Development, diversification and shelf life studies of passion fruit products

By

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THESIS

Submitted in partial fulfilment of the requirement
for the degree
MASTER OF SCIENCE IN AGRICULTURE
Faculty of Agriculture
Kerala Agriculture University

Department of Home Science
College of Agriculture
Vellayani
Thiruvananthapuram
1995

Certificate

Certified that this title entitled "**Development, diversification and shelf life studies of Passion fruit products**" is a record of research work done by Smt. DIJU.D.PAL 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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DECLARATION

I here by declare that this entitled **"Development, diversification and shelf life studies of Passion fruit products"** is a bonafied record of research work done by me during the course of research and that the thesis has not previously formed the basics for the award to me of any degree, diploma, associateship or other similar title, of any other University or Society.

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ACKNOWLEDGEMENT

It is my pleasant duty to express my deep sense of gratitude to the Chairman of my Advisory Committee Dr.(Mrs) Mary Ukkuru.P, Asociate Professor, Department of Home Science, College of Agriculture for the able guidance and valuable suggestions extended to me during the conduct of this research work and for co-operation and generous help in the preperation of this thesis.

I am grateful to Dr.(Mrs) L.Prema, Professor and Head, Department of Home Science for the able guidance and who had extended help in the formulation and conduct of experiment.

I am grateful to Dr. N.Saifudeen, Associate Professor, Department of Soil Science and Agriculture Chemistry and Dr.B.R.Reghunath, Associate Professor, Department of Horticulture for serving in the Advisory Committee and helping me with valuable advise through out the coyrse of this study and for going through the manuscript and making valuable suggestions.

All other staff and Post graduate students of Department of Home Science especially my classmates Bindu.P.Oommen, Sailaxmi and Kavita are duly thanked for their whole hearted co-operation.

I have special pleasure, love and gratitude to my affectionate parents and brother who were the main source of inspiration and support to me and I dedicate this work of mine to them.

Above all, I pay tribute to the Mighty Power for His eternal love and blessings

DIJU .D. PAL

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INTRODUCTION

Fruits are perhaps the first edible natural product consumed by man. The story of Adam eating an apple avers this theory. Intially man used to eat fruit as it was but later on began to eat it by treating it in myriad ways to enhance its taste and usefulness. Fruit products are the outcome of such and endeavour.

Fruits are no longer considered as a luxury since they belongs to an important class of protective food which provide adequate vitamins and minerals needed for the maintenance of health.

India ranked 3rd in the production of fruits after Brazil and United States (Pandey, 1991). Sethi (1993) reported that India is one of the largest producers of fruits (27 million tonnes) in the world.

Sethi (1993) has stated that 20-30 per cent of the fruit produced in this country are not utilized due to post harvest problems and hardly 1 per cent of the total produce is being utilized for processing.

According to Roy (1993) surplus production of perishable fruits and vegetable during the seasonal glut could be converted into durable products in order to avoid wastage.

Shaw (1993) remarked that owing to rich horticultural potential that exist in our country, fruit and vegetable industry can play important role in salvaging prices during glut seasons generating employment opportunity, meeting the requirements of defence forces in border area and earning foreign exchange for the country by development of exports.

Poonia (1994) is also of the view that fruit processing helps to imtigate the problem of under employment during off season in Agriculture Sector besides it ensures fair returns to the growers and improves their economic conditions.

Export of processed fruits and vegetable in 1991-92 amounts to 73,000 metric tonnes valued at Rs. 120 crores and for 92-93 the expected export will be 86,500 metric tonnes valued at Rs. 142 crores. It has the potential to go upto 1,30,000 metric tonnes valued at Rs. 345 crores in 1996-97 (Patil, 1992).

Kaushal (1987) have stressed on the rise in demand for processed fruits and vegetable because of the increased defence requirements and urbanisation trend.

The fruit and vegetable processing industry has been declared as a thrust area and is likely to take off in the near future as a potential earner of foreign exchange through export of processed fruits and vegetables (Kapoor, 1993).

According to Pareek (1993), unexploited fruits are the several less known fruit species which have the potential for commercial exploitation and are yet to be utilised for their potential. Kumar (1993) reported that considerable efforts are needed to make a new product from unexploited fruits and vegetables, competitive in the world market with respect to nutritional and microbial quantity as well as zero level chemical residues.

Kumar (1993) reported that the export of processed products from under exploited indigenous fruits and vegetable in nil. There is a need to make new products from indigenous raw materials having nutritional and medicinal value in order to open new channels for export market. The commercial potential of these fruits are immense, but large quantities of fruits are going waste as no serious efforts has been made to use the technologies 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 under exploited fruits.

Passion fruit is one such under exploited fruit which can be very useful and profitable crop particularly in developing countries where a subsistance agricultural pattern is

established.) According to Khurdiya (1994), passion fruit is a native of Brazil but is also available as wild in Nilgiri hills, Wynad, Kodaikanal, Shevmys, Coorg, Malabar and Kerala. Now it is being grown in Himachal Pradesh, Nagaland, and Mizoram. Since passion fruit has vast potential in quantity processed product, area under its cultivation is increasing day by day.

Passion fruit, commonly found in India is the yellow passion fruit (*Passiflora edulis var flavicarpa*). They are 6-12 cm long and 4-7 cm in diameter. The shell of the fruit is hard and 3-10 mm thick. The pulp is yellow to orange in colour and is highly aromatic and juicy. According to Khurdiya (1994), the passion fruit juice with good aroma, yellow in colour has great potential of processing in India.

(According to Ramadas (1988), this uniquely named fruit has wonderful commercial opportunities for growers as well as for fruit processing industries.)

(In the present study an attempt is made to develop three different products utilizing) passion fruit) and also by blending it with other tropical fruits. /It is important that whether a new food or beverage is acceptable or not is to be investigated before it is introduced into open market.

With these points in mind, the present study is taken up. Objectives outlined in the present study include.

1. Development of new products viz. RTS beverage, wine and jelly using passion fruit, and with blends of other fruits.
2. To ascertain the organoleptic, nutritional and shelf life qualities of the products developed.

REVIEW OF LITERATURE

The relevant literature available on the study entitled **"Development, diversification and self-life studies of passion fruit products"** have been briefly revieved here. Wherever sufficient literature is not available on the fruit or the product tried in this experiment, result of experiment conducted on related fruits or products are also cited.

The literature are reviewed under the following titles:-

2.1 Passion fruit and its composition

2.2 Importance of fruit beverages.

2.2.1 RTS beverage from fruits

2.2.2 Blended RTS beverage

2.2.3 Wine-A fermented drink from fruits

2.3 Other products from fruits.

2.1 Passion fruit and its composition

Passion fruit also known as *Parchita granadilla* is a fruit of American tropical vine (Whittaker, 1973) *Passiflora edulis* (yellow Passion fruit) is the most common passion fruit found in India. It has a family to itself the, Passifloracea. The name "Passion" flower is reported to have been given by early missionaries in South America in allusion to a fancied representation in the flower of the implements of crucifixon (Ramadas, 1988).

2.1.1. *Chemical composition.*

According to Boyle et al. (1995), constituents of yellow passion fruit are moisture 82.0; solids 15.0; acidity 4.0; pH-3.0; reducing sugar 7.0; total sugar 10.0; protein 0.8g; calcium 18.0mg, iron 3 mg; ascorbic acid 12 mg; riboflavin-nil; vitamin A-570 IU. Among the soluble carbohydrate of passion fruit juice, sucrose makes upto 25 per cent of the total sugar. It also contains ~~the~~ glucose and fructose. The principle acid in passion fruit juice is citric acid which contributed 93-96 per cent of the total acidity while malic acid contributes 4-7 per cent (Pruthi, 1958). According to Hayes (1960), the passion fruit juice contains about 12.4 per cent sugar and 3.5 per cent acid. It is also a good source of acetic acid and carotene. The characteristic flavour of passion fruit is found in the water insoluble oil, which constituted about 36 ppm of passion fruit juice (Hiu et al. 1961). Mollenhauer (1962) studied the chemical and physical properties of passion fruit pulp, the fruit pulp consisted of juicy arillus tissue and black seeds, had 10-15 per cent sugar, 2.3-3.5 per cent acid as citric acid and a pH of 3.4. As reported by Pruthi (1964), passion fruit juice is a good source of ascorbic acid.

Analysing the total edible pulp / 100 g, according to Whittakar (1973), it contains 75 per cent water, calorific value of 80-100 K cal; protein 2.2-2.5g, carbohydrate 15-20g; starch 2.5-3.5g, fat 0.75-1.5g, ash 0.60-0.80g, trace elements (Calcium, Phosphorous, Iron, Aluminium, Sodium, Potassium, Magnesium, Silicon) 1.5-2.5mg; vitamin A-500 IU; vitamin B (complex) 1.8mg; vitamin C (ascorbic acid) 20 - 30mg; Acidity (as citric hydrated) 2.5-3.5 per cent; Sugar (reducing) 6.5-8 per cent; non-reducing 1.5-3.9 per cent. According to Whittakar (1973), the component of whole passion fruit and the analysis of edible pulp vary considerably with variety and may vary within variety according to climate, seasonal conditions and geographic locations. According to Woodroof (1975), major sugars in passion fruit are fructose, glucose and sucrose.

Nutritionally passion fruit is a rich source of carotene 1968 mg, ascorbic acid 13 mg, and riboflavin 0.2 mg (Gopalan et al. 1989).

According to Ramadas (1988) average passion fruit (yellow) weighs 59.10g; pulp 48-92 per cent; juice 29-39 percent; TSS (Brix) 16.00; acidity 5.19 per cent; ascorbic acid 32-85 per cent; total sugar 9.16 per cent; reducing sugar 3.71 per cent; vitamin A-2410 IU; moisture 85 per cent; protein 0.7 per cent;

Fat 0.2 per cent; Ash 0.5 per cent; Calcium 4 per cent; phosphorous-25mg; Iron-0.4mg; Riboflavin 0.10mg; Niacin 2.2mg per 100ml. Hicks (1990) reported that passion fruit juice has a soluble solid content of about 15 per cent and pH of 2.6-3.2.

According to Khurdiya (1994), the physico-chemical composition of passion fruit juice yield-18.56 percent, Brix-21.70; pH 3.55; acidity-1.01 per cent; ascorbic acid 22.34mg; Total carotenoid 233.83mcg; carotene 103.66mcg/100ml; Reducing sugar 7.81 per cent;sucrose 6.60 per cent and total sugar 14.40 per cent. He further stated that the juice obtained from passion fruit is a rich source of carbohydrate, ascorbic acid, carotenoid, B-carotene and sugar.

2.2 Importance of fruit beverage

Olsen (1991) pointed out that world trade in tropical fruit juice, concentrates and pulps has expanded rapidly and would continue its upward trend over the next several years. According to Kalra (1991), fruit drinks are lately engulfing the domestic markets. They are rightly being encouraged as they provide much needed vitamins and minerals.

Khurdiya (1988) pointed out that about 65 per cent of the total processed products manufactured by FPO licences in India are sweetened aerated water.

Khurdiya (1990) reported that the dietetic value of real fruit based beverage is far greater than that of synthetic products which are being produced in large quantities and the fruit juice are added to the beverage which can impart natural colour and flavour there is no need for synthetic additives. As reported by Kalra (1991), installed capacity of soft drinks exceeded 900 million bottles (200ml) which for fruit based beverage it was over 700 million (200ml) tetrapacks till 1986 in India.

Ambadan (1984) stated that it is necessary to introduce new fruit beverage utilising fruits like passion fruit guava, grape, litchi, phalsa etc, because of their exotic aroma, and excellent colour. Olsen (1991) indicated that the three leading tropical fruit juice, concentrate and pulp, apart from pineapple are banana, passion fruit and mango which together probably account for three-fourth of the trade in tropical fruit juice other than pineapple.

Khurdiya (1988) reported that fruit beverages are able to offer more variety of flavour, nutrient and other physiological benefits with a greater margin of safety in a drink with lower inherent cost. As reported by Kaur (1993), fruit beverages are becoming increasingly popular in the market with the growing conciousness of people in the nutritive value of fruits.

According to Ambadan (1984), the fruit beverage of tomorrow may be based on fruit other than mango, orange, pineapple and also utilizing passion fruit, guava, and grape.

2.2.1 *Ready to serve beverage (RTS) from fruits*

Various fruits can be utilized successfully for the preparation of fruit beverages. According to Mukherjee *et al* (1963), pear juice developed good appearance and possesed natural flavour and taste of the fruit, but lack shelf stability. Nanjundaswamy *et al* (1964) was of the opinion that plain guava juice required dilution with sugar syrup to make it a highly acceptable beverage. According to Subhadra *et al*. (1965), wood apple can be preserved by conversion into RTS beverage. The pulp containing 18° Brix, 2.4 per cent acidity and 3.2 pH was diluted with water at different extent. The resulting beverage had excellent taste and aroma characteristic of the fruit. Muskemelon beverage of 13° Brix and 0.35 per cent acidity is a pleasant drink when chilled and served (Katiyar, 1967).

According to Jain *et al*. (1970), a good quality of 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

keeps for 4-5 months without spoilage (Nalwadi 1970). Singh and Singh (1988) developed a recipe for amla juice which was found organoleptically acceptable even after 6 months of storage. Standardization of a method of juice extraction and preparation of RTS nectar from Rhodopetals was carried out by Vyas et al (1989).

According to Okoli and Ezenweke (1990), papaya juice at pH 3.9 was highly acceptable. Preparation of RTS beverage using 10 per cent ber juice which contained 15 per cent TSS and 0.25 per cent acidity was evaluated by Kadam et al. (1991) and found that it was liked extremely by the panel members. They were of the opinion that ber RTS can be prepared at a reasonably low cost. RTS beverage from phalsa fruit was formulated and standardized by Wasker et al. (1991). Krawger et al. (1992) determined major and minor constituents like TSS (11.2 - 16.2g / 100ml), acidity 0.46 - 12g citric acid / 100ml, fructose (1.72-4.75g), glucose (1.21-4.25g) and sucrose (2.47-9.73g) in pineapple juice. Papaya RTS standardized by Thirumaran et al. (1992) contained ~~of~~ 25 per cent pulp, 9.5 per cent sugar (15^{0} brix) and 65 per cent water and it was found to be highly acceptable. Carrot based RTS was also standardized and the formula for the preparation of carrot based RTS which was acceptable even after 6 months.

The RTS beverage prepared from fresh pulp of apricots was found satisfactory with respect to sensory quality attributes upto 6 months storage at room temperature. Renote et al. (1993) pointed out that physico- chemical characteristics and sensory evaluation has revealed that a highly acceptable quality RTS beverage can be prepared from Kinnow mandarin. Acceptable quality RTS beverage can be prepared from clarified water melon juice (Chakraborty et al. 1993). RTS beverage prepared from apricot, peach, and plum were analysed for TSS, acidity and pH. The fruit juice prepared from 20 per cent pulp was found to be the best on the basis of sensory evaluation (Chauhan et al. 1993). Kaushik et al. (1994) developed RTS and squash like beverage based on unripe Dushehari mangoes and found that RTS beverage prepared from it was accetable.

Various studies shown that passion fruit can be used in the production of beverages. Consumer for frozen, sweetened passion fruit juice intended for dilution before consumption was investigated by Scott as early as (1956). He concluded that for most general acceptance the sugar juice ratio should not be more than 55 : 100 or less than 45 : 100 and the rate of dilution should be one plus three. In Australian experience, passion fruit juice sweetened at 50^{0} Brix (sugar : juice ratio

approximately 70 : 100) gave a very pleasant beverage when diluted one plus four (Scale and Sherman, 1960). (According to Annapurna (1977) the physico-chemical characteristics of RTS Passion fruit beverage was Brix 6.0 , pH-3.5 and acidity 0.7 per cent.)

2.2.2 *Blended RTS beverage.*

According to Karla et al. (1991), the blending of fruit drinks could be economic requisite to utilize profitably some fruit varieties for processing. These fruits may not have favourable characteristic including cost of product preparation. He further stated that the objective could be to supplement appearance, nutritive value and flavour and one could simply think of new product development through blending.

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 Woodroof (1974), the manufacture of blended juice of the traditional or popular juice has been used as a base, others are used to built up the beverage qualities. Rao (1989) reported that blends may go a long way in reducing cost of juice used in making beverage.

Woodroof (1975) observed that the purees and juices of orange, banana, papaya and guava can be successfully blended with passion fruit juice into tropical fruit drinks, punches and syrups.

Blending of fruit juice, such as guava, papaya and passion fruit which are rarely known for making beverage has been reported by Annapurna (1977). She further stated that passion fruit which is rich in vitamin but low in calcium and protein could be blended with fruits such as woodapple or yelachi. According to Annapurna (1977), passion fruit juice which blended with pineapple and cardamon was found to be highly acceptable. Blends of passion fruit with orange, rose, mango, pineapple and peppermint was also studied by her. She further stated that the thinner and homogenous nature of fruit juice like cashew apple and passion fruit product were used but in recent years interest has increase in juice consisting of two or more fruits for instance apple and passion fruit ,pineapple and passion fruit ,mango and banana; orange, pineapple, passion fruit and mango.

Nanjundaswamy 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 also be blended with other fruit juice to make it an acceptable beverage. Krishna et al. (1969) reported that organoleptically acceptable blends canbe prepared by mixing Bokri juice and highly coloured sweet juice of Beauty seedless grape. (50 : 50) blends of grape-citrus juice and grape-pineapple juice have been reported to be excellant by Pruthi (1971).

Pruthi and Sondhi (1978) reported about the development of interesting products like cashew apple RTS beverage from blends with carotene rich fruit pulps of mango and papaya. Rao (1979), tried the preparation of beverage bleding with Rangapur lime and acid lime. He found that the beverage was acceptable when they were in ratio 5 : 10 and 20 : 5 and was not acceptable when the ratio was 12.5 : 12.5. Verma et al. (1983), have tried pineapple and mango pulp mixture in ratio of 25 : 75, 50 : 50 and 75 : 25 for squash. Khan (1988) found that carrot when blended with other fruit juices containing less B-carotene produced a drink rich in carotene.

Kalra et al. (1991), reported that beverage made from mango-papaya blend was organoleptically acceptable when preserved for one year. The muskmelon and mango pulp were blended in the ratio 25 : 75, 50 : 50, 75 : 25 respectively to prepare RTS beverage, containing 10 per cent pulp blend having 15 Brix 0.3

per cent acidity. However the beverage made from 50 : 50 blend was adjudged to be the best because of its balanced flavour (Teotia et al. 1992). Acording to Kaur et al. (1993) the richness of carotenoid in mango has a great potential for improving the quality and nutrition of fruit beverage to which it is mixed. Keeping this in mind, a non-conventional drink from mango was prepared with various fruits viz. pineapple, orange and plum. According to Chakraborty (1993), clarified water melon juice blended with lime juice or pineapple juice yielded RTS beverage for acceptable quality.

2.2.3 *Wine - A fermented drink from fruits*

Fermented beverages have been known to mankind from time immemorial. According to the old testament "Noah was the first tiller in the soil. He planted vineyard and he drank of the wine and became drunk" (Genesis, 9.20-21). Anthropological study indicated that wine has been appreciated for more than 9000 years and Plato noted that "nothing more excellent or valuable than vine was ever granted by God to the man". No other drinks except milk and water has earned such universal acceptance throughout the ages as has wine (Vradis, 1993). Pederson (1979) remarked that at a time when food was not the best, wine was an important food adjunct.

Wine is a natural, non-toxic, healthful, fermented alcoholic product rich in calcium, vitamins and minerals (Adusle, 1992).

According to Joshi and Attri (1990), there is a considerable scope for fruit based fermented beverage in India. Passion fruit is considered to be an excellent mix for alcoholic beverage (Hicks, 1990).

Grape wines are of two kinds - dry and sweet and in dry wine, there is practically very little or no sugar. In the sweet wine either fermentation is arrested to retain some of the original sugar, or extra sugar or fresh juice is added to the fermented juice (Siddappa, 1986). According to Vradis (1993), light wines can be produced by practically removing alcohol from regular wine using various methods or by fermenting "low sugar" must.

Rarrales (1958) has described the design and development of suitable cashew apple juice expeller for the manufacture of cashew apple wine. The feasibility of producing high quality liqour and standardizing method for producing wine from cahew apple has been investigated by Augustin (1987).

Studies done by Ough and Baker (1961) indicated the possibility of preparation of commercially acceptable vermouth

from tamarind fruit wines. Singh et al. (1975) observed that Golden Delicious and Red Delicious apples were suitable for cider production. Experiments on the production of ciders and brandy from Indian apples has been reported by Patel et al. (1977). Wines prepared from the combination of more then two varieties were found to the quite acceptable in apple (Dang et at. 1979).

Kulkarni et al. (1980) screened a number of mango varieties and observed that Fazri, Langra and Chausa produced good quality wines. Sweet wines from Dushehari had a characteristic fruity flavour. The possibility of producing acceptable quality dessert and madeira style wines from several mango varieties have also been indicated (Onkarayya and Singh, 1984). Preparation of new alcoholic beverage, mango vermouth has been reported by Onkarayya (1985). Suitable herb mixture formulae have been suggested for preparing acceptable grade of dry and sweet mango vermouths. A rapid madeirization process to improve the quality of mango desert wine by the addition of 0.1 per cent ascorbic acid and madeirization at 50°C for 7 days has been developed (Onkarayya, 1986).

Conditions for the production of guava wine were standardized by Bardiya et al. (1974). Wines prepared from guava juice were found to be highly acceptable due to low tannin

content, optimum colour and flavour.) In a similar study, conditions for the production of banana wine have been standardized (Kundu et al., 1976). Fermentation of pulp diluted in 1 : 1, 1 : 2 or 1 : 3 proportions produced acceptable quality wines.

Dilution of plum fruit in 1 : 1 ratio makes acceptable quality of wine (Vyas, 1982). (Jamun was used in the preperation of wine by Khurdia and (1984).)

(Study done by Pilando (1985) on the influence of fruit composition, maturity and mold contamination on the colour and appearance of strawberry wine indicated that over ripe fruits with its higher anthocyanin and total phenolics gives wine with better colour and appearance of strawberry juice.) It has been reported by Azad et al. (1985) that perry a low alcoholic drink could successfully be prepared out of this fruit. Nutritional data of palm wine from *Hyphaene coriacea* and *Phoenix reclinata* showed that palm wine is ~~a reclinata showed that palm wine is~~ an important source of nicotinic acid and vitamic C (Cunnigham, 1988).

Wine produced from wild apricot in 1:2 (fruit pulp : water) dilution recorded higher scores compared to other proportions due to the balanced acid, alcohol, sugar taste, appealing colour and flavour (Joshi, 1990). Studies done by Adsule (1992) showed that a good quality wine can be successfully prepared from pomegranate juice was however slower than grape juice. An attempt was made by Adsule (1992) to produce an acceptable quality fermented beverage (wine) from ber fruit. The preliminary studies showed that wine from ber fruit was comparable to that of grape juice wine.Wine prepared from culled apple was found to be acceptable (Vyas, 1993).

2.3 Other products from fruits

Apart from the various beverage products that can be prepared out of fruits a number of other products can also be prepared utilizing fruits.

Miani et al. (1982) reported that more fruits are preserved by any other method as these methods have major advantages of greater concentration in dry form, production with minimal labour, less expensive and economic equipment for processing and storage. The preparation of dried papaya and jack fruit were established by Jayaraman and Gupta (1991).

Candied fruits are prepared by gradually concentrating fruit in syrup by repeated boiling until the fruit is heavily impregnated with sugar, this process being followed by drying to overcome stickiness (Cruess, 1966). Thirumaran et al. (1985), standardized a simple processing technique for papaya candy making use of fully matured but unripe papaya. Mohammed et al. (1993) developed a recipe for candy using pineapple which was organoleptically acceptable also. Siddappa et al. (1986) has defined fruit juice powder as highly hygroscopic powder made from fruit juice to which natural fruit flavours in powder form is incorporated to compensate for any loss of flavour. Different fruit powders with avocado, banana, mango and guava were standardised by Pruthi and Lal (1959).

