inconsistent with respect to the RTS beverages. During the first week of storage, the appearance of the five RTS beverages significantly differed from one

another. But for rest of the four weeks the blended RTS beverages (R_4 and R_5) was observed to possess the same level for appearance. R_3 possessed the least score for appearance during all the periods of storage, while R_2 had the best score throughout the storage period of five weeks. The appearance of R_3 and R_4 was observed to have the same level for the five weeks of storage. In the case of R_1 and R_5, the first two weeks and last three weeks was on par with respect to appearance, while for R_2, the first three weeks and last two weeks was observed to be on par.

Even though storage slightly reduced the appearance score of plain jamun and plain grapes RTS, it was adequately high at the end of storage period, followed by jamun blended RTS.

4.4.3.2.2. Taste attribute

Generally a reduction in taste was exhibited on storage of RTS (Table 40) which ranged from 2 to 5 per cent. The taste was highly acceptable and was constant for two weeks in R_1, R_2 and R_4 (Jamun RTS, grapes RTS and Jamun grapes RTS). Thereafter a minimun decrease was observed. The minimum percentage decrease of 2 was observed for R_2 and 3 per cent each for R_1 and R_4. The maximum percentage decrease was only 5, which was noted for watermelon RTS. The percentage decrease of taste with storage in jamun RTS was negligibly higher only to grapes RTS.

Table 40

Effect of storage on taste of RTS (Mean Scores)

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	4.46	4.43	4.40	4.23	4.20	4.34
R_2	5.00	5.00	4.97	4.93	4.90	4.96
R_3	2.97	2.97	2.97	2.83	2.80	2.91
R_4	4.50	4.50	4.33	4.30	4.30	4.39
R_5	4.13	4.13	4.10	3.93	3.90	4.04
Mean W	4.21	4.21	4.15	4.05	4.02	

W CD 0.031
R CD 0.031
WR CD 0.068

Mukherjee (1963) had stated that taste of a product change considerably during storage. Bansal and Dhawan (1993) noted that the heat preserved Bhadri lemon juice developed bitterness during processing and storage. Hitherto in the present study with jamun, eventhough the fruits were heat processed for juice extraction, bitterness even to a minimal level was not associated and taste of the products with jamun and grapes excelled the products from watermelon, for which the steaming was not applied for juice extraction.

The taste of the RTS was observed to be inconsistent throughout the storage period. Except R_1 and R_4 which was observed to be on par with respect to taste during the first period, all other RTS beverages was observed to be different in taste during the five weeks of storage. R_2 was best with regards to taste and R_3 was the least preferred one. In all RTS

beverages except R_4, the first three weeks of storage as well as the last two weeks was observed to possess the same level with respect to taste, while in R_4, the taste was of the same level for first two weeks as well as the last three weeks of storage.

To conclude, it may be stated that taste reduction on storage was unnoticable for RTS processed with grapes, jamun and their blends, and even for the other samples, the maximum percentage was only upto 5.

4.4.3.2.3. Colour attribute

The scores obtained for the sensory characteristic, colour of the various RTS is presented in Table 41.

Table 41

Effect of storage on colour of RTS (Mean Scores)

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	4.83	4.80	4.73	4.70	4.70	4.75
R_2	4.93	4.90	4.90	4.90	4.90	4.91
R_3	3.10	3.10	3.07	3.07	3.07	3.08
R_4	3.93	3.93	3.90	4.83	4.80	4.88
R_5	4.73	4.73	4.70	7.70	4.70	4.71
Mean W	4.51	4.49	4.40	4.44	4.43	

W CD 0.028
R CD 0.028

As evident from the Table, the colour intensity of different RTS was not affected noticably. There was only a

minimal decrease of 1 to 3 per cent. According to Thorner (1978), colour changes in fruit juices may occur during storage.

Even with a comparatively more fading of colour due to storage in R_1 and R_4, these samples maintained a superior level of 94 and 97 per cent score during the fifth month. Smulder (1978) opined that absolute colour scores cannot be provided through visual assessment, since it is extremely difficult for humans to develop a colour memory. Since originally the jamun RTS possessed more intensity in colour (97 per cent), a small reduction in its hue on storage might have reflected in the judgement by the panel members, where as in the case of R_3, with lesser per cent score reduction during storage, the colour value was maintained only at a level of 61 to 62 per cent. To this fruit (watermelon), blending of jamun juice highly elevted its colour quality. The formulation of brown pigments in the stored RTS is attributed to the degradation of the products of sugar, ascorbic acid and protein as reported by Ranote (1992). However browning was not noted in the products developed in the present study.

Statistical analysis revealed that there existed significant difference in the colour attribute with respect to various RTS beverages prepared except R_2 and R_5 which was on par.The changes observed during storage was also found tobe non significant. All the beverages possessed the same level for colour throughout the storage period.

The decrease in colour concentration of RTS was very low and all samples except watermelon RTS performed highly appreciable score in colour at the end of storage period.

4.4.3.2.4. Flavour attribute

The flavour changes of RTS beverages were assessed weekly and the mean scores of this sensory testing in given in Table 42.

