DEVELOPMENT OF WOOD APPLE (*Ferronia limonia* L.) FRUIT PRODUCTS

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IN

POMOLOGY

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Dedicated to

My Beloved Parents

DIVISION OF HORTICULTURE

UNIVERSITY OF AGRICULTURAL SCIENCES

BANGALORE

CERTIFICATE

This is to certify that the thesis entitled **"DEVELOPMENT OF WOOD APPLE (Feronia limonia L.) FRUIT PRODUCTS"** submitted by **Mr. RAVINDRA S. PATIL** for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **POMOLOGY** of the University of Agricultural Sciences, Bangalore, is a record of research work conducted by him during the period of his study in this University, under my guidance and supervision. This thesis has not been the basis for award of other degree, diploma, associateship, fellowship or similar other titles.

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(**RAVINDRA S. PATIL**)

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INTRODUCTION

INTRODUCTION

Wood apple (*Feronia limonia* L.) belongs to the family Rutaceae and is believed to be native of India. It grows wildly in southern and central dry forests of India. It is commonly grown as a border plant in addition to jungles. Wood apple is a good source of ascorbic acid, riboflavin, pectin, carbohydrates, protein, calcium, phosphorus and iron. The fruits are used in the preparation of chutney and as well as consumed with jaggery as well. In Burma fruits are used for making jam and jelly (Singh and Dutta, 1941).

Wood apple is a medium-sized tree that grows well in dry parts of India. It is also an important avenue tree planted on either side of highways.

Wood apple is a deciduous tree with short erect cylindrical trunk. It grows to a height of 10 to 12 meters and possesses thorny branches. Leaves measure three to four inches in length with small ovate leaflets. Flowers large, round fruits having hard woody pericarp. Seeds are numerous, small and compressed. The pulp is pleasant and sweet. Wood apple is a perennial tree and takes about 10 years to bear economic yields.

On an average a well grown tree bears about 400 to 800 fruits in a year (Swamy Rao et al., 1989).

There are no specific and improved varieties of wood apple. The University of Agricultural Sciences, Bangalore has identified promising trees bearing large, oblong shaped fruits from dry decidious forests of Tumkur district (Swamy Rao et al., 1989).

Wood apple grows luxuriously in dry climates and is found growing up to an elevation of 300 meters. The tree thrives better in deep, well drained soils of dry forests. It prefers slightly acidic soils but can be grown on a variety of soils.

Wood apple fruit has hard shell containing mucilaginous pulp with numerous seeds. Hence, it is difficult to consume the pulp directly and is therefore, not popular as a dessert fruit. Unlike other indigenous minor fruits such as phalsa (Grewia asiatica), annonaceous fruits, jamun (Syzygium cuminii) and ber (Zizyphus mauritiana). Because of its excellent and delightful pulp characters having exceptional medicinal value this fruit can be exploited for commercial processing into value added products for local consumption and export market.

Wood apple is normally cultivated on a small scale in rural areas, which are marketed in local shandies. If these fruits are collected and processed into commercial products they form important nutritional products for rural folk.

Therefore, in order to explore the possibilities of utilising the fruits for processing an attempt has been made to find out the chemical composition of pulp and storage stability of processed products such as squash, nectar and jelly.

The present investigation was carried out with the following objectives.

1. To standardize the recipes for preparing stable products of wood apple.
2. To analyse the chemical composition of processed products of wood apple.
3. To find out the storage stability of the processed products of wood apple.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

Wood apple is an uncommon minor fruit compared to other major tropical fruits. Literature reveals that there is limited research work on the various aspects of wood apple, particularly on processing and preservation of wood apple pulp and their storage stability. Hence, the available literature is reviewed here under this chapter covering not only work conducted on wood apple fruit, but also on the other commonly grown fruits of India.

2.1 Wood apple fruits

Wood apple (Feronia limonia L.) is a native of India and belongs to the family Rutaceae. Generally fruits ripen during November to March (Bhat, 1944). Well grown wood apple tree yields about 400-800 fruits during the season (Swamy Rao et al., 1989) and the average fruit weight is about 350 g (Vaidehi and Annapurna, 1976).

Fruits possess an outer hard shell and mucilaginous pulp with numerous small seeds. Therefore, it is difficult to consume the pulp directly without preparation in to a product. The fruit consists of 43 per cent edible portion and 57 per cent waste

(Vaidehi *et al.*, 1977a) According to Gopalan *et al.*, (1971) it is most nutritious fruit containing 64.2 per cent water, 7.1 per cent protein, 3.7 per cent fat, 1.9 per cent minerals, 5 per cent fibre and 18.1 per cent carbohydrates. The fruit pulp is a good source of minerals such as phosphorus (0.11 per cent), calcium (0.13 per cent) and iron (0.06 per cent).

Fruit pulp is an excellent source of pectic substances and organic acids. The pectin content of ripe fruit may be around 3.5 per cent and acidity varies from 1.5 to 2.0 per cent (Singh and Datta, 1941; Bhat, 1944). Naturally ripe wood apple pulp containing high quality pectin and acidity therefore forms an excellent raw material for the preparation of products like jam and jelly. Swamy Rao *et al.*, (1989) reported that wood apple fruit contains up to 7.25 per cent total sugars.

2.2 Extraction of wood apple pulp

According to Roy and Singh (1979b) the bael fruit pulp can be successfully extracted by addition of equal quantity of water to the pulp (with seeds and fibre) by adjusting the pH to about 4.3 by adding citric acid and heating to a temperature of $80^{o}C$ for one minute and then passing through a pulper. Finally seeds and fibre are separated by straining the hot mass through muslin cloth. Singh and Roy (1984) reported that the application of heat not only inactivates the enzyme methyl pectin esterase but also helps in dissolving the mucilage uniformly to obtain a homogenous pulp. The pulp thus recovered by this method has almost the same comparable consistency and colour to that of mango pulp.

2.3 Fruit beverage

Most commonly the fruits that are used by the Indian processing industries for the preparation of beverages are mango, mandarins, sweet orange, pineapple and some of the minor fruits such as lemons, passionfruit, jambolana, cashewapple, jack etc. Among the frutis commonly processed into squash and nectar in India, mango ranks first followed by citrus and pineapple (Giridhari Lal et al., 1959; Milton Gatterson, 1971). They also reported that the citrus fruits are the most ideal for beverage preparation due to the fact that they are juicy, refreshing and retain the characteristic taste and aroma even after a few months of their preparation in to a beverage.

Among the commercially grown mango varieties Raspuri, Alphonso, Dusheri, Langra, Rumani, Navaneethum and Suvarnarekha are reported to yield good quality beverage (Bhatia and Siddappa, 1955; Krishnamurthy et al., 1984). However, beverage prepared from Totapari mango fruits was found to yield poor quality product (Krishnamurthy et al., 1984).

Beverage prepared from citrus fruits is valued for its quality, especially vitamin C, and refreshing properties to quench the thirst during the hot months of the year (Mookerjee et al., 1964; Jain et al., 1984). The sweet oranges (tight skin oranges) are reported to be superior compared to mandarins (loose skin oranges) for preparing ready to serve beverage.

Bhatia et al., (1956) reported that good quality squash can be prepared out of edible ripe jack fruit bulbs. Devarajaiah (1987) observed that yellow type jack fruit bulbs are better for preparing squash than other types.

Roy and Singh (1979c) found that a good nectar and squash can be prepared from ripe bael fruits. They also stated that mucilage of the pulp gives a very good body and consistency to the nectar.

The other fruits normally used for preparing beverage are guava (Kalra et al., 1987), ber (Pareek, 1983), phalsa (Wasker and Khurdiya, 1987) and wood apple (Vaidehi et al., 1977a).

2.3.1 Beverage preparation

The principle and methodology of beverage preparation is same for most of the fruits with certain minor manipulations depending upon the type of fruit which are either highly acidic or extremely low in their acids or those fruits which exhibit interfering factors such as high astringency and bitterness (Gridhari Lal et al., 1959; Paul, 1979).

The basic ingredients used in the preparation of beverage are fruit juice, sugar, organic acids and permissible preservative with or without artificial colours and flavours. An ideal beverage should have a proper balance of sugar-acid ratio, which imparts the characteristic taste, flavour and their retention during the storage (Mabesa et al., 1982). The effective processing and sterilization while the bottling or canning is the other important factor determined by proper sugar-acid ratio (Giridhari Lal et al., 1959; Paul, 1979).

The method for squash and nectar preparation involves the extraction of clear juice from the fruit, mixing it with sugar syrup of desirable strength and the addition of organic acid (citric acid). Finally the prepared squash or nectar is either canned or bottled after adding suitable quantity of permitted preservative and then the cans or bottles are properly processed and sealed hermitically in order to ensure storage stability without spoilage (Bhatia, 1956). It is necessary to add permitted artificial colour and flavour to the product to substitute the loss of natural colour and flavour during its preparation (Furia, 1980).

2.3.2 Preservation and storage of beverages

Some of the detrimental factors that affect the preservation and quality of beverages are acidity, proper sterilization, type of preservative used and ambient temperature in the storage chamber (Tressler and Joslyn, 1981). All these factors are complementary in nature and add to the total success to prolong shelf life and storage stability of fruit beverages.

An ideal squash should have an acidity in the order of 1.00 to 1.50 per cent whereas, in nectar it should be in the range of 0.3 to 0.5 per cent. It is reported that acidity helps in the effective processing, rentention of colour, taste and flavour. Acidity also prevents development of off flavour or off odour during the storage of the product (Bhatia *et al*., 1958; Mabesa *et al*., 1982; Jain *et al*., 1984). Acidity of 0.5 per cent is the best composition of wood apple juice (Vaidehi *et al*., 1977b).

The role of preservative has been emphasised by many workers to keep the beverage free from spoilage during storage. The most commonly used preservatives in fruit products are potassium metabisulphite and sodium benzoate. These two preservatives are reported to be very effective in preventing the spoilage of the product during storage (Giridhari Lal *et al*., 1959). Sodium benzoate is normally preferred for the products which are rich in anthocyanin pigments (grape, phalsa etc), while the potassium metabisulphite is advocated for the products rich in carotenoid pigments (Goodenough and Atkin, 1981).

Storage conditions of the beverages are equally important as that of ingredients used in its preparation. For effective storage of squash or nectar the product should be stored in cool and dry place.

Comparatively, citrus fruit products are found to retain their natural colour at low temperature of 15°C.

Reports reveal that organoleptic qualities of beverage was found to be better when the product was stored at a temperature of 15°C for a period of one year (Tressler and Joslyn, 1981).

Phalsa fruit beverage retained maximum of its anthocyanin content at a storage temperature of 3°C followed by cool chamber (11° to 20°C) and room temperature (15° to 32°C) (Waskar and Khurdiya, 1987).

Sadashiva and Neelakantan (1976) found that the jack fruit squash stored at 15°C retained all its best qualities when stored for almost a year.

Anand (1970) working with amla preserve noticed that loss of ascorbic acid was less when packed in glass container then in plastic containers. Johnson and Toledo (1975) also made similar observation in case of orange juice concentrate preserved in glass containers which retained maximum flavour compared to plastic containers.

2.3.3 Physico-chemical and sensory changes in fruit beverages during storage

The extent of the physico-chemical and sensory changes during the storage of squash or nectar depends on the kind of fruit used for preparation, ingredients, preservatives, mode of processing, correctness of sealing and storage condition (Paul, 1979).

In most of the fruit beverages, there was increase in total soluble solids (TSS) and reducing sugars. Whereas, the ascorbic acid content and titratable acidity was reduced proportionately as the storage duration prolonged.