Jam is prepared by boiling the whole fruit pulp with sugar to a moderately thick consistency without retaining the shape of the fruit (Cruess, 1966). Donchencko and his colleagues (1983) observed that the pectin / sugar solution prepared in the ratio of 1:5 with water at 30 volume per weight of pectin and pH in the range of 2.5 - 6.0 was observed to result in increased jam strength. Thirumaran et al. (1986) had standardized the formula for papaya jam with a shelf life of eight months and with an overall acceptability score of 3.75. Bhatnagar (1991) conducted

studies on the preparation of jam from watermelon rind. The jam, though low in acid and pectin was highly acceptable and had a shelf life of six months.

According to Mudambi (1991), a perfect jelly should be transparent, well set but not too stiff and should have original flavour of the fruit, it should be attractive in colour and should keep its shape when removed from the mould when cut, it should retain its shape and show clear cut surface and it should be tender enough but should not flow.

According to Siddappa (1986), jelly is prepared by boiling fruit with or without the addition of water, straining the extract and mixing clear extract with sugar and boiling the mixture to a stage at which it will set to a clear jel. Although there is a difference in opinion about the exact nature of pectin, it is generally accepted that pectin from jellies, when mixed and boiled with the proper amounts of sugar, acid and water and all these constituents must be present in a particular proportion for making a good jelly (Siddhappa, 1986).

Hayes (1960), reported that the rind of fruits contains a good amount of pectin for making jelly. According to Mukherjee (1963), pear jelly can be prepared from the peel and

cores. The set was, however poor in both ~~in~~ product because of inferior quality of the pectin of the fruit. Peel of orange can be utilized in the production of jelly (Pareek, 1965). Since long, the need for a stable raw material for the recovery of pectin for commercial use has been felt by the fruit preservation industry. Mandarin orange waste (both peel and pomace) constitutes good source of pectin (Pruthi, 1971). Jelly from grape skin was prepared by Pruthi (1971) and average of 24 oz of jelly was obtained from each pound of pomace. Extraction of pectin from mango peel has been well studied and good quality jelly grade pectin could be extracted from the peel (Kinsella, 1974). According to Pruthi (1979), there is a scope for improving the recovery and quality of pectin from cashew apple waste notably with respect to methoxyl content and jelly grade.

MATERIALS AND METHODS

The study entitled **"Development, diversification and shelf life studies of Passion fruit products"** is a comprehensive study aimed at developing ~~three~~ six different products utilizing passion fruit and also in combination with other fruits. Assessment of chemical, organoleptic and shelf life qualities of the products were also investigated in the study.

3.1 Selection of the fruit for study

According to Pareek (1993), un-exploited fruits are the several less known fruit species which have the potential for commercial exploitation and are yet to be utilised for their potential. Kumar (1993) opined that considerable efforts are needed to make a new product from under exploited fruits and vegetable, competitive in the world market with respect to nutritional and microbial quality as well as with zero level chemical residues.

Among the various under exploited fruit, passion fruit was selected for the study. The fruit was selected for the study due to the following reasons.

FIG 1. PASSION FRUIT

(i) *Passion fruit is rich source of various nutrients.* According to Hayes (1960), passion fruit is a rich source of vitamins and minerals and hence suitable for making nutritious fruit drinks. Khurdiya (1994) reported that the juice obtained from passion fruit is a rich source of carbohydrate, acetic acid, carotenoid, carotene and sugars. According to Bose (1990), passion fruit is a fair source of provitamin A, ascorbic acid, riboflavin and niacin and have a high mineral content.

(ii). *Passion fruit is an under exploited fruit endowed with rich organoleptic qualities.* According to Tressler (1968), passion fruit juice is golden yellow in colour, it has a sharply acid taste combined with a distinctive flavour and aroma. Luh (1975) reported that passion fruit pulp has an acidic but highly attractive and distinctive flavour and added with its unique intense flavour described as a natural concentrate.

(iii). *Passion fruit can be blended very well with other fruits.* Hayes (1960) reported that passion fruit juice when sweetened and diluted makes a drink which compares well with other fruit juices. Tressler (1968) opined that passion fruit is useful for combining with other fruits such as in juice blends and fruit mixes. According to Luh (1975), passion fruit pulp when

sweetened and diluted makes a highly palatable beverage and the flavour blends well with other fruit and fruit juices. Prahlad (1989) was also of the opinion that passion fruit with its flavour and colour blends well with other fruit juices.

(iv). *Passion fruit can be utilized in the formulation of different types of products.* As early as in 1960, Pruthi standardized a recipe for passion fruit juice powder. A carbonated drink made from passion fruit is reported to be well acceptable (Khurdiya, 1994). Passion fruit is considered to be an excellent mix for alcoholic beverage such as vodka, gin and rum (Hicks, 1990). Typical examples of processed products from passion fruit are ice cream, sherbet, fruit nectar, nectar in combination with citrus, pineapple and other juices, jam, jelly, squash, passion fruit, fruit in syrup and passion fruit concentrates (Bose, 1990). The rind of passion fruit is a rich source of pectin and hence can be utilized in the production of jelly. (Ramadas, 1988).

3.2 Selection of fruits used for blending

Following fruits were used for blending, for the preparation of various products.

3.2.1 *Banana*: It is one of the most important fruit crops in Kerala. This fruit is available throughout the year unlike the other fruits which are seasonal. Palayamkodan (Mysore Poovan) is one among the many varieties of banana. This ripe fruit is very good source of vitamin A and a fair source of vitamin C , B1 and B2 (Ranjit, 1969). This variety is very cheap and is readily available in abundance. George (1994) reported that not much processing techniques have been applied for this fruit. Banana have a special value in the human diet as they are rich source of energy and contains nearly all the nutrients including minerals and vitamins. According to Gopalan et al. (1992), ripe banana is used in the making of confectionaries, malted milk drinks and even alcoholic beverages.

3.2.2 *Papaya*:- It is a cheap fruit available in all seasons in all places to all people and is a good source of carotene. According to Gopalan et al. (1992) regular consumption of papaya will ensure a good supply of vitamin A and C which are both essential for good health. These are large, deep-yellow coloured fruit and is concerned primarily as table fruit or salad vegetable (Hayes, 1993). It is a nutritive fruit containing 0.5 per cent protein and an equivalent amount of minerals, consisting mainly of iron, calcium and phosphorus (Ranjit, 1969). Jams,

jellies, marmalades and squashes can be made from papaya and the fruit blends easily into fruit salads and ice creams. (Gopalan et al. 1992)

3.2.3 *Pineapple*:-This fruit has an attractive, crunchy, acidic taste and is a good source of thiamine compared to other fruits. (Gopalan et el. 1992). Pineapple is a good source of vitamin A and B and is rich in calcium. In addition, it contains phosphorous, iron and an enzyme bromelin (Pawar et al. 1985). Gopalan et al. (1992) further stated that pineapple syrup has great demand in fruit jam and juice industry because it blends very well with all fruit juices.

3.2.4 *Lime*:- It is widely used in sherbets, soft drinks and for pickling. The fruit is juicy with few seeds and is very aromatic. Lime is a rich source of vitamin C and they has beneficial effect on building up resistance against infection. (Gopalan et al. 1992).

3.3 Selection of the products proposed

3.3.1. *Ready to serve (RTS) beverage*: Fruit beverages are delicious and have universal appeal unlike any other beverage (Siddappa, 1988). RTS is a fruit juice which is considerably

altered in composition with sugar and water during preparation. No amount of dilution is necessary prior to serving and it is in the ready to serve form. Since cold drinks are in demand practically throughout the year an attempt is made to prepare low cost nutritious drink from passion fruit and also in combination with other fruits. Fruits like pineapple and lime were selected for the preparation of blended RTS beverage. The pleasing colour and intense flavour of pineapple and lime is found most suitable for blending.

3.3.2. *Wine* : This is a fruit juice which has undergone alcoholic fermentation by yeast and the product contains varying amounts of alcohol. The presence of large amount of sugar in passion fruit encourages its utilization in the production of wines. Banana and pineapple were used for blending with passion fruit, in order to get an entirely new flavour.

3.3.3 *Jelly* : For the preparation of jelly, pectin is the most essential constituent. Ramadas (1988) found that rind of passion fruit is rich in pectin which is otherwise bitter in taste and with a light colour. Fruits like banana and papaya were used as blends to provide the much needed colour and flavour apart from the pectin. A low cost jelly can be produced using passion fruit rind which would otherwise go as a waste.

3.4. Standardization of fruit products

3.4.1 *Selection of different proportion for the preparation of products*

The fruit products viz. RTS beverage, wine and jelly were prepared by selecting various proportions (Table 1).

TABLE -1

Standardization of the products

Products	I	II	III
RTS beverage	a:b:c	a:a^1:b:c	a:a^2:b:c
	1:2:6	1:1:1:8	1:1:2:8
	1:1:5	1:1:2:8	1:1:2:10
	1:1:2	1:2:2:8	2:1:3:10
	1:2:4	2:1:2:10	2:1:3:12
Wine	a:b:c	a:a^3:b:c	a:a^1b:c
	1:1:1	1:1:2:2	1:1:2:2
	1:1:2	3:1:4:4	3:1:4:4
Jelly	a^4:b:c	a^4:a^3:b:c	a^4:a^5:b:c
	2:1:8	1:1:1:8	1:1:1:8
	1:3:4	3:1:6:16	3:1:6:16

a – passion fruit
b – sugar
c – water

a_2^1 – pineapple
a_3 – lime
a_4 – banana
a^4 – passion fruit rind
a^5 – Papaya

3.4.2 *Preparation of the products*

3.4.2.1 Preparation of RTS Beverage

Steps followed in the preparation of RTS beverage are presented in flow chart (Fig 2.)

3.4.2.1 *Collection of fruits*:

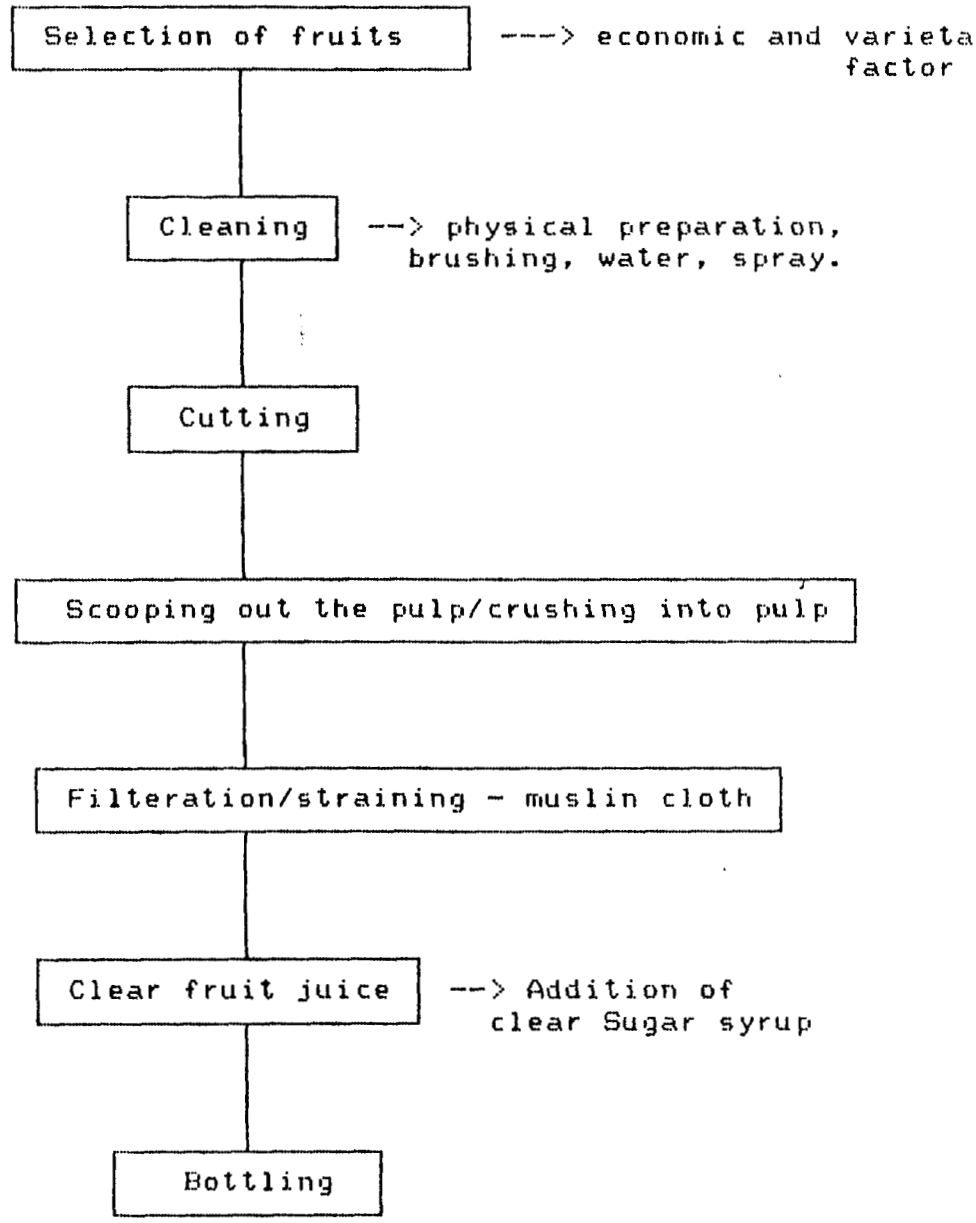
According to Ranote (1982) to obtain a high quality product free from bitterness, harvesting must be planned and scheduled according to processing maturity. Decayed/damaged fruits did not yield good juices. The fruits were collected from the Instructional Farm of the College of Agriculture, Vellayani and from adjacent private farm.

3.4.2.1 *Extraction of juices*

White mucilagenous materials and seeds are the undesirable constituents in the juice which are to be avoided as far as possible. During extraction, the juice was not unduly exposed to air. Though mechanical extraction and centrifugal extraction can be used for the extraction of juice from passion fruit, in the present study fresh juice was extracted manually. The fruits were washed thoroughly and halved with stainless steel knives and mucilagenous yellow matter was scopped out with a spoon.

Fig 2

FLOW CHART FOR THE PREPARATION OF RTS BEVERAGES



Fruit juice after extraction contains varying amounts of suspended matter which contained of broken fruit tissues, seeds and skin in colloidal suspension. The coarse particles in suspension in the juice were removed by straining through muslin cloth and by sedimentation. The presence of these constituents causes deterioriation in the quality of final product. ~~But the colloidal suspension was not removed and fruit juice was reasonably cloudy in appearance~~, It was also found to be more nutritious than the clear juice. For the preparation of blended RTS beverage, the juice of pineapple and lime were used. The juice was extracted and suspension was removed by straining through muslin cloth.

3.4.2.1 *Formation of the product*

Required proportion of sugar and water were mixed and heated. According to Ashurst (1986), sugar is a principal component for the formulation of the beverage. Sugar contributes flavour, sweetness mouthfeel, ~~body fruitiness~~, ~~nutrition~~ and facilitates water absorbtion. Water contributes bulk and mass and is a solvent carrier and thirst quencher.

FIG 3. READY TO SERVE BEVERAGE

The dirt layer on top of the syrup was skimmed off. The syrup was cooled slightly and filtered through muslin cloth. The clean syrup was blended with the juice of pineapple/lime. Kuo et al. (1995) indicated that thermal processing of passion fruit juice would causes considerable flavour loss. Use of colouring substance was found unnecessary since the pure passion fruit juice itself imparted rich yellow colour. Addition of citric acid was not required since the acidity level in the original juice was adequate.

3.4.2.1 *Filling*

The sterile glass bottles were used to fill the prepared juice leaving to about 1.2 - 2.5 cm of head space. The bottles were washed, dried, labelled and stored in cool and dry place for shelf life studies. Sedimentation ~~of RTS~~ occurs in RTS during storage, however it resumes attractive appearance upon shaking of bottles prior to serving.

3.4.2.2 Preparation of wine

Step discussed in the wine making procedure are presented in Fig 5

3.4.2.2 *Selection of fruit* :- Firm ripe passion fruits were selected. They were washed thoroughly to remove the micro organism and other extraneous matter which would otherwise contaminate the product.

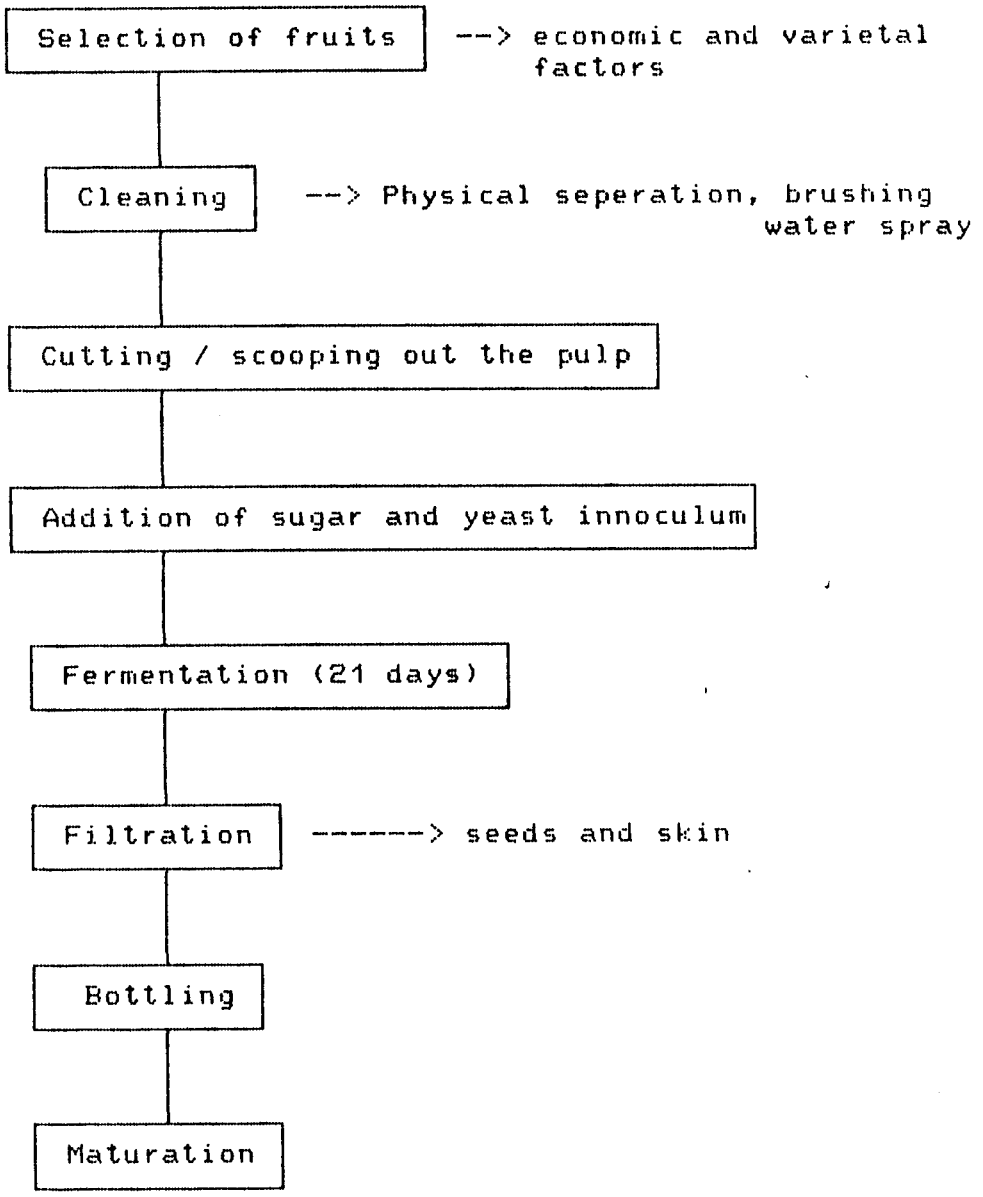
3.4.2.2 *Formulation of the Product*:- The fruits were halved and the required yellow mucilagenous pulp, along with the brownish black seeds were scooped out with a spoon. For the preparation of blends of wine, fruits like banana and pineapple were taken and cut into medium size pieces.

The fruits with water and sugar in the proportions selected were kept sealed in ceramic pots (Bharani). 5g of yeast (*Saccharomyces cerevisiae*) was added as a starter. Ceramic pots were sealed and kept for fermentation. According to Asgar (1992), yeast play an important role in the fermentation of various beverages and several species are being increasingly used in beverage fermentation industry.

According to Sreekantaiah (1966), out of different strains of yeast *Saccharomyces cerevisiae var. ellipsoides*, in the most suitable and best one for fermentation of grapes.

Fig 5

FLOW CHART FOR THE PREPARATION OF WINE



3.4.2.2 *Extration and filteration:* After 21 days when the fermentation was over,the clear wine was syphoned from the ceramic pots and filled into bottles.As reported by Vradis (1993) the character provided by alcohol are the heat in mouth and fullness in body.

3.4.2.2 *Maturation and Aging:-* The bottles were sealed airtight to exclude air. In course of time the wine matures . According to Revilla (1993), the fining or clarification of wine is one of the stabilisation processes which are carried out in cellars after the fermentation is finished. This process may reduce the number of substance which may appear in the wines, and that may originate undesirable precipitates.

Amerine (1970) reported that usually wine fining and other stabilisation process lead to clear, stable wine for satisfactory marketing.

2.4.2.3 Preparation of Jelly

Steps followed for the preparation of jelly are presented in Fig 6.

3.4.2.3 *Selection of fruit:-* The passion fruit selected was sufficiently ripe but not over ripe. According to

Siddappa (1986), the rinds of slightly under ripe fruits yeild more pectin than over ripe fruits. During ripening the pectin present in it decomposes into pectic acid and sugar.

The rind which was the waste product obtained after the preparation of RTS beverage and wine was utilized in jelly making. After taking out the fruit pulp, rind was used without any delay for jelly making. If kept for longer time, the rind loses its moisture and becomes shrivelled and it also causes the degradation of pectin (Siddappa, 1986).

3.4.2.3 *Preparation of fruit rind* . It was necessary to remove the outer yellow portion of the peel to get the jelly free from excessive bitterness. The rinds were the cut out into thin slices so that the pectin extracted easily. In the preparation of blended jelly the fruit like banana and papaya were cut out into small pieces and used along the rind for extracting pectin

3.4.2.3 *Extraction of pectin*. The rind of the passion fruit and water were taken in the proportion suggested for the extraction of pectin. A large quantities of water for extraction should be avoided. Excessive dilution of pectin would necessitate prolonged

boiling which in turn would reduce the jelly strength (Siddappa, 1986). Citric acid was added to adjust the pH. A second extract was taken and it was combined with the first extract. The extraction was done in a stainless steel container.

3.4.2.3 *Straining and Clarification.* The pectin extract was clarified by passing through muslin cloth folded several times. The cloth containing the fruit extract was not squeezed because otherwise the pectin will not be clear due to particles passing through the pores of the cloth. The pectin extracts was allowed to settle overnight and the supernatent liquid was drained off.

3.4.2.3 *Formulation of the product.* Sugar was mixed with the fruit extract and when it started boiling the mixure was stirred to ensure complete dissolution. ~~Tying up~~ Binding moisture by addition of solutes such as sugar also prevents growth of micro organisms and helps to preserve foods (Mudambi, 1991). During boiling, the scum which rises to the top was removed from time to time. It was occassionally stirred to prevent sticking to the sides of the pan and also to remove dissolved air.