Table 42

Effect of storage on flavour of RTS (Mean Scores)

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	4.80	4.80	4.50	4.47	4.47	4.49
R_2	4.73	4.73	4.70	4.70	4.67	4.71
R_3	2.93	2.93	2.90	2.83	2.90	2.90
R_4	4.60	4.60	4.60	4.57	4.57	4.59
R_5	4.60	4.57	4.57	4.57	4.57	4.57
Mean W	4.27	4.27	4.25	4.23	4.23	

W CD 0.028
R CD 0.038

From the result, it could be seen that flavour of RTS was highly acceptable, even at the end of fifth week except in R_3. Flavour intensity reduction observed was minute, being 1 to 2 per cent in various samples. Flavour reduction in R_2 was more compared to others. No flavour loss was recorded during the first three weeks in R_1 and R_4 and for two weeks in R_2 and R_3. In R_5, although a decrease was noted in the second week, it remained constant throughout the storage period. According to

Thorner (1978), the RTS beverage during shelf life precipitates, and this precipitated material contributed to the flavour. The RTS samples under observation were stored at room temperature and this might have influenced for the minute reduction of flavour as noticed in the values obtained for flavour. The flavour of grapes is most familiar and hence the members could clearly distinguish the difference in its flavour appeal more accurately than other samples.

Stastistical analysis of the data obtained for the flavour of RTS beverages during storage indicated that significant difference between all beverages except R_4 and R_5 which was found to be on par.

Flavour retention during storage of RTS was superior in jamun and jamun blended samples. Flavour was comparatively low in R_3 after storage, where the appreciation in this parameter prior to storage was also noted low in watermelon RTS.

4.4.3.2.5. Clarity attribute

The clarity performance of RTS beverages on storage upto 5 weeks attained an increase as per the score value. The scores obtained for this particular attribute periodically is depicted in Table 44. An increase upto 2 per cent was noticed in the different RTS samples. In all the RTS beverages except R_4, the score value increased after the second week and in R4, improvement in clarity was noted from fourth week onwards.

Table 43

Effect of storage on clarity of RTS (Mean Scores)

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	3.83	3.83	3.87	3.90	3.90	3.87
R_2	3.93	3.93	3.97	3.97	4.00	3.96
R_3	3.37	3.37	3.40	3.40	3.40	3.39
R_4	3.83	3.83	3.83	3.97	3.97	3.89
R_5	3.73	3.73	3.80	3.80	3.83	3.78
Mean W	3.74	3.74	3.77	3.81	3.82	

W CD 0.035
R CD 0.035

In the present study, storage was found beneficial with respect to clarity improvement of RTS beverages. Progress in clarity was noted more by 1 per cent in blended RTS and plain grapes RTS than others. This could probably be due its more sedimentation of fruit particles during storage. In the case of jamun juice, application of clarifying agents before the preparation of RTS had helped in discarding the clouds earlier. More over, the pectolytic enzymes present in jamun activates on clouds (Khurdiya 1992). Watermelon juice was clear by itself when juice was extracted due to its particular nature. Pal (1995) observed that in passion fruit based RTS beverages, the variation in clarity improvement ranged from 1.00 to 1.4.

Statistical analysis indicated that as far as the clarity attribute was concerned, all the beverages were significantly different except R_1 and R_4 which was found to be on par.

On storage, the RTS beverages progressed in clarity. Grapes and blended RTS become more clear during its storage.

4.4.3.2.6. Overall acceptability

The overall acceptability of stored RTS was evaluated based on quality changes and the data is presented in Table 44.

Table 44

Effect of storage on overall acceptability of RTS (Mean Scores)

RTS beverages	Storage period (weeks) 1	2	3	4	5	Mean R
R_1	4.39	4.37	4.29	4.25	4.24	4.31
R_2	4.63	4.63	4.62	4.58	4.57	4.61
R_3	3.09	3.09	3.07	3.04	3.07	3.07
R_4	4.36	4.36	4.32	4.31	4.31	4.33
R_5	4.24	4.23	4.15	4.17	4.17	4.19
Mean W	4.14	4.14	4.09	4.07	4.07	

W CD 0.023
R CD 0.023

The Table revealed that due to storage there was only very little effect on the overall acceptability of RTS developed in the present study. The fall in overall acceptability was within a range of 1 to 3 per cent. Even at the end of storage of five weeks, all the products had over 80 per cent acceptability value except plain watermelon RTS. The highest value observed was in R_2 followed by R_1. THe decrease in overall acceptability of jamun RTS could be stated for the bleaching of colour due to oxidation and thus its appearance.

Like other characters, 5 week storage had imposed only a minimal effect on the overall acceptability of RTS. From the foregoing discussion, it may be concluded that the sensory quality attribute viz. appearance, taste, colour and flavour increased during storage. Meanwhile, the clarity aspect improved with the storage period. Even though the scores obtained between the various RTS beverages differed, the trend observed during the storage of RTS beverages was almost similar. All the RTS beverages, although they were meant for ready usage, remained acceptable upto 35 days, just with an unnoticeable decline in their sensory parameters. Jamun, grapes and blended RTS possessed equally good sensory characteristics even at the end of observation period of 5 weeks. A Pineapple beverage prepared by CFTRI (1989) could be stored upto one to two months. This result agrees with the data obtained in the present storage trial.

Statistical analysis revealed that the overall acceptability of the various RTS beverages remained significantly different from one another, except between R_1 and R_4.