Palaniswamy et al., (1974) reported that mango squash prepared from different varieties showed increase in reducing sugar and reduction in acidity during the storage, whereas the total soluble solids (TSS) content was almost same without much change. The decrease in acidity and ascorbic acid content and increase in total soluble solids (TSS) and acid ratio was reported by Ahamad et al., (1986a). They also observed that there was little effect on colour but maximum flavour was retained in the squash prepared from 50 per cent sugar and one per cent acid. However, a slight increase in the total soluble solids (TSS) and decrease in acidity and ascorbic acid was found in lime squash (Palaniswamy and Muthukrishnan 1974).

Palaniswamy and Muthukrishnan (1974) reported that crude protein content of lime juice squash remained unaffected during the storage. Potassium metabisulphite treatment to fruit beverage is effective for colour retention. The colour of the juice was not affected while preparing the orange juice from Blood Red variety treated with potassium metabisulphite. A slight change was observed in colour of Kinnow and Villa Franca juice after a storage period of six months (Urmil Mehata and Satinder 1983; Ahamad et al., 1986b).

The quality of squashes preserved in bottles covered with different coloured cellophane paper retained natural colour for almost one year with better organoleptic characters, whereas, the control (without wrapping cellophane paper) was found in good condition only for a period of six months (Jain et al., 1984).

Ahamad et al., (1986a) reported that the sugar-acid ratio of 50:1 was best in citrus and mango squash for developing optimum taste, and retaining the natural colour during storage.

In guava beverage the loss of ascorbic acid was in the range of 35-40 per cent after one year of storage, whereas total soluable solids (TSS) and titratable acidity increased slightly over the control (Kalra et al., 1987).

Roy and Singh (1979d) reported that squash and nectar prepared from bael fruit changed its original colour to light brown colour during storage. They further reported a decrease in acid and an increase in total sugar and reducing sugar content of squash and nectar after six months of storage at room temperature.

The jack fruit squash preserved with potassium metabisulphite was reported to have changed very little in its colour, taste and flavour during storage (Bhatia, 1956; Devarajaiah, 1987)

In phalsa beverge, Wasker and Khurdiya (1987) found drastic change in anthocyanin content when the product was stored at room temperataure for a very short duration.

2.4 Wood apple jelly

In the history of Indian food processing industry, jelly preparation could be traced back to 18th century. Pectin is a very important ingradient for preparing good quality jelly.

Jelly is prepared by boiling the fruit pulp with or without addition of water. After straining the boiling fruit mass the clear extract thus obtained is mixed with required quantity of sugar and boiled to a stage at which it would set into a clear jelly. A perfect jelly should be transparent, well set but not too stiff and should have the original flavour of fruit. It should possess an attractive colour and should keep its shape and retain a clear-cut surface. It should be tender enough to quiver but not to flow (Giridhari Lal et al., 1959).

2.4.1 Fruits used in jelly preparation

Pectin is present in the cell wall of most fruits. The presence of pectin varies with the type of fruit, variety, and stage of maturity. Fruits with high content of pectin and organic acids are well suited for jelly making. The fruits such as guava, kumquat, carambola, black berries, kiwi fruit, wood apple, apples, citrus peels and papaya are good source of pectin (Giridhari Lal et al., 1959; Swamy Rao et al., 1989).

Wood apple is a rich source of high quality pectin and organic acids (Singh and Datta, 1941; Bhat, 1944; Swamy Rao et al., 1989). Because of a large proportion of pectin, organic acids and aromatic flavour of pulp. Wood apple is good fruit for preparing exceptionally good quality jelly. Joshi et al., (1986) reported that mixing up of one part of wood apple pulp with two parts of curd whey developed best quality jelly.

2.4.2. Factors affecting jelly formation

2.4.2.1 Pectin

Campbell (1920) found that 1.25 per cent pectin produces a fine commercial jelly, whereas, 1.0 to 0.75 per cent produces a delicate jelly. The higher the percentage of pectin present in the fruit pulp, the lower the sugar requirement to form the jelly (Lal Singh, 1922; Giridhari Lal *et al*., 1959). Giridhari Lal *et al*., (1959) also found that the jelly strength increased as the pectin content increased. The pectin forms better jelly in presence of proper blend of sugar and acids (Baldini *et al*., 1982).

2.4.2.2 Acid

The fruit pulp used for jelly making should have acid content between 0.8 and 1.5 per cent as citric acid for obtaining a satisfactory good fruit jelly. Higher acidity with low pH of the pulp results in faster inversion of sugars and increases the browning reaction in the jelly (Muralikrishna, 1967). Muralikrishna (1967) further stated that least degradation of ascorbic acid was noticed under acidic condition of the pulp.

2.4.2.3 pH

The relation of pH to jelly formation was first reported by Tarr (1923). The strength of jellies increased as the pH decreased from 3.65 to 3.19 and then again it decreased with further lowering of pH. Harvey (1960) reported that when sugar concentration was 60 to 70 per cent, the pH level also changed from 4.30 to 3.51. A minimum pH of 3.6 was best for forming good gel with sea gelling agents (sea gel DG and sea gel GH) for citrus jellies (Rouse and Moore, 1972). Basamokov (1977) also reported that increase in the pH hastened the jelly formation.

2.4.2.4 Sugar

Goldthwaite (1909) prepared jellies without adding sugar; but additon of sugar was considered essential to keep the texture, flavour and appearance of the jelly at its best and also for a satisfactory end product. The sugar required for jelly formation is always proportional to the acidity of the fruit pulp (Lal Singh, 1922). The jelly strength decreased with decrease in sugar content from 74 to 60 per cent. Weak and tender jellies resulted at lower concentrations (Giridhari Lal et al., 1959). Increase in the inversion of sugars was noticed with increased acidity under jelly storage conditions (Muralikrishna, 1967). Citrus jellies prepared with cane sugar were found good in their flavour retention (Rouse and Moore, 1972).

2.4.3 Fruit jellies

The conventional method for preparation of wood apple jelly was reported by Bhat (1944). Giridhari Lal et al., (1959) described a common method for preparation of jelly from different fruits such as guava, carambola, black berries, kiwi fruit and apple.

2.4.4 Storage of fruit jellies

Bhatia et al., (1958) recorded 9.5 and 2.7 per cent retention of ascorbic acid after storing for period of 31 and 57 weeks. Loss of ascorbic acid was more in guava jellies stored for longer duration in addition to browning of the product. Anand (1970) recorded less loss of ascorbic acid in the jellies preserved in glass containers than in plastic container. Similar observation was made by Ramanjaneya (1981) in guava jelly prepared from different strengths of pectin content.

Muralikrishna (1967) noticed decrease in acidity of jelly with increase in the inversion of sugars during storage. He further reported that decrease in acidity was found to increase the duration of storage. Similar observation was also made by Ramanjaneya (1981).

The higher the storage temperature, the faster the deterioration of jelly quality, which can be better preserved at low temperature (Muralikrishna, 1967; Ramanjaneya, 1981). Jelly prepared from pasteurized mango-orange juice was found to retain better marketing qualities after 26 weeks of storage at $80^{o}F$ and 78 weeks at $32^{o}F$ (Rouse and Moore, 1973).

2.4.5 Non-enzymatic browning of jelly

Most of the food products undergo browning during storage. Browning is a clear sign of deterioration in the quality of the product. Browning is invariably due to one or more of the following reasons: Maillard reaction, caramelisation, oxidation of ascorbic acid, reaction between acids and sugars or reactions among organic acids themselves.

The addition of sugar during jelly preparation was very essential to keep the texture, flavour and appearance of the jelly at its best state (Goldthwaite, 1909; Giridhari Lal et al., 1959).

Rouse and Moore (1972) reported that the pasteurized chilled jellies made from citrus fruits are found to be superior in retaining flavour compared to jellies stored at 80^{o}F for 24 weeks.

Giridhari Lal *et al.*, (1959) opinioned that hermetically sealed glass jars and cans are best suited for packing of jellies and to prevent mold growth inside the container. They also revealed that improper sealing encourages mold growth inside the container. Jellies contain higher per cent of sugars which controls microbial growth by reducing the availability of moisture for their development and multplication (Frazier and Westhoff, 1978; Fields, 1979).

MATERIAL AND METHODS

III MATERIAL AND METHODS

The present investigation was carried out at the processing laboratory of the Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore, during the year 1990. The details of the experiments are as follows.

3.1 Wood apple fruits

Wood apple fruits used in this experiment, were obtained from the local market (K.R. Market, Bangalore) at fully ripe edibal condition during the season, selected fruits of uniform size and shape were used for the experiment.

3.2 Extraction of pulp

The wood apple fruits were opened by breaking against the hard surface. The pulp along with the seeds and fiber was separated with the help of stainless steel spoon from the hard shell. To extract the fine pulp without seeds and fiber equal amount of water by weight was added and boiled. The mass was passed through musline cloth to separate the seeds and fiber. Pulp thus obtained was homogenous and free from seeds and fiber. This fine pulp was used for the preparation of squash, nectar and jelly.

3.3. Experiment details

The different fruit products such as wood apple squash, wood apple jelly and wood apple nectar were prepared.

3.3.1 Recipes of squash

	Pulp(%)	T.S.S.(^{o}Brix)	Acidity(%)
Recipe 1	25	40	1.25
2	25	50	1.25
3	35	40	1.25
4	35	50	1.25
5	45	40	1.25
6	45	50	1.25

The prepared squash was analysed for its chemical composition after 3 months of storage and visual observations were recorded during storage.

3.3.2 Recipes for jelly

	Pulp(%)	T.S.S.(^{o}Brix)	Acidity(%)
Recipe 1	50	60	1.00
2	50	63	1.00
3	50	66	1.00
4	50	69	1.00

The prepared jelly was analysed for its chemical composition after 3 months of storage.

3.3.3 Recipes for nectar.

	Pulp(%)	T.S.S.(^{o}Brix)	Acidity(%)
Recipe 1	20	20	0.40
2	20	30	0.40
3	25	20	0.40
4	25	30	0.40
5	30	20	0.40
6	30	30	0.40

The prepared nectar was analysed for its chemical composition after 3 months of storage and visual observations were made during the storage.

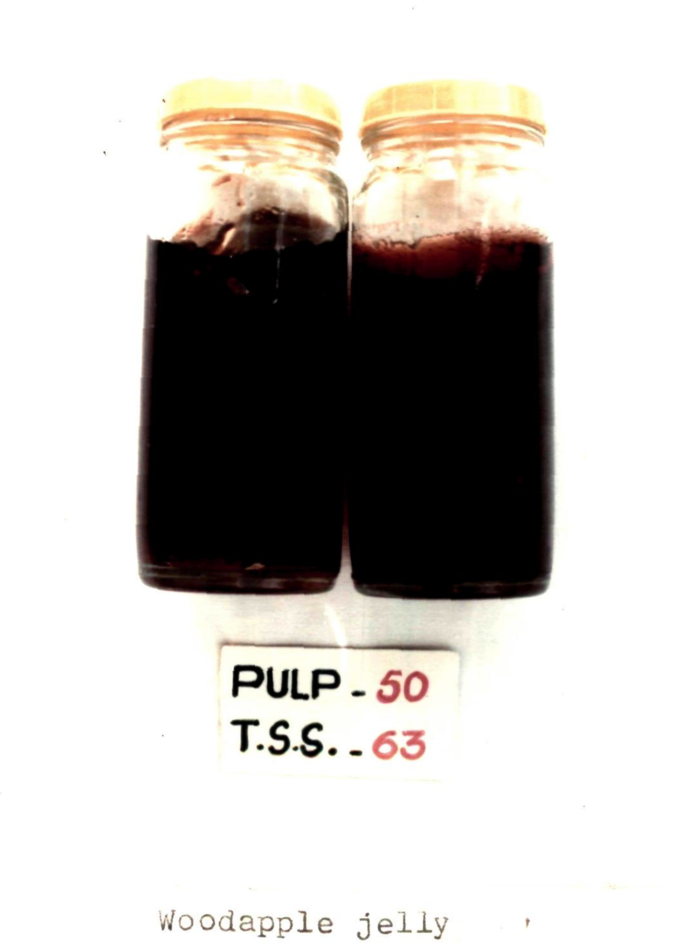
3.4 Preparation of products

3.4.1 Wood apple squash

Sugar syrup was prepared by adding cane sugar to the boiling water. The strength of the sugar syrup was ascertained by testing with hand refractometer (30-60^{o} Brix range). The syrup, thus prepared was filtered through a muslin cloth to remove impurites.