Determination of end point of jelly The end point was determined by sheet/flake test (Siddappa, 1986). A small portion of jelly liquid was taken into the large spoon, cooled slightly and

Fig 6

FLOW CHART FOR THE PREPARATION OF JELLY

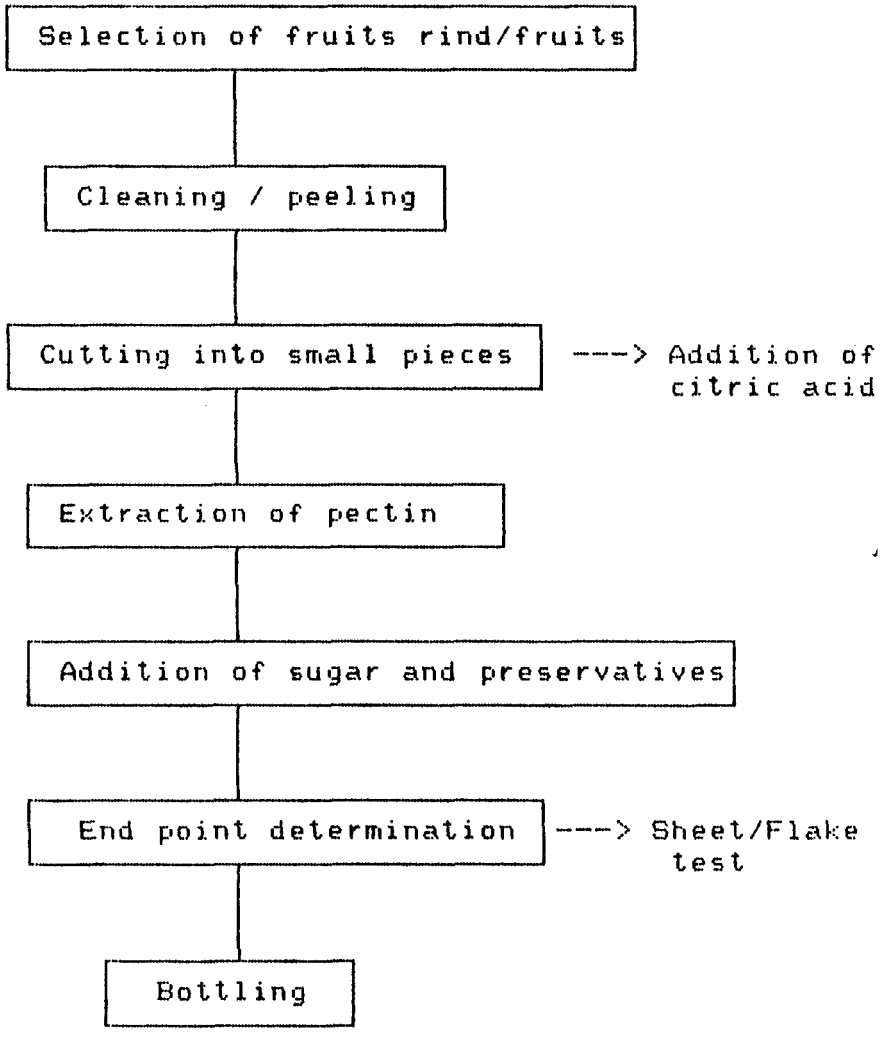


FIG 7. JELLY.

allowed to drop off. When the jelly falls in the form of sheets, the end point is denoted and it required no further concentration.

3.4.2.3 *Filling* The sterile glass bottles were filled with jelly in liquid form, leaving about 1.2-2.5 cm of head space. The the bottles were closed with sterile lids and were cooled and was labelled. Bottles were then kept for shelf life studies.

3.5 Analytical work carried out

3.5.1 *Assessment of chemical and nutritional constituents in the product.*

The freshly prepared, RTS beverage, wine and jelly were analysed for pH, acidity, total sugar, total soluble solids, and vitamin C. In addition to the above the wine was also analysed for alcohol percentage and residual sugar.

All the samples were drawn randomly in required quantities (duplicate) for analysis. The sampling procedure is given below:

Liquid sample. From liquid sample like wine and in RTS beverage, 10 ml of the sample was taken for analysis.

Solid Sample From solid sample like jelly 10 gm of the sample was weighed and taken for analysis. Products were analysed for various constituents as detailed below

Constituents	Standardization method
Acidity	AOAC (1960)
Total soluble solids	Renganna (1977)
PH	Renganna (1928)
Total Sugar	AOAC (1960)
Vitamin C	Sadasivan et al. (1984)
Alcohol percentage	Hart (1971)
Residual sugar	AOAC (1960).

3.5.2 *Assessment of organoleptic qualities*

The organoleptic qualities of the products was evaluated by a taste panel immediately after the preparation of products. The panel members for acceptability trials at the laboratory level were selected by employing the triangle test as suggested by Jellinck (1964). Evaluation card for triangle test is presented in Appendix . In the triangle test, three sets of sugar solutions of different concentrations were used. Of the three sets, two solutions were of identical concentration and members were asked to identify the third sample which is of different concentration. A small highly sensitive panel would usually give more reliable results than large less sensitive groups, (Mahony, 1985). Thus ten members were selected as judges for the present acceptability trials.

The products prepared were kept in clear plates/clear glasses so that the judges could see the colour and appearance very clearly. The panel members were not oriented about the type of blend in each variation. According to Renote et al. (1992), the RTS beverage was found to be highly acceptable when assessed in chilled form hence RTS beverage and wine were served chilled.

The products were evaluated based on the various quality attributed viz. appearance, flavour, colour, taste, texture, clarity and overall acceptability. The Score Card developed for the study is presented in the Appendix. Water was provided for the judges for oral rinsing after tasting each sample and were allowed to retaste and take as much time as desired to make a decision.

3.5.3 *Assessment of ensurance of FPO requirement in the products*

Food standards are made to ensure the quality and safety of natural and processed food for human consumption (Swaminathan, 1988). FPO has specified minimum percentage of total soluble solids (TSS) in the final products of the special characteristics of RTS beverage and jelly. Similarly FPO specifies minimum per cent of the fruit in the final products on the fresh fruit basis (w/w) in RTS beverage and jelly Specification was indicated for table wine by FPO. Details pertaining to the three products in this respect were tested for conformity of FPO specification.

3.5.4 *Assessment of consumer acceptance of the product*

For consumer quality acceptance there is still no substitute for measuring with people. Potter (1986) is of the opinion that

use for consumer acceptance test groups are better than individuals because differences of opinion average out. Consumer acceptance survey of the products was carried out in order to find out the acceptablity of the product. It was assessed by suitably structured Score Card and administering it on 50 subjects drawn at random. Major quality attributes scored by the consumers on a five point scale were taste, appearance, flavour, colour and clarity, in all the three products viz. RTS beverage wine and jelly. Strength of wine and texture attribute of jelly were also scored. The tests were conducted as per the standardized procedure prescribed by Swaminathan (1974).

3.5.5. ***Assessment of the cost benefit analysis of the products***

According to How (1990), information as accurate and up to date as possible on supply, demand and prices is essential for anyone directly involved in the business of marketing fresh fruits. Obtaining such informations for these commodities is especially challenging because the way they widely fluctuate, in the production and use. Cost benefit analysis was carried out based on the prices of different items during the time of preparation of the product. The cost calculated included cost of the fruit (passion fruit, bananas, pineapple, papaya and lime), sugar and preservatives used, cost of the bottles and bottling

charge. Labour cost was also taken into consideration while deriving the individual cost of the product.

3.5.6 *Assessment of shelf life qualities of the products*

The shelf life qualities of the three products were ascertained, based on the shelf stability, changes in the chemical and organoleptic qualities and occurance of microbial infestation in the product.

3.5.6.1 *Storage of the products:*

Products were kept in ambient conditions. Details of the sample kept for storage are given in Table 2

TABLE - 2

Shelf life quantities of the products

Products	Storage capacity(ml)	Number of bottles
1. RTS beverage		
(i) Plain passion fruit (R1)	200	12
(ii) Passion fruit-pineapple blend (R2)	200	12
(iii) Passion fruit-lime blend (R3)	200	12
2. Wine		
(i) Plain passion fruit (W1)	250	18
(ii) Passion fruit-banana blend (W2)	250	18
(iii) Passion fruit-pineapple blend (W3)	250	18
3. Jelly		
(i) Plain passion fruit rind jelly (J1)	200	10
(ii) Passion fruit rind-banana jelly (J2)	200	10
(iii) Passion fruit rind-papaya jelly (J3)	200	10

3.5.6.2 *Changes in the chemical and organoleptic qualities during storage*

Changes in the chemical constituents viz. pH, acidity, total soluble solids, total sugar, and vitamic C and alcohol percentage (wine) were assessed during storage period, drawing samples in duplicate. Changes in the organoleptic qualities of the products were ascertained through the panel of judges. These tests were conducted monthly in the case of wine and weekly in RTS beverage and jelly.

3.5.6.3 *Assessment of microbial contamination*

The products prepared were assessed for microbial contamination viz. bacteria, fungus and yeast. For the detection, nutrient agar, potato dextrose agar and maltose extract were used respectively. These tests were conducted monthly in the case of wine and weekly in RTS beverage and jelly

3.5.7 ***Statistical analysis of the data***

All the above said observations were statistically analysed. The CRD was used as the programme for the statistical analysis. CD values were computed at 15 per cent level of significance in order to compare the means of the effects

RESULTS AND DISCUSSION

Salient findings of the study entitled *"Development, diversification and shelf life studies of passion fruit products"* are presented and discussed under the following headings :-

4.1 Assessment of the standardisation procedures undertaken.

4.2 Assessment of chemical components in the fresh products.

4.3 Organoleptic assessment of the fresh products.

4.4 Assessment of the changes in chemical components of the products during storage.

4.5 Changes in the organoleptic qualities of the products during storage.

4.6 Assessment of microbial contamination of the products during storage.

4.7 Assessment of the products for FPO standards.

4.8 Assessment of cost benefit analysis of the products.

4.9 Assessment of consumer preference of the products.

4.1 Assessment of the standardisation procedures undertaken.

Various proportions were tried out for the standardisation of the products. The ingredients selected for the formulation of the products were based on the local availability, nutritional value, economical significance, shelf life qualities acceptibility and easiness for processing and digestibility. Based on the organoleptic assessment, the proportions which secured highest scores were selected for product development. The mean scores obtained for different properties and combinations and are presented in the Tables 3,4, and 5.

As indicated in the Table 3 the overall acceptability scores of B_2, B_7 and B_{10} were found to be the highest with an overall acceptabilities score of 4.1, 4.6 and 4.5 respectively. Judicious mixing up of the ingredients in these proportions was found to be organoleptically acceptable to the panel members. Sugar and water are the essential constituent of RTS beverage besides the fruit and it gave sweetness as well as body to the RTS beverage. If the concentration of the sugar is high with relatively less amount of water or vice versa, it would result in low scores for the products. Though B_3, B_8 and B_9 had secured high scores (5.0 each) for appearance, the overall acceptability

TABLE 3

Acceptability levels (mean scores) of RTS beverage

Attri-butes	Plain PF RTS beverage(R1) PF : Sugar : water					PF-PA RTS beverage(R2) PF : PA : Sugar : water				PF-Lime RTS beverage (R3) PF : Lime : Sugar : Water		
	B1 1:2:6	B2 1:1:5	B3 1:1:2	B4 1:2:4	B5 1:1:1:8	B6 1:1:2:8	B7 1:2:2:8	B8 2:1:2:10	B9 1:1:2:8	B10 1:1:2:10	B11 2:1:3:10	B12 2:1:3:12
Taste	1.2	4.4	2.3	2.5	2.3	1.2	5.0	2.5	1.2	4.9	2.5	2.7
Appear-ence	3.9	4.3	5.0	3.2	3.2	3.9	5.0	5.0	5.0	5.0	3.9	3.3
Flavour	2.0	4.2	2.8	3.1	2.0	2.0	5.0	2.6	3.1	4.8	3.0	3.2
Colour	3.0	5.0	3.9	3.2	3.0	2.2	5.0	3.9	3.9	4.9	3.0	2.1
Clarity	1.2	2.6	2.0	1.3	1.2	1.4	3.0	2.6	2.9	2.9	1.2	2.2
OA	2.6	4.1	3.2	2.7	2.3	2.1	4.6	3.9	3.2	4.5	2.7	2.7

PF: Passion Fruit; PA: Pineapple; B: Blends; OA:Overall Acceptability.

scores were found to be low because of low scores obtained for the other quality attributes viz. taste, flavour and clarity.

Acceptability levels of wines are presented in Table 4 When the two products from plain passion fruit, (B_1 and B_2) were compared, B_1 secured higher scores for overall acceptability (3.4). According to Kordylas (1990), the overall acceptability depends on the concentration or amount of particular components,the nutritional and other hidden attributes of a food and its palatability or sensory quality. B_1 secured high scores over B_2. Excessive dilution of B_2 resulted in low scores for all the quality attributes viz. taste, appearance, flavour, colour and strength except for clarity attribute.

When the blends of passion fruit-banana wine (B_3 and B_4) and blends of passion fruit-pineapple wine (B_5 and B_6) were compared,the blends B_4 and B_6 secured high scores over B_3 and B_5 respectively. In blends B_4 and B_6, the passion fruit pulp was three times the quantity present in B_3 and B_5.Since passion fruit impart intense flavour and rich colour, the scores for appearance, flavour and colour were comparatively higher.Use of high amount of sugar, resulted in high scores of taste and strength in the wine.

TABLE - 4

Acceptability levels (mean scores) of wine

Quality Attributes	Plain PF wine(W1) (PF : Sugar : water)		PF-banana wine (W2) (PF :banana: Sugar: water)		PF - PA wine(W3) (PF: PA: Sugar: Water)	
	B1 (1:1:1)	B2 (1:1:2)	B3 (1:1:2:2)	B4 (3:1:4:4)	B5 (1:1:2:2)	B6 (3:1:4:4)
Taste	4.4	2.0	2.8	4.7	2.3	4.5
Appearance	3.0	2.3	2.3	3.0	2.1	3.0
Flavour	3.0	1.2	2.1	4.0	2.0	3.0
Colour	5.0	3.6	1.6	4.0	1.8	3.0
Clarity	2.0	3.0	3.0	4.0	2.7	3.0
Strength	2.8	2.6	3.0	3.2	2.9	3.0
OA	3.4	2.5	2.5	3.8	2.3	3.4

PF: Passion fruit; B: blend; OA: Overall acceptability; PA: Pineapple

TABLE - 5

Acceptability levels (mean scores) of jelly

Quality attributes	Plain PF jelly(j1) (PF : Sugar : water)		PF-banana jelly (j2) (PF :banana: Sugar: water)		PF-PA papayajelly(j3) (PF: rind-papaya Sugar:Water	
	B1 (1:3:4)	B2 (2:1:8)	B3 (1:1:1:8)	B4 (3:1:6:16)	B5 (1:1:1:8)	B6 (3:1:6:16)
Taste	4.1	3.2	2.7	5.0	2.5	4.6
Appearance	4.4	2.6	3.6	5.0	3.2	4.7
Flavour	4.2	3.7	2.3	5.0	2.0	4.9
Colour	4.0	3.1	3.0	5.0	3.1	4.9
Texture	4.1	2.1	2.2	4.7	2.0	4.9
OA	4.2	2.9	2.8	4.9	2.6	4.8

PF: Passion fruit; B: blends; OA: Overall acceptability; PA: Papaya

As indicated in the Table 5, in the plain passion fruit rind jelly the blend B_1 obtained high scores for all the quality attributes when compared with B_2. This may be due to the large proportion of water added in B_2. According to Siddappa (1986), addition of large quantity of water for extraction should be avoided, because excessive dilution of pectin would necessitate prolonged boiling which in turn would reduce the jellying strength. Thus the blend B_2 secured low scores for appearance and texture attribute.

When the blends of passion fruit rind-banana jelly (B_3 and B_4) and passion fruit rind-papaya jelly (B_5 and B_6) were compared, the blends B_4 and B_6 secured high scores over B_3 and B_5 respectively. The gel srength may be prepared by the proper combination of sugar, water, acid and pectin. In B_4 amd B_6 the proportions were found to be most ideal. Increase in sugar accelerates the gel strength and setting of jelly due to increased hydration. Low amount of water in B_3 and B_5 resulted in low score for appearance, colour and texture. According to Siddappa (1986), if the water added is too small, the pectin extract will be viscous, cloudy and difficult to clarify.

Thus based on the organoleptic and overall acceptibility following proportions were selected for the preparation of different products utilising passion fruit.

TABLE 6

4.1.1 Proportions selected for product development

	RTS beverage	Wine	Jelly
1	1: 1: 5 (PF:Sugar:water)	1: 1: 1 (PF:Sugar:Water)	1: 3: 4 (PF rind:Sugar:Water)
2	2: 1: 2: 10 (PF:Pa:Sugar:Water)	3: 1: 4: 4 (PF:B:Sugar:Water)	3: 1: 6: 16 (PF rind:B:Sugar:Water)
3	2: 1: 3: 10 (PF:L:Sugar:Water	3: 1: 4: 4 (PF:Pa:Sugar:Water	3: 1: 6: 16 (PF rind:P:Sugar:Water)

PF: Passion fruit; Pa: Pineapple; P: Papaya; B: Banana, L: Lime

4.2 Assessment of the chemical components in the fresh products

According to Potter (1986), the knowledge of the constituents of foods and their properties 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. Analysis of the chemical constituents in the products provide valuable information about the nature of the product and their

susceptibility to deterioration. Analysis was carried out with respect to pH, acidity, total sugar, total soluble solids (TSS), alcohol percentage and vitamin C in the products prepared in the study.

4.2.1 *Assessment of chemical constituents in RTS beverage*

Chemical constituents of the three types of fresh samples of RTS were assessed, results of which are presented in the Table 7

TABLE – 7

Chemical constituents of fresh RTS beverages

Type of product	pH	Acidity citric acid/g	TSS %	Total sugar %	Vitamin C %
R1	3.50	0.16	14.00	13.60	6.00
R2	3.62	0.15	12.45	12.80	11.60
R3	2.83	0.17	18.65	11.55	15.50

Chemical constituents of the fruit and the fruits used for blending will influence the chemical constituents of the RTS beverage prepared. According to Renganna (1977), pH is a measure of active acidity which influences the flavour or palatability of a product and affect the processing requirements. pH of the

product varied according to the acidity of the product. The pH of RTS beverage during the first week ranged between 2.83-3.62. Annapurana (1977) observed that physico-chemical analysis of RTS beverage prepared from passion fruit showed an acidity value of 0.70. Passion fruit, pineapple and lime were found to have pH of 2.80, 3.65 and 1.80 respectively. Since the pH of pineapple was high, the product passion fruit-pineapple blend (R2) had slightly high value of pH (3.62) followed by plain passion fruit RTS beverage (3.50). Passion fruit-lime had a low value of pH (2.83) as the pH of lime was as low as 1.80. pH of the three RTS beverage was found to be 3.50 in plain passion fruit RTS beverage, 3.62 in passion fruit-pineapple RTS beverage and 2.83 in passion fruit-lime RTS beverage. Determination of pH reveals the acidity and alkalinity of the product which in turn gives a positive indication of deteriorative change in the product. Physico chemical analysis of RTS beverage prepared from passion fruit showed a pH of 3.5 (Annapurna, 1977). According to Ranote (1993), RTS beverage prepared from Kinnow mandarin had a pH of 4.00. Carbonated passion fruit drink showed a pH of 3.25 (Khurdiya, 1994).

The acids occurring in large amounts in fruits are citric acid and malic acid. Many other organic acids also occur in small amounts in fruits. The acidity of the three types of RTS beverage was found to range from 0.15 - 0.17. The variation in acidity was due to the difference in the acidity of fresh passion fruit, pineapple and lime which are 5.19 (Ramadas, 1988), 0.72 and 5.9 (Swamination, 1979) respectively. The acidity of passion fruit-lime RTS blend was found to be the highest (0.17) followed by plain passion fruit RTS beverage (0.16) and passion fruit-pineapple RTS beverage (0.15). Wasker (1991) opined that the RTS beverage from phalsa fruit showed an acidity value of 0.42.

Total soluble solid (TSS) value is defined as the amount of sugar and soluble minerals present in the fruit and vegetable extracts. The total soluble solid of the fresh fruits when assessed was found to be 6.0, 9.0 and 19.0 respectively in passion fruit, pineapple and lime. Thus passion fruit-lime blend (R3) was found to have a high TSS (18.6) followed by plain passion fruit RTS (14.00) and passion fruit-pineapple blend (12.45). According to Annapurna (1977), the TSS of RTS beverage from passion fruit was 14.00. RTS prepared from ber fruit was found to have a TSS of 15 per cent (Kadam, 1991). Total soluble solids of RTS prepared from Kinnow mandarin was found to be 15.00

as reported by Ranote (1993). Studies done by Khurdiya (1994) revealed that the TSS of carbonated passion fruit drink was 9.65

According to Swaminathan (1979), total sugar content of the fruits vary from 3-18 per cent. The sugars present in the fruit consists of a mixture of sucrose, fructose and glucose. The total sugars found in passion fruit was reported to be 9.16 (Ramadas, 1988) whereas in pineapple and lime it was found to be 13.7 and 2.5 respectively (Swaminathan, 1979). This accounts for the variation in the total sugar of the three RTS beverages prepared in the present study. The total sugar vary from 11.55 to 13.60 in RTS beverage prepared. The total sugar of the plain passion fruit RTS beverage (R1) was found to be the highest (13.60) followed by passion fruit-pineapple RTS beverage (12.80) and passion fruit - lime RTS beverage (11.50). According to Ranote (1993), the total sugar of RTS prepared from Kinnow mandarin was found to be 9.95.

The ascorbic acid content of the fruit varies depending on the type of fruits. The citrus fruit is one among the most nutritious fruits and is a rich source of vitamin C. (Gopalan et al. 1992). The passion fruit-lime RTS beverage (R3) was found to have comparatively more vitamin C (15.50) followed by passion fruit-pineapple RTS (11.60) and plain passion fruit

RTS beverage (6.00). RTS beverage prepared from lime by Palaniswamy (1974), showed an ascorbic acid content of 14.76 percent. Ranote (1991) reported that RTS beverage prepared from Kinnow mandarin showed an ascorbic acid percentage of 3.0.

4.2.2 *Assessment of chemical constituents in wines*

Chemical constituents of the three types of wines were assessed, results of which are presented in the Table 8.

TABLE - 8

Chemical constituents of fresh wine

Type of products	pH	Acidity citric acid/g	TSS (%)	Residual Sugar(%)	Vitamin C (%)	Alcohol (%)
W1	3.60	0.63	20.10	3.80	6.90	9.00
W2	3.90	0.59	28.60	4.60	5.10	11.00
W3	3.30	0.73	25.10	4.20	6.10	10.60

The chemical constituents of the fresh samples were assessed immediately after the preparation of the wine. pH of the three type of wines were found to be 3.60, 3.90 and 3.30 respectively in W1, W2 and W3. Vyas (1982) reported that plum wine showed a pH of 3.9; wild apricot wine had a pH of 2.58 while the wine made

from undiluted pulp of apricot had a pH of 3.80 (Joshi 1990). Vyas (1993) also reported that pH of wines made from Golden apple was found to be 4.5.

Wines prepared showed an acidity of 0.59 - 0.73. The acidity of the passion fruit - pineapple wine was found to be highest (0.73) followed by plain passion fruit wine (0.63) and passion fruit - banana wine (0.59). Studies done by Vyas (1982) indicated an acidity of 0.62 in wine made from plum. According to Joshi (1990), wines made from wild apricot had acidity value of 0.75. Acidity of wine from Golden apple was found to be 0.50 (Vyas, 1993).

Analysis of total soluble solids indicated that the fresh passion fruit-banana wine (W2) was found to have high total soluble solids (28.6) followed by passion-fruit pineapple wine (25.10) and plain passion fruit wine (20.10). Vyas (1982) reported a TSS of 18.00 in the plum wine while in wild apricot wine the TSS was found to be 12.00 (Joshi, 1990).

The residual sugar was found to be highest in passion fruit - banana wine (4.60) followed by in passion fruit-pineapple wine (4.20) and in plain passion fruit wine (3.80).

Vitamin C found in passion fruit was reported to be 27mg/100g in passion fruit (Ramadas, 1988) whereas in pineaple and banana it was found to be 24mg/100g and 10mg/100g respectively. Vitamin C was found to be highest in plain passion fruit wine (6.90) followed by passion fruit-pineapple wine (6.10) and passion fruit-banana wine (5.10).

Alcohol provides body mass,solvent, flavour, mouthfeel, bite and punch (Ashurst, 1986).Alcohol per cent was found to be highest in passion fruit-banana wine (11.00) followed by passion fruit-pineapple wine (10.60) and plain passion fruit wine (9.00). According to Vyas (1982), plum wine had an alcohol percentage of 8.0 per cent. Wine produced from Golden apples had an alcohol percentage of 8.04 (Vyas, 1993).