4.4.3.3. Changes in the organoleptic qualities of wine during storage.

Quality is the most important criterion on which the acceptability of any product depends. According to Joshi et al (1995), effect of maturation in relation to the sensory qualities of wine is profound. The data on storage behaviour of the sensory parameters of wines are presented and discussed below.

4.4.3.3.1. Appearance attribute

Appearance of any product is of prime importance in its acceptability. According to Amerine (1972), the appearance of wine will often tell the experienced taster about its conditions. In the present study, the scores obtained for appearance was found to be increasing with the advancement of storage period (Table 45).

Table 45

Effect of storage on appearance of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	4.63	4.63	4.63	4.67	4.70	4.97	4.97	5.00	4.76
W_2	4.30	4.33	4.37	4.57	4.60	4.80	4.80	4.83	4.58
W_3	3.43	3.43	3.43	3.50	3.57	3.60	3.60	3.67	3.53
W_4	4.43	4.43	4.50	4.50	4.53	4.60	4.60	4.67	4.53
W_5	3.60	3.63	3.67	3.70	3.77	3.80	3.80	3.87	3.73
Mean M	4.08	4.09	4.12	4.19	4.23	4.35	4.35	4.41	3.73

M CD 0.032
W CD 0.025
MW CD 0.071

There was an increase of 4 to 11 per cent in the visual performance of wine by 8 months. Vyas et al (1991) reported an increase in appearance value of culled apple wine during storage. In another study by Vyas (1993), he noted that the appearance was improved in ciders and wines during storage. Considering the percentage of increase secured for appearance, grapes wine and jamun wine was placed ahead to other samples. It was interesting

to note that at the end of storage (8 months), the appearance of plain jamun wine was excellent scoring cent per cent, and plain grapes wine was almost closer in value scoring 97 per cent. The highest score recorded for W_1 might be related to the excellent colour of the product. Even though lower increase was recorded by W_4, the final score obtained by W_4 (jamun-grapes blend) was comparatively high with a score of 93 per cent at the end of storage period.

The appearance of wine was observed to be inconsistent throughout the storage period with respect to the wines. Except W_4 and W_2, which was observed to be at the same level for appearance during the fourth and fifth month, all the other wines differed from one another in appearance throughout the storage period. W_1 possessed the highest score for appearance throughout the storage period, while W_3 had the least score for this particular attribute. In W_1, the appearance score possessed the same level for first five months and the scores of last three months was also observed to be on par. In W_3 and W_4, the first four months of storage did not have any marked effect on their appearance. The last three months score for appearnce were also on par for all wines except W_3.

Storage increased the visual appearance of all the wine samples developed. Jamun wine was the one which attained highest and cent per cent score at the end of storage period, eventhough the percentage increase noted was more in grapes. The wine developed from jamun-grapes blend was also highly appreciable.

West Indian cherry wine and its blend exhibited comparatively lower increase in its appearance rating.

4.4.3.3.2. Taste attribute

Table 46 depicts the score data for taste of wine during storage.

Table 46

Effect of storage on taste of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	4.00	4.17	4.20	4.37	4.40	4.40	4.57	4.77	4.36
W_2	4.40	4.40	4.43	4.57	4.80	4.80	4.97	4.97	4.67
W_3	3.33	3.33	3.37	3.50	3.50	3.57	3.60	3.60	3.48
W_4	4.33	4.33	4.40	4.43	4.60	4.70	4.73	4.80	4.54
W_5	3.60	3.60	3.63	3.70	3.80	3.80	3.87	3.90	3.74
Mean M	3.93	3.97	4.01	4.11	4.22	4.25	4.35	4.41	

M CD 0.028
W CD 0.022
MW CD 0.063

On examining the score, it is clearly evident that there was a considerable increase in the taste of wine in tune with the advancement of storage period. An improvement of 5 to 15 per cent score was recorded in the taste performance of different wines. Majeed (1995) opined that wine becomes more acceptable on ageing during which the alcohol conversion is stabilised and good aroma is developed. Improvement in taste of wine was observed from the first month itself in plain jamun wine, and from second month in the other wines. Thereafter, a steady increase was

noted in all the wines. The maximum percentage of increase of 15 per cent was recorded for W_1 (plain jamun), followed by W_2 (grapes wines). The percentage of increase observed for blended wines were 7 and 6 per cent respectively, and W_3 (plain West Indian cherry) observed the lower increase. Earlier workers have also reported similar improvement in taste of fruit wines with ageing. Vyas et al, (1991) reported that during storage of wine, its harsh taste and yeasty odour diminishes. According to Pathak (1978), the taste characteristic of wine is affected not only by aldehydes and esters present in it, but also due to the presence of phenolic substances. In the wines prepared, the alcohol content was observed to increase with storage, and this in turn resulted in a superior taste and aroma after storage.

Statistical analysis of the data revealed that the taste character was observed to be inconsistent throughout the storage period with respect to the wines. In the third month of storage, W_2 and W_4 was observed to have the same value for taste character. Similarly, W_1 and W_4 was observed to be on par in taste character during fourth and eighth months of storage. W_2 recorded the best performance for taste throughout the storage period. The first three months of storage does not seem to have influenced the taste of wines W_2, W_3 and W_5. In W_1, a marked improvement was observed in the second month which remained on par with that of third month. No difference in taste was also recorded during fourth, fifth and sixth months of storage in W_1. The change occured in the second, fourth and seventh month in W_4 was on par with that of the respective previous months.