Fruit pulp and the freshly prepared hot syrup were added together in the proportion of proposed recipe on

Woodapple Squash



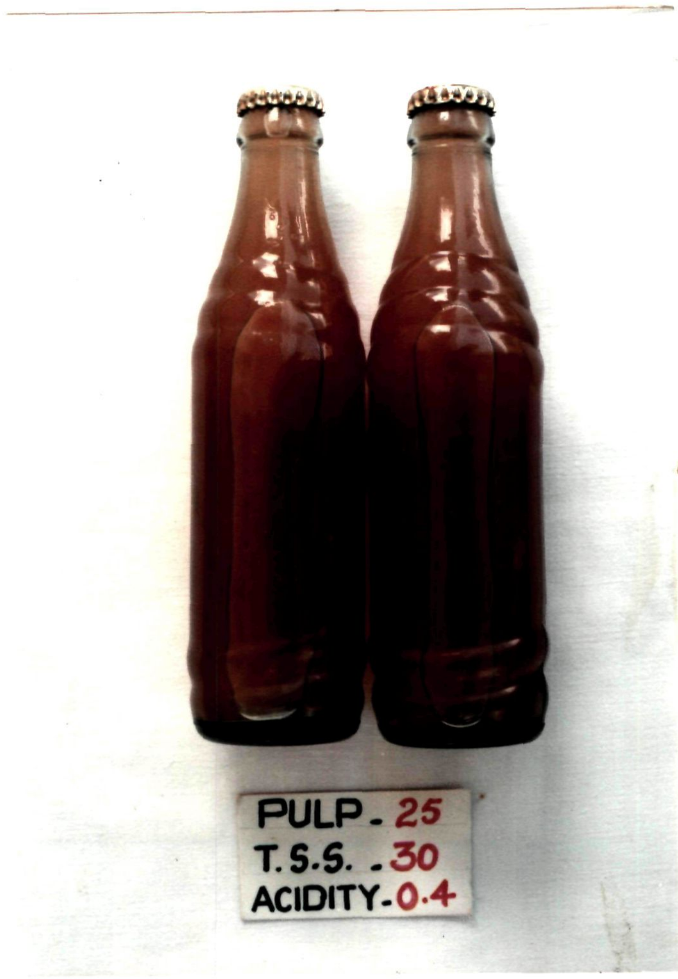
Woodapple jelly

weight basis. The mixture was boiled by adding required amount of citric acid. Finally the product was treated with potassium metabisulphite (300ppm) to prevent spoilage.

The prepared hot squash was filled in to the pre-sterilized glass bottles of 220 ml capacity. Immediately, bottles were sealed by using crown caps with the help of crown corking machine. Bottles were than sterilized in the boiling water and cooled immediately. Finally stored at room temperature for further studies (Plate I).

3.4.2 Wood apple Jelly

One kilogram pulp was mixed in one litre of water in a container and homogenised with the help of waering blender. The prepared pulp was boiled for 30 minutes continuously by stirring. The hot boiling mass was passed through muslin cloth and the extract was diluted to one litre. Then calculated amount of sugar was added slowly to the pulp and boiled to a temperature of 103^{o}C with addition of citric acid. Boiling of mixture continued till it reached the temperature of 107^{o}C. The scum formed during boiling was removed with the help of ladle. Finally the prepared jelly was allowed to cool to



Woodapple nectar

a temperature 90^{o}C and filled into pre-sterilized dry glass jars. The filled jars were sealed and stored at room temepratture for further use (Plate II).

3.4.3 Wood apple nectar

Sugar syrup was prepared by adding cane sugar to the boiling water. The strength of sugar was estimated with the help of hand refractometer. The prepared syrup was filtered through a muslin cloth to remove impurities. The hot syrup was mixed with fruit pulp on the weight basis. The mixture was boiled by adding citric acid to get a consistent product.

The prepared nectar was filled into the pre-sterilized glass bottles of 220 ml capacity and sealed air tight by using crown caps. The bottles were sterilized in boiling water for 25 minutes, cooled to room temperature and utilized for further use (Plate III).

3.5 Analysis of fruits

3.5.1 Physical parameters

Ten fruits were selected randomly for assessing average weight of the fruit. The length and diameter of these fruits were measured with the help of vernier callipers. The weight of pulp, seeds and fibre was recorded per fruit. Mean weight was calculated and expressed as percentage.

3.5.2 Chemical composition

3.5.2.1 Total Soluble Solids (TSS)

Total soluble solids of wood apple pulp was measured by using hand refractometer and expressed as ^{o}Brix.

3.5.2.2 Total titratable acidity

Total titratable acidity of the fruit pulp was estimated by preparing an aliquot, using 10g of the representative sample. The volume was made up to 100 ml filtered and twenty ml of this filtrate was titrated against standard 0.1N sodium hydroxide using phenolphthalein as an indicator. Results were expressed as per cent citric acid (Ranganna, 1977).

3.5.2.3 Ascorbic acid

Five grams of the representative fruit pulp was blended with three per cent metaphosphoric acid as a stabilizing agent and the volume was made upto 100 ml with oxalic acid, and the mass was filtered by using filter paper. Ascorbic acid was estimated by titrating 10 ml of filtrate against 2,6-dichlorophenol indophenol dye. Ascorbic acid content was expressed as mg per 100 g of fruit pulp.

3.5.2.4 Sugars

3.5.2.4.1 Reducing sugars

Twenty grams of representative fresh pulp was taken in 250 ml volumetric flask and slightly diluted with 100 ml of distilled water and the sample was neutralized. The sample was clarified by adding 1.8 ml of lead acetate and allowed to stand for 2 minutes. The excess lead was removed with addition of potassium oxalate and then the volume was made up to 250 ml with distilled water and filtered. Reducing sugars were estimated by using the method outlined by Lane and Eynon (1923).

3.5.2.4.2 Total sugars

Fifty ml of the filtrate was hydrolysed by adding 5 ml of concentrated hydrochloric acid and kept overnight for inversion. It was then diluted to 100 ml in a volumetric flask after neutralizing the filtrate with 6 N NaOH by adding distilled water. This solution was used for estimation of total sugars and expressed as per cent.

3.5.2.5 Moisture

For estimation of moisture, flat bottom disks were dried to complete dryness at 108^{o}C for one hour. To each of these disks 100 g of pulp was uniformly spread and kept in oven for drying by maintaining oven temperature at 70^{o}C for 18 hours. After drying, the samples were weighed till the flask recorded a constant weight. The moisture content in the sample was expressed as percentage by calculating loss of moisture.

3.5.2.6 Crude protein

Crude protein was estimated by determining total nitrogen content in one gram dried pulp sample following micro-kjeldahl method (A.O.A.C., 1970). The crude protein was calculated by multiplying the per cent nitrogen content of sample with the factor 6.25.

3.5.2.7 Inorganic constituents

Inorganic constituents such as calcium and phosphorus in the wood apple pulp was estimated by adopting standard procedure (Amerine and Ough, 1974).

Twenty five gram of prepared pulp was transfered to 250 ml conical flask and evaporated to dryness on a water bath. These dried samples were digested with triacid mixture.

Preparation of triacid mixture and digestion of sample.

The evoparated sample residue was predigested with 5 ml nitric acid overnight. Then the sample was digested with triacid mixture consisting of nitric acid, perchloric acid and sulphuric acid in the ratio of 10:4:1. Twenty five milli litres of triacid mixture was added to each sample and digested on a low flame till digestion was completed. The sample was then cooled and diluted to 50 ml by double distilled water into 50 ml volumetric flask. Then the sample was filtered through whatman No.1 filter paper into plastic bottles for further analysis.

Calcium

One milli litre of triacid mixture extract was diluted to 50 ml with double distilled water. The aliquot was used for estimating calcium content by using multichannel atomic absorptive flame photometer.

Phosphorus

Two ml of triacid mixture was pipetted out into 50 ml volumetric flask and 5 ml of vendomolybdate reagent was added and volume was made up with distilled water. The sample was allowed to stand for 2 hours for colour development. The colour intensity was measured by using photo electric colorimeter with blue filter. The amount of phosphorus in the sample was calculated by comparing with standard curve obtained for standard phosphorus (Jackson, 1960).

3.6 Analysis of products

3.6.1 Chemical analysis

3.6.1. Total soluble solids (TSS)

Total soluble solids content was recorded by using an 'Erma' hand refractometer and values were expressed as per cent total soluble solids after making necessary temperature corrections.

3.6.1.2 Total titratable acidity

Ten grams of sample was dissolved in a small quantity of distilled water and the volume was made up to 100 ml. Twenty ml of aliquot was titrated against standard 0.1 N NaOH using phenolphthalein as indicator. Results were expressed as percentage citric acid (Ranganna, 1977).

3.6.1.3 Moisture

The flat bottom disks were dried at $100^{o}C$ for one hour. To each of these dried and weighed disks 100 g of sample was uniformly spread and kept in the oven for drying. The temperature was maintained at $55^{o}C$ for 4 days. After drying, the disks were weighed along with samples. The moisture content was expressed as per cent.

3.6.1.4 Ascorbic acid

Ten grams of prepared product was blended with 3 per cent metaphosphoric acid as a stabilizing agent and the volume was made up to 100 ml. Ascorbic acid was estimated by titrating 10 ml of aliquot against standard 2, 6-dichlorophenol indophenol. The ascorbic acid content was expressed as mg per 100 g of sample.

3.6.1.5 Sugars

Five grams of product was blended with distilled water and neutralized with 0.1 N NaOH. After adding lead acetate for clarification, potassium oxalate was added to remove excess of lead and the volume was made upto 250 ml with distilled water and filtered. Twenty ml of this filterate was further diluted to 100 ml and used for analysis. Reducing sugars were estimated following the method outlined by Lane and Eynon (1923).

For estimating total sugars, 50 ml of the filtrate was hydrolysed with 5 ml of concentrated hydrochloric acid at room temperature for a day. After neutralizing with 6 N NaOH using phenolphthalein as indicator the bvolume was made upto 100 ml with distilled water. This aliquot was used for the estimation of total sugars.

3.6.1.6 Crude protein

The crude protein content was calculated by multiplying the per cent nitrogen with factor 6.25 and the total nitrogen content in the sample was estimated by using micro-kjeldahl method.

To a 500 ml kjeldahl flask, 10 ml of sample was transfered and boiling mixture (10 g of potassium sulphate, 5 g of sodium thiosulphate and 1 g of copper sulphate) was added to each sample. Then 20 ml of sulphuric salicylic acid reagent and 15 ml of concentrated sulphuric acid were added and mixed throughly. To prevent bumping a few glass beads were placed in the flask and heated on low flame until frothing (foaming) subsided. Subsequently the flasks were heated on high flame till the sample became clear and heating was continued for another 20 minutes after completion of digestion. The sample was cooled and 150 ml of distilled water was added. The sample was neutralised with 12 N NaOH after adding a few drops of phenophthalein indicator. The flasks were attached to a distillation set and 150 ml of distillate was collected in to 250 ml conical flask containing 30 ml of 4 per cent boric acid with a few drops of 0.2 per cent methyl red indicator. After termination of distillation, the condenser tip was rinsed into the flask. The distillate was then titrated against 0.1 N hydrochloric acid to a red end point.