4.2.3 *Assessment of chemical constituents in jelly*

Chemical constituents of passion fruit rind jelly and that of blended jelly were assessed. Results are presented in the Table 9.

TABLE 9

Chemical constituents of fresh jelly

Type of Products	pH	Acidity Citric acid/g	TSS (%)	Total Sugar (%)	Vitamin C (%)
J1	3.30	0.55	65.10	42.20	2.60
J2	3.00	0.75	68.05	44.10	3.50
J3	3.10	0.72	66.00	42.60	3.90

As per the above table, the pH of the three jelly products were 3.30 in plain passion fruit rind jelly (J1), 3.00 in passion fruit rind-banana jelly (J2) and 3.10 in passion fruit rind-papaya jelly (J3). Correspondingly acidity of J2 was found to the highest 0.75 in J2 and lowest in J1 (0.55). According to Siddappa (1986), acid is essential for pectin-gel formation, and without it jelly of good taste cannot be made. Slight variation was seen in the total soluble solid of the products. TSS was found to be highest in J2 (68.05) closely followed by J3 (66.00) and J1 (65.10).

The vitamin C content of the prepared jelly ranged from 2.6 to 3.9. The highest vitamin C value (3.90) was noted in passion fruit rind-papaya jelly. The values obtained for passion fruit rind-banana jelly was 3.50 and that of plain passion fruit rind jelly was 2.60.

The chemical constituents of all the three products of passion fruit viz. RTS beverage, wine and jelly were compared. The pH was found to be almost same in all the three products. The lowest value for pH was secured by passion fruit-lime RTS beverage (2.83) while that of passion fruit-banana wine secured the highest value (3.90). The acidity value of products showed marked variation. Among the different products RTS beverage was found to have low acidity while that of wine and jelly were of moderate levels and it showed a range of 0.59-0.73 and 0.55-0.75 respectively. Among the three products the TSS of the jelly was found to be high as expected and it was followed by wine and RTS beverage. In wines, since the major portion of the total sugar was converted to alcohol, the residual sugar was found in a very low amount.

With regard to the vitamin C content passion fruit-lime RTS beverage was found to have moderate amounts of vitamin C followed by passion fruit-pineapple RTS. Among the products Jelly had a very low vitamin C content.

4.3 Organoleptic assessment of the fresh products

Sensory evaluation of food is assumed to be of increasing significance as this provides information which may be utilized for product development (George, 1994). The organoleptic qualities

of the products can be assessed by sensory evaluation. According to Mahony (1985), the organoleptically assessed samples formed a true representative of the products developed and organoleptic assessment stands essential for the further development of the product. According to Kramer and Twigg (1970), food quality detectable by our senses can be broken down into the main categories viz appearance, texture and flavour.

According to Kramer (1970), among the various quality attributes, taste is the primary and most important one.

The first impression of a food is usually visual, and a major part of our willingness to accept a food depends upon its appearance. According to Birch (1977), the appearance is the compound of all information about the product and its environment which reaches the eyes. As the consumer preference to appearance is one of the major factor leading to the increasing demand of the product, it is very essential to keep the appearance of the product quite attractive (Christianson, 1985). According to Peterson (1979), the relationship between colour and other sensory attribute and nutritional factors of food often exist but the fact remains that if the primary impression of the food, and if the total colour and total appearance are judged unacceptable the food is summarily rejected. According to

Potter (1986), food colour determines quality$, and also function as a common index of spoilage.

All our senses are utilized in the appreciation of flavour of the food. According to Heath (1978), flavour is a substance which may be a single chemical entity or a blend of chemicals of natural or synthetic origin whose primary purpose is to provide all or part of particular flavour or effect to any food or other products taken into the mouth. Stillman (1993) stated that flavour is seen in several sensations originating from the elementation of taste receptors, olfactory receptors and nerve fibres registering touch and chemical feelings. Hence flavour is very important and our diet by itself can be unattractive, unappreciating and often lacking in intrinsic flavour that it is insipid and quite unpalatable.

According to Matz (1962) texture has long been recognised as an important element in the total sensory impression obtained during the consumption of the food. It is becoming increasingly evident that some form of texture measurement is highly desirable in the grading of nearly all foods. British Standard Institution (1975) define texture as the attribute of the substance resulting, in the combination of physical property perceived by the senses of taste, sight and hearing. Physical properties may

include size, shape, number, nature and confirmation of constituent structural element. According to Potter (1986), the range of texture in food is very great and the departure from an expected texture is a quality defect.

Taking into consideration of all the above factors sensory qualities of the products under study were evaluated in terms of attributes viz. taste, appearance, flavour, colour and texture. Panel members which constituted ten in number assessed the organoleptic qualities and the results were based on the mean scores obtained for each quality attribute.

4.3.1 *Organoleptic assessment of RTS beverage*

The three blends of RTS beverage prepared were evaluated by the panel of ten judges. The mean score obtained is given in Table 10.

TABLE - 10

Organoleptic assessment of fresh RTS beverage

Type of products	Mean scores (for quality attributes)					Overall acceptability
	Taste	Appear Rance	Flavour	Colour	Clarity	
R1	4.4	4.3	4.2	5.0	2.6	4.1
R2	5.0	5.0	5.0	5.0	3.0	4.6
R3	4.9	5.0	4.8	4.9	2.9	4.5

The above table indicates that among the three types of RTS prepared, in taste attribute score, passion fruit-pineapple blend RTS was found to be scored high (5.0) closely followed by passion fruit - lime RTS (4.9) and plain passion fruit RTS beverage(4.4) indicating that the pineapple and lime when blended with passion fruit produced a rich taste. In appearance attribute, passion fruit-pineapple RTS beverage(R2) and passion fruit-lime RTS beverage (R3) had maximum score of 5.0, while plain passion fruit RTS (R1) obtained a medium score of 4.3. This is mainly due to the cloudiness appeared in the juice. The clondiness was comparatively less in the blended RTS. The flavour scores of plain passion fruit RTS beverage was found to be low (4.2). This may be due to the intense flavour of passion fruit but when it was blended with pineapple and lime, the scores were found to be more and it was 5.0 and 4.8 respectively in passion fruit-pineapple RTS and passion fruit-lime RTS beverage.

The colour scores of all the three types of RTS beverage showed high acceptance among the judges. The scores were found to be 5.0 each in plain passion fruit RTS beverage and passion fruit-pineapple RTS beverage closely followed by passion fruit-lime RTS beverage(4.9). This clearly indicates that the rich colour of passion fruit juice itself is attractive and it blends

well with pineapple juice ~~fruit~~ and lime juice. However clarity attribute scores of all the fresh RTS beverage(R1, R2 and R3) were found to be low and it was 2.6, 3.0 and 2.9 respectively. This is assumed to be due to cloudiness, which affected both the appearance and clarity. Though in the present study addition of clarifying substance is not envisaged, the addition of clarifying substance improve the quality of RTS beverage.

Among the RTS beverages prepared passion fruit-pineapple blend was found to be the most accepted RTS beverage among judges followed by passion fruit-lime blended RTS and plain passion fruit RTS beverage. It is also worth mentioning that all the three RTS beverage prepared scored above 4.0 in overall acceptability.

4.3.2 *Organoleptic assessment of wine*

The wines prepared with passion fruit and blended with other fruits were evaluated by the panel members. The mean scores obtained are presented in Table 11.

TABLE - 11

Organoleptic assessment of fresh wine.

Type of Products	Mean scores for quality attributes						Overall acceptability
	Taste	Appearance	Flavour	Colour	Clarity	Strength	
W1	4.4	3.0	3.0	5.0	2.0	2.8	3.4
W2	4.7	3.0	4.0	4.0	4.0	3.2	3.8
W3	4.5	3.0	3.0	3.9	3.0	3.0	3.4

The above table indicates that among the three types of wines prepared, in taste attribute, passion fruit-banana wine (W2) scored highest (4.7) followed by passion fruit -pineapple wine (4.5) and plain passion fruit - wine (4.4). High scores obtained for taste attribute may be due to the presence of residual sugar in the wine during the initial stages as reported by Amerine (1972).

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.

Appearance attribute scored comparatively low in all the three wines (3.0). This may be due to the fact that the suspended fruit particles gave a cloudy look which is not an appealing

characteristic of wines. This attribute will be improved during storage. According to Amerine (1972), appearance of the wine increased gradually during storage.

Singletone and Ough (1962) reported that the single characteristic most important in making wine an attractive beverage is the complexity of flavour. The main ingredient in wine, decides the particular flavour produced in the wine (Maud, 1991). Mean flavour score was found to be 3.0 each in plain passion fruit wine and passion fruit-pineapple wine. Passion fruit-banana wine was observed to have score of 4.0 indicating that the above combination scored high in flavour. Vyas (1993) reported that wine of pleasing flavour could be made from fruits containing tannins. Tannins are present in banana and that contributed for the high score in passion fruit-banana wine.

The colour attribute scores in the wines ranged from 3.9 - 5.0 . Plain passion fruit wine obtained the maximum score of 5.0 due to the rich yellow colour of passion fruit pulp. Low score of 3.9 was obtained by passion fruit -pineapple wine. The clarity attribute scores ranged from 2.0-4.0. The passion fruit-banana wine obtained a high score of 4.0 followed by passion fruit-pineapple wine (3.0) and plain passion fruit wine (2.0). Since

the colour and clarity determine the appearance attribute, the low score for clarity and high scores of colour has resulted in the average scores in appearance attribute in the wines.

The strength of the wine depends upon the alcohol percentage. (Amerine, 1972). The alcohol percentage of passion fruit-banana wine was the highest and hence in strength it scored the highest(3.2) followed by passion fruit-pine apple wine(3.0) and plain passion fruit wine (3.0). Overall acceptability of the wines indicated that passion fruit-banana wine (W2) was found to be highly acceptable (3.8) followed by plain passion fruit wine and passion fruit-pineapple wine, (score 3.4 each).

4.3.3 *Organoleptic assessment of jelly*

Jellies prepared with passion fruit rind as a major ingredient were assessed for organoleptic qualities. Mean scores for quality attributes are presented in Table 12.

TABLE - 12

Organoleptic assessment of fresh jelly

Type of products	Mean scores for quality attribute					Overall acceptability
	Taste	Appearance	Flavour	Colour	Texture	
J1	4.1	4.4	4.2	4.0	4.1	4.2
J2	5.0	5.0	5.0	5.0	4.7	4.9
J3	4.6	4.7	4.9	4.9	4.9	4.8

As indicated in the table the taste attribute scores of passion fruit rind-banana jelly scored maximum (5.0) closely followed by 'passion fruit rind-papaya jelly (4.6) and plain passion fruit rind jelly (4.1). Passion fruit rind which is fairly good source of pectin, together with banana produced acceptable jelly with good taste. In appearance also the passion fruit rind banana jelly secured maximum score of 5.0 which was followed by passion fruit rind-papaya jelly (4.7) and plain passion fruit rind jelly (4.4). The same trend was found in flavour and colour attribute, in passion fruit rind-banana jelly (J2) with a maximum score of 5.0 . Passion fruit rind-papaya jelly also obtained a score of 4.9 for texture attribute closely followed by passion fruit rind-banana jelly (4.7). Overall acceptability scores showed that J2 was found to be highly

acceptable being secured a high score of 4.9 which was followed by passion fruit rind papaya jelly (4.8) and plain passion fruit rind jelly(4.2).

The three different products prepared utilizing passion fruits and in combination with other fruits for quality attributes were compared. The highest score for quality taste attribute (5.0) was obtained by two products viz. passion fruit-pineapple RTS beverage and passion fruit rind-banana jelly. Rest of the products obtained scores above 4.0. Wine obtained a low score of 3.0 for appearance while for the other two products (RTS beverage and jelly) the scores were well above 4.3. RTS beverage and jelly has almost same range of scores for flavour (4.2-5.0) while it was slightly low for wine (3.0-4.0). The colour attribute scores were found to be well above 3.9 in all the three products. Results confirms that three type of RTS beverages and Jellies were well acceptable to the judges as evidenced in the results. In the case of wines comparatively low scores were secured, for overall acceptability. Generally taste and other characters in wine improve only with storage. This may be the reason for low acceplability of the fresh wines.

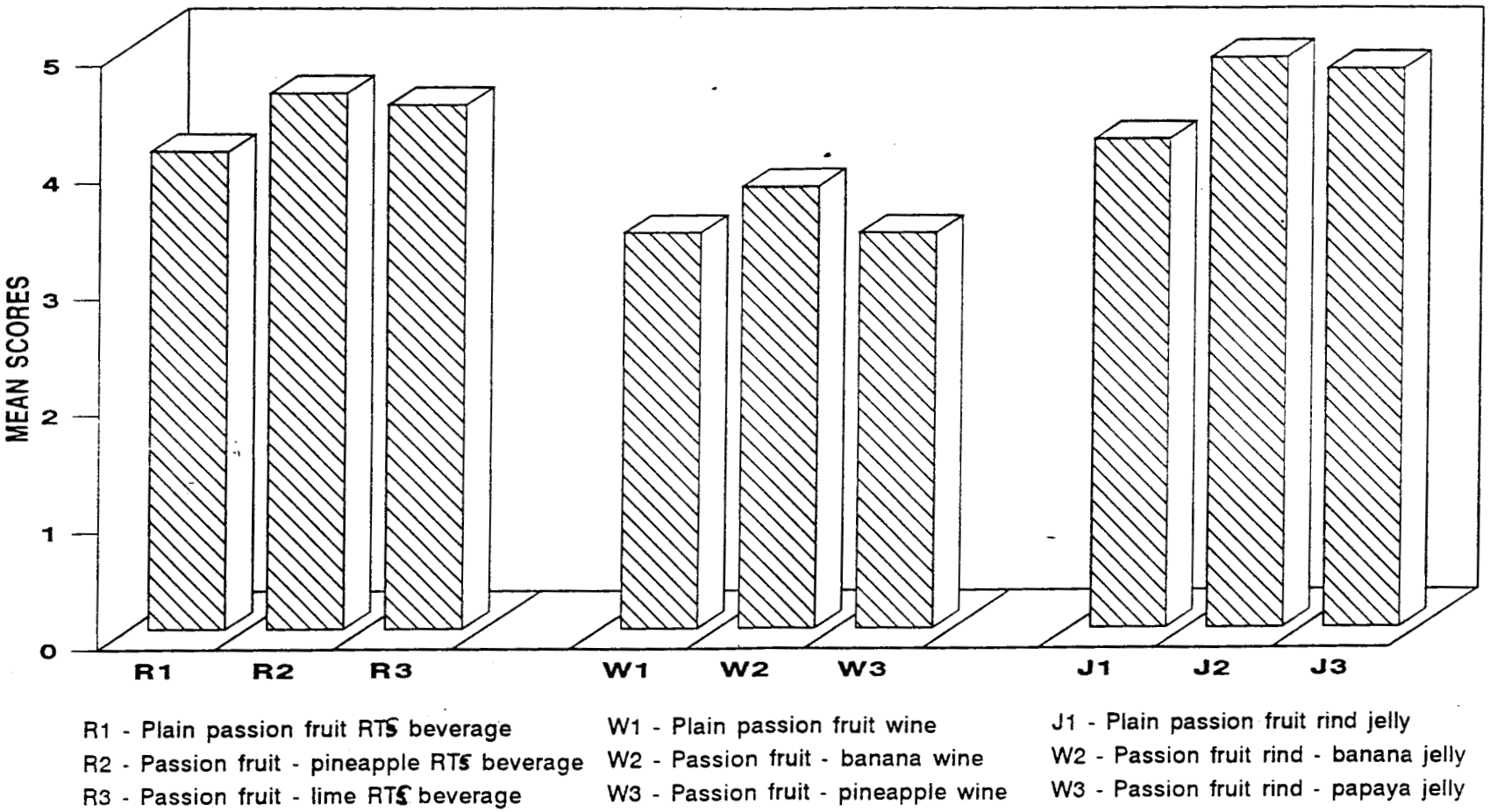


Fig. 8. Overall acceptability of the fresh products

4.4 ASSESSMENT OF THE CHANGES IN CHEMICAL COMPONENTS OF THE PRODUCTS DURING STORAGE.

Chemical components undergo changes when the product are stored for a longer period. The changes in the chemical components in the processed foods are indicative of the deteriorative changes in the products. Hence the periodical(weekly/monthly) assessment of the chemical components of the products are essential.

4.4.1 Assessment of chemical components of RTS beverage with storage.

The changes in the pH of three types of RTS beverage are presented in the table 13

TABLE - 13

Changes in the pH of RTS beverage during storage

Type of Products	Storage period (in weeks) 1	2	3	4	5
R1	3.50	3.49 (0.30)	3.48 (0.60)	3.46 (1.10)	3.42 (2.20)
R2	3.62	3.62	3.61 (0.30)	3.60 (0.60)	3.60 (0.60)
R3	2.83	2.83	2.82 (0.40)	2.80 (1.00)	2.78 (1.70)

CD (interaction) : 0.013
The values in the parenthesis indicate the percentage variation

The above table indicates that a decrease in pH was observed in RTS beverage during storage. Passion fruit pineapple and lime was found to have pH of 2.80, 3.65 and 1.80 respectively. The pH of plain passion fruit RTS beverage (R1) ranged from 3.50-3.42 during a period of five weeks and the decrease was accounted to be 2.20 per cent. The pH of passion fruit-pineapple RTS beverage (R2) ranged from 3.62-3.60 with a decrease of 0.60 per cent. While the pH of passion fruit-lime RTS beverage (R3) ranged from 2.83-2.78 and there was a decrease of 1.70 per cent.

Decrease in pH value was interpreted statistically. Results indicated that R1 showed a highest difference in pH (0.04) during the 4th and the 5th week. A highest significant difference of 0.04 in R1 and 0.02 each in R2 and R3 was found in pH during 4th and 5th week. This difference may be attributed to the change in the acidity of the products after 3rd week of storage There was a difference of 0.01 in pH between 1st and 3rd week in passion fruit-lime RTS beverage(R3). The highest difference (0.02) was during the 4th and 5th week. Earlier studies conducted by Palaniswamy (1971) revealed that there was a fall in pH in case of lime ginger cocktail and gingerale during storage. Chakraborthy (1993) pointed out that clarified watermelon juice when stored for 5 months at room temperature showed a decrease

in pH. Similar trend in pH was noticed in tomato concentrate by Sethi (1994). The above findings were in tune with the results obtained in the present study.

Contradictory to the above results, analysis of citrus juice by Mehta et al (1983) revealed that there was no change in pH in citrus juice during storage. Vyas (1989) found that there was no change in pH in the Rhodopetal RTS. Tripathi et al. (1988) revealed that due to the chemical changes, a slight change in pH was noticed in amla juice. A study done on grape juice by Perlette (1992) failed to reflect any change in pH during 24 weeks of storage.

The changes in acidity of RTS beverages during storage is presented Table 14.

TABLE - 14

Changes in the acidity of RTS beverage during storage

Type of products	storage period (in weeks) 1	2	3	4	5
R1	0.16	0.16	0.16	0.17 (5.80)	0.17 (5.80)
R2	0.15	0.15	0.16 (6.20)	0.16 (6.20)	0.16 (6.20)
R3	0.17	0.17	0.17	0.18 (5.50)	0.18 (5.50)

CD (interaction) : 6.7
The values in the parenthesis indicate the percentage variation

The acidity of RTS beverage was found to increase slightly during storage in all the three RTS beverage blends. Acidity values range from 0.16-0.17 in plain passion fruit RTS beverage(R1), 0.15-0.16 in Passion fruit-pineapple RTS beverage(R2) and 0.17-0.18 in Passion fruit-lime RTS beverage(R3) during the storage period of five weeks. The increase in acidity value was accounted to be 5.8 per cent in R1, 6.20 per cent in R2 and 5.5 per cent in R3. It was observed that the acidity remained unchanged till third week in R1 and R3 while for R2 it remained unchanged till second week. Increase in acidity value during storage corresponds to the drop in the pH value of the products . Thus the increase in the acidity was found to be maximum in passion fruit-pineapple RTS beverage(R2) followed by plain passion-fruit RTS beverage and passion fruit-lime RTS beverage..

Statistical analysis of the data showed no significant difference in acidity in three blends of RTS beverage during the storage period.

Earlier studies conducted by various researches observed either decreasing or increasing trends in acidity in the products during storage. Palaniswamy et al. (1974) observed an increase in acidity in lime-ginger cocktail and gingerale 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 (1985) 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) had also noticed similar trends in tomato juice concentrate. Shelf-life studies in whole tomato concentrate, showed an increasing in titrable acidity by 2.08 per cent (Sethi, 1994).

A decreasing trend in acidity was observed. Acidity in stored apple juice (Shreshta, 1982), Jamun beverage (Khurdiya 1984), muskmelon-mango beverage (Teotia, 1992) and in grape juice (Perlette, 1992) during storage.

No appreciable change in the acidity was reported in Rhodopetal RTS beverage by Vyas (1989). Kalra (1991) found that there was no change in acidity in the market fruit drinks stored for six months. He had also reported that acidity does not change significantly during twelve months of storage of mango - papaya blend beverage. The Kinnow RTS beverage stored at ambient conditions when evaluated showed negligible changes in acidity (Ranote et al. 1992).

Change in the total soluble solids of RTS beverage during storage is presented in Table 15

TABLE - 15

Changes in the total soluble solids of RTS beverage during storage

Type of Product	Storage period (in weeks) 1	2	3	4	5
R1	14.00	14.00	14.00	14.00	14.00
R2	12.45	12.45	12.45	12.45	12.45
R3	18.60	18.60	18.60	18.60	18.60

CD (interaction) : 0.31

As indicated in the above table the total soluble solids of RTS beverage during the storage period was 14.00, 12.45 and 18.60 respectively in plain passion RTS,passion fruit-pineapple RTS and passion fruit-lime RTS beverage. Katiyar(1967) observed that the muskmelon fruit beverage showed a TSS of 13^{0} Brix. Physico-chemical analysis of RTS beverage prepared from passion fruit showed a TSS of 14^{0} Brix (Annapurna, 1977). According to Adsule (1992) the total soluble solids of ber RTS was found to be 15.

The statistical analysis of the data showed no difference in TSS in the three blends during storage period. The total soluble solids of RTS was found to remain the same throughout the shelf life period in all the three blends. This observation was in line with the earlier studies conducted. According to Shreshta (1982), there was practically no change in total soluble solids during storage in apple juice. Similarly there was not much change in total soluble solids in jamun beverage during storage (Khudriya, 1982). According to Waskar (1987), minor changes were observed in the TSS of Phalsa beverage during storage at room temperature. No appreciable variation was noted in the total soluble solids in fresh and stored litchi sample (Jain, 1988). Analysis of total soluble solid of RTS nectar from rhodopetals did not show any appreciable change during storage (Vyas, 1989). During the quality evaluation of fruit drinks, TSS was found to remain unchanged. Kalra et al. (1991) reported that,no significant change in TSS in mango-papaya blended beverage stored over a period of one year at ambient temperature. Similarly Kinnow RTS stored at ambient condition over 24 weeks (Shah and Bains 1992) and Kinnow juice over a period of 6 months (Ranote et al. 1993) had indicated negligible change in total soluble solids.

In contradiction to the above results, the total soluble solids of tomato juice concentrate was observed to decline with storage, (Thirumaran et al 1990). According to Chakraborty et al. (1993) total soluble solids declined in the clarified watermelon juice after 5 months storage at room temperature .

Guava pulp stored at different temperature showed an increase in total soluble solids within forty five days of storage (Kalra and Revath 1981). Mehta and Bajaj (1983) also observed increase in total soluble solids in citrus juice during storage at room temperature. Sethi(1985) reported that Litchi juice stored at room temperature and low temperature showed a rise in total soluble solids.

The Charges in the total Sugar Content of RTS beverage during storage is presented in Table - 16.