From the results obtained, it was encouraging to note that jamun wine exhibited the highest percentage taste increase, followed by the wine from plain grapes and the mixed jamun-grapes wine.

4.4.3.2.3. Colour attribute

Results of the colour appeal of wine at various periods of storage are given in Table 47.

Table 47

Effect of storage on colour of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	4.60	4.60	4.67	4.67	4.80	4.93	5.00	5.00	4.78
W_2	4.30	4.30	4.47	4.57	4.60	4.80	4.80	5.00	4.60
W_3	3.00	3.00	3.30	3.33	3.40	3.43	3.50	3.80	3.31
W_4	4.50	4.50	4.60	4.63	4.67	4.70	4.90	4.90	4.68
W_5	3.23	3.23	3.27	3.37	3.46	3.50	3.60	3.60	3.40
Mean M	3.93	3.93	4.06	4.11	4.17	4.27	4.36	4.40	

M CD 0.027
W CD 0.021
MW CD 0.060

The mean panellist score for colour of fruit wines under storage indicated that the colour attraction of all wines increased at varying levels. The percentage increase of score value ranged from 8 to 14. The data revealed that in all the samples, the colour started improving after a stable period of two months, Subraro (1978) reported that change of colour occurs in wine as it ages. Plain jamun wine was observed to have the

highest score at the beginning itself, and it touched the maximum level (100 per cent) by seventh month. Plain grapes wine reached this level by eighth month. Colour developmnt was superior in W_2, followed by W_3 but the later could reach a maximum of only 70 per cent. Rao (1978) reported that astringency and colour of wine could be attributed to the phenolic constituent present in it. Jamun is a fruit rich in this constituent imparting attractive colour hue to wine.

The colour of the wines was observed to be inconsistent throughout the storage period with respect to the wines. W_1 had better colour compared to others throughout the storage period. W_3 and W_5 was observed to be on par with respect to colour during the third, fourth and fifth months of storage. Also W_4 was observed to be on par with W_2 and W_1 during the fourth month. The colour of W_2 and W_1 possessed the same level during the last month of storage. The colour of W_1 extremely differed during the eight months of storage. In W_2, the changes occurred in the fifth and seventh months was observed to be on par with that of previous months. In W_3 and W_4 the increase noticed in the fourth and sixth months was at the same level as that of third and fifth month respectively. The first three months of storage and last two months of storage does not seem to have influenced the colour of W_5.

To comment on the values shown by the colour perception of stored wines, it can be stated that even though better improvement in colour was achieved by grapes wine during stor

jamun fruit established its superiority to other fruits like grapes and west Indian cherry in the colour appeal of wine from the initial observation and attainment of maximum attraction at the earlist. However the scores obtained for grapes wine and the blended jamun-grapes wine were comparable to that of jamun wine at the end of storage period.

4.4.3.2.4. Flavour attribute

Flavour is the most important factor influencing the acceptability of wine as reported by Sandhu et al (1995). Flavour appraisal of wines in this experiment during storage is summarised in Table 48.

Table 48

Effect of storage on flavour of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	4.40	4.43	4.57	4.60	4.77	4.80	4.83	4.90	4.70
W_2	4.60	4.60	4.63	4.63	4.73	4.77	4.80	4.80	4.70
W_3	3.30	3.30	3.33	3.40	3.43	3.60	3.63	3.70	3.50
W_4	4.40	4.43	4.43	4.60	4.63	4.77	4.80	4.80	4.61
W_5	3.57	3.57	3.60	3.60	3.60	3.77	3.80	3.80	3.70
Mean M	4.10	4.10	4.11	4.20	4.20	4.34	4.40	4.40	

M CD 0.030
W CD 0.024
MW CD 0.068

A steady increase was observed in the mean scores for flavour intensity of all the wines (Table 48). The increase in flavour profile was from 4 to 10 percent during 8 months. Among

the wines, highest flavour development at storage was recorded for W_1. Flavour addition was comparatively lower in W_2. This could be due to its superior flavour performance at the early stages itself. The characteristic flavour formation was effected from the initial observation onwards in W1 and W4 and the same was noticed from second month in rest of the wines. Singleton (1969) stated that ageing can produce more harmonious, yet more complex flavour by a slow loss of obstrusive flavour and a gain of additional flavour nauces while retaining much of the original desirable flavour. The formation of aroma compounds in wines is also dependent on the composition of the fermentation medium and variety of fruits used as reported by Houtman et.al, (1980) Vyas et.al,(1991) reported that the yeasty odour diminished during storage of wine. Rodrigues (1992) also noted an increase in the volatile aromatic compounds during storage of alcoholic orange juice beverage. This increase in volatile aromatic compounds exist as the cause for the development of more appreciable flavour during storage in the present study.

Considering the flavour attribute of wines during the storage period, it could be noted that the flavour does not remain consistent with respect to the wines. W_1 and W_4 was observed to have the same level in the first and second months of storage. W_2, W_1 and W_4 possessed the same level for flavour during the fourth, sixth and seventh months of storage. Jamun wine and grapes wine was observed to have the same level in the fifth month of storage and grapes wine was on par with the blended wine of jamun and grapes in the eight month of storage.