The blank was also carried through the same procedure with 10 ml of distilled water. The amount of nitrogen in the sample was calculated by using the following formula.

$$\text{Nitrogen mg/1000 ml} = \frac{(A - B)\ (N)\ (14)\ (1000)}{V}$$

whereas,

A = Volume of HCl (ml) used in sample titration

B = Balnk titrate value

N = Normality of hydrochloric acid and

V = Volume of sample taken.

3.6.1.7 Crude fibre

Ten milli litre of sample was taken for estimation and dried. This dried sample was digested with 200 ml of 1.25 per cent H_2SO_4 and the digestion was carried out with 200 ml of 1.25 per cent NaOH. Crude fibre was calculated as per the method outlined in A.O.A.C. (1970).

3.6.1.8 Inorganic constituents

Inorganic constituents such as calcium and phosphorus in the wood apple products was estimated by following standard procedure. 25 ml of prepared sample was transfered to 250 ml conical flask, and evoporated to dryness on a water bath. These dried samples were digested with triacid mixture. The digested samples were diluted to 50 ml by double distilled water in 50 ml volumetric flasks, and then the samples were filtered through whatman No.1 filter paper into plastic bottles for further analysis.

Calcium

One milli litre of triacid extract was diluted to 50 ml with double distilled water. The aliquot was used for estimating calcium content by using multichannel atomic absorptive flame photometer.

Phosphorus

Two milli litres of triacid extract was pipetted out in to 50 ml volumetric flask and 5 ml of venadomolybdate reagent was added and diluted to volume with distilled water. The sample was allowed to stand for two hours for colour development. The colour intensity was measured by using photo electric colorimeter with blue filter. The amount of phosphorus in the sample was calculated by comparing standard curve obtained for standard phsophorus.

3.6.2 Organoleptic evaluation

The organoleptic evaluation of squash, nectar and jelly for quality attributes such as appearance, flavour, aroma, taste and overall quality was assessed by using ranking test. The sensory evaluation was carried out by a panel of judges.

The following chart was used for evaluation of the products.

SENSORY EVALUATION

NAME: DATE:

Evaluation of Wood apple product Squash/Nectar/ Jelly by ranking test.

Quality attributes	Sample Code
Appearance	
Flavour	
Aroma and Taste	
Overall Quality	
Comments	

Note: Rank the samples for the attributes, appearance flavour, and overall acceptabilities. The samples will be ranked from higher to low in descending order of acceptability.

3.7 Storage of wood apple products

Wood apple products prepard were stored to study the chemical and physical changes such as colour, taste, flavour and extent of spoilage for a period of 3 months and observations were recorded at an interval of 15 days in all the samples.

3.7.1. Change in colour

The colour change of the products were recorded by visual observations and grouped into the following categories: Original characteristic colour, slight colour fading and complete change in colour from its original.

3.7.2 Taste and flavour

Products were organoleptically evaluated for taste, flavour and grouped into various categories based on their quality such as highly pleasant, pleasant, moderately pleasant, unpleasant and highly unpleasant.

3.7.3 Microbial spoilage

The microbial spoilage of the products was recorded as follows: No spoilage,slightly spoiled and fully spoiled.

3.8 Statistical analysis

The data obtained on various parameters for each product in three replications were subjected to analysis by factorial CRD statistical design, while in case of jelly the data were analysed by following completely randamised design (CRD).

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The results of the experiments conducted on various aspects of wood apple products are presented in this chapter.

4.1 Physico-chemical composition of wood apple

4.1.1 Physical characters

The physical parameters viz., weight, length, diameter of the fruit, shell, seeds, fibre and pulp content of fruits were recorded following standard procedures. The data thus obtained are presented in Table 1.

The average fruit weight was found to be 205.6 g and the average length of fruit was 7.07 cm whereas, the diameter of the fruit was found 7.64 cm (Plate IV).

The wood apple fruit consisted pulp (23.18%) seeds and fibre (16.27%). The shell content of the fruit was about 60.66 per cent. Moisture content of pulp was 66.80 per cent.

4.1.2 Chemical composition of wood apple

The characters such as total soluble solids, acidity, sugars, crude protein, calcium, phosphorus,

Woodapple (Feronia limonia L.) Fruit.

Tabele 1: Physical parameters of wood apple (<u>Feronia limonia</u> L.)

Sl.No.	Parameter	Unit	Observation
1	Length	cm	7.07
2.	Diameter	cm	7.64
3.	Wt. of fruit	g	205.60
4.	Pulp	%	23.18
5.	Shell	%	60.55
6.	Seeds and fiber	%	16.27
7.	Moisture	%	66.80
8.			

Tabele 2: Chemical composition of wood apple (<u>Feronia limonia</u> L.)

Sl.No.	Parameter	Unit	Observation
1	TSS	^{o}B	7.50
2.	Acidity	%	1.80
3.	Total Sugar	%	6.25
4.	Reducing sugar	%	3.75
5.	Non-reducing sugar	%	2.50
6.	Crude protein	g/100g	7.10
7.	Crude fiber	g/100g	5.38
8.	Phosphorus	mg/100g	108.00
9.	Calcium	mg/100g	128.00
10.	Ascorbic acid	mg/100g	44.75

fibre and ascorbic acid were studied and results are presented in Table 2.

The total soluble solids of wood apple pulp was $7.5^{O}B$ whereas, acidity was 1.8 per cent. The total sugars and reducing sugars content was 5.89 and 3.75 per cent respectively, while non reducing sugars content was 2.46 per cent. The ascorbic acid content of fruit pulp was 44.75 mg per 100g and crude fibre was 5.38 per cent, whereas calcium and phosphorus contents were 121 mg and 108 mg per 100 g of pulp, respectively.

4.2 Wood apple squash

4.2.1 Chemical composition of wood apple squash

The chemical constituents of sqush such as crude protein, crude fibre, moisture, calcium and phosphorus were studied and results are presented in Table 3.

4.2.1.1 Moisture

The moisture content of squash was dependent on the pulp percentage in it. It was 91.42 per cent in the sample which has 25 per cent pulp, 88.57 per cent in 35 per cent pulp and 84.82 per cent in 45 per cent pulp levels. The total soluble solids levels and interaction between pulp and total soluble solids were not significant.

Table 3: Chemcial composition of wood apple (<u>Feronia limonia</u>) squash (after storage)

	Moisture %	Crude Protein g/100g	Crude fibre g/100g	Calcium mg/100g	Phosphorus mg/100g
FACTORS					
Pulp 25% (P_1)	91.417	1.798	1.240	32.467	28.263
Pulp 35% (P_2)	88.572	2.450	1.951	44.933	36.983
Pulp 45% (P_2)	84.817	3.195	2.418	59.067	48.417
TSS					
40^{o}Brix (S_1)	88.306	2.500	1.850	45.333	37.765
50^{o}Brix (S_2)	88.231	2.462	1.885	45.644	38.001
Interaction					
P_1S_1	91.487	1.800	1.230	32.000	27.683
P_1S_2	91.347	1.797	1.250	32.933	28.843
P_2S_1	88.650	2.500	1.897	44.533	36.817
P_2S_2	88.493	2.400	2.005	45.333	37.150
P_3S_1	84.780	3.200	2.435	58.467	48.793
P_3S_2	84.853	3.190	2.400	58.667	48.040
Pulp F test	*	*	*	*	*
SEM	0.099	0.032	0.031	0.228	0.217
CD	0.304	0.099	0.093	0.702	0.667
TSS F test	NS	NS	NS	NS	NS
SEM	0.081	0.026	0.021	0.186	0.177
CD	0.249	0.081	0.064	0.573	0.545
Interaction					
F test	NS	*	*	*	*
SEM	0.140	0.064	0.058	0.322	0.306
CD	0.431	0.240	0.154	0.992	0.944

4.2.1.2 Crude protein

The increase in crude protein content was recorded with increase in pulp content. The increase was significant between 25 and 35, 25 and 45 and 35 and 45 per cent pulp. Results showed not much change in crude protein content with the levels of total soluble solids. The interaction effect of pulp and total soluble solids levels recorded non-significant differences.

4.2.1.3 Calcium

The data reveal that the squash prepared from three different levels of pulp varied significantly with respect to calcium content. The calcium content of the sample where in 25 per cent pulp was used recorded 32.467 mg per 100 g, while 35 per cent level of pulp registered 44.933 mg per 100 g and 45 per cent pulp level showed 59.067 mg per 100 g. There was not much variation in calcium content in samples containing different levels of soluble solids. The interaction effect between pulp and total soluble solids was found significant but, two levels of total soluble solids with variation in pulp level did not vary much in their calcium content.

4.2.1.4 Phosphorus

Phosphorus content was influenced significantly with increase in pulp concentration. Phosphorus content was 28.263 mg per 100 g in 25 per cent pulp, 36.983 mg per 100 g in 35 per cent pulp and 48.417 mg per 100 g in 45 per cent pulp. Levels of total soluble solids did not appreciably change the phosphorus content, whereas the interaction effect between pulp and total soluble solids was found significant but, two levels of total soluble solids with each level of pulp did not vary in their phosphorus content.

4.2.1.5 Crude fibre

There was a significant increase in crude fibre content of squash with increase in percentage composition of pulp. It was highest in 45 per cent pulp (2.418 g per 100 g) and lowest in 25 per cent pulp (1.240 g per 100 g). Total soluble solids levels were found to have no significant effect, whereas the interaction effects were found significant. But each level of pulp with different levels of total soluble solids did not show much difference regarding crude protein content in their compositions.

4.2.2 Changes in chemical composition of wood apple squash during storage

The data on various chemical changes during the storage of wood apple squash are presented in Table 4.

Table 4: Changes in chemical composition of wood apple squash content during storage

	TSS (^{o}Brix)		Acidity (%)		Total Sugars (%)		Reducing sugar (%)		Non-reducing sugar (%)		Ascorbic acid (mg/100g)	
	I	II	I	II	I	II	I	II	I	II	I	II
FACTORS												
Pulp 25% (P_1)	45.000	46.990	1.250	1.01	40.573	40.887	5.852	34.720	34.718	6.160	13.333	10.772
Pulp 35% (P_2)	45.000	47.421	1.250	1.06	39.015	39.470	4.317	33.700	33.635	5.597	14.667	11.639
Pulp 45% (P_3)	45.000	47.200	1.250	1.07	40.571	40.882	5.676	34.890	34.895	5.992	17.000	13.189
TSS												
40^{o}Brix (S_1)	40.000	41.459	1.250	1.05	35.589	35.861	4.882	30 710	30.693	5.149	14.889	11.763
50^{o}Brix (S_2)	50.000	52.680	1.250	1.03	44.516	44.882	6.348	38.163	38.138	6.683	15.111	11.713
Interaction												
P_1S_1	40.000	41.333	1.250	0.99	35.803	36.087	5.206	30.600	30.592	5.480	13.333	10.222
P_1S_2	50.000	52.665	1.250	1.03	45.343	45 887	6.498	38.840	38.845	6.840	13.333	10.500
P_2S_1	40.000	41.750	1.250	1.05	34.563	34.807	4.525	30.043	30.008	4.763	14.667	11.744
P_2S_2	50.000	53.125	1.250	1.07	43.467	43.887	6.108	37.357	37.259	6.430	14.600	11.534
P_3S_1	40.000	41.550	1.250	1.05	36.403	36.690	4.918	31.487	31.480	5.203	16.667	13.122
P_3S_2	50.000	52.850	1.250	1.07	44.739	45.073	6.439	38.293	38.310	6.780	17.330	13.256
Pulp F test	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	*	*
SEM	0.000	0.662	0.000	0.012	0.618	0.637	0.343	0.671	0.662	0.366	0.667	0.576
CD	0.000	2.039	0.000	0.070	1.904	1.964	1.057	2.068	2.039	1.126	2.054	1.774
TSS F test	*	*	NS	*	*	*	*	*	*	*	NS	NS
SEM	0.582	0.572	0.000	0.009	0.504	0.520	0.280	0.548	0.546	0.299	0.544	0.523
CD	1.772	1.762	0.000	0.058	1.554	1.602	0.863	1.688	0.920	1.672	1.610	1.774
Interaction												
F test	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS
SEM	1.174	1.174	0.000	0.017	0.874	0.901	0.485	0.949	0.090	0.517	0.943	0.898
CD	3.616	3.616	0.000	0.051	2.692	2.725	1.495	2.924	0.277	1.593	2.905	2.765

Note. I - Before storage
II - After storage
* - Significant at 5%
NS - Not significant

4.2.2.1 Total soluble solids

The total soluble solids content of squash slightly increased during storage for a period of 90 days. In the begining of storage the squash samples with total soluble solids content of all three pulp levels were maintained at $40^{o}B$ and $50^{o}B$. After the storage, there was increase in total soluble solids from $1.990^{o}B$ to $2.421^{o}B$. There was an increase in total soluble solids content during storage period. It increased by $1.459^{o}B$ in $40^{o}B$ and $2.680^{o}B$ in $50^{o}B$ levels of total soluble solids, whereas the interaction effect of pulp and total soluble solids was found non-significant. But a slight increase of 1.333 to $3.125^{o}B$ total soluble solids was noticed in different recipes of squashes.