TABLE - 16

Changes in the total sugar of RTS during storage

Type of Product	Storage period (in weeks) 1	2	3	4	5
R_1	12.80	12.80	12.80	12.70 (0.78)	12.70 (0.78)
R_2	13.60	13.60	13.50 (0.73)	13.50 (0.73)	13.50 (0.73)
R_3	11.55	11.55	11.45 (0.86)	11.45 (0.86)	11.45 (0.86)

CD (interation) : 0.39

The values in the parenthesis indicates the percentage variation in total sugar.

As indicated in the above table there is a slight decline in the total sugar during storage in RTS beverage and it ranged between 12.80 - 12.70 in plain passion fruit RTS beverage (R_1), 13.60 - 13.50 in passion fruit - pineapple RTS beverage (R_2) and 11.55 - 11.45 in passion fruit - lime RTS beverage (R_3).

Bawa and Saini (1987) reported that during the storage of Carrot Juice the total sugar was found to decline by 0.14 per cent when stored at room temperature compared to a decline of 0.04 per cent at low temperature storage.

The changes in the vitamin C of three types of RTS beverage during storage is presented in the Table 18.

TABLE 18

Change in the vitamin C content of RTS beverage during storage

Type of products	Storage Period (in weeks) 1	2	3	4	5
R1	6.0	5.8 (3.3)	4.3 (28.3)	2.8 (53.3)	1.3 (78.3)
R2	11.6	11.0 (5.1)	8.3 (28.4)	4.3 (62.9)	1.3 (88.7)
R3	15.5	13.0 (16.1)	7.0 (54.8)	5.6 (63.8)	2.7 (82.5)

CD (interaction): 0.52.
The values in the parenthesis indicate the percentage variation

Vitamin C is essential for the normal functioning of our body and it protects essential fatty acids, essential amino acids, vitamin A, vitamin E, thiamine and folic acid.

There was a decline in the vitamin C content in the three blends of RTS beverage during storage. The vitamin C content of RTS beverages ranged between 6.0-15.5 during the initial period. However the values decreased from 6.0 to 1.5 in R1, 11.6 to 1.3 in R2 and 15.5 to 2.7 in R3 during the storage period. The decrease was observed to be 78.3 per cent in R1, 88.7 per cent in R2 and 82.5 percentage in R3, during storage. Vitamin C is strong antioxidant and it oxidises itself resulting in the high decline

of vitamin C during storage. Kalra (1991) reported that during storage, vitamin C content decreased by 50 percentage in all market drinks except guava, in which the vitamin C retention was better.

Statistical analysis of data indicated that vitamin C content varied during storage. The difference was between the second and third week (1.5) and third and fourth week (1.5) in R1, while in R2 there was a difference in all the weeks and the higher difference value of (4.0) was found during third and fourth weeks. In R3 also there was a significant difference in all the weeks and was found to be highest (6.0) during second and third weeks

From the above findings it can be concluded that chemical components such as pH, total sugar and vitamin C content of prepared RTS beverage decreased during storage. In plain passion fruit RTS beverage the decline in pH initiated in the second week but for passion fruit-pineapple and passion fruit-lime RTS beverage the decline was set only in the third week. Total sugar of plain passion fruit RTS declined only in the fourth week while it declined early in the other two types of RTS beverage. The decrease of vitamin C content was drastic in all the three types of RTS beverage. The total soluble solids was found to remain constant

while there was a steady increase in the acidity. The acidity increased during the third week in passion fruit-pineapple RTS beverage and in the fourth,week in rest of the variations.

4.4.2 *Assessment of changes in chemical components of wine during storage.*

Fermented products are more susceptible to changes in the chemical components during storage. Storage studies in developed wine continued till 12 month period.

The changes in pH in three types of wine during storage is presented in Table 17

During the first month the mean score obtained for pH in plain passion fruit wine, passion fruit-banana wine and passion fruit-pineapple wine ranged between 3.60-3.20, 3.90-3.40 and 3.30-2.90 respectively during 12 months of storage. The pH content of the three types of wine prepared in the present study fall between 3.30-3.90. It was observed that the pH of the wines declined gradually during storage. The decline in pH was found to be 11.11 per cent in W1, 12.82 per cent in W2 and 12.12 per cent in W3.

TABLE 17

Changes in the pH of wine during storage:-

Type of products	Storage period (in months) 1	2	3	4	5	6	7	8	9	10	11	12
W1	3.60	3.60	3.50	3.50	3.50	3.40	3.40	3.30	3.30	3.20	3.20	3.20
			(2.77)	(2.77)	(2.77)	(5.55)	(5.55)	(8.33)	(8.33)	(11.11)	(11.11)	(11.11)
W2	3.90	3.90	3.90	3.90	3.80	3.80	3.70	3.60	3.50	3.50	3.40	3.40
					(2.56)	(2.56)	(5.12)	(7.69)	(10.20)	(10.20)	(12.82)	(12.82)
W3	3.30	3.30	3.30	3.30	3.30	3.10	3.10	3.10	3.10	3.00	2.90	2.90
						(6.06)	(6.06)	(6.06)	(9.09)	(9.09)	(12.12)	(12.12)

CD(interaction) : 4.47
Values in the parenthesis indicates the percentage variation .

Statistical analysis showed that there is no difference in pH during storage in any of the three blends of wine prepared. According to a study done by Adsule (1992), there was no significant change in pH in the fermented grape and pomegranate wine. Alcoholic orange juice beverage showed no appreciable change in pH during its storage (Rodriguez, 1992).

Change in the acidity of three types of wines during storage is presented in Table 19

As per table the acidity of wine during the first month was 0.63, 0.59 and 0.73 respectively in W1, W2 and W3. Sreekantaiah (1966) reported 0.9 percent acidity in grape wines prepared from Banglore Blue variety. Passion fruit-pineapple blended wine was found to show higher acidity (0.73) followed by plain passion fruit wine (0.63) and passion fruit-banana wine (0.59). The acidity of wines prepared was found to increase slightly over the period of shelf life. Variation in acidity was accounted to be 0.63-0.67 in plain passion fruit wine (W1), 0.59-0.62 in passion fruit - banana wine (W2) and 0.73-0.76 in passion fruit-pineapple wine (W3). The increase in acidity was 5.97 per cent in W1, 4.80 per cent in W2 and 3.90 per cent in W3. Vyas (1993), reported an increase in acidity in cider and culled apple fruit wine.

TABLE ~~18~~ 19

Changes in the acidity of wine during storage.

Type of products	Storage period (in months) 1	2	3	4	5	6	7	8	9	10	11	12
W1	0.63	0.63	0.63	0.63	0.64	0.64	0.64	0.65	0.65	0.66	0.67	0.67
					(1.50)	(1.50)	(1.50)	(3.00)	(3.00)	(4.50)	(5.97)	(5.97)
W2	0.59	0.59	0.59	0.60	0.61	0.61	0.62	0.62	0.62	0.62	0.62	0.62
				(1.60)	(3.20)	(3.20)	(3.20)	(4.80)	(4.80)	(4.80)	(4.80)	(4.80)
W3	0.73	0.73	0.73	0.73	0.74	0.74	0.74	0.74	0.76	0.76	0.76	0.76
					(1.30)	(1.30)	(1.30)	(1.30)	(3.90)	(3.90)	(3.90)	(3.90)

CD(interaction) : 1.06
Values in the parenthesis indicates the percentage variation.

Statistical analysis of data indicated no significant difference in the acidity in three types of wine during storage. Adsule (1992) reported that there was no significant change in the acidity in fermented grape and pomegranate juice. Rodriguez (1992) found that alcoholic orange juice beverage during storage showed no appreciable change in acidity.

The change in total soluble solids in three types of wines during storage are presented in Table ~~19~~ 20.

The total soluble solids of the three wines were found to range between 20.10 - 28.60 during the first month. The passion fruit-banana wine was found to have highest TSS (28.60) followed by passion fruit-pineapple blend and plain passion fruit wine. Decline in the TSS was found to be 0.49 per cent in plain passion fruit wine, 0.35 per cent in passion fruit-banana wine and 0.39 percent in passion fruit-pineapple wine.

Statistical analysis of data showed no significant difference in TSS in three types of wines during storage. But there was slight decline in TSS from 5th month onwards in all the three types of wines. Unfermented sugar present in the wine may convert to alcohol and this could be the reason for the change in

TABLE ~~19~~ 20

Changes in the TSS of wine during storage:-

Type of products	Storage period (in months) 1	2	3	4	5	6	7	8	9	10	11	12
W1	20.10	20.10	20.10	20.10	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
					(0.49)	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)
W2	28.60	28.60	28.60	28.60	28.50	28.50	28.50	28.50	28.50	28.50	28.50	28.50
					(0.35)	(0.35)	(0.35)	(0.35)	(0.35)	(0.35)	(0.35)	(0.35)
W3	25.10	25.10	25.10	25.10	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
					(0.39	(0.39)	(0.39)	(0.39	(0.39)	(0.39)	(0.39	(0.39)

CD(interaction) : 0.19
The values in the parenthesis gives the percentage variation

TSS.(Kadam et al 1992).TSS of pomegranate wine decreased during storage. Similar results were observed in ber wine by (Chavan et al 1991).

The changes in the residual sugar of the three types of wines during storage are presented in the Table ~~20~~ 21

The passion fruit- banana blend showed a high residual sugar of 4.5 followed by passion fruit - pineapple blend (4.20) and plain passion fruit wine (3.80). The residual sugar present in the wines ranged from 3.80-1.80 in plain passion fruit wine (W1), 4.60-2.40 in passion fruit banana wine (W2) and 4.20-1.80 in passion fruit pineapple wine (W3). As per the table there was a steady decline in the residual sugar in wine during storage. The decline in residual sugar was found to be 52.60 per cent in W1, 47.80 per cent in W2 and 57.10 per cent in W3. The conversion of residual sugar into alchohol results in the decline of residual sugar during storage. It was also observed that there was no change in residual sugar till four months of storage in the three blends, however a slight decrease in residual sugar was found after four months, though the difference was not significant when statistically analysed.

TABLE ~~20~~ 2/

Changes in the residual sugar of wines during storage.

Type of product	Storage period (in month) 1	2	3	4	5	6	7	8	9	10	11	12
W1	3.80	3.80	3.80	3.80	3.70	3.70	3.20	3.20	2.80	2.00	1.80	1.80
					(2.60)	(2.60)	(15.70)	(15.70)	(26.30)	(47.30)	(52.60)	(52.60)
W2	4.60	4.60	4.60	4.60	4.50	4.20	4.20	4.00	3.60	3.20	2.40	2.40
					(2.10)	(8.60)	(8.60)	(13.00)	(21.70)	(30.40)	(47.80)	(47.80)
W3	4.20	4.20	4.20	4.20	4.20	3.90	3.20	3.00	2.80	2.00	1.80	1.80
					(4.7)	(7.1)	(23.8)	(28.5)	(33.3)	(52.30)	(57.10)	(57.10)

CD (interaction) : 7.12
Values in the parenthesis indicates the percentage variation.

The changes in alcohol per cent of wines during storage is given in Table 21

Alcohol is quantitatively the most important component of wine after water (Vradis 1993). The alcohol percentage in passion fruit ~~banana~~ wine (W1) was found to range between 9.00-9.10 , 11.0-11.1 in passion fruit banana wine (W2) and 10.60 - 10.70 in passion fruit pineapple wine (W3). As indicated in the table, the alcohol percentage of wines was found to increase slightly during the shelf life. According to Ethiraj and Suresh (1993), most wines produced in the world are 'still wines' which contain 8-14 per cent alcohol and without excess carbondioxide. A drywine prepared from Banglore Blue grape had about 15 per cent alcohol (Sreekantiah, 1966). Fermented muskmelon juice with 6.5 per cent alcohol was adjudged to be the best by sensory panel (Teotia, 1991). In cider wine alcohol content was 1.1 per cent whereas in culled apple wine alcohol per cent was 8-10 per cent (Vyas, 1993). The alcohol percentage of wild apricot wine was 10.65 (Joshi, 1990).

There was a slight increase in the alcohol percentage from 4th month to the 12th month. The increase was found to be 1.09,0.90 and 0.93 in W1, W2 and W3 respectively. This increase was due to the conversion of residual sugar into alcohol during storage.

TABLE 22

Changes in the alcohol percentage in wine during storage.

Type of products	Storage period (in months) 1	2	3	4	5	6	7	8	9	10	11	12
W1	9.00	9.00	9.00	9.00	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10
					(1.09)	(1.09)	(1.09)	(1.09)	(1.09)	(1.09)	(1.09)	(1.09)
W2	11.00	11.00	11.00	11.00	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10
					(0.90)	(0.90)	(0.90)	(0.90)	(0.90)	(0.90)	(0.90)	(0.90)
W3	10.60	10.60	10.60	10.60	10.70	10.70	10.70	10.70	10.70	10.70	10.70	10.70
					(0.93)	(0.93)	(0.93)	(0.93)	(0.93)	(0.93)	(0.93)	(0.93)

CD (interaction) : 0.20
Values in the parenthesis indicates the percentage variation.

When the data was statistically analysed the variation in alcohol percentage during the storage was not found to be significant storage. Rodriguez (1992) reported that the alcoholic orange juice beverage showed no appreciable change in alcohol content at $40^{o}C$

The mean change in the vitamin C content of wines during storage is given in the table 23

The vitamin C content of wine during the first month was 5.10-6.90. The plain passion fruit wine had high vitamin C (6.90) followed by plain passion fruit pineapple blend (6.10)and passion fruit banana blend (5.10). As indicated in the table, the vitamin C content of wines declined during storage. The vitamin C content in W1, W2, W3 varied from 6.90 - 2.90, in plain passion fruit wine 5.10 - 2.90 in passion fruit-banana and 6.10-1.90 in passion fruit-pineapple wine respectively. Over a period of 12 months a decrease in vitamin C was observed and the decrease was found to be 57.90 per cent in W1, 66.60 per cent in W2 and 68.85 per cent in W3.

When the data was statistically analysed, W1 showed the highest difference during 4th and 5th month (0.8). In W2 the highest difference (0.6) was found during the 7th and 8th month

TABLE ~~22~~ 23

Changes in the vitamin C content of wine during storage

Type of products	Storage period (in months) 1	2	3	4	5	6	7	8	9	10	11	12
W1	6.90	6.90	6.70	6.60	5.80	5.60	4.40	4.00	3.60	3.00	2.90	2.90
			(2.89)	(4.34)	(15.94)	(18.84)	(36.23)	(42.02)	(47.82)	(56.52)	(57.52)	(57.90)
W2	5.10	5.10	4.70	4.40	4.10	3.90	3.40	2.70	2.10	2.00	1.70	1.70
			(7.84)	(13.7)	(19.60)	(23.52)	(33.30)	(47.09)	(58.80)	(60.70)	(66.60)	(66.60)
W3	6.10	6.10	5.90	5.70	5.10	4.90	3.90	3.30	2.50	1.10	1.90	1.90
			(3.27)	(6.55)	(16.39)	(19.67)	(36.06)	(45.90)	(59.01)	(65.57)	(68.85)	(68.85)

CD (interaction) : 0.49
Values in the parenthesis indicates the percentage variation.

and lowest difference during the 6th and 7th month . In W3 the highest difference in vitamin C was found during 6th and 7th month (1.0). The wines prepared in the present study were stored at room temprature which might have contributed to the loss of vitamin C, due to oxidation.

From the above findings it can be concluded that the chemical component such as pH, TSS, residual sugar and vitamin C content of the wines prepared in the present study decreased during storage in all the three types. Whereas there is an increase in acidity in all the three types of wines.

4.4.3 *Assessment of changes in chemical components of jelly during storage.*

During storage various changes occurs to the chemical constituents in jelly. These changes are discussed below.

Changes in the acidity of jelly during storage is given in the Table ~~23~~ 24

TABLE - 23 24

Changes in the acidity of jelly during storage

Type of Products	Storage period (in weeks) 1	2	3	4	5	6
J1	0.55	0.55	0.55	0.56 (1.78)	0.56 (1.78)	0.57 (3.50)
J2	0.75	0.75	0.75	0.76 (1.31)	0.76 (1.31)	0.76 (1.31)
J3	0.72	0.72	0.72	0.73 (1.36)	0.73 (1.36)	0.73 (1.36)

CD (interaction) :9.3
The values in the parenthesis indicates percentage variation

According to Ashurst (1986), acidity gives flavour and offer antimicrobial activity. Acid content is of great importance in fruit juice as it concerns flavour in combination with sugar (Adsule, 1992). The acidity of the product during the first week ranged from 0.55-0.75. Passion fruit rind - banana jelly was found to have comparatively higher acidity (0.75) and it was followed by passion fruit-papaya jelly (0.72).

As indicated in the table the acidity was found to increase gradually during storage in all the three blends of jelly prepared. The acidity values ranged from 0.55-0.57 in J1, 0.75-0.76 in J2 and 0.72- 0.73 in J3. The percentage of increase was found to be 3.50 per cent in J1, 1.31 per cent in J2 and 1.36

per cent in J3. According to Bhatia et al. (1993) there was an increase in the acidity of culled apple jelly.

Statistical analysis of the jellies indicated no significant difference in acidity during storage in the three types of jellies prepared.

The change in the pH in jelly during storage is given in Table ~~24~~ 25.

TABLE - ~~24~~ 25

Changes in the pH of jelly during storage.

Type of Products	Storage period (in weeks) 1	2	3	4	5	6
J1	3.3	3.3	3.3	3.1 (6.0)	3.1 (6.0)	3.0 (9.0)
J2	3.0	3.0	3.0	2.9 (3.3)	2.9 (3.3)	2.8 (6.6)
J3	3.1	3.1	3.1	3.0 (3.2)	2.9 (6.4)	2.9 (6.4)

CD (interaction) : 2.7
The values in the parenthesis indicates the percentage variation

As per the table, pH of the product was found to decline during storage and the decline was found to be 9.0 per cent in J1, 6.6 per cent in J2 and 6.4 per cent in J3. According to Swaminathan (1979), in the formation of jelly of good quality the hydrogen ion concentration of jelly mixture should be between

3.0-3.3. The pH of jelly prepared was found to range between 3.3-3.0 in plain passion fruit rind jelly (J1), 3.0-2.8 in passion fruit rind-banana jelly (J2) and 3.1-2.9 in passion fruit rind papaya jelly (J3) over a period of six months. The pH of the three products during the 1st week was found to range between 3.0-3.3. Increase in acidity during the 4th week of storage resulted in the decrease in pH of the products . The acidity remained unchanged till the first three weeks in all the three types of jellies. A high acidity of passion fruit rind-papaya jelly showed a correspondingly low value of pH (3.0). Similarly a low acidity (0.55) of passion fruit rind-jelly showed a high pH (3.3)

Statistical analyses of the three products indicated no significant difference in the pH of the jellies during storage.

The changes in the total soluble solids of jelly during storage is given in Table 25 26

TABLE - ~~25~~ 26

Changes in the total soluble solids of jelly during storage

Type of Products	Storage period (in weeks) 1	2	3	4	5	6
J1	65.10	65.10	65.10	65.10	65.10	65.10
J2	68.05	68.05	68.05	68.05	68.05	68.05
J3	66.00	66.00	66.00	66.00	66.00	66.00

CD (interaction): 0.19

The total soluble solids of the jellies varied from 65.10-68.05 during the first week. According to Swaminathan (1979),the final product of jelly should have 65 per cent total soluble solids. The passion fruit rind-banana jelly was found to have high total soluble solids (68.05),closely followed by passion fruit rind-papaya blended jelly (66.00) and plain passion fruit jelly. It was observed that the TSS remain unchanged during the storage period.

Statistical analysis showed no significant difference in the products during storage.

The change in the total sugar of Jelly during storage is given in Table ~~26~~ 27

TABLE - ~~26~~ 27

Changes in the total sugar of jelly during storage

Type of products	storage period (in weeks) 1	2	3	4	5	6
J1	42.20	42.10	42.10	42.00 (0.24)	42.00 (0.47)	42.00 (0.47)
J2	44.10	44.10	44.00 (0.22)	44.00 (0.22)	44.00 (0.22)	44.00 (0.22)
J3	42.60	42.60	42.60	42.50 (0.23)	42.50 (0.23)	42.40 (0.47)

CD (interaction) : 7.6
The values in the parenthesis indicates the percentage variation

The total sugar content of the jellies ranged between 42.20-42.00 in plain passion fruit rind jelly (J1), 44.10-44.00 in passion fruit rind-banana jelly (J2) and 42.60-42.40 in passion fruit rind-papaya jelly (J3). As indicated in the above table, the total sugar of jelly was found to decline during storage. The decline was found to be 0.47 per cent in J1 and J3 and 0.22 per cent in passion fruit rind-banana jelly(J2).

Statistical analysis of the products showed no significant difference in the total sugar in all the three type of jellies prepared during the six weeks of storage.

The change in the vitamin C content of jelly during the storage is given in the Table ~~27~~ 28

TABLE - 27 28

Changes in the vitamin C content of jelly during storage.

Type of products	Storage period (In weeks) 1	2	3	4	5	6
J1	2.60	2.60	2.60	1.80 (30.70)	1.10 (57.60)	1.10 (57.60)
J2	3.50	3.50	2.70 (22.80)	1.60 (54.20)	1.60 (54.20)	1.10 (68.50)
J3	3.90	3.90	2.80 (28.20)	2.70 (30.70)	2.60 (33.30)	2.30 (41.00)

CD (interaction) : 6.9
The values in the parenthesis indicates the percentage variation

The vitamin C content of jelly ranged from 2.60 -1.10 in plain passion fruit rind jelly (J1), 3.50-1.10 in passion fruit rind-banana jelly (J2) and 3.90-2.30 in passion fruit rind papaya jelly (J3). The vitamin C content of the products ranged between 2.60-3.90 during the 1st week of storage. The vitamin C content of J3 was found to be the highest and it was due to high vitamin C content of papaya and this was followed by passion fruit-banana jelly. As indicated in the table, the vitamin C content of jelly showed a decline during storage. The decline was found to be 57.60 per cent in passion fruit rind jelly, 68.57 per cent in passion fruit rind-banana jelly and 41.02 percent in passion fruit rind - papaya jelly.

Statistical analysis showed that there was no difference in the vitamin C content during storage.

From the above findings it can be concluded that the chemical components such as pH, total sugar and vitamin C content analysed decreased during storage. In the three types of jellies prepared in the present study, the decrease in pH was found to be very low and the decline started only in the 4th week in all the three types of RTS bevarage. The decline in the total sugar started only in the 4th week in plain passion fruit rind jelly and passion fruit rind - papaya jelly while the decline started earlier in passion fruit rind - banana jelly (3rd week). There was a massive destruction of vitamin C in all the three types of jellies. The total soluble solids was found to remain constant in all the three types of products. The acidity was found to increase in the 4th week in all the three types of jellies.

4.5 Changes in the organoleptic qualities of the products during storage.

The organoleptic qualities were found to change during storage. The organoleptic qualities of the passion fruit products were assessed till the end of shelf life, details of which are discussed below

Changes in the organoleptic qualities of RTS beverage during storage.

Due to the short shelf life of RTS beverage, assessment of changes in the organoleptic qualities is very important.

The changes in the taste attribute with storage in RTS beverage is presented in Table 28

TABLE – ~~28~~ 29

Mean score for taste attribute of RTS beverage during storage

Type of products	storage period (in weeks) 1	2	3	4	5	6
R1	4.4	4.1 (6.8)	4.1 (6.8)	3.7 (15.9)	3.1 (29.5)	2.2 (50.0)
R2	5.0	4.8 (4.0)	4.7 (6.0)	4.5 (11.1)	4.0 (20.0)	3.0 (40.0)
R3	4.9	4.7 (4.0)	4.4 (10.2)	4.1 (16.3)	3.7 (24.4)	3.2 (34.6)

CD(interaction) : 0.30
The values in the parenthesis indicates the percentage variation

According to Hicks (1990), all soft drinks contain nutrients high enough to support the growth of micro-organism and fruit drinks are particularly vulnerable in this aspect.