W_5 was observed to have no difference in flavour for first five months, while flavour of W_2 was at the same level for first four months. The flavour of W_3 and W_4 kept the same for first three months and for W_1 it remained same for only two months. The flavour of last three months also possessed the same level for W_2, W_4 and W_5.

More encouraging results on storage of wine with respect to flavour was noted in the case of plain jamun and jamun-grape blended wines with 10 percent and 8 percent increase in flavour, where the onset of rise was noted at the earliest. Other wines also improved in its flavour during storage.

4.4.3.2.5. Clarity attribute:

Table 49 depicts the mean values of clarity performance of stored wines.

Table 49

Effect of storage on clarity of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	4.07	4.07	4.10	4.20	4.20	4.33	4.33	4.57	4.23
W_2	4.00	4.00	4.07	4.33	4.37	4.57	4.57	4.60	4.31
W_3	2.97	3.00	3.00	3.00	3.00	3.07	3.10	3.13	3.03
W_4	4.00	4.00	4.10	4.10	4.10	4.17	4.17	4.27	4.11
W_5	2.93	2.93	2.93	3.00	3.00	3.03	3.10	3.13	3.01
Mean M	3.59	3.60	3.64	3.73	3.73	3.83	3.85	3.94	
M CD	0.031								
W CD	0.024								
MW CD	0.068								

In the present study, results are evident to prove that clarity of wines progressed with storage time. Percentage increase at a wider range from 4 to 12 was observed on panel evaluation for clarity at storage. Improvement in clarity of grape wine (W_2) and jamun wine (W_1) was more than other wines with 12 and 10 per cent score increase respectively. West Indian cherry wine and jamun blended West Indian cherry wine were the samples that stood below the clarity progress upon ageing. Considering the percentage of increase in the scores obtained for appearance and clarity, it could be stated that these parameters are interreleated as clarity had an influence on the appearance of wine. Sedimentation of suspended particles helped wine to become more clear upon storage and this phenomenon took place in jamun wine better due to the presence of pectolytic enzyme in the fruit. Khurdiya (1994) reported that unheated and chemically preserved wine became more clear in little time probably because the pectolytic enzymes remained active and broken down the clouds. In preparation of wine, jamun fruits were not heated and thus the enzymus remained active.

With respect to clarity, the wines were observed to be inconsistent throughout the storage period. W_5 and W_3 were observed to be on par in clarity attribute during all periods except the second and third months, while W_4 and W_1 was observed to be at the same level during the third month. W_3 was observed to have no improvement in clarity for the first five months of storage and the improvement occured in the sixth month remained the same for the rest of the storage period. The improvement in

clarity was observed to occur from fourth month onwards in W_1 and W_5 and third month onwards in W_2 and W_4.

On storage, jamun wine and grape wine observed higher clarity improvement. Clarity of other wines were also improved satisfactorily.

4.4.3.2.6. Strength Attribute

Data on effect of storage on the strength of wine is presented in Table 50.

Table 50

Effect of storage on strength of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	3.37	3.40	3.40	3.57	3.60	3.70	3.70	4.03	3.60
W_2	4.10	4.13	4.17	4.30	4.53	4.53	4.77	4.90	4.43
W_3	3.00	3.00	3.10	3.10	3.13	3.47	3.47	3.53	3.23
W_4	3.90	3.93	3.93	4.03	4.07	4.20	4.23	4.30	4.08
W_5	3.20	3.20	3.30	3.33	3.47	3.50	3.70	3.70	3.43
Mean M	3.51	3.53	3.58	3.67	3.76	3.88	3.97	4.09	

M CD 0.029
W CD 0.023
MW CD 0.065

A steady and linear increase in the strength of wines occured during storage. 11 and 10 percent increase in mean score values was recorded by W_2 and W_1 respectively. Increase in the other samples were 7 and 6 percent and among the blended wines, grape blended jamun wine performed better than its West Indian

cherry blend. The strength of the wine is dependent upon its alcohol percentage and the alcohol content in the wines under study was also observed to be elevated during its shelf period. This compositional variation explains the fact for attainment of more strength to the wine on storage. Even though as fresh product, jamun wine could not achieve a better alcohol level, on storage, alcohol formation was rapidly effected and strength was maintained to a level almost equivalent to grapes by eighth month.

All the five types of wines developed did not remain consistent throughout the storage period with respect to strength. All the wines difered significantly throughout the storage period. W_2 was observed to be superior than other wines with respect to strength throughout the storage period. W_1 and W_3 remained unchanged as far as the character strength was concerned for the first three months while W_2, W_4 and W_3 kept the same level for first two months. The change that was observed in the fifth and seventh months of storage was observed to be on par with those of the respective previous months in W_1 and W_4.

On storage, the wines became more strong due to its component variation. Jamun wine was comparable to grapes wine with respect to its strength and aroma development. Strength of blended wine was valued higher with grape blend than its west Indian cherry blend.

4.4.3.2.7. Over all acceptability

The variation in the over all acceptability level of the stored wine was also computed and presented in Table 51.