4.2.2.2 Acidity

Acidity was significantly reduced in all the recipes of squashes during storage. The initial titratable acidity of 1.25 per cent was reduced to 1.01, 1.06 and 1.07 per cent in squash prepared from 25, 35 and 45 per cent pulp, respectively. In respect of total soluble solids acidity was reduced significantly to 1.05 per cent in $40^{o}B$ and 1.03 per cent in $50^{o}B$. The data recorded on the interaction effect revealed that there was a fall in acidity during the storage. The maximum reduction of acidity (0.99 per cent) was found in 25 per cent pulp with $40^{O}B$ total soluble solids and the maximum (1.09 per cent) reduction was in 45 per cent with $50^{O}B$ total soluble solids.

4.2.2.3 Total sugars

The total sugars content of the squash slighlty increased during the storage period of 90 days. The data showed no significant variations among differnt concentrations of pulp mixed in each recipe with respect to total sugars. The interaction effects of pulp and total soluble solids and total solubal solids levels with regard to total sugar content before and after storage period was found non-significant. However, there was significant increase in total sugars content among the samples of different total soluble solids levels. The maximum increase of 0.35 per cent was recorded after storing the samples for a period of 90 days.

4.2.2.4 Reducing sugar

Interactions of different levels of pulp and total soluble solids have shown no significant effect on reducing sugar content, whereas total soluble solids levels were found significant before and after the storage in case of squash samples. It was also evident from the data that there was increase in reducing sugar content after the storage period. The increase was almost 3 to 4 times that of initial reducing sugar content.

4.2.2.5 Non reducing sugar

The three different levels of pulp recorded non-significant results with respect to non reducing sugars before and after the storage. The interaction of pulp and total soluble solids also showed no significant differences in relation to pulp, whereas total soluble solids levels recorded positive results. It was 30.693 in $40^{o}B$ and 38.138 per cent in $50^{o}B$. Before storage and after storage the non-reducing sugar content was greatly reduced to the extent of 3.149 in $40^{o}B$ and 6.683 per cent in $50^{o}B$ total soluble solids.

4.2.2.6 Ascorbic acid

Significant variations were noticed with regard to ascorbic acid content of squash prepared with different levels of pulp before and after storage. The maximum ascorbic acid was found in the squash with 45 per cent pulp followed by 35 and 25 per cent pulp levels. There was no significant change in ascorbic acid content with change in total soluble solids and their interactions.

There was reduction in ascorbic acid content in the sample during the storage. This reduction was nearly 20-25 per cent after storing the samples for a period of 90 days.

4.2.3 Organoleptic quality of squash

Organoleptic evaluation was done to assess the quality of squash made from different recipes for quality attribute such as, appearance, flavour, aroma, taste and overall quality of squash. The scores obtained for the quality parameters are presented in Table 5.

4.2.3.1 Appearance

Different levels of pulp used in the preparation showed significant effect on the appearance of squash. Scores obtained for appearance were 4.316 rank in 25 per cent pulp, 3.64 ranks in 35 per cent pulp and 2.727 rank in 45 per cent pulp. The total soluble solid levels showed significant effect. It had 3.879 rank in 40^{O}B and 2.939 rank in 50^{O}Brix. The interactions between pulp and total soluble solids were also found significant. The highest (1.907) score was found in recipe with 45 per cent pulp and 40^{O}B total soluble solids. The minimum rank of 5.545 was found for the recipe with 25 per cent pulp and 40^{O}B total soluble solids.

Table 5: Organoleptic qualities of different recipes of wood apple squash

	Appearance	Flavour	Aroma and taste	Overall quality
FACTORS				
Pulp 25% (P_1)	4.136	4.682	1.798	1.240
Pulp 35% (P_2)	3.364	3.500	4.182	3.091
Pulp 45% (P_3)	2.727	1.955	2.955	2.545
TSS				
40^oBrix (S_1)	3.879	3.515	3.727	3.818
50^oBrix (S_2)	2.939	3.242	3.424	3.182
Interaction				
P_1S_1	5.545	4.909	4.455	5.545
P_1S_2	2.727	4.555	2.636	2.182
P_2S_1	4.182	4.182	5.182	4.364
P_2S_2	2.545	2.818	3.182	3.813
P_3S_1	1.909	1.455	1.455	1.545
P_3S_2	3.545	2.455	4.455	3.545
Pulp F test	*	*	*	*
SEM	0.241	0.247	0.243	0.240
CD	0.482	0.494	0.486	0.480
TSS F test	*	NS	NS	*
SEM	0.197	0.201	0.198	0.196
CD	0.364	0.402	0.396	0.392
Interaction				
F test	*	NS	NS	*
SEM	0.341	0.349	0.344	0.339
CD	0.642	0.686	0.688	0.678

* - Significant at 5%
NS - Non-significant

4.2.3.2 Flavour

The data reveals that the squash prepared from three different levels of pulp differed significantly in their flavour composition. The sample with 25 per cent pulp scored 4.682, followed by 35 per cent pulp (3.500) and 45 per cent (1.955). There was no significant change in flavour with variation in total soluble solids levels. The interaction between pulp and total soluble solids recorded positive results. The maximum rank of 1.455 was registered in 45 per cent pulp and $40^{O}B$ total soluble solids recipe, and the minimum of 4.909 was in 25 per cent pulp with $40^{O}B$ total soluble solids.

4.2.3.3 Aroma and taste

There was significant difference between the levels of pulp in relation to aroma and taste of the squash. The maximum score of 1.955 was found in 45 per cent pulp followed by 35 per cent (3.500) and in 25 per cent (4.682) pulp. Non-significant results were obtained in different levels of total soluble solids and its effect with aroma and taste of the squash, whereas interaction effect was found significant. The highest rank was found in recipe with 45 per cent pulp and $40^{O}B$ total soluble solids. The lowest rank of 5.182 was found in recipe with 25 per cent pulp and $40^{o}B$ total soluble solids, whereas 25 per cent pulp with $40^{o}B$ total soluble solids and 45 per cent pulp with $50^{o}B$ total soluble solids were not similar to others, but they were found similar in their rankings.

4.2.3.4 Overall quality

Maximum score was recorded for overall quality of squash with proportional increase in the pulp content. This increase was significant between the pulp levels. It is evident from the result that total soluble solids levels had significant influence on overall quality of squash. The score was 3.818 in $40^{o}B$ and 3.182 in $50^{o}B$ total soluble solids. The interaction effect of pulp and total soluble solids was also found significant. It ranged from 1.545 in recipe containing 45 per cent pulp and $40^{o}B$ total soluble solids to 5.455 in recipe with 25 per cent pulp and $40^{o}B$ total soluble solids.

4.2.4 Changes in the visual characters of wood apple sqush

Changes in visual quality characters were recorded during the storage of squash for a period of 90 days. The results obtained are presented in Table 6.

Table 6: Changes in visual characters of wood apple squash during the storage

	25 Per cent Pulp		35 Per cent Pulp		45 Per cent Pulp	
	40 °Brix	50 °Brix	40 °Brix	50 °Brix	40 °Brix	50°Brix
1. Colour						
After 15 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 30 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 45 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 60 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 75 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 90 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
2. Taste and flavour						
After 15 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 30 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 45 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 60 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 75 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 90 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
3. Microbial growth						
After 15 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 30 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 45 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 60 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 75 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 90 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage

4.2.4.1 Colour

The squash was prepared from three different levels of pulp. It was clear that the colour of the finished product was influenced by percentage of pulp used in the preparation of squash. The results showed that there was no change in the colour of the squash even after 90 days of storage.

4.2.4.2 Taste and flavour

From the data it was apparent that the taste and flavour of squash remained practically unchanged inspite of long storage of 90 days.

4.2.3.3 Microbial spoilage

The observations recorded for the mcorobial spoilage indicate that squash could remain free from any form of spoliage either mould, or bacterial even after storage for 90 days.

4.3 Wood apple nectar

4.3.1 Chemical composition of wood apple nectar

Chemical constituents such as moisture, crude protein, crude fibre, calcium and phosphorus were estimated and the results are presented in Table 7.

Table 7: Chemcial composition of woodapple nectar after 3 months storage

	Moisture %	Crude Protein g/100g	Crude fibre g/100g	Calcium mg/100g	Phosphorus mg/100g
FACTORS					
Pulp 20% (P_1)	93.477	1.425	1.105	26.800	20.762
Pulp 25% (P_2)	91.192	1.700	1.220	32.800	26.991
Pulp 30% (P_2)	90.208	2.258	1.384	39.067	32.383
TSS					
20^oBrix (S_1)	91.610	1.788	1.182	33.156	26.739
30^oBrix (S_2)	91.641	1.800	1.193	32.622	26.686
Interaction					
P_1S_1	93.287	1.450	1.075	26.933	20.467
P_1S_2	93.667	1.400	1.125	26.662	21.057
P_2S_1	91.340	1.717	1.233	33.660	26.912
P_2S_2	91.043	1.683	1.215	32.000	27.833
P_3S_1	90.203	2.200	1.238	38.933	32.833
P_3S_2	90.213	2.317	1.255	39.200	31.933
Pulp F test	*	*	*	*	*
SEM	0.112	0.017	0.011	0.231	0.182
CD	0.346	0.051	0.034	0.712	0.560
TSS F test	NS	NS	NS	NS	NS
SEM	0.092	0.024	0.015	0.189	0.148
CD	0.282	0.042	0.046	0.581	0.457
Interaction					
F test	NS	NS	NS	NS	*
SEM	0.159	0.024	0.016	0.327	0.257
CD	0.489	0.073	0.049	1.006	0.792

* - Significant at 5%
NS - Not significant

4.3.1.1 Moisture

The moisture content of the nectar was significantly influenced by the levels of pulp used in its preparation. It was maximum in the nectar prepared with 20 per cent pulp and minimum was recorded in the sample with 30 per cent pulp content. The different levels of total soluble solids did not alter the moisture content in the nectar. The interaction between pulp and total soluble solids also was found non-significant, in relation to its moisture level.

4.3.1.2 Crude protein

Crude protein varied significantly among the differnt levels of pulp. It ranged from 1.425 mg, 1.700 mg and 2.258 mg per 100 g for 20 per cent, 25 per cent and 30 per cent pulp levels respectively. However, total soluble solids levels had no effect on the crude protein content of nectar. Interaction between the pulp and total soluble solids showed no positive relation regarding protein content.