The taste attribute scores of RTS beverage was found to decline during storage bringing a bitter taste towards the end of shelf life. The mean score obtained ranged between 4.9-3.2 in plain passion fruit RTS beverage, 5.0-3.0 in passion fruit-pineapple RTS beverage and 4.9-3.2 in passion fruit -lime RTS beverage. The percentage decrease was 50.0 per cent in plain passion fruit RTS beverage, 40.0 per cent in passion fruit-pineapple RTS beverage and 34.6 per cent in passion fruit - lime RTS beverage. The percentage of decline was found to be maximum during the end of the shelf life in all the three types of RTS beverage and higher in plain passion fruit RTS beverage. According to Siddappa (1986), oxygen of the air adversly affect taste and aroma of the food.

When the data was statistically analysed it was found that the significant difference in taste attribute was found to be highest (0.9) during 5th and 6th weeks and lowest during 1st and 2nd weeks (0.3) in the case of R1. In R2 and R3 also the highest significant difference was found during the 5th and 6th weeks (1.0 and 0.5 respectively). Lowest significant difference (0.5)

was observed during 4th and 5th weeks in R2 and there was no significant difference during the rest of the storage period. In R3 the lowest significant difference was found during 2nd to 4th weeks (0.30). From the above results it is clear that plain passion fruit RTS and the other two blends remained acceptable in taste attribute till 3rd week and it started deteriorating after 3rd week. Variation in taste attribute was least in passion fruit-lime blend followed by plain passion fruit and passion fruit - pineapple blend.

According to Mukherjee (1963), during storage the taste of the product change considerably. Investigation on bottled pear juice stored at 24^0-30^0C developed peculiar disagreeable taste towards the end of one year. Since the fruit drinks are inherently susceptible to spoilage by fermentative microrganisms during storage, it brought about deteriorative changes in the taste attribute at the end of the shelf life.

Changes in the appearance attribute in RTS beverage during storage is given in Table 29 30

TABLE - ~~29~~ 30

Mean score for appearance attribute of RTS beverage during storage

Type of products	Storage time (in weeks) 1	2	3	4	5	6
R1	4.3	3.9 (9.3)	3.8 (11.6)	3.2 (25.0)	2.4 (44.0)	2.1 (51.0)
R2	5.0	5.0	4.7 (6.0)	4.4 (12.0)	4.0 (20.0)	3.1 (38.0)
R3	5.0	4.3 (14.0)	4.0 (20.0)	3.8 (24.0)	3.5 (30.0)	2.9 (42.0)

CD (interaction) : 0.37
The values in the parenthesis indicates the percentage variation

According to Hicks (1990), for maximum acceptability the drink must look fresh and should have good fruit appearance.

The appearance scores of RTS was found to decrease during storage and the product gave a dull appearance towards the end of the storage period. The score obtained for appearance attribute was found to be 4.3 in plain passion fruit RTS beverage, 5.0 each in passion fruit pineapple and passion fruit -lime RTS beverage during the 1st week while it ranged between 2.1 and 3.1 at the end of the 6th week. The appearance of R1 declined by 51.0 per cent in plain passion fruit RTS beverage and 38.0 per cent in passion fruit - pineapple RTS and 42.0 percent in passion fruit lime RTS

beverage. The decline in the appearance attribute was found to be maximum towards the end of the storage. It was also noted that passion fruit-pineapple blend remained unaffected till the second week after which slight changes occured in the appearance.

Statistical analysis of the data revealed that R1 showed highest difference in the appearance during 4th and 5th week (0.8) while R2 showed highest difference in appearance during the 5th and 6th week (0.9) while in R3 the highest significant difference was found during 1st and 2nd week (0.7), lowest during 5th and 6th week and no significant difference from 2nd week to the 8th week. The appearance of the passion fruit-lime RTS beverage remained constant during the 2nd to 8th week, and declined during 5th and 6th week due to fading of colours as evidenced in the present study.

The cloudy appearance is an important property of soft drinks like orange - lime and lemon juice since it give natural appeal to the fruit drink (Shamel, 1993).

According to Teotia (1992), the RTS beverage made from muskmelon-mango blend resumed attractive appearance upon shaking the bottle prior to serving. The three types of RTS beverage prepared in the present study gave a cloudy appearance upon

shaking of the bottles. Non-enzymatic and interaction between chemical components may bring changes in the food constituents which attribute to the decline in appearance attribute in the products of the present study.

Changes in the flavour attribute with storage in RTS beverage is given Table 3031

TABLE - 3031

Mean score of flavour attribute of RTS beverage during storage.

Type of products	Storage time (in weeks) 1	2	3	4	5	6
R1	4.2	4.0 (5.0)	3.4 (19.0)	3.1 (26.0)	2.4 (42.0)	1.7 (60.0)
R2	5.0	4.8 (4.0)	4.6 (8.0)	4.5 (10.0)	4.4 (12.0)	3.8 (24.0)
R3	4.8	4.7 (2.0)	4.4 (8.0)	4.1 (15.0)	4.0 (17.0)	3.2 (33.0)

CD (interaction) : 0.39
The value in the parenthesis indicates the percentage variation

The flavour attribute scores decreased during storage and there is development of off-flavour towards the end of the shelf life. The scores of the flavour attribute in three types of fresh products ranged between 4.2-5.0 in three types of RTS beverage during first week which subsequently declined during storage. The mean score of flavour attribute in R1 ranged between 4.2-1.7

while in R2 and R3 it ranged between 5.0-3.8 and 4.8-3.2 respectively. The decrease was found to be 60 per cent in plain passion fruit RTS beverage, 24 percent in passion fruit-pineapple RTS and 33 per cent in passion fruit - lime RTS.

Statistical analysis of the data revealed that R1 showed high significant difference of 0.7 during 4th and 5th week and during 5th and 6th week which showed that there was very high deterioration towards the end of the storage in plain passion fruit RTS beverage. The flavour attribute scores of passion fruit-pineapple RTS beverage (R2) showed no significant difference from the 1st to the 5th week but during the 5th and 6th week there was a significant difference of 0.6. Same trend was also noted in R3 with a difference of 0.8 during the 5th and 6th week. Thus the flavour attribute of passion fruit - pineapple RTS and passion fruit - lime RTS was found to remain constant till the 5th week with out any significant deterioration. Tressler (1968), supported the above finding stating that though passion fruit juice can be preserved by heating, some of the flavour deterioration occur during storage. Freezing is the preffered method of preservation for preserving passion fruit juice. In the present study RTS was stored at ambient conditions and this may be one of the reasons for flavour changes.

Mukherjee (1963), found that pear juice stored for a year at 24 – 30°C developed a disagreeable flavour and was not acceptable. According to Potter (1986), loss of flavour volatiles progress with time. Thorner (1978) reported that regardless of the storage temperature off-flavour will eventually develop and absence of Oxygen cannot retard off- flavour development.

Changes in colour attribute during storage in RTS beverage is given in Table 31

TABLE – 31

Mean score for colour attribute of RTS beverage during storage

Type of products	Storage period (in weeks) 1	2	3	4	5	6
R1	5.0	5.0	4.8 (4.0)	4.4 (12.0)	4.0 (20.0)	3.3 (34.0)
R2	5.0	4.5 (10.0)	4.0 (20.0)	3.9 (22.0)	3.5 (30.0)	2.9 (42.0)
R3	4.9	4.3 (12.0)	4.0 (18.4)	4.0 (18.4)	3.6 (26.5)	2.3 (53.0)

CD (interaction) : 0.37.
The values in the parenthesis indicates the percentage variation

According to Siddappa (1986), oxygen of air adversly affect the colour of the fruit product.

As indicated in the table 32 that the colour attribute scores of RTS beverage decreased during six weeks of storage with fading of colour in all the three types of products. The mean scores ranged between 5.0-3.3 in R1, 5.0-2.9 in R2 and 4.9-2.3 in R3. The scores of the product in the first week varied from 4.9-5.0 in all the three types of RTS and was found to be highly acceptable. The decline was found to be 34.0 percent in plain passion fruit RTS beverage (R1), 42.0 percent in passion fruit-pineapple RTS beverage (R2). The decline in colour attribute score started from the 2nd week itself in passion fruit pineapple RTS (R2) and passion fruit-lime RTS (R3).

Statistical analysis, indicated significant difference during 5th and 6th week (0.7 in R1, 0.6 in R2 and 1.3 in R3). and was highest Thus the decline was found to be maximum during last week of storage. Colour pigments particularly carotenoids are susceptible to oxidation both initially and during storage (Ashurst, 1986).

Ranote (1992) reported that formulation of brown pigments in the stored RTS is attributed to the degradation of the products of sugar, ascorbic acid and protein. Saini et al. (1985), also observed some decline in colour score of bottled kinnow juice stored under room temperature for a period of six months.

According to Ranote et al. (1992), colour scores of Kinnow RTS declined during storage. The decline was more pronounced for products packed in flexible pouches as compared to other two types of containers which can be attributed to the catalytic effect of light on deterioration, as the pouches were transparent. According to Thorner (1978), colour changes may occur during storage and in light coloured juices such as pineapple and this browning effect can be easily detected. Many of the above factors, contribute to the deterioration of colour in the stored RTS beverage in the present study.

Changes in the clarity attribute with storage in RTS beverge during storage 'given Table ~~32~~ 33

TABLE - ~~32~~ 33

Mean score for clarity attribute of RTS beverage during storage.

Type of product	Store period (in weeks) 1	2	3	4	5	6
R1	2.6	2.9 (10.0)	3.0 (13.0)	4.0 (35.0)	4.0 (35.0)	4.0 (35.0)
R2	3.0	4.0 (25.0)	4.0 (25.0)	4.0 (25.0)	4.0 (25.0)	4.0 (25.0)
R3	2.9	3.0 (3.0)	4.0 (28.0)	4.0 (28.0)	4.0 (28.0)	4.0 (28.0)

CD (interaction) : 0.19

The value in the parenthesis indicates the percentage variation

The clarity attribute score was found to increase during storage and thus the product became more clear during storage. In plain passion fruit ~~—pineapple~~ RTS, clarity scores were found to increase by 35.0 per cent, whereas in passion fruit-pineapple RTS beverage and in passion fruit lime RTS beverage it increased by 25.0 and 28.0 respectively. The clarity score was found to be 2.6, 3.0 and 2.9 respectively in R1, R2 and R3 during the first week. Clarity attribute was found to increased by 13.3 per cent in plain passion fruit by the end of 3rd week, whereas in R2 the increase was 25 per cent and in R3 it was 28 per cent at this period.

Statistical analysis indicated that in R1 the significant difference was found to be highest during 1st and 2nd week (0.3). While in R2 the difference was only during 1st and 2nd week. In passion fruit-lime RTS beverage the difference was maximum during 2nd and 3rd week. According to Thorner (1978), the RTS beverage during shelf life precipitates and this precipitated material contribute to flavour.

Changes in the overall acceptability of RTS beverage during storage is given in Table 33 34

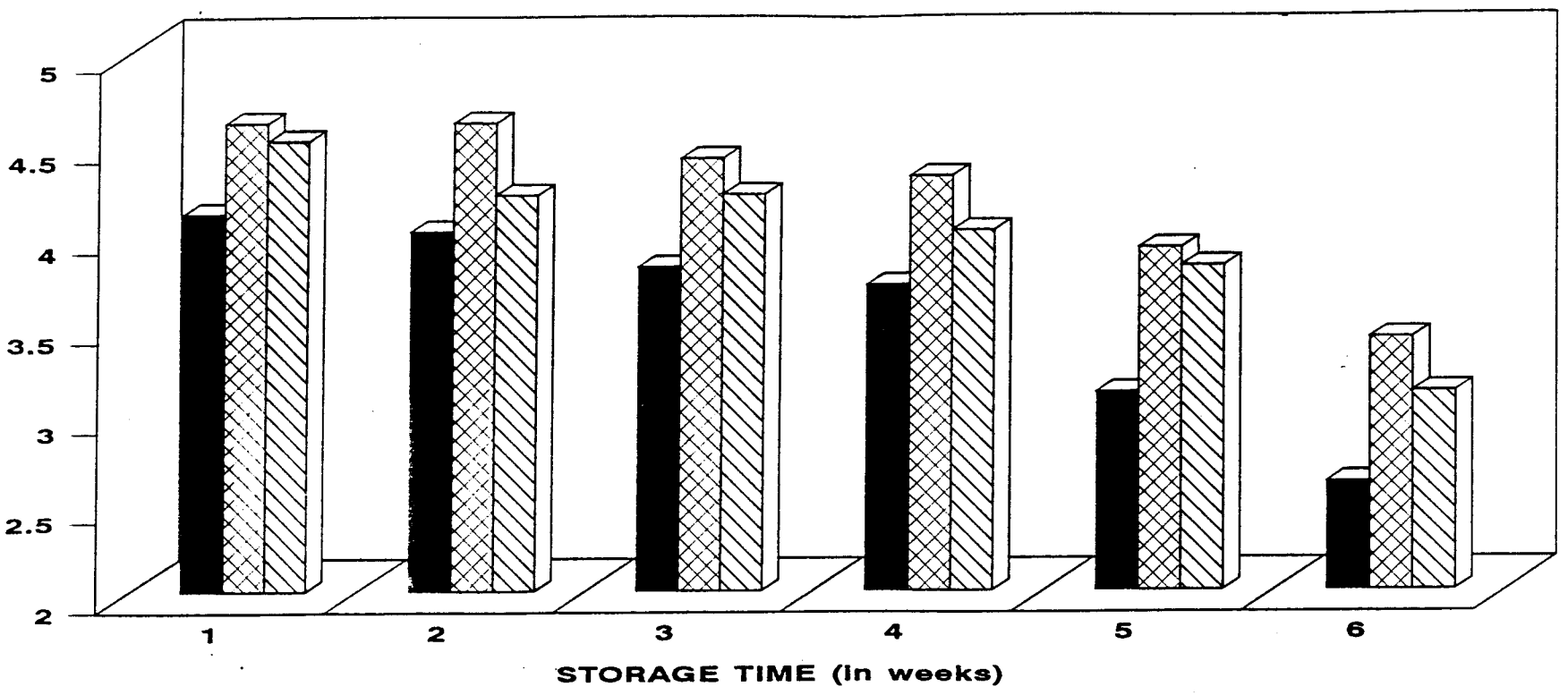
TABLE - 3334

Overall acceptability of RTS beverage during storage

Type of products	Storage time (in weeks) 1	2	3	4	5	6
R1	4.1	4.0 (2.4)	3.8 (6.8)	3.7 (10.2)	3.1 24.3)	2.6 (36.6)
R2	4.6	4.6	4.4 (4.3)	4.3 (6.5)	3.9 (13.5)	3.4 (26.0)
R3	4.5	4.2 (6.6)	4.2 (7.5)	4.0 (11.1)	3.8 (16.4)	3.1 (30.6)

Values in the parenthesis indicates the percentage variation

As per the above table, steady decline was observed in the overall acceptability of all the three blends during storage. The scores for overall acceptability ranged between 4.1-2.6 in plain passion fruit RTS beverage (R1), 4.6-3.4 in passion fruit-pineapple RTS beverage (R2) and 4.5-3.1 in passion fruit-lime RTS beverage (R3). The percentage of decline was found to be 36.6 in R1, 26.0 per cent in R2 and 30.6 in R3. The overall acceptability during the first week ranged between 4.1 - 4.6. The passion fruit - pineapple blend was found to be highly acceptable and the decline in the overall aceptability was minimum when compared to plain passion fruit RTS and passion fruit - lime RTS beverage. According to Kaur (1993), overall acceptability was highest for mango-pineapple blended nectar. Results of the



R1 - Plain passion fruit RTS beverage R2 - Passion fruit - pineapple RTS beverage R3 - Passion fruit - lime RTS beverage

R1 R2 R3

Fig. 9. Overall acceptability of RTS beverage during storage

present study can be compared with the study done by Kaushik (1994). According to him, the RTS beverage prepared from unripe Dushehari Mangoes remained acceptable, though its mean sensory score decreased during storage.

From the above findings it can be concluded that the quality attributes such as taste, appearance, flavour and colour decreased during storage of RTS beverage prepared in the study. The trend was almost similar in all the three types of RTS beverage. However in plain passion fruit RTS and passion fruit - lime RTS beverage the changes appeared at an early period whereas in Passion fruit - pineapple RTS the change was noticed after an interval of two weeks. These changes were primainly due to deteriorative changes caused by the microbial activity. Increase in the clarity attribute was noticed during storage in all the three blends. The Pineapple beverage prepared by CFTRI could be stored upto one to two months (CFTRI 1989) and in the present study the RTS prepared kept well upto 45 days.

4.5.2 *Changes in the organoleptic qualities of wine during storage*

Changes in the taste attribute of wine during storage is given in Table 2435

Table 34

Overall acceptability scores of wine during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	3.4	3.4	3.4	3.4	3.6	3.7	3.8	3.8	3.8	3.9	3.9	4.0
					(5.5)	(8.1)	(10.5)	(10.5)	(10.5)	(12.8)	(12.8)	(15.0)
W2	3.8	3.9	4.0	4.1	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.5
		(2.5)	(5.0)	(7.3)	(11.6)	(11.6)	(13.6)	(13.6)	(13.6)	(13.6)	(13.6)	(15.5)
W3	3.4	3.4	3.5	3.5	3.7	3.8	3.8	4.0	4.0	4.0	4.0	4.0
			(2.8)	(2.8)	(8.1)	(10.5)	(15.0)	(15.0)	(15.0)	(15.0)	(15.0)	(15.0)

values in the parenthesis gives the percentage variation in taste attribute score

Taste attribute scores of the three wines increased slightly during the shelf life period. The taste scores increased by 2.2 per cent in W1, 2.0 per cent in W2 and 2.1 per cent in W3. Mean scores ranged between 4.4 - 4.5 in W1, 4.7 - 4.8 in W2 and 4.5 - 4.6 in W3. According to Attri (1990), Sandpear vermouth had an acceptable taste when compared to Sandpear base wine. The mean scores of the wines the 1st month of storage was 4.4, 4.7 and 4.5 respectively in plain passion fruit wine, passion fruit - banana wine and passion fruit-pineapple wine. The taste scores increased slightly during the 5th month in all the three types of wine.This may be due to the conversion of the residual sugar into alcohol to give the wine its characteristic taste and a decrease in astringency was observed. Studies done by Adsule in (1992) showed that wine from ber juice was comparable to that of wine from grape juice except slight astringent taste.

Statistical analysis of the data showed no significant difference in taste in the three types of wine during storage.

Changes in the appearance attribute of ~~is~~ wine with storage is presented in Table ~~35~~ 36

According to Amerine (1972), the appearance of wine will often tell the experienced taster much about its conditions. According to Dass (1990), the appearance is one of the most

Table ~~(35)~~ 36

Mean score for appearance attribute during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	3.0	3.0	3.0	3.1	3.2	3.5	3.7	3.8	3.8	3.8	3.8	4.1
				(3.2)	(6.2)	(14.2)	(18.2)	(21.0)	(21.0)	(21.0)	(21.0)	(21.0)
W2	3.0	3.2	3.4	3.7	4.0	4.3	4.6	4.8	5.0	5.0	5.0	5.0
		(6.2)	(11.7)	(18.9)	(25.0)	(30.2)	(34.7)	(37.5)	(40.0)	(40.0)	(40.0)	(40.0)
W3	3.0	3.2	3.4	3.7	3.9	4.2	4.4	4.5	4.7	4.7	4.9	5.0
		(6.2)	(11.7)	(18.9)	(23.0)	(28.5)	(31.8)	(33.3)	(36.1)	(36.1)	(38.7)	(40.0)

CD (interaction : 0.33
values in the parenthesis gives the percentage variation in appearance attribute score

important quality characteristic of sparkling wine. The appearance of the wine was found to increase during storage in all the three types of wine. The increase was found to be 20.0 per cent in plain passion fruit wine, 40.0 per cent each in passion fruit-banana wine and passion fruit - pineapple wine. According to Hicks (1990), appearance is a strong indicator of flavour and clarity is an important indicator of satisfactory condition. The clarity attribute scores increased during storage. The mean score was found to range between 3.0 - 4.1 in plain passion fruit wine (W1), 3.0 - 5.0 in passion fruit- banana wine (W2) and 3.0 - 5.0 in passion fruit-pineapple wine (W3). The decline in the colour score did not seem to have any effect on appearance score since the faded colour was still acceptable to the judges.

Statistical analysis of the data revealed that there was no significant difference in the appearance attribute between the two adjacent months. But a significant difference (1.1) was observed between 1st and 12th month indicating an increase in appearance attribute during storage. Vyas (1993) found that ciders and wines improved in appearance during storage. Results of the present study was also in line with above findings and this may be attributed to that fact that during storage suspended

particles precipitates and settles down giving a sparkling appearance to the wine.

Changes in flavour attribute scores of wine during storage is given in Table ~~36~~ 37

Esters are a group of odiferous molecules which makes an important contribution to the flavour and aroma of wine. Brownsell (1985) reported that flavour is generally used to designate the odiferous components of young wines and depends on the primary flavour from the fruits plus a secondary flavour from alcoholic fermentation .

According to Singleton (1969), aging can produce more harmonious yet more complex flavour by a slow loss of obtrusive flavours and a gain of additional flavour nauces while retaining much of the original desirable flavour. The flavour attribute scores of wines during the first month was found to be 3.0, 4.1 and 3.0 in W1, W2 and W3 respectively.

The flavour attribute scores of all the three types of wines were found to increase gradually during storage. The increase was found to be 33.30 per cent in plain passion fruit wine(W1), 18 per cent in passion fruit-banana wine(W2) and 40 per cent in passion friut-pineapple wine(W3). The score ranged between 3.0 -

Table ~~(36)~~ 29

Mean score for flavour attribute during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	3.0	3.0	3.1	3.2	3.3	3.5	3.7	3.9	4.2	4.4	4.4	4.5
			(3.2)	(6.2)	(9.1)	(14.2)	(18.9)	(23.0)	(28.5)	(31.0)	(31.0)	(33.3)
W2	4.1	4.1	4.2	4.4	4.6	4.8	4.9	4.9	5.0	5.0	5.0	5.0
			(2.3)	(6.8)	(10.8)	(14.5)	(16.3)	(16.3)	(18.0)	(18.0)	(18.0)	(18.0)
W3	3.0	3.0	3.1	3.3	3.5	3.7	3.9	4.1	4.1	4.4	4.7	5.0
			(3.2)	(9.1)	(14.2)	(18.9)	(23.1)	(26.8)	(26.8)	(25.0)	(36.1)	(40.0)

CD (interaction : 0.33
values in the parenthesis gives the percentage variation in flavour attribute score

4.5 in W1, 4.1 - 5.0 in W2 and 3.0-5.0 in W3. . Among the three types, passion fruit - banana wine (W2) attained highest score during the initial period of storage and during end of the storage. It is worth mentioning that passion fruit-banana blend as well as passion fruit - pineapple blend (W3) attained a maximum score of 5.0.

Data when statistically analysed showed that there was no significant difference in all the three types of wines between the adjacent months. Joshi (1990) reported that there was no significant difference in the apricot wine prepared using 1:1 and 1:2 propotions, But a significant difference of 1.5 was observed in plain passion fruit wine (W1), 0.9 in passion fruit-banana wine (W2) and 2.0 in passion fruit-pineaple wine (W3) between 1st and 12th month. Thus all the three types of wine showed significant difference in the flavour attribute scores during storage.

The flavour of wine is not mainly due to the alcohols, aldehydes and esters present in it, but also due to its phenolic substances. Vyas et al (1991) reported that the yeasty odour diminished during storage. Alcoholic orange juice beverage showed the development of various volatile aromatic compounds during storage (Rodriguez, 1992). These may be the reasons for better

Table 37

Mean score for colour attribute during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	5.0	5.0	5.0	4.9	4.9	4.8	4.7	4.3	4.0	3.9	3.9	3.9
				(2.0)	(2.0)	(4.0)	(6.0)	(14.0)	(20.0)	(22.0)	(22.0)	(22.0)
W2	4.0	4.0	4.0	3.7	3.5	3.5	3.5	3.4	3.3	3.1	2.9	2.9
				(12.5)	(12.5)	(12.5)	(12.5)	(15.0)	(17.5)	(22.5)	(27.5)	(27.5)
W3	3.9	3.9	3.9	3.7	3.6	3.6	3.4	3.4	3.2	2.8	2.6	2.4
				(5.1)	(7.6)	(7.6)	(12.8)	(12.8)	(17.9)	(28.2)	(33.3)	(38.4)

CD (interaction : 0.12
values in the parenthesis gives the percentage variation in colour attribute score

flavour development in the wines prepared in the present study during storage. The sensory evaluation studies showed that pomegranate wine has better flavour than grape wine (Adsule, 1992).