Table 51

Effect of storage on overall acceptability of wine (mean scores)

Wines	Storage period (months)								
	1	2	3	4	5	6	7	8	Mean W
W_1	4.18	4.22	4.26	4.35	4.41	4.52	4.57	4.71	4.40
W_2	4.28	4.29	4.35	4.49	4.61	4.71	4.78	4.85	4.55
W_3	3.17	3.18	3.26	3.31	3.34	3.46	3.48	3.52	3.34
W_4	4.26	4.27	4.33	4.38	4.38	4.43	4.52	4.57	4.42
W_5	3.36	3.36	3.40	3.45	3.51	3.57	3.64	3.67	3.50
Mean M	3.85	3.86	3.92	4.00	4.06	4.16	4.21	4.28	

M CD 0.013
W CD 0.009
MW CD 0.252

Like wise the trend observed in all the quality parameters, the over all acceptability was also valued higher after storage by panel members. A percentage increase of 8 to 16 per cent was obtained and the increase was found right from the first month itself in all wines. The rise in over all acceptability level for W_2 and W_1 was distinctively more than the other wines with 16 and 14 per cent increase respectively. The range of acceptability improvement for rest of the wines on storage was 8 to 11 per cent. Storage performance of taste, clarity, strength, flavour and appearance have contributed to this high rating. Patel (1978) has ascertained that ageing increases the over all

acceptability of wines. Sandhu et al (1995) suggested the blending of wine with 2-3 per cent sugar and 0.2 per cent alcohol for improving its sensory quality.

The overall acceptability was observed to be inconsistent during the storage period with respect to the wines. West Indian cherry blended wine as well as West Indian cherry wine was observed to be on par in overall acceptability throughout the storage period. W_1, W_4 and W_2 had the same level as far as overall acceptability is considered for the first five months of storage. W_4 and W_1 was observed to be on par for the sixth, seventh and eight months of storage. W_1 and W_3 did not seem to have under gone any change with respect to overall acceptability for the first five months, while W_4 and W_5 remained unchanged for six months and W_2 for first four months. All the wines except W_3 possessed the same level for overall acceptability for the last three months of storage while in W_3 overall acceptability was observed on par for the last four months of storage.

On perusal of the pooled data, it may be concluded that all the sensory attributes namely, appearence, taste, colour, flavour, clarity and strength of wines increased considerably during storage. Among the different wines stored, higher increase in most of the sensory attributes and over all performance were in favour of grapes wine closely followed by jamun wine. In certain major quality parameters viz, taste and flavour. Jamun wine even excelled grapes wine with higher percentage increase in

these qualities upon storage as per panel evaluation. Upon storage, maximum colour perfection was attained in jamun, earlier than grapes. Generally grapes wine, jamun wine and their blend improved more in quality upon storage than West Indian cherry and its blend with jamun.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present study entitled "Development, diversification and shelf life of jamun (Eugenia Jambolana.L) based products" was undertaken to study the suitability of the locally available jamun fruit in processing into acceptable beverages. Product diversification through blending with suitable fruits was also attempted by ascertaining the organoleptic, nutritional and shelf life qualities and the consumer acceptance and preference of the developed products.

Jamun, an indigenous fruit having attractive colour and excellent taste with some therapeutic value is highly perishable and a considerable amount of this seasonal fruit is wasted during its peak harvest. Hence the utilisation of this fruit by beverage industry for plain and mixed beverages (Squash, ready to serve beverage and wine) were attempted in this experiment. The fruits selected for blending were grapes, watermelon and West Indian cherry. In this trial for product development, jamun based plain and mixed squashes and ready to serve beverages combining grapes and watermelon were attempted. Jamun was also considered for its feasibility to ferment into wine along with the diversification of the product by blending with grapes and West Indian cherry in this study.

Recipes were formulated for plain jamun beverages by conducting systematic trials at the laboratory following varied procedures and quality assessment by experts at each trial. For

the standardisation of squash, the "hot break" method was confirmed to be the ideal juice extraction procedure as against the "Cold break" method, since this method resulted in maximum juice retention and pigment leaching. The best method identified for clarification of juice was the addition of gelatin as this method claimed maximum clarity and moderate sediment formation.

In the case of RTS beverages, the beverage prepared by using 25 per cent juice content was liked most, as this contributed a pleasing fruity flavor to the beverage compared to 15 and 20 per cent juice content.

For wine, the procedure with 1:1 pulp and water ratio and addition of hot water to must produced jamun wine with better quality than with a higher dilution and combining with cold water or boiling the fruit along with water.

The most acceptable proportion of each mixed beverage was also selected by trying out at three different proportion with every combination. When blended squash and RTS beverage was assessed, the most acceptable ratio identified for jamun - grape mix and jamun - watermelon mix was 1:1 and 3:1 respectively. Similarly, for blended wine, the selected ratios were 1:1 and 3:1 for jamun-grape and jamun - West Indian cherry combination. Plain jamun beverages and the selected blended beverages along with their plain counter products composed of grapes, watermelon and West Indian cherry (fruits taken for mixing) were prepared in

adequate quantity following the procedure standardised under this experiment for further investigations.

The physico-chemical examination of jamun fruit revealed its highly attractive colour, balanced sugar - acid level which are important characters in the preparation of attractive fruit beverage. The TSS and pH of jamun fruit was observed as 9° brix and 3.1 respectively. The juice percentage recovery was also good enough to find an outlet for the fruit by beverage production particularly to overcome its underutilisation by processing industry.

The fresh products were subjected to a comparative detailed study since analysed for their nutritional cum organoleptic qualities, FPO standard comparison, cost analysis, yield ratio and consumer acceptance.