4.3.1.3 Calcium

There was a significant increase in calcium content of the nectar with increase in percentage pulp in it. It was 26.800 mg per 100 g, 32.800 mg per 100 g and 39.067 mg per 100 g for 20 per cent, 25 per cent and 30 per cent pulp levels respectively. However, there was no significant difference in the total soluble solids and interaction between the pulp and total soluble solids with respect to total calcium content.

4.3.1.4 Phosphorus

Variations in the phosphorus content of nectar prepared out of three different pulp levels were significant. Phosphorus content ranged between 20.762 mg per 100 g in 20 per cent pulp level and 32.383 mg per 100 g in 30 per cent pulp level. The differnt levels of total soluble solids did not affect the phosphorus content. However, intraction effect was significant but, the total soluble solids levels with differnt concentration of pulp levels did not show any positive variation in phosphorus content of the nectar.

4.3.1.5 Crude fibre

Different levels of pulp had significant influence on the moisture content of nectar. It was 1.425 g per 100 g in 20 per cent pulp, 1.700 g per 100 g in 25 per cent pulp and 2.258 g per 100 g in 30 per cent pulp. The total soluble solids levels and their interactions in relation to pulp levels recorded non-significant results for crude fibre.

4.3.2 Changes in chemical composition of wood apple nectar during storage

Data obtained on various chemical changes occurring in wood apple nectar during the storage period are presented in Table 8.

4.3.2.1 Total soluble solids

Before storing the nectar, the total soluble solids content of all the pulp levels were maintained at $20^{O}B$ and $30^{O}B$. After the storage of nectar, an increase of 1.499 and $1.711^{O}B$ was noticed in total soluble solids of $20^{O}B$ and 30^{O}Brix respectively. The change in pulp levels and their interactions were found non-significant with respect to total soluble solids content.

4.3.2.2 Acidity

Acidity was significantly reduced in all the recipes during the storage. The initial titratable acidity of 0.40 per cent was reduced to 0.248, 0.256 and 0.249 per cent in nectar prepared from 20, 25 and 30 per cent pulp, respectively. The total titratable acidity varied in the samples where total soluble solids were different. It was 0.251 per cent in $20^{O}B$ and 0.252 per cent in $30^{O}B$. The interaction effects of pulp levels and total soluble solids also were found

Table 8: Changes in chemical composition of woodapple nectar content during storage

	TSS (^{o}Brix)		Acidity (%)		Total Sugars (%)		Reducing sugar(%)		Non-reducing sugar(%)		Ascorbic acid	
	I	II	I	II	I	II	I	II	I	II	I	II
FACTORS												
Pulp 20% (P_1)	25.000	25.999	0.400	0.248	20.006	21.082	5.317	17.763	15.530	3.319	11.667	9.309
Pulp 25% (P_2)	25.000	27.234	0.400	0.256	21.007	21.265	5.042	17.967	18.795	3.297	13.000	10.181
Pulp 30% (P_2)	25.000	26.583	0.400	0.259	21.268	21.490	4.181	18.319	17.105	3.136	14.333	11.803
TSS												
20^{o}Brix (S_1)	20.000	21.711	0.400	0.251	17.241	17.467	4.219	14.033	14.944	3.431	12.889	10.378
30^{o}Brix (S_2)	30.000	31.499	0.400	0.252	24.806	25.091	5.474	22.000	19.242	3.091	13.111	10.484
Interaction												
P_1S_1	20.000	21.333	0.400	0.253	17.337	17.600	4.868	14.050	12.570	3.575	11.333	9.250
P_1S_2	30.000	30.666	0.400	0.243	24.533	24.563	5.767	21.500	18.490	3.063	12.000	9.368
P_2S_1	20.000	22.135	0.400	0.256	16.593	16.807	4.048	13.950	12.213	2.857	12.667	10.127
P_2S_2	30.000	32.333	0.400	0.256	25.420	25.723	6.305	21.985	19.377	3.738	13.333	10.235
P_3S_1	20.000	21.666	0.400	0.246	17.793	17.993	3.743	14.123	14.050	3.870	14.000	11.757
P_3S_2	30.000	31.500	0.400	0.253	24.743	24.987	4.619	22.515	20.160	2.472	14.667	11.850
Pulp F test	NS	NS	NS	*	NS	NS	NS	NS	NS	*	*	*
SEM	0.000	0.392	0.000	0.006	0.376	0.380	0.306	1.902	1.758	0.214	0.385	0.342
CD	0.000	1.207	0.000	0.018	1.156	1.170	0.944	5.859	5.518	0.659	1.186	1.053
TSS F test	'*	*	NS	NS	*	*	*	*	*	NS	NS	NS
SEM	0.352	0.367	0.000	0.003	0.307	0.310	0.250	1.532	1.436	0.194	0.314	0.284
CD	1.084	1.131	0.000	0.009	0.945	0.955	0.771	4.719	4.424	0.597	0.968	0.863
Interaction												
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEM	0.000	0.651	0.000	0.008	0.531	0.537	0.433	2.684	2.487	0.402	0.544	0.483
CD	0.000	2.005	0.000	0.025	1.636	0.655	1.335	8.268	7.662	1.238	1.677	1.487

Note I - Before storage
II - After storage
* - Significant at 5%
NS - Not significant

significant and the decrease in the acidity was maximum (0.243 per cent) in 20 per cent pulp with 30^{o}Brix total soluble solids and maximum (0.256 per cent) in 25 per cent pulp with 20^{o}Brix total solids.

4.3.2.3 Total sugars

The total sugar content of the nectar slightly increased during the storage. The data revealed that there were no variations among the pulp levels and interaction effects of pulp levels and total soluble solids levels with respect to total sugar content before and after the storage period, whereas a significant difference was found among total soluble solids levels. The total sugars of 17.241 per cent and 24.806 per cent was found in 20^{o}B and 30^{o}B, respectively, before storage. After storing the samples the total sugars increased to an extent of 0.22 per cent over the initial content.

4.3.2.4 Reducing sugars

The reducing sugar content of the nectar was found non-significant in relation to the pulp levels and the interaction between pulp and total soluble solids. The total soluble solids levels were found significant before and after the storage of nectar. It was initially

4.219 per cent in 20°B and 5.474 per cent in 30°B, whereas it increased to 14.033 per cent in 20°Brix and 22.000 per cent in 30°B total soluble solids levels after the storage.

4.3.2.5 Non reducing sugars

Among the three different levels of pulp used for the preparation of nectar the data showed no difference with respect to its non reducing sugar content. The interaction combinations of pulp levels and total soluble solids were also found non-significant, whereas the total soluble solids levels were found significant. It was 14.944 per cent in 20°B and 19.342 per cent in 30°B total soluble solids before storage. But, it decreased to 3.431 per cent in 20°B and 3.091 per cent in 30°B total soluble solids after the storage.

4.3.2.6 Ascorbic acid

The levels of pulp had significant variation with regard to ascorbic acid content before and after storage period of the wood apple nectar. The maximum ascorbic acid content was found in 30 per cent pulp followed by 25 and 20 per cent pulp level. A reduction of 25 per cent found in the ascorbic acid content during the storage period of 90 days. The interactions pulps were found non-significant.

4.3.3 Organoleptic quality of nectar

Organoleptic evaluation of nectar samples of different recipes was done for the quality attributes such as, appearance, aroma, taste, flavour and overall quality of nectar. The scores obtained for each quality attribute are presented in Table 9.

4.3.3.1 Appearance

There was significant difference between the levels of pulp and appearance of nectar. The rank 2.615 was found in 25 per cent pulp followed by 3.115 in 30 per cent and 4.231 in 20 per cent pulp. The levels of total soluble solids were found significant. The highest ranking of 2.872 was recorded in $30^{o}B$, whereas the interaction between pulp and total soluble solids levels was found non-significant.

4.3.3.2 Flavour

The levels of the pulp had significant effect on flavour component of the nectar. The maximum score of 2.615 was in 25 per cent and minimum of 4.462 in 20 per cent pulp. There was significant difference between levels of total soluble solids and flavour of nectar. It was 3.923 ranks in $20^{o}B$ and 2.795 rank in $30^{o}B$ total soluble solids, whereas interaction between pulp and total soluble solids was found non-significant.

Table 9: Organoleptic qualities of different recipes of wood apple nectar

	Appearance	Flavour	Aroma and taste	Overall quality
FACTORS				
Pulp 20% (P_1)	4.231	4.462	4.500	4.654
Pulp 25% (P_2)	2.615	2.615	2.807	2.692
Pulp 30% (P_2)	3.115	3.000	3.076	3.192
TSS				
20^0Brix (S_1)	3.769	3.923	3.974	4.231
30^0Brix (S_2)	2.872	2.794	2.948	2.795
Interaction				
P_1S_1	4.462	4.923	4.303	4.692
P_1S_2	4.615	4.000	4.692	4.615
P_2S_1	4.000	3.692	4.000	4.000
P_2S_2	1.385	1.538	1.615	1.385
P_3S_1	4.000	3.154	3.165	4.000
P_3S_2	2.385	2.846	2/538	2.385
Pulp F test	*	*	*	*
SEM	0.284	0.260	0.262	0.242
CD	0.568	0.520	0.524	0.484
TSS F test	NS	NS	*	*
SEM	0.232	0.212	0.214	0.198
CD	0.464	0.424	0.428	0.396
Interaction				
F test	NS	NS	*	*
SEM	0.402	0.367	0.371	0.343
CD	0.804	0.734	0.742	0.796

* - Significant at 5%

NS - Non-significant

4.3.3.3 Aroma and taste

The three different levels of pulp used in nectar preparation differed significantly with respect to aroma and taste. The highest score of 2.808 was found in 25 per cent pulp and minimum of 4.500 was found in 20 per cent pulp. The total soluble solids levels were shown to affect the quality significantly. Maximum score of 2.949 in 30^{O}B and 3.974 in 20^{O}B total soluble solids. The interaction between pulp and total soluble solids recorded significant differences. The maximum score was found in recipe of 25 per cent with 30^{O}B total soluble solids (1.615), and the minimum score was found in recipe of 20 per cent pulp with 30^{O}B total soluble solids (4.692).

4.3.3.4 Overall quality

The pulp levels had significant effect on overall quality of nectar. It scored 2.808 rank in 25 per cent pulp, 3.077 in 30 per cent pulp and 4.500 rank in 20 per cent pulp. Total soluble solids levels also showed significant effect. The rank was 3.974 in 20^{O}B and 2.949 in 30^{O}B total soluble solids. The interaction between pulp and total soluble solids was also found significant. The highest rank was found in 25 per cent pulp with 30^{O}B total soluble solids recipe (1.385), the maximum rank was found in 20 per cent pulp with 20^{o}B total soluble solids recipe (4.692).

4.3.4 Changes in visual characters of wood apple nectar

The data on various changes observed during the storage of wood apple nectar are presented in Table 10.

4.3.4.1 Colour

The colour of the final product was unchanged till 45 days of storage. But slight change in the colour was observed after 60 days of storage.

4.3.4.2 Taste and flavour

From the data presented it is clear that the taste and flavour of nectar were retained without any change in its composition even after storage for a period of 90 days.

4.3.4.3 Microbial spoilage

The observations recorded for the microbial spoilage revealed that there was no spoilage in the contents of nectar.

4.4 Wood apple jelly

4.4.1 Chemical composition of wood apple jelly

The chemical constituents such as crude protein, crude fibre, calcium and phosphorus were estimated and the results are presented in Table 11.