Changes in the colour attribute scores of the wine during storage is presented in Table 37

The colour attribute score was found to be in the range of 5.0 - 3.9 in W1, 4.0 - 2.9 in W2 and 3.9 - 2.4 in W3 which indicates that plain passion fruit wine scored the maximum followed by passion fruit -banana wine and passion fruit-pineapple wine. However in general the colour attribute scores of wines were found to decrease during 12 months of storage. The decrease was found to be 22 per cent in plain passion fruit wine (W1), 27.5 per cent in passion fruit-banana wine (W2) and 38.4 per cent in passion fruit-pineapple wine (W3). The scores of all the three blends remained constant during the first three months and was found to increase after 3rd month corresponding to the increase in the clarity scores.

Statistical analysis of the data revealed that there was significant difference in all the three types of wine between the adjacent months. According to Merory (1978), the shade of the

Table 38

Mean score for clarity attribute of wine during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	2.0	2.0	2.0	2.0	2.6	2.8	2.9	3.2	3.4	3.5	3.8	3.9
					(23.0)	(28.5)	(31.0)	(37.5)	(41.1)	(42.8)	(47.3)	(48.7)
W2	4.0	4.3	4.6	4.6	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		(6.9)	(13.0)	(13.0)	(20.0)	(20.0)	(20.0)	(20.0)	(20.0)	(20.0)	(20.0)	(20.0)
W3	3.0	3.0	3.0	3.0	3.4	3.6	3.6	3.8	3.9	3.9	4.0	4.0
					(11.7)	(16.6)	(16.6)	(21.0)	(23.1)	(23.1)	(25.0)	(25.0)

CD (interaction) : 0.28
values in the parenthesis gives the percentage variation in clarity attribute score

colour is often indicative of the flavour strength of the wine. However in the present study the flavour of wine was found to increase during storage whereas colour scores decreased in the sample.

Changes in the clarity attribute of wine during storage is presented in Table ~~38~~ 39

The clarity attributes scores were between 2.0 - 3.9 in W1, 4.0-5.0 in W2 and 3.0-4.0 in W3. It was observed that clarity attribute of wine was found to increase gradually during storage in all the three types of wines. The percentage of increase was found to be 48.7 per cent in plain passion fruit-wine (W1), 20 per cent in passion fruit-banana wine(W2) and 25.0 per cent in passion fruit-pineapple wine(W3).

Statistical analysis of the data showed a high significant difference during 4th and 5th month in all the three blends and there was a corresponding increase in appearance.

Changes in the strength attribute of wine during storagee is presented in Table ~~39~~ 40

Table 39

Mean score for strength of wine during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	2.8	2.8	2.8	2.8	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1
					(6.1)	(9.6)	(9.6)	(9.6)	(9.6)	(9.6)	(9.6)	(9.6)
W2	3.2	3.2	3.2	3.2	3.3	3.4	3.4	3.4	3.4	3.4	3.5	3.5
					(3.0)	(5.8)	(5.8)	(5.8)	(5.8)	(5.8)	(8.5)	(8.5)
W3	3.0	3.0	3.0	3.0	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4
					(9.0)	(9.0)	(11.8)	(11.8)	(11.8)	(11.8)	(11.8)	(11.8)

CD (interaction) : 0.34
values in the parenthesis gives the percentage variation in strength attribute score

The strength of the wine increased gradually during storage. The score of the product during first week ranged from 2.8-3.2.The percentage of increase in strength was found to be 9.6 in W1, 8.5 in W2 and 11.8 in W3.

Statistical analysis of the data showed a difference in strength during 4th and 5th month in all the three blends but it was not significant. During the first four months there was no change in the strength attribute scores, while after the fourth month there was a slight increase in the strength attribute scores.

Changes in the overall acceptability of wines during storage is presented Table 40

As per the above table there was a steady increase in the overall acceptability scores of all the three blends during storage. The scores of overall acceptability ranged between 3.4 - 4.0 in plain passion fruit wine (W1) 3.8 - 4.5 in passion fruit banana wine (W2) and 3.4 - 4.0 in passion fruit-pineapple wine (W3). The percentage of decline was found to be 15.00 in W1, 15.56 in passion fruit-banana wine (W2) and 15 in passion fruit-pineapple wine (W3). The overall acceptability during the first week ranged between 3.4 - 3.8. The result obtained indicates that

Table 40 (9)

Overall acceptability scores of wine during storage

Type of product	Storage period (in months)											
	1	2	3	4	5	6	7	8	9	10	11	12
W1	3.4	3.4	3.4	3.4	3.6	3.7	3.8	3.8	3.8	3.7	3.9	4.0
					(5.5)	(8.1)	(10.5)	(10.5)	(10.5)	(12.8)	(12.8)	(15.0)
W2	3.8	3.9	4.0	4.1	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.5
		(2.5)	(5.0)	(7.3)	(11.6)	(11.6)	(13.6)	(13.6)	(13.6)	(13.6)	(13.6)	(15.5)
W3	3.4	3.4	3.5	3.5	3.7	3.8	3.8	4.0	4.0	4.0	4.0	4.0
			(2.8)	(2.8)	(8.1)	(10.5)	(15.0)	(15.0)	(15.0)	(15.0)	(15.0)	(15.0)

values in the parenthesis gives the percentage variation in taste attribute score

the passion fruit-banana wine (W2) had high overall acceptability (3.8) and the changes were minimum during storage (15.5 per cent) when compared with plain passion fruit wine (W1) and passion fruit-pineapple wine (W3).

From the foregoing discussion on organoleptic qualities of wine it is evident that the quality attributes such as taste, appearance, flavour, clarity and strength improved during storage in all the three types of wine. The taste attribute increased during the 5th month in plain passion fruit wine and passion fruit-banana wine while in passion fruit-pineapple wine the taste attribute increased only in the 6th month. The appearance attribute increased in the second month in both the blended wine, while the increase was only during the 4th month in plain passion fruit wine. The flavour started increasing in the 3rd month itself in all the three types of wine. The improvement in the clarity was observed in the 5th month in plain passion fruit wine and passion fruit-pineapple wine while in passion fruit-banana wine the product became clear in second month itself. There is a increase in the strength of the wines in the 5th month. The colour attribute score was found to decline during storage and this decline started from the 4th month in all the three types of wine.

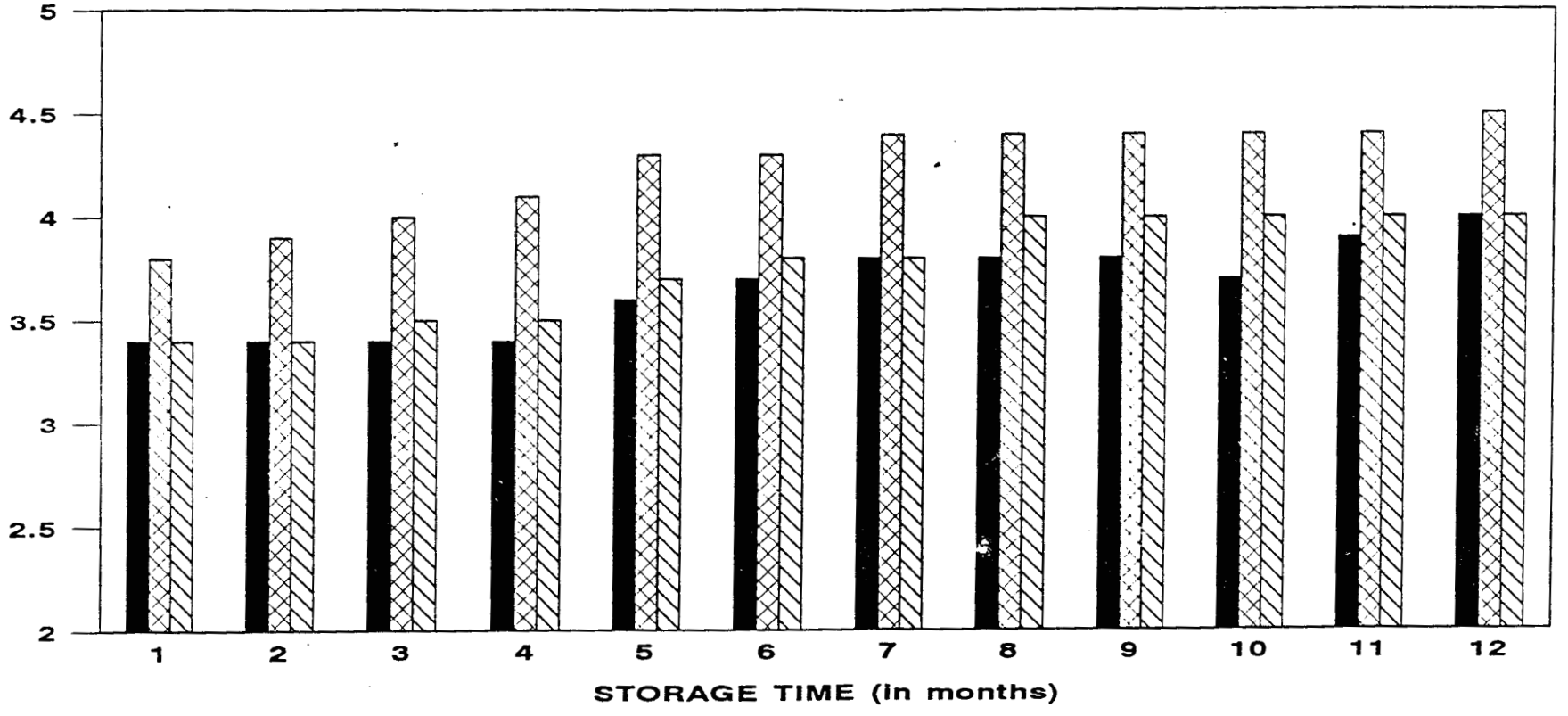


Fig.10 . Overall acceptability of wine during storage

4.5.3 *Changes in the organoleptic qualities of jelly with storage.*

Organoleptic qualities of jelly was found to change considerably with respect to quality attribute viz taste, appearance, flavour, colour and texture.

The changes in the taste attribute in jelly with storage presented in Table 41

TABLE - 41

Mean score for taste attribute of jelly during storage.

Type of products	storage time (in weeks) 1	2	3	4	5	6	7
J1	4.1	4.1	4.0 (2.4)	4.0 (2.4)	3.7 (9.7)	2.8 (31.7)	1.6 (60.9)
J2	5.0	4.9 (2.0)	4.8 (4.0)	4.6 (8.0)	4.4 (12.0)	3.3 (34.0)	2.0 (60.0)
J3	4.6	4.9 (4.3)	4.1 (10.8)	3.9 (15.2)	3.6 (21.7)	2.7 (41.3)	1.7 (63.0)

CD (intraction) : 0.37
Values in the parenthesis indicates percentage variation.

Taste is not only a sensory response but also an aesthetic appreciation of the mouth feel towards soluble materials. Taste is the major attribute which determines the acceptability of food materials (Thampi, 1994).

As per the table, the taste attribute scores was found to decrease during storage. The decline was found to be 60.9 per cent in plain passion fruit rind jelly, 60.0 per cent in passion fruit rind-banana jelly and 63.0 per cent in passion fruit-papaya jelly. The mean score of the taste attribute ranged between 4.1-1.6 in J1, 5.0 - 2.0 in J2 and 4.6 - 1.7 in J3. Passion fruit rind - banana jelly obtained the maximum score (5.0) followed by passion fruit rind - papaya jelly (4.6) and plain passion fruit rind jelly (4.1). during the initial period

Statistical analysis of the data revealed that the change in the taste attribute was found to be significant only after the 5th week in all the three types of jelly. The highest significant difference of 1.2, 1.3 and 1.0 was found during the 6th and 7th week in J1, J2 and J3 respectively. The taste of jelly decreased due to the bacterial contamination which caused the spoilage of jelly at the end of shelf life.

Changes in the appearance attribute of jelly with the storage is presented in Table 42

TABLE - 42

Mean score for appearance attribute of jelly during storage

Type of products	storage time (in weeks) 1	2	3	4	5	6	7
J1	4.4	4.4	4.1 (6.8)	3.8 (13.6)	3.5 (20.4)	2.5 (43.1)	1.3 (70.4)
J2	5.0	5.0	4.9 (2.0)	4.4 (12.0)	4.1 (18.0)	3.3 (34.0)	2.8 (44.0)
J3	4.7	4.7	4.4 (6.3)	4.1 (12.8)	3.8 (19.1)	2.2 (53.1)	1.6 (65.9)

CD(interaction) : 0.4
Values in the parenthesis indicates percentage vairation

Colour change is the major factor that usually occurs in the processed products which affects the appearance of the product (Stillman, 1993).

Appearance attribute in all three type of jelly was found to decline during storage. Slight decline was noted in appearance during the initial months of storage in all the three blends. The decline was found to be 70.4 per cent in J1, 44.0 per cent in J2 and 65.9 per cent in J3. Mean score of jelly ranged between 4.4 - 1.3 in J1, 5.0 - 2.8 in J2 and 4.7 - 1.6 in J3.

Statistical analysis showed that there was no significant difference in the appearance attribute scores in the three types during the weekly intervals. After 5th and 6th week, two types of

jelly showed a very high significant difference ie 0.8 in passion fruit rind - banana jelly and 1.6 in passion fruit rind - papaya jelly while in passion fruit rind jelly the difference (1.2) which was highest during the 6th and 7th week. During storage, pH was found to decrease and the water tends to separate out from surface (Swaminathan, 1979). Bacterial contamination during the end of shelf life brought about an increase in acidity and lowering of pH thereby causing a decline in the appearance attribute score during the storage life in all the three types of jellies.

The changes in the flavour attribute of jelly storage is presented in Table 43

TABLE - 43

Mean score for flavour attribute during storage.

Type of products	storage time (in weeks) 1	2	3	4	5	6	7
J1	4.2	4.1 (2.3)	4.0 (4.7)	3.8 (9.5)	3.5 (16.6)	3.2 (23.8)	2.1 (50.0)
J2	5.0	4.9 (2.0)	4.6 (8.0)	4.3 (14.0)	4.0 20.0)	3.7 (26.0)	2.4 (52.0)
J3	4.9	4.6 (6.1)	4.4 (10.2)	4.1 (16.3)	3.9 (20.4)	3.9 (20.4)	2.2 (55.1)

CD (interaction)
Values in the parenthesis indicates percentage variation.

Flavour is the unique character of odour and taste. Ranganna (1986) stated that, flavour is an important factor which enriches the consumer's preference to a particular product. The flavour scores were found to decline during storage indicating a deterioration of the three products during storage. The decline was found to be 50 per cent in plain passion fruit rind jelly (J1), 52 per cent in passion fruit rind banana jelly (J2) and 55 per cent in passion frui rind papaya jelly (J3). Mean scores obtained were 4.2 - 2.1 in plain passion fruit rind jelly (J1), 5.0 - 2.4 in passion fruit rind-banana jelly (J2) and 4.9 - 2.2 in passion fruit rind-papaya jelly (J3).

According to Thorner (1978), it is advisable to store fruit products in the coolest available area. The lower the temperature the slower will be the flavour deterioration. The three different types of jelly prepared were stored at room temperature which might have led to the deterioration in flavour during shelf life.

According to Hicks (1990), appearance is a strong indicator of flavour. The appearance was found to decrease during the final stages of shelf life indicating a change in the flavour as well. The change was found to be significant only during the 6th and 7th week indicating a sharp deterioration in the flavour scores.

The loss of flavour can be attributed to the spoilage of jelly by microbial cantamination.

The changes in the colour attribute of jelly during storage is given in Table 44

TABLE - 44

Mean score for colour attribute of jelly during storage.

Type of products	storage time (in weeks) 1	2	3	4	5	6	7
J1	4.0	4.0	4.0	3.9 (2.5)	3.7 (7.5)	3.7 (7.5)	3.5 (12.5)
J2	5.0	5.0	5.0	4.8 (4.0)	4.6 (8.0)	4.5 (10.0)	4.3 (14.0)
J3	4.9	4.9	4.9	4.8 (2.0)	4.7 (4.0)	4.6 (6.1)	4.5 (10.2)

CD(interaction) : 0.30
The values in the parenthesis indicates the percentage varitation

According to the reports from CFTRI (1990), the aesthetics, safety, sensory characteristics and acceptability of food are all affected by colour. The joint FAO/WHO expert committee on food additives recognised that colour has an effect on food choices (Anonymous, 1991).

The scores for colour attribute ranged between 4.0 - 3.5 in J1,5.0-4.3 in J2 and 4.9-4.5 in J3. From the table it is evident that the colour scores of three blends of jelly were found to decline slightly during the storage period. The decrease in the colour attribute was found to be 12.5 per cent in plain passion fruit rind jelly (J1), 14 per cent in passion fruit rind -banana jelly (J2) and 10.2 per cent in passion fruit rind-papaya jelly (J3). The colour scores were found to remain constant till the first three weeks and the decline started from the 3rd week in all the three blends.

Statistical analysis showed no significant changes during the weekly intervals but a significant change was noted during 1st and 7th week which was found to be 1.5 in plain passion fruit rind jelly, 0.7 in passion fruit rind - banana jelly and 0.4 in passion fruit rind - papaya jelly.

The natural pigments are highly susceptible to chemical changes. Complex colour changes also occur when many organic chemicals present in food come in contact with air (Potter,1986). According to Pilando (1985), microbial contamination accelerates colour degradation also. In this experiment the colour of jelly which was rich yellow intially began to fade slightly during the storage.

The changes in the texture attribute of jelly during storage is presented in Table 45

TABLE - 45

Mean score for texture scores of jelly during storage

Type of products	storage time (in weeks) 1	2	3	4	5	6	7
J1	4.1	4.1	4.1	4.9 (4.8)	3.6 (12.1)	3.3 (19.5)	2.3 (43.9)
J2	4.7	4.7	4.7	4.5 (4.2)	4.3 (8.5)	4.0 (14.8)	3.0 (36.1)
J3	4.9	4.9	4.9	4.6 (6.1)	4.4 (10.2)	4.1 (16.3)	3.2 (34.6)

CD (interaction) : 0.40
The values in the parenthesis indicates the percentage variation.

The texture attribute score of jelly was found to decrease during storage. The decline was found to be 43.9 per cent in plain passion fruit rind jelly (J1), 36.1 per cent in passion fruit rind - banana jelly (J2), 34.6 per cent in passion fruit rind - papaya jelly(J3). Scores obtained during the first week was found to range between 4.1 - 4.9 in three types of jelly.

Mean scores ranged between 4.1 - 2.3 in plain passion fruit rind jelly (J1), 4.7 - 3.0 in passion fruit rind - banana jelly (J2) and 4.9 - 3.2 in passion fruit rind - papaya jelly (J3) during storage. The scores of the three products remained

constant for the first three month after which it began to decline.

Statistical analysis of the data showed a significant difference in the decline of the texture attribute scores during 6th and 7th week of storage. The significant difference was found to be 1.0 in J1 and J2 and 0.9 in J3.

Changes in the overall acceptability of jelly during storage is presented Table 46

TABLE - 46

Overall acceptabilty scores of jelly during storage.

Type of products	storage time (in weeks) 1	2	3	4	5	6	7
J1	4.2	4.1 (2.3)	4.0 (4.7)	3.9 (7.1)	3.6 (14.2)	3.1 (26.1)	2.2 (47.6)
J2	4.9	4.9	4.8 (2.0)	4.5 (8.1)	4.3 (12.2)	3.8 (22.2)	2.9 (40.8)
J3	4.8	4.7 (2.0)	4.5 (6.2)	4.3 (10.4)	4.1 (14.5)	3.5 (27.0)	2.6 (45.8)

CD (interaction) : 0.42

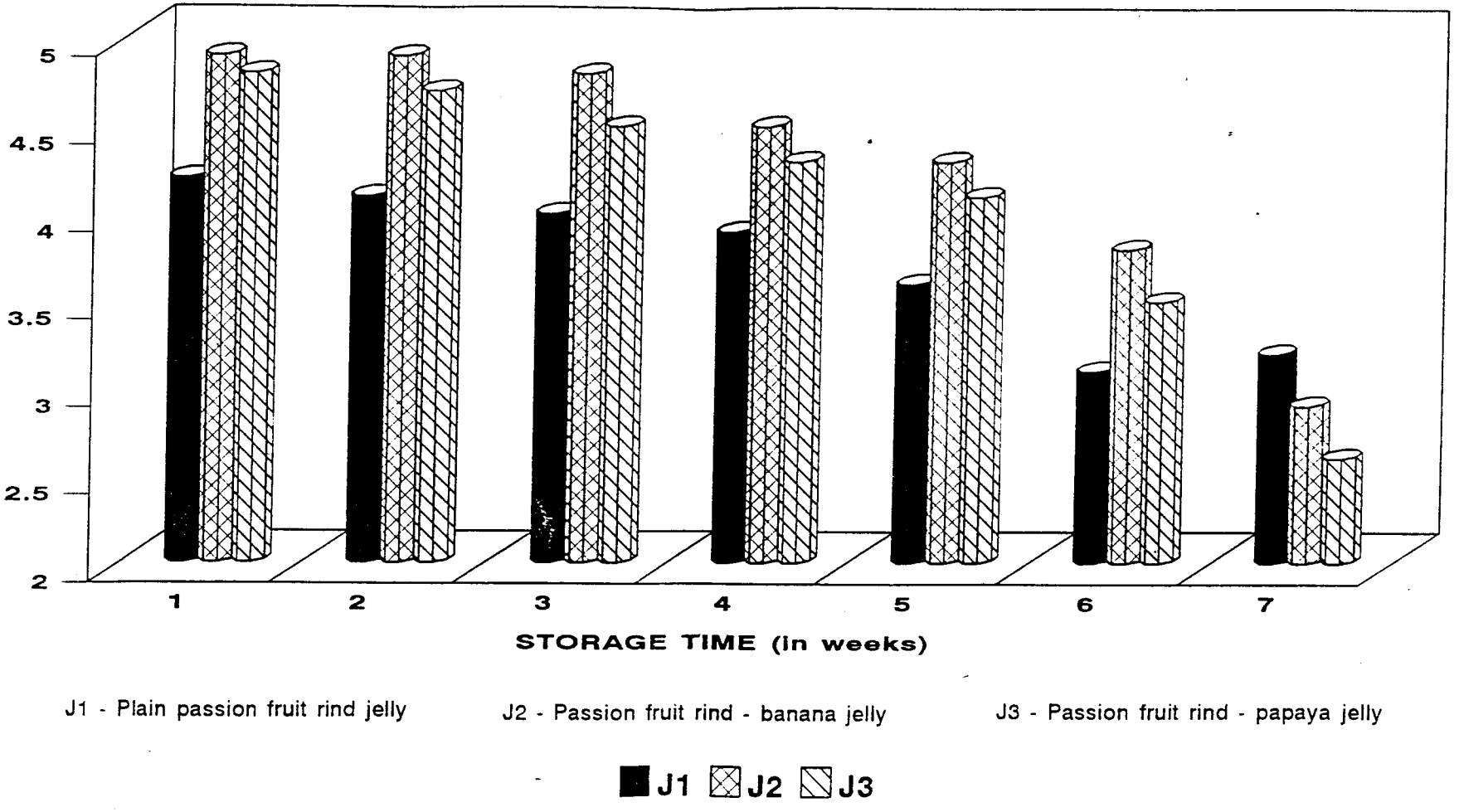


Fig. 11. Overall acceptability of jelly during storage

The scores for overall acceptability were 4.12 - 2.16 in plain passion fruit rind jelly, 4.90 -2.90 in passion fruit rind-banana jelly and 4.80 - 2.64 in passion fruit rind papaya jelly during storage. There is a steady decline in the overall acceptability scores of all the three blends of jelly. The decline was found to be 47.6 per cent in J1, 40.8 per cent in J2 and 45.8 per cent in J3. The overall acceptability scores during the first week ranged between 4.16 - 4.90. The passion fruit rind - banana jelly (J2) had high acceptability (4.94) among the three jellies prepared during the initial stages.