The results of the chemical analysis done on fresh beverages showed that the values obtained for the jamun based beverages developed agrees with the chemical composition of similar beverages prepared from popular conventional fruits. The values obtained for products from jamun and its blend with grapes were comparable to those from grapes. Improvement in the nutritive value of products from watermelon/ West Indian cherry, when blended with jamun was also noted in the present study.

The organoleptic assessment of the fresh beverages, clearly indicated the comparability of jamun based products with beverages from grapes. For squash, the overall acceptability

performance of jamun-grapes blend and grapes alone were equal with a mean score of 4.9. As far as the general acceptability of RTS beverages were considered an analogy could be drawn among jamun (4.4) and plain grapes (4.6). The focal point of overall acceptability level of wines was that the product brewed from jamun, as well as that from its blend with grapes was commensurate with that of grapes.

Jamun based products and other beverages developed in the study were compared with FPO specifications for its quality standards and the values were found in agreement with that of FPO regulations. The scientific measures taken and the standardised procedure followed, enabled to formulate products with quality standards upto the mark in this investigation.

The percentage of alcohol in jamun wine and its allied product with grapes was 8.63 and 9.55, where as that of West Indian Cherry and its blend were found below the minimum prescribed level for table wines. However ageing could upbring its alcohol to an acceptable level.

A comparison of the cost of the products developed indicated that the expense for production of jamun beverages was lowest. Even though the juice yield of grapes was higher than jamun, the cost of production could be lowered in the case of jamun products mainly due to the indigenousity of the fruit and thus its availability at a lower price. Expense for preparation of squash and RTS with watermelon fruit was observed maximum.

The price of jamun wine was also found to be lowest (Rs 11.85/lit).

When cost between the three beverages from jamun fruit alone was compared, wine was identified as the cheapest item among the three type of beverages. It may be also stated that the comparatively lower price of the jamun products compared to similar products from other studies, would increase the "likelihood to buy" its products at an effort of popularisation.

The product yield ratio of beverages from jamun and the blended fruits when calculated, it was clear that the product yield from jamun fruit was second only to grapes, even with its drawback of having a very big seed which decreased the edible portion. However, the yield obtained was comparable to the yield production of many conventional and unconventional fruits considered for processing. Besides considering the under exploited situation, its product yield ratio can be stated as quite attractive.

Consumer acceptance study on jamun beverages disclosed the comparatively higher acceptability performance of jamun, grapes and its combination for squash and RTS beverages while watermelon was not acceptable to consumers. Judgement of the acceptability of different wine, by consumers recommended jamun wine for the best quality and grapes was scored at second place in acceptability by consumers. West Indian cherry wine was graded as less satisfactry. The study also highlighted that with

respect to beverages in the ready to serve form (wine and RTS), the consumer acceptability favoured a step ahead for plain beverages from jamun and grapes, while in the matter of squash, performance of jamun-grapes combination was graded better to plain jamun squash. The consumer acceptance of jamun beverages offer scope for commercialisation of these products.

Preference ranking of jamun beverages by consumer revealed that, the highest percentage of consumers preferred wine at the first choice, followed by RTS beverages. Squash was given the third preference among the three beverages developed based on jamun.

The products, stored at ambient conditions for a period of 5 weeks to 8 months were assessed periodically for its shelf life performance on chemical, microbial and organoleptic changes.

Periodical evaluation of the squashes for 8 months revealed that there was an increase in acidity upon storage and the change observed was very low in jamun squash. The increase in total sugar and TSS was observed to be similar in all squashes developed and the pH decreased with the corresponding increase in acidity. The acceptability of the squashes were adequately preserved even with the slight decrease observed for colour, taste, flavour and appearance. Clarity of the squashes were found to improve upon storage in all characteristics analysed. Jamun squash was observed to be on par with grapes. Negative results obtained for microbial count is a positive indication

for the safe use of all squashes over eight months under ambient storage conditions.

The weekly evaluation of the RTS beverages revealed its stability with respect to chemical constituents. The change observed were meagre and not worthy of deteriorative signs. The trend observed in the change of chemical characters was similar in all the RTS beverages. The organoleptic qualities of RTS beverages during storage period, showed a reduction in score values in most quality attributes except clarity, which observed an increase. RTS drinks were tested for microbial count only to obtain negative results, during 5 weeks storage except in watermelon RTS, in which an onset of infestation with yeast was identified by the fifth week of storage.

On storage, certain chemical constituents of wine viz. acidity and alcohol content was increased. The increase observed for alcohol percent remained at a similar rate in all wines. The decrease in sugar level was corresponding to the increase in alcohol content. Perusal of the organoleptic data obtained on stored wines indicated that storage favoured all sensory attributes of wine. In certain major quality parameters viz. taste and flavour, jamun wine even excelled grapes wine with higher percentage increase in these qualities. The over all acceptability of jamun wine was also on par with that of grapes wine. The products also confirmed its safety as per the microbial examinations conducted.

The study highlighted the scope for successful exploitation of jamun having high nutritive and therapeutic values in the preparation of acceptable beverages viz. squash, RTS and wine. Jamun, being less expensive than grapes has proved to be an ideal substitute to grapes with the resultant product showing comparable qualities. The blending of jamun with watermelon/West Indian cherry could be thought of in increasing the acceptability of plain beverages from watermelon/West Indian Cherry to considerable extent, indicating its commercial potential as an input in the preparation of acceptable quality beverages.