Table 10: Changes in visual characters of wood apple nectar during the storage

	30 Per cent Pulp		25 Per cent Pulp		20 Per cent Pulp	
	20 °Brix	30 °Brix	20 °Brix	30°Brix	20°Brix	30°Brix
1. Colour						
After 15 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 30 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 45 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour	Retaind full original colour	Retained full original colour
After 60 days	Slight change in original colour	Retained full original colour	Slight change in original colour	Retained full original colour	Slight change in original colour	Slight change in original colour
After 75 days	Slight change in original colour	Slight change in original colour	Slight change in original colour	Slight change in original colour	Slight change in original colour	Slight change in original colour
After 90 days	Slight change in original colour	Slight change in original colour	Slight change in original colour	Slight change in original colour	Slight change in original colour	Slight change in original colour
2. Taste and flavour						
After 15 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 30 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 45 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 60 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 75 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
After 90 days	Pleasent	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
3. Microbial growth						
After 15 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 30 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 45 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 60 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 75 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage
After 90 days	No spoilage	No spoilage	No spoilage	No spoilage	No spoilage	No Spoilage

Table 11: Chemcial composition of different recipes of wood apple jelly (after storage)

Recipes	Moisture %	Crude Protein g/100g	Crude fibre g/100g	Calcium mg/100g	Phosphorus mg/100g
50 Per cent Pulp 60°B TSS 1 per cent acidity		2.950	1.985	57.266	47.350
50 Per cent Pulp 63°B TSS 1 per cent acidity		2.850	1.972	58.400	48.055
50 Per cent Pulp 66°B TSS 1 per cent acidity		2.950	2.075	59.200	47.575
50 Per cent Pulp 69°B TSS 1 per cent acidity		3.100	1.935	56.267	58.541
F test	NS	NS	NS	NS	NS
SEM		0.987	0.072	0.718	0.306
CD		0.286	0.236	2.342	0.945

* - Significant at 5%
NS - Non-Significant

4.4.1.1 Crude protein

Variation in the crude protein content of wood apple jelly prepared out of four different recipes recorded non significant results.

4.4.1.2 Crude fibre

There was no change in the crude fibre content of jelly prepared with different recipes.

4.4.1.3 Calcium

The calcium content of wood apple jelly was found non significant in all the four differnt recipes.

4.4.1.4 Phosporus

There was no significant change in the phosphorus content of wood apple jelly prepared from different recipes.

4.4.2 Changes in chemical composition of wood apple jelly during storage

The data on various chemical changes observed during the storage of wood apple jelly are presented in Table 12.

4.4.2.1 Total soluble solids

There was increase in total soluble solids content during the storage period. This increase of total

Table 12: Changes in chemical composition of wood apple jelly content during storage

Recipes	TSS (^{o}Brix) I	TSS (^{o}Brix) II	Acidity (%) I	Acidity (%) II	Total sugars (%) I	Total sugars (%) II	Reducing sugar (%) I	Reducing sugar (%) II	Non-reducing sugar (%) I	Non-reducing sugar (%) II	Ascorbic acid (mg/100g) I	Ascorbic acid (mg/100g) II
50 Per cent Pulp 60^{o}B TSS 1 per cent acidity	60.000	63.333	1.00	0.62	55.640	54.070	10.950	39.570	44.356	17.500	18.810	14.970
50 Per cent Pulp 63^{o}B TSS 1 per cent acidity	63.000	65.500	1.00	0.63	58.733	56.810	12.356	46.250	46.367	12.465	17.070	15.250
50 Per cent Pulp 66^{o}B TSS 1 per cent acidity	66.000	67.890	1.00	0.65	60.430	61.220	9.616	49.660	51.016	9.560	19.220	15.345
50 Per cent Pulp 69^{o}B TSS 1 per cent acidity	69.000	71.500	1.00	0.64	63.123	62.840	11.380	49.550	52.050	11.290	17.580	14.955
F test	*	*	NS	NS	*	*	NS	NS	NS	NS	NS	NS
SEM	0.721	0.814	0.00	0.125	0.591	0.624	0.982	0.701	0.886	0.824	0.943	0.981
CD	2.392	2.405	0.00	0.448	1.921	2.435	3.202	2.938	2.889	2.318	2.905	3.125

Note: I - Before storage
II - After storage
* - Significant at 5%
NS - Not significant

soluble solids ranged from 2.50 to 3.33^{o}B in various recipes.

4.4.2.2 Acidity

The acidity in the jelly sample was drastically reduced during the storage. In the begining of storage the jelly samples maintained the acidity at 1.00 per cent. However, after the storage there was decrease in acidity to the extent of 35 to 38 per cent in most of the jelly samples.

4.4.2.3 Total sugars

The total sugars content of jelly slightly increased during the storage period of 90 days. This increase ranged from 0.15 to 2.5 per cent.

4.4.2.4 Reducing sugars

Reducing sugars significantly increased in all the recipes of jelly during storage. The maximum increase of reducing sugar was found in the recipe which had 66^{o}B of total soluble solids, whereas the minimum increase was found in 60^{o}B total soluble solids.

4.4.2.5 Non reducing sugars

Non reducing sugars were significantly reduced in all the recipes of wood apple jelly during the storage period of 90 days. The decrease ranged from 65 to 78 per cent.

4.4.2.6 Ascorbic acid

The data recorded on the ascorbic acid content of wood apple jelly revealed that there was a fall in the ascorbic acid content during the storage. The reduction ranged from 10 to 30 per cent in different recipes of wood apple jelly.

4.4.3 Organoleptic quality of jelly

Organoleptic evaluation was done for all the jelly samples and results are presented in Table 13.

4.4.3.1 Appearance

Significant differences were noticed among various recipes of jelly for its appearance. The maximum score was recorded in sample with $63^{o}B$ total soluble solids (1.181) followed by $66^{o}B$ (2.454), $60^{o}B$ (3.272) and $69^{o}B$ (3.454) total solube solids.

4.4.3.2 Flavour

There was a significant difference in scores obtained for flavour of jelly with respect to change in the total soluble solids content. It was 1.091 score in $63^{o}B$, 2.636 score in $60^{o}B$, 3.000 score in $66^{o}B$ and 3.636 score in $69^{o}B$ total soluble solids.

Table 13: Organoleptic qualities of different recipes of wood apple jelly

Recipes	Appearance	Flavur	Armoa and Taste	Overll Quality
50 Per cent Pulp 60^{o}B TSS 1 per cent acidity	3.272	2.636	2.454	2.727
50 Per cent Pulp 63^{o}B TSS 1 per cent acidity	1.181	1.091	1.454	1.181
50 Per cent Pulp 66^{o}B TSS 1 per cent acidity	2.454	3.000	2.818	2.454
50 Per cent Pulp 69^{o}B TSS 1 per cent acidity	3.454	3.636	3.272	3.636
F test	*	*	*	*
SEM	0.186	0.213	0.249	0.173
CD				

* - Significant at 5%
NS - Non-Significant

4.4.3.3. Aroma and taste

Aroma and taste of jelly significantly differed among the recipes. The maximum score of 1.454 was found in 63^{O}B total soluble solids content recipe and the minimum score of 3.272 was found in 69^{O}B total soluble solids containing recipe.

4.4.3.4 Overall quality

The different recipes significantly differed in overll quality of the jelly. It ranged from 1.181 rank in 63^{O}B to 3.636 rankin 69^{O}B total soluble solids levels recipes.

4.4.4 Changes in visual characters of wood apple jelly

Change in the sensory properties of jelly was observed and the results obtained are presented in Table 14.

4.4.4.1 Colour of jelly

It was evident from the data that colour of jelly was unaltered throughout the storage period of 90 days.

4.4.4.2 Taste and flavour

The taste and flavour were unchanged throughout the storage period.

Table 14: Changes in visual characters of wood apple jelly during the storage

	50 Per cent Pulp 60°B TSS 1 per cent acidity	50 Per cent Pulp 63°B TSS 1 per cent acidity	50 Per cent Pulp 66°B TSS 1 per cent acidity	50 Per cent Pulp 69°B TSS 1 per cent acidity
1. Colour				
After 15 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour
After 30 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour
After 45 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour
After 60 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour
After 75 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour
After 90 days	Retained full original colour	Retained full original colour	Retained full original colour	Retained full original colour
2. Taste and flavour				
After 15 days	Pleasent	Pleasant	Pleasant	Pleasant
After 30 days	Pleasent	Pleasant	Pleasant	Pleasant
After 45 days	Pleasent	Pleasant	Pleasant	Pleasant
After 60 days	Pleasent	Pleasant	Pleasant	Pleasant
After 75 days	Pleasent	Pleasant	Pleasant	Pleasant
After 90 days	Pleasent	Pleasant	Pleasant	Pleasant
3. Microbial growth				
After 15 days	No spoilage	No spoilage	No spoilage	No spoilage
After 30 days	No spoilage	No spoilage	No spoilage	No spoilage
After 45 days	No spoilage	No spoilage	No spoilage	No spoilage
After 60 days	No spoilage	No spoilage	No spoilage	No spoilage
After 75 days	No spoilage	No spoilage	No spoilage	No spoilage
After 90 days	No spoilage	No spoilage	No spoilage	No spoilage

4.4.4.3 Microbial spoilage

The jelly was free from the microbial spoilage till 90 days of storage.

DISCUSSION

V DISCUSSION

The results of the investigation on chemical composition, organoleptic evaluation and storage stability of wood apple products are discussed in this chapter.

5.1 Physico-chemical composition of wood apple fruit

The wood apple fruits are round, medium to large in size, weighing on an average 205.60 g per fruit. The length of wood apple fruit was 7.07 cm with a diameter of 7.64 cm. These values are very closely comparable with the findings of Swamy Rao et al., (1989). The edible portion of the wood apple fruit was about 23.18 per cent, while the shell was almost 60.00 per cent. Seeds and fibre together constitute about 16.27 per cent of the total fruit weight.

The wood apple is known to have less moisture (66.80 per cent) content than other fruits. This could be possibly due to the presence of a higher percentage of mucilage which contributes towards the dry matter. Similar observations were made by Roy and Singh (1979a) in bael fruit. Wood apple was found to be richer in ascorbic acid content (44.75 mg/100 g) compared to many other fruits, such as mango, citrus, pineapple etc. The crude protein content of wood apple fruit appears to be quite high (7.1 g per 100 g) compared to other fruits. Gopalan *et al*., (1971) reported that wood apple fruit pulp contains nearly 7 g of crude protein per 100 g edible portion. The total soluble solids of wood apple was very low (7.5^{o}B), but the acidity was more (1.8 per cent) compared to other fruits. Wood apple pulp consisted of 3.75 per cent reducing sugars and 2.46 per cent non-reducing sugars out of total sugars of 5.89 per cent. Similar results were also reported by Bhat (1944). Wood apple fruit is a good source of calcium (121 mg per 100 g) and phosphorus (108 mg per 100 g) Swamy Rao *et al*., (1989) reported that the calcium and phosphorus contents were 0.13 and 0.11 per cent, respectively.

5.2 Wood apple squash

5.2.1 Chemical composition of wood apple squash

5.2.1.1 Crude protein

Crude protein content increased with increase in pulp concentration of the product. This increase may be due to high percentage of pulp levels which added more crude protein to the squash. Thus it was clear that 45 per cent pulp level showed higher protein since it had more pulp in the product.

5.2.1.2 Calcium

The calcium content in the prepared squash differed markedly with different pulp levels. The maximum calcium content of 59.067 mg per 100 g was found in 45 per cent pulp level as compared to other two pulp levels. This increase may be related with increase in total pulp concentration in wood apple squash.