The general analysis of scores obtained for various quality attributes viz. taste, appearance, flavour, colour and texture in jelly indicated a decreasing trend during shelf life. Taste and flavour attribute scores of the jellies started declining slightly from the second week while the scores for appearance showed decrease in the third week. Colour and texture attribute scores declined only in the fourth week in all the three types of jellies.

4.6 Assessment of microbial contamination of the stored products

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 microorganism during processing and storage (Frazier, 1994)

Monthly/weekly analysis of the processed product is necessary in order to find out whether the product has any quality deterioration.

The products prepared from passion fruit was analysed for the microbial infestation such as yeast, bacteria and fungi. In the present study, RTS beverage and jelly were analysed weekly for microbial contamination. Pencillium species was detected from RTS beverage after a shelf life of six weeks and jelly was found to be contamimated with Aspergillus species after seven weeks of shelf life. Till that period, these products were organoleptically acceptable and no microbial infestation was detected in the products. pH was found to have declined in both the products during its shelf life. According to Siddappa (1986), mould grow in a pH range of 2.5 - 3.5 in fruit beverages. Bhatnagar (1984) reported that microbial examination of muskmelon rind-grape jam showed presence of microbes at the end of storage period. The wines prepared in the present study were also assessed monthly for microbial infestation. But the test, failed to show any deterioration even after 12 months of storage.

4.7 Assessment of the products for FPO standards

Food standards are made to ensure the quality and safety of natural and processed foods for human consumption (Swaminathan, 1988). To ensure food quality, many type of quality standards have come into existence. The exercise of the powers confirmed by section 3 of the Essential Commodities Act 1955, the Central Government promulgated the Fruit Product Order in 1955. The Order has been modified in 1961 as Fruit Products (Amendment) Order, 1961.

The two products RTS beverage and jelly and the blends made from passion fruit were analysed for FPO standards. Results obtained are presented in Table 47

TABLE - 47

Confirmation of FPO requirement in RTS beverage and jelly

Type of Products	Minimum percent of TSS in final product w/w	Minimum percent of fruit juice in the final product w/w
FPO specification for RTS	10	10
R1	14.00	14.20
R2	12.45	20.00
R3	18.60	20.00
FPO specification for jelly	65	45
J1	65.10	45.80
J2	68.05	47.30
J3	66.00	47.30

FPO standards prescribe a minimum of 10 per cent total soluble solids in the final product of RTS beverage. Total soluble solids of passion fruit-lime beverage was found to have a TSS of 18.6 followed by the TSS of plain passion fruit RTS beverage (14.0) and passion fruit - pineapple RTS beverage (12.45). Thus the TSS of the three RTS products prepared in the present studies were found to be in line with the minimum TSS percentage prescribed by FPO.

The minimum percentage of fruit juice prescribed by FPO in the final product is 10. The percentage of fruit juice present in passion fruit - pineapple RTS beverage and passion fruit - lime RTS beverage were 20.00 while for plain passion fruit RTS beverage, it was 14.20. Therefore the minimum percentage of fruit juice in the final product is also well above the FPO specification.

With respect to jelly, the minimum total soluble solids prescribe by FPO is 65 per cent. When the jellies were analysed for TSS, passion fruit rind - banana jelly was found to have a TSS of 68.05 followed by passion fruit rind - papaya jelly (65.10) and plain passion fruit rind jelly (66.0). All the three type of jellies prepared thus confirmed with the FPO standards.

FPO specification indicates that the minimum per cent of fruit juice present is the final product of jelly is 45. When the products were analysed the minimum per cent of fruit juice was found to be 47.30 each in passion fruit rind - banana jelly and passion fruit rind - papaya jelly, while for plain passion fruit rind jelly it was 45.80. From the above findings it can be concluded that the prepared RTS beverage and jelly satisfies the prescribed FPO standards. In the case of wines, the alcohol percentage is also within the permissible limit.

4.8 Assessment of cost benefit analysis of the products

Keeping up prices is one of the most challenging and difficult tasks facing marketers of fruit products (Potter, 1986). Prices often fluctuate from day to day, month to month and year to year and different prices usually exists for the same commodity at different locations or different stages in the marketing process. (How, 1990). Prices of many fruits exhibit fairly regular seasonal variations although at times the seasonal pattern may be obscured by other factors. Hence cost benefit analysis is of utmost importance in the products development.

Cost benefit analysis was carried out to assess the extent of expense effected to obtain different products from passion fruit.

Cost of the products calculated were based on the cost of the fruits, sugar, preservatives. Bottling charges, fuel and labour costs were also accounted while deriving the total cost of the product. The cost of the products obtained are presented in Table 48

TABLE 48

Cost benefit analysis of the products

Particulars	Cost per kg/litre
Ready to serve beverage	**Rs.Ps**
1. Plain Passion fruit	10-00
2. Passion fruit - Pineapple	14-40
3. Passion fruit - lime	12-50
Wine	
1. Plain Passion fruit	16-00
2. Passion fruit - banana	16-00
3. Passion fruit - Pineapple	16-80
Jelly	
1. Passion fruit rind	24-00
2. Passion fruit rind-banana	18-00
3. Passion fruit rind-Papaya	17-50

The above table indicates that the cost of three types of RTS beverage ranged from Rs 10.00 - 14.00 per litre. The cost of passion fruit - pineapple blend was found to be highest i.e Rs. 14.40 per litre and this may be due to the higher cost of pineapple. This was followed by passion fruit - lime blend, the cost of which was found to be Rs 12.50 per litre. The RTS beverage from plain Passion fruit was found to have a low cost of Rs 10.00 per litre. When compared to the other common fruit juices in the market which cost Rs 6.00 for 100 ml, nutritious RTS beverage from Passion fruit and its blends could be made

at a low cost. Cost of plain passion fruit RTS was comparitively less and this under exploited fruit can thus be recommended for the development of nutritious low cost beverage.

Cost benefit analysis of wine indicated that the cost per litre of wine was Rs 16-Rs 16 Ps 80, with a very negligible difference between the three types. The passion fruit - pineapple wine was found to have slightly higher cost of Rs 16 ps 80 when compared to plain passion fruit wine and passion fruit-banana wine both of which were found to cost Rs 16 per litre. The cost of laboratory scale production of ber wine was found to be Rs 26 Ps 75 per litre and Rs 20 per litre for grape wine (Adsule, 1992). When compared to the high market price of wines, processing wine from passion fruit and its blends were found to be very economical.

The cost of production of jelly ranged from Rs 17 Ps 50 - Rs 24 per kg. The passion fruit - papaya jelly could be produced at a low cost of Rs 17 Ps 50 per kg which was followed by passion fruit rind-banana jelly which was found to cost Rs 18 per kg. The plain passion fruit rind jelly could be made at a cost of Rs 24 per kg as the quantity of the sugar used for its production

was more compared to the two other types. Rind of the passion fruit, which is generally thrown away could also be utilized for the production of value added products.

On comparing the cost benefit analysis of the three different products made from passion fruit and its blends it could be concluded that the cost of production of RTS was found to be followed by wine and jelly beverage. All the products prepared are acceptable and within the reach of common man and were below the cost of the similar marketed commodities.

4.8.1 *Fruit product yield ratio*

The fruit to product yield was also assessed in the products prepared. One of the factors which determine the cost of the final product is the turn over of the final product from the fruits. Understanding of fruit product yield in the products prepared were hence assessed. All the fruits used viz. passion fruit, pineapple, papaya, banana, lime had wastage due to skin/peel/rind and pitting loss. In Passion fruit, the pulp and peel are in the ratio 1:1, thereby lowering the product yield to a large extent. The fruit to product yield of the products prepared were assessed and the details are given in Table 49

TABLE 49

Fruit product yield for 1000g of fresh fruit

Fruit product	fruits(gm)	Product obtained	fruit product Ratio
RTS beverage			
R1	1000	1200	1:2.2
R2	1000	1840	1:8.8
R3	1000	1100	1:1.1
Wine			
W1	1000	450	1:0.45
W2	1000	650	1:0.65
W3	1000	700	1:0.70
Jelly			
J1	1000	600	1:0.60
J2	1000	700	1:0.70
J3	1000	900	1:0.90

The fruit product yield for passion fruit-pineapple RTS beverage (R2) was found to be the highest. It was followed by passion fruit-lime RTS beverage (R3) and plain passion fruit RTS beverage (R1). It can be attributed to the fact that pineapple which has used as a blend had lower fruit waste compared to passion fruit and lime. Similarly passion fruit-pineapple wine

(W3) had high fruit product yield product ratio followed by passion fruit - banana wine (W2) and plain passion fruit wine. While in case of jelly, passion fruit rind-pappaya jelly (J3) had high fruit product yield ratio followed by passion fruit rind-bannana jelly and plain passion friut rind jelly (J1).

4.9 Assessments of consumer preference of the products

According to Potter (1986), 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. Consumer quality acceptance should always be considered while bringing a product into the market.The consumer preference groups are not specificaly trained but can provide a good insight into what customers generally will prefer (Potter, 1985).

According to Kordylas (1990), the overall acceptability depends on the concentration or amount of particular components, the nutritional and other hidden attributes of a food and its palatability or sensory quality. The absence of nutritional qualities and the preference of harmful or toxic ingredients are parameters which are of vital interest to the consumer. Hence consumers preference of the products prepared in the present study was assessed

4.9.1 Consumer acceptance and overall acceptability of three types of RTS beverage is presented in Table 50 and 51

TABLE 50

Percentage scores for quality attributes of RTS beverage as judged by the consumers

Products	Percentage of score for quality attributes					
	Taste	Appearance	Flavour	Colour	Clarity	Overall acceptability
R1	72.8	71.2	78.8	91.6	70.0	76
R2	91.2	86.0	90.4	83.2	74.0	84
R3	88.4	74.8	74.0	71.6	68.8	74

As per the table, among the different RTS beverage prepared passion fruit - pineapple blended RTS was found to secure higher scores in all the quality attributes viz taste, appearance, flavour and clarity except in colour. Highest score for colour was secured by plain passion fruit RTS beverage (91.6 per cent), when compared to the other two RTS beverage, overall acceptability score was also found to be highest (84 per cent) for passion fruit-pineapple RTS beverage followed by plain passion fruit RTS and passion fruit-lime RTS beverage. It was also observed that all the three types of products obtained scores above 70 per cent for overall acceptability, thereby making them highly acceptable among the consumers.

TABLE 51

Consumer acceptance for RTS beverage

Scores of overall acceptability (in per cent)	Distribution of consumer R1	R2	R3
Above 70	84	87	80
40 - 69	9	10	19
below 39	7	3	1

As per the table, 87 per cent consumers gave scores above 70 per cent for passion fruit - pineapple RTS beverage while 84 per cent consumers for plain passion fruit RTS beverage and 80 per cent for passion fruit - lime RTS beverage. All the three variations were found to be highly accepted by the consumers. The scores below 70 per cent were scored by only 16 per cent consumers for R1, 13 per cent consumers for R2 and 10 per cent consumers for R3.

The above results clearly indicate that all of RTS beverages were found to be acceptable for the majority of consumers.

4.9.2 Consumer acceptance and overall acceptability of wine is presented in Tables (52) and (53)

TABLE - 52

Percentage scores for quality attribut of wine as judged by the consumers

Product	Percentage score for quality attributes						
	Taste	Appearance	Flavour	Colour	Clarity	strength	Overall acceptability
W1	58.6	66.3	62.5	76.3	61.6	57.3	76.0
W2	76.6	81.3	72.6	68.3	81.3	61.0	90.0
W3	80.3	65.0	77.6	71.5	68	60.6	84.0

As indicated in the table, the passion fruit-pineapple wine (W3) was found to secure higher scores in quality attribute viz taste, flavour and strength among the consumers. Maximum scores for appearance and clarity was scored by passion fruit - banana wine (W2). While plain passion fruit wine secured high scores for colour attribute (76.3 per cent). Passion fruit-banana wine was found to be highly acceptable among the consumer since it secured a score of 90 per cent in overall acceptability which was closely followed by passion fruit - pineapple wine (84 per cent). All the three types of wines secured scores well above 70 per cent for overall acceptability, thus making them highly acceptable among the consumers.

TABLE - 53

Consumer acceptance for wine

Scores of overall acceptability (in per cent)	Consumer (in per cent) W1	W2	W3
Above 70	78	92	83
40 - 69	16	8	12
below 39	6	-	5

As indicated in table, 92 per cent consumers gave scores above, 70 per cent for passion fruit - banana wine (W2) followed by 83 per cent for passion fruit - pineapple wine (W3) and 78 per cent for plain passion fruit wine. The scores below 70 per cent were scored by only 22 per cent consumers for R1, 8 percent consumers for R2 and 17 per cent consumers for R3. All the three variations of wine were found to be acceptable for the consumers.

4.9.3 Overall acceptability and consumer acceptance survey of three types of jelly is presented in Tables (54) and (55)

TABLE - 54

Percentage scores for quality attribute of jelly as judged by the consumers

Products	Quality attributes (in per cent)					
	Taste	Appearance	Flavour	Colour	Texture	Overall acceptability
J1	75.2	74.0	69.6	89.6	87.2	78.0
J2	89.0	92.8	94.0	94.8	91.2	92.0
J3	84.4	89.6	87.6	90.8	84.4	88.0

The above table depicts that the passion fruit rind- banana jelly (J2) secured the highest scores for all the quality attributes viz taste, appearance, flavour, colour and texture with a high overall acceptability scores of 92 per cent. Passion fruit rind banana jelly(J2) is followed by Passion fruit rind- Papaya jelly (J3) and plain Passion fruit jelly in quality attribute. The overall acceptability score was found to be more than 70 per cent in all the three types of jelly showing its high consumer acceptance.

TABLE - 55

Consumer acceptance for jelly

Scores of overall acceptability (in per cent)	Consumers (in per cent) J1	J2	J3
Above 70	76	96	93
40 - 69	17	4	7
below 39	7	-	-

The table depicts that 96 per cent consumers gave scores above 70 per cent for passion fruit rind-banana jelly (J2) followed by 93 per cent for passion fruit rind-papaya jelly (J3) and 76 per cent for plain passion fruit-rind jelly. The scores below 70 per cent were scored by only 7 per cent consumers in plain passion fruit rind jelly(J1) while none of the consumers gave scores below 40 per cent in passion fruit rind-banana jelly (J2) and passion fruit rind-papaya jelly (J3). This clearly indicates that all the three types of jellies were found to be highly acceptable for the consumers.

Consumer acceptance of the products indicated that majority of the consumers (76-92 per cent) surveyed, gave scores above 70 per cent for all the products indicating their acceptance for the products developed

SUMMARY

The present study entitled "**Development, diversification and shelf life studies of passion fruit products**" was undertaken to develop new products viz. RTS beverage, wine and jelly utilizing passion fruit and with blends of other fruits. Organoleptic, nutritional and shelf life qualities of the product developed and its changes during storage was analysed in detail in the study.

Results of the standardization work carried out for product development indicated that in the formulation of RTS beverage in 1:1:5 proportion of passion fruit juice, sugar and water was found to be most acceptable. In passion fruit-pineapple blended RTS beverage and passion-fruit lime RTS beverage, the proportion most ideal was found to be 2:1:2:10 and 2:1:3:10 respectively. In the preparation of wine, the proportion 1:1:1 (passion fruit, sugar and water) was adjudged to be the best while in the blended wines passion fruit-banana wine and passion fruit-pineapple wine the proportion most suitable was found to the 3:1:4:4.

Study also indicated that, rinds of passion fruit can be utilized for the preparation of jelly. Jelly was formulated with passion fruit, sugar and water in 1:3:4 ratio. Two blended jellies, *ie* passion fruit rind- banana jelly and passion fruit rind-papaya jelly were also standardized in the present study.

Chemical components in the fresh products were assessed with regard to pH, acidity, total soluble solids, total sugar and vitamin C. Alcohol percentage and residual sugar were also assessed in case of wine.

Results revealed that pH was found to be almost same in all the three products. The lowest value of pH was secured by passion fruit - lime RTS beverage (2.83) and passion fruit-banana wine secured the highest value (3.90). The acidity value of the products showed marked variations. Among the different products, RTS beverage was found to have low acidity while that of wine and jelly were of moderate levels and it showed a range of 0.59 - 0.73 and 0.55 - 0.75 respectively. Among the three products, the TSS of the jelly was found to be high as expected and it was followed by wine and RTS beverage. In wines, since the major portion of the total sugar was converted into alcohol, the residual sugar was found to be very low.

With regard to the vitamin C content, passion fruit - lime RTS beverage was found to have moderate amounts of vitamin C followed by passion fruit - pineapple RTS beverage. Among the products jelly had a very low vitamin C content.

On comparison of the organoleptic qualities of the different products developed, the highest score for taste attribute (5.0) was secured by two products viz. passion fruit - pineapple RTS beverage and passion fruit rind - banana jelly. Rest of the products attained scores above 40 for taste attribute. Wine obtained a low score of 3.0 for appearance when evaluated in the fresh state while for the other two products (RTS beverage and jelly) the scores were well above 4.3. RTS beverage and jelly had almost same range of scores for flavour (4.2 - 5.0) while it was slightly low for wine. The colour attribute was also found to be attractive in all the three products. Of all the three products prepared from passion fruit, passion fruit rind - banana jelly obtained the highest scores for overall acceptability and the scores of the rest of the products were above 3.4 in the fresh state indicating that all the products are acceptable.

Evaluation of the changes in the chemical components with storage revealed that pH, total sugar and vitamin C content of prepared RTS beverage and jelly decreased during strage. The residual sugar of wine also decreased with storage. However TSS was found to remain constant in RTS beverage and jelly while it

increased in case of wine. There was a steady increase in acidity in all the three products. The alcohol percentage was found to increase slightly during storage in wine.

Changes in the organoleptic qualities of the product with storage indicated that the quality attribute such as taste, appearance and flavour declined in RTS beverage and jelly while all these attribute were found to improve in wine. However colour attribute declined in all the three products. The clarity attribute was found to improve in RTS beverage and wine while it decreased in jelly. The strength of the wine was found to increase during storage.

Evaluation of the microbial contamination of the stored passion fruit product revealed that in RTS beverage Pencillium species were detected after a shelf life of 6 weeks, while jelly was found to be contaminated with Aspergillus species after seven weeks of storage. In wine no microbial contamination was detected till twelve months of storage.

The products developed were assessed for FPO standards. RTS beverages prepared were found to have TSS higher than the prescribed levels of FPO. Similarly minimum percentage of fruit juice in the final prouct was is also found to be above the minimum FPO specifications.

All the three types of jellies prepared were confirmed with FPO standards. In case of wines, the alcohol percentage was within the permissable limit.

Cost benefit analysis revealed that among the different products passion fruit rind jelly was found to have comparatively higher cost ranging from Rs 17 Ps 50 to 24 per Kg, followed by wine (Rs 16 Ps 80 to 16 per litre) and RTS beverage (Rs 10 to Rs 14 Ps 40 per litre).

The fruit to product yield ratio indicated that, out of the three products, passion fruit - pineapple RTS beverage had high fruit product yield ratio (1:2.2) while the fruit product yield ratio of plain passion fruit wine was found to be the lowest (1:0.45).

Consumer acceptance of the products indicated that majority of the consumers (76-92 per cent) surveyed, gave scores above 70 per cent for all the products indicating their acceptance for the products developed.

It can be concluded that the passion fruit can be processed successfully into RTS beverage, wines and its rind can be utilized in the production of jellies which are very much

acceptable to the consumers. Thus the study proved that this unexploited fruit could be utilized for the production of delicious and nutritious commodities.

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* Originals not seen.

APPENDICES

APPENDIX-1

Qualitative analysis of Pectin content.

The amount of pectin was found out by precipitating it with alcohol. When the fruit is being cooked for extraction of pectin, a spoonful of juice is taken out and poured into a glass tumbler. After cooling it, three teaspoonful of methylated spirit is added gently along the sides of the tumbler and mixed with the extract by rotating the tumbler carefully. The mixture is then allowed to stand for a few minutes. A transparent lump of jelly like consistency forms indicating that the extracts of all the three types of jelly was rich in pectin.

APPENDIX-2

Sheet test to determine the end point in jelly.

A small portion of jelly is taken in a large spoon, cooled slightly and then allowed to drop off. When the jelly fall in the form of sheets the end point was reached.

APPENDIX-3

Evaluation card for triangle test.

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

Name of the product : Sugar solution

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

S.No	Code No.of samples	Code No.of the identical samples	Code No.of the odd samples
1	XYZ		
2	ABC		

APPENDIX-4

Score Card

Criteria		A	B	C
1. Appearance				
Very good	(5)			
good	(4)			
Fair	(3)			
Poor	(2)			
Very poor	(1)			
2. Taste				
Excellent	(5)			
Very good	(4)			
good	(3)			
fair	(2)			
poor	(1)			
3. Flavour				
Very pleasent	(5)			
pleasent	(4)			
Neither pleasant nor unpleasent	(2)			
Unpleasant	(2)			
not at all pleasent	(1)			

4. Colour

Very acceptable	(5)
Acceptable	(4)
Slightly acceptable	(3)
Neither acceptable nor unacceptable	(2)
Unacceptable	(1)

5. Clarity

Sparking clarity	(5)
Clear	(4)
Slightly clear	(3)
Slightly cloudy	(2)
Very cloudy	(1)

6. Texture

Very good	(5)
Good	(4)
Fair	(3)
Poor	(2)
Very poor	(1)

7. Strength

Very strong	(1)
Strong	(2)
Slightly strong	(3)
Slightly mild	(4)
Mild	(5)

Development, diversification and shelf life studies of passion fruit products

By

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ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement
for the degree
MASTER OF SCIENCE IN AGRICULTURE
Faculty of Agriculture
Kerala Agriculture University

Department of Home Science
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Vellayani
Thiruvananthapuram

1995

The study entitled **"Development, diversification and shelf life studies of passion fruit products"** was undertaken for the development of new products viz. RTS beverage, wine and jelly utilizing passion fruit and with blends of other fruits. Organoleptic, nutritional and shelf life qualities of the product developed and its changes during storage were analysed in detail in the study.

RTS beverage with plain passion fruit in combination with other fruits was standardized. Similarly formulation of wines with passion fruit and two blended wines were also standardized. Rind of the passion fruit was utilized for the preparation of jelly.

Assessment of the chemical components viz. pH, acidity, total soluble solids, total sugar, vitamin C, alcohol percentage and residual sugar of the fresh products carried out revealed that pH almost fall in the same range in the three products while the acidity value showed marked variation. The TSS of the jelly was found to be high followed by wine and RTS

beverage. Among the products, jelly had a very low vitamin C content.

Assessment of the organoleptic qualities indicated that the products obtained scores above 4.0 for taste attribute when evaluated in the fresh state. Wine obtained a low score for appearance while the other two products (RTS beverage and jelly) the scores were well above 4.3. RTS beverage and jelly had almost same range of scores for flavour while it was slightly low for wine. The colour attribute was also found to be attractive in all the three products.

The score of all the products were above 3.4 for overall acceptability sorce indicating that all the products were acceptable.

Evaluation of the changes in the chemical components with storage revealed that pH, total sugar and vitamin C content of RTS beverage and jelly decreased during storage. TSS was found to remain constant in RTS beverage and jelly while it increased slightly in case of wine. There was a steady increase in acidity in all the three products.

Changes in the organoleptic qualities of the product with storage indicated that the quality attribute such as taste, appearance and flavour declined in RTS beverage and jelly while all these attributes were found to improve in wine. The clarity attribute was found to improve in RTS beverage and wine while it decreased in jelly. The strength of wine was found to increase during storage.

Shelf life qualities of the product indicated that RTS beverage had a shelf life of six weeks and that of jelly had seven weeks of storage life.

All the products developed were in conformity with FPO requirements.

Cost of the products was from Rs 17 Ps 50 to Rs 24 per kg for jelly, Rs 16 Ps 80 to Rs 16 per litre for wine and Rs.10 to Rs 14 Ps 40 per litre for RTS beverage.

Consumer acceptance of the products developed indicates a higher favourable trend.