The neglectful attitude towards this crop available in the rural belt and the barrier of its ready market availability has deterred the fruit processing industry from extracting the untapped potential of this versatile fruit. The market scarcity of this fruit can be attributed to the lack of awareness of its nutritive value and commercial feasibility, which has prevented its widespread cultivation. Jamun being a steardy tree, is capable of being reared anywhere with minimal attention. Prospective farmers should be made to understand the nutritive value, commercial viability and the ease with which it can be grown, inorder to maintain jamun orchards in lands which would otherwise be barren, thereby availing them a seasonal income.

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APPENDICES

APPENDIX I

PROCEDURE FOR THE TRIANGLE TEST

In the triangle test, three sets of sugar solutions of different concentrations were used. Of the three sets two solutions were of identical concentrations and the women were asked to identified to the third samples which is of different concentration.

EVALUATION CARD FOR THE TRIANGLE TEST

Name of the product Sugar solution

Note Two of the three samples are identical

Identify The Odd Samples

Sl. No.	Code No. of 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 (SQUASH AND RTS BEVERAGE)

Charateristics	1	2	3	4	5

1. Appearance

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

2. Taste

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

3. Colour

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

4. Flavour

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

5. Clarity

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

APPENDIX III

SCORE CARD (WINE)

Charateristics	1	2	3	4	5

1. Appearance

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

2. Taste

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

3. Colour

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

4. Flavour

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

5. Clarity

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

6. Strength

Very Good	- 5
Good	- 4
Fair	- 3
Very poor	- 2
Poor	- 1

DEVELOPMENT, DIVERSIFICATION AND SHELF LIFE OF JAMUN (EUGENIA JAMBOLANA L.) BASED PRODUCTS

BY

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ABSTRACT

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The present study entitled **"Development, diversification and Shelf life of jamun (Eugenia jambolana.L) based products"** was undertaken to study the suitability of jamun fruit in processing into acceptable beverages. Product diversification through blending with suitable fruits was also attempted by ascertaining the organoleptic, nutritional and shelf life qualities and the consumer acceptance and preference of the developed products.

Jamun, an indigenous fruit having attractive colour and excellent taste along with therapeutic value is not utilised by the processing industry. Hence in this trial for product development, jamun based plain and mixed squashes and ready to serve beverages combining grapes and watermelon were attempted.For wine preparation, jamun alone and blending the fruit with grapes and west Indian cherry was attempted for diversification.

For standardisatiion of squash, the "hot break" method was confirmed to be the ideal juice extratioin procedure and for clarification of juice addition of gelatin was identified as the best method. In the case of RTS beverages, the formula with 25 per cent juice was liked most. For wine, the procedure with 1:1 pulp and water ratio and addition of hot water to must produced jamun wine with better quality.

For blended squashes and RTS beverages, the most acceptable ratios identified for jamun-grape mix and jamun-watermelon mix were 1:1 and 3:1 respectively. Similarly, for blended wines the best ratios were 1:1 for jamun-grapes and 3:1 for jamun-West Indian cherry combination.

The chemical composition of the products were found to be equivalent to the level of similar accepted items. The organoleptic qualities of the standardised jamun products proved to be appreciable and comparable to the sensory attributes performed by these products form grapes in many aspects. Jamun wine excelled in quality comparison with grape wine. The products were also observed to satisfy the FPO requirements.

The cost analysis of the products revealed that expense for production of jamun beverages was lowest and wine was identified as the cheapest item among the three beverages prepared from jamun alone. The fruit product yield ratio when calculated indicated that yield from jamun fruit was second only to grapes. More over considering the under exploited situation of jamun, this factor need not be taken into account.

Consumer acceptance study on jamun beverages disclosed the comparable acceptability performance of plain jamun and its grape combination with that of plain grapes for squash and RTS beverages. Meanwhile consumers preferred plain jamun wine than grapes. Preference ranking of jamun beverages revealed that wine was preferred most followed by RTS beverage and squash.

The products developed were assessed periodically for its shelf life performance on chemical, microbial and organoleptic changes.

A slight increase in acidity, total sugar and TSS and a decrease in pH was observed in squashes upon 8 months of storage. The acceptability of squashes were also adequately preserved even with the slight decrease observed for colour, taste, flavour and appearance. Negative results were obtained on microbial examination.

The evaluation of RTS beverages for 5 weeks revealed its stability with respect to chemical constituents. The organoleptic qualities of RTS beverages during storage period showed slight reduction in score values in most quality attributes except clarity. No organisms were detected in microbial examination except in watermelon RTS which showed an onset of infestation with yeast by the fifth week of storage.

Storage for 8 months revealed an increase in acidity and alcohol content in wine with a decrease in sugar level. Storage favoured all sensory attributes of wine. The products also confirmed its safety as per the microbial examinations conducted.

Jamun, being less expensive than grapes has proved to be an ideal substitue to grapes with the resultant product showing comparable qualities. But the neglectful attitude towards this crop available in the rural belt and the barrier of its ready

market availability has deterred the fruit processing industry from extracting the untapped potential of this versatile fruit. Therefore prospective farmers should be made to understand the nutritive value, commercial viability and the ease with which it can be grown, in order to maintain jamun orchards in lands, which would otherwise be barren, thereby availing them a seasonal income.