5.2.1.3 Phosphorus

The phosphorus content varied with the levels of pulp concentrations. This variation in phosphorus content could be due to differnt levels of pulp in the squash. As the pulp concentration decreased in squash the phosphorus content per unit of squash decreased. However, the interactions between pulp levels and the total soluble solids have shown changes in the phosphorus content. This change in phosphorus content could be attributed to the proportional addition of the pulp in the preparation of squash. Interaction effect of pulp and sugar on the phosphorus content of squash revealed that the higher levels of pulp added contributed towards increased phosphorus content compared to the lower levels of total soluble solids.

5.2.1.4 Crude fibre

The maximum crude fibre content of 2.418 g per 100 g was found in 45 per cent pulp compared to 35 and 25 per cent pulp levels. Thus there was positive relation between pulp level and crude fibre content. However, when the per cent pulp was more the crude fibre content increased. The interaction effects of pulp and total soluble solids on crude fibre content of the pulp levels dominated over those of total soluble solids levels.

5.2.1.5 Moisture

The maximum moisture content of 91.42 per cent was noticed in 25 per cent pulp, followed by 35 per cent pulp (88.22 per cent) and 45 per cent pulp (84.82 per cent). The moisture content of the squash was greatly influenced by the levels of pulp added to the squash which,in turn recorded higher dry matter content in the squash. Similar observations were made by Roy and Singh (1979a) in bael fruit.

5.2.2 Changes in chemical composition of wood apple squash during storage

5.2.2.1 Total soluble solids

The storage of wood apple squash resulted in a slight increase in its total soluble solids content. A similar magnitude of increase in total soluble solids was noticed by Bhatia et al., (1956) and Jain et al., (1984).

5.2.2.2 Acidity

Stored wood apple squash was found to decrease in its titratable acidity over a period of time. The investigations revealed that reduction in acidity of squash was governed by both pulp and total soluble solids levels. More reduction of acidity was found in 25 per cent pulp level than in others. The decrease in acidity during the storage of beverage in presence of sugar is a general phenomenon as reported by Bhatia et al., (1956). Further, it was reported that reduction in acidity would be governed by the sugar concentration in squash. The results obtained in the present investigation are in line with earlier observations made by Bhaita et al., (1956) and Jain et al., (1984).

5.2.2.3 Sugars

During the storage there was loss of non reducing sugars with increase in reducing sugars and total sugars in the wood apple squash. This could be due to the hydrolysis of polysaccharides and inversion of non reducing sugars. It may be also due to slight increase in acidity due to addition of potassium metabisulphite to squash during the storage, which might have caused the rapid inversion of non reducing sugars to reducing sugars as reported by Roy and Singh (1979d). The results obtained in this investigation are comparable with observations made by Roy and Singh (1979d) and Palaniswamy and Muthukrishnan (1974).

5.2.2.4 Ascorbic acid

It is known that normally wood apple pulp contains a fairly high level of ascorbic acid. The maximum ascorbic acid content of squash was noticed in 45 per cent pulp followed by 35 per cent and 25 per cent pulp. The presence of higher pulp content in the squash might have influenced change in ascorbic acid content. The decrease in ascorbic acid was found to be 20 to 25 per cent after the storage of squash. It might be due to oxidation of squash samples during storage. Similar observations were made by Roy and Singh (1979d) in bael fruit squash.

5.2.3 Organoleptic quality of wood apple squash

5.2.3.1 Appearance

Among the samples prepared from different pulp levels, the squash sample with 45 per cent pulp had excellent appearance. This could be due to the influecne of pulp level on the development of characteristic appearance. Similarly, higher soluble solids in the squash exhibited superior quality. The interaction between the pulp levels and the total soluble solids was found significant. This could be attributed to the dominance of both pulp and total soluble solids levels. Thus, it implies that there is a positive relationship between the pulp and total soluble solids content of squash with respect to the appearance. Roy and Singh (1979c) reported that 50 per cent pulp with $50^{o}B$ of total soluble solids was found best in bael fruit.

5.2.3.2 Flavour

The flavour of the squash was best with the highest pulp concentration. The pulp level of 45 per cent was recorded the highest score (1.955) compared to 35 per cent (3.500) and 25 per cent (4.682) pulp level. This could be due to better compatibality in improving palatability of squash through more pulp by enriching the flavour. Thus 45 per cent pulp level was found to have a tendency towards increasing the flavour of squash. There were significant differences among interactions of pulp and total soluble solids. There was no change in flavour of squash samples of different pulp level with change in total soluble solids levels. This could be attributed to the dominance of pulp over the level of total soluble solids.

5.2.3.3 Aroma and taste

The present investigation showed that there was considerable change in respect of aroma and taste of wood apple squash with the change in the pulp concentration. It was inferred that the squash prepared from 45 per cent pulp maintained the strength of $40^{O}B$ and was adjudged superior to the rest of the recipes. Thus scoring highest rank may be related with the increase in total pulp concentration which improved better aroma and taste at $40^{O}B$, and it could be also due to the fact that the sugar acid ratio might be at its best palatability level.

5.2.3.4 Overall quality

The maximum rank was found in 45 per cent pulp as comapared to 35 per cent and 25 per cent of pulp in the squash. This might be due to positive relationship between the pulp level and overall quality of squash. Total soluble solids content was also found significant. The maximum score was found in $50^{O}B$. It had a tendency towards increasing the overall quality of squash. The 45 per cent pulp with the $40^{O}B$ total soluble solids showed the highest rank of 1.545. This could be attributed to the dominance of pulp and total soluble solids levels which might have advantage over other combination of pulp and total soluble solids. And also it might be due to the best combination of sugar-acid ratio. Roy and Singh (1979c) observed that, the 50 per cent pulp with 50^{o}B of total soluble solid at 1.50 per cent acidity had the highest organoleptic quality in bael fruit squash. Ahamad et al., (1986a) also reported that sugar-acid ratio of 50:1 in citrus and mango fruit squash helped in developing optimum taste.

5.2.4 Changes in visual characters of wood apple squash

Wood apple squash stored showed no change in it natural colour. This could be attributed to the fact that the colour pigments responsible for imparting charterstic colour to squash as anthocyanin and carotiniods were not degraded due to the addition of potassium metabisulphite treatment, which in turn helped to retain colour. The pattern of results obtained in present investigation are in line with the earlier observations made in citrus juice by Urmil Mehata and Satinder (1983), and Ahamad et al., (1986b). Wasker and Khurdiya (1987) reported that more anthocyanin pigments retained in squash prepared from phalsa fruit and packed in glass bottle.

The present investigation also showed that there was no change in taste and flavour of wood apple squash during the storage period. It could be due to the potassium metabisulphite which might influence the retention of taste and flavour of squash. These results are in agreement with the findings of Bhatia et al., (1956) in jack fruit squash.

The samples stored for 90 days were free from any form of microbial spoilage. This could be due to the fact that higher total solube solids in the squash in addition to preservative added to the squash whould have prevented the growth of microorganisms. Similar findings were also reported by Giridhari Lal et al., 1959 and Frazier and Westhoff, 1978).

5.3 Wood apple nectar

5.3.1 Chemical composition of wood apple nectar

5.3.1.1 Curde protein

Crude protein content in the product increased with the increase in pulp concentration in the nectar samples. This increase may be due to addition of higher percentage of pulp which increased protein content in the nectar. Thus it is clear that 30 per cent pulp level showed higher protein content as it had more pulp in the product.

5.3.1.2 Calcium

The maximum calcium content of 39.067 mg per 100 g of nectar was found in 30 per cent pulp level as compared to other two pulp levels. This increase may be related with increase in total pulp concentration in the wood apple nectar.

5.3.1.3 Phosphorus

Phosphorus content varied with change in the pulp concentration. This variation in phosphorus content could be due to different levels of pulp in the nectar. As the pulp concentration decreased in the nectar the phosphorus content per unit pulp decreased.

5.3.1.4 Crude fibre

The maximum crude fibre content of 2.258 mg per 100 g of sample was found in 30 per cent compared to 25 and 20 per cent pulp levels. It is due to direct relationship beween pulp level and crude fibre content of nectar. Hence, as the per cent of pulp increased there was concomitant increase in the crude fibre content.

5.3.1.5 Moisture

The maximum moisture content of 93.477 per cent was noticed in 20 per cent pulp level followed by 25 per cent (91.192 per cent) and 30 per cent pulp (90.208 per cent) level. This might be due to the increase in the concentration of pulp in nectar which increased the dry matter content of nectar.

5.3.2 Changes in chemical composition of wood apple nectar during storage

5.3.2.1 Total soluble solids

The storage of wood apple nectar was characterised by a slight increase in its total soluble solids content. A similar magnitude of increase in total soluble solids was noticed by Palaniswamy and Muthukrishnan (1974) in Lemon juice.

5.3.2.2 Acidity

Storage of wood apple nectar indicated a reduction in the total titratable acidity during storage. The reduction in acidity was positively influenced by the pulp and total soluble soilds levels. Maximum reduction of acidity (0.248 per cent) was noticed in 20 per cent pulp level and the minimum to 0.256 per cent was found in 25 per cent pulp. The total soluble solids levels also were found to reduce the total acidity in the nectar. The reduction was more in 30^{o}B compared to 20^{o}B total soluble solids. This reduction in acidity could be due to change in sugar concentration in the nectar. The results obtained in the present investigation are in agreement with the earlier findings of Roy and Singh (1979d) in bael fruit nectar.

5.3.2.3 Sugars

The storage of wood apple nectar was characterized by reduction in non reducing sugars and an increase in reducing sugars and total sugars. This could be attributed to the hydrolysis of polysaccharides and inversion of disaccharides to reducing sugars. These findings are highly comparable with the investigations of Palaniswamy and Muthukrishnan (1974) in lime squash and of Roy and Singh (1979) in bael fruit nectar.

5.3.2.4 Ascorbic acid

The maximum ascorbic acid content in the nectar was noticed in the samples with 30 per cent pulp followed by 25 and 20 per cent pulp. The presence of high percentage pulp in the squash might have greatly influenced the ascorbic acid content. The decrease in ascoribc acid content of 25 per cent was recorded after the storage in nectar samples. It might be due to the oxidation of nectar samples during storage. Similar observations were made by Roy and Singh (1979d) in bael nectar.

5.3.3 Organoleptic quality of wood apple nectar

5.3.3.1 Appearance

The appearance of nectar was influenced by both the pulp and total soluble solids levels. The maximum score (2.615 rank) was found in 25 per cent pulp, as compared to 20 and 30 per cent pulp levels. Thus it was very clear that, addition of 25 per cent pulp was positively effective in imparting a good appearance to the nectar. Thus, 25 per cent pulp might be the optimum level of pulp which imparts the maximum eye appeal to the product. The scores recorded for the appearance differed markedly at two different total soluble solids levels. The nectar with 30^{o}B has scored highest rank of 2.872 followed by 20^{o}B (3.769). It may be due to the higher strength of syrup which contributed towards the development of better viscosity to the product.

5.3.3.2 Aroma and taste

The highest score of 2.808 was recorded in the 25 per cent pulp level. The pulp level of 30 per cent registered comparatively higher rank than that of 20 per cent pulp level. But 25 per cent pulp level was superior to the other two pulp levels, in maintaining good aroma and taste in the nectar. The optimum level of aroma and taste might have been contributed by 25 per cent pulp as the best level in the sample. The highest score of 2.795 for aroma and taste was in 30^{O}B as compared to 20^{O}B (4.231) total soluble solids. This might be due to the presence of large quantity of sugar in higher total soluble solids which in turn helped to improve the taste of the nectar. It may be also due to formation of appropriate sugar-acid blend in the product which gave better taste to the nectar. Similar findings were reported by Mabesa et al., (1982).

5.3.3.3 Flavour

The flavour of nectar was influenced by pulp levels. The maximum score was found in the 25 per cent pulp level compared to other levels of pulp. The flavour score of nectar differed markedly at two different levels of total soluble solids. The 30^{O}B has highest score (2.795) than 20^{O}B (3.923). The sugar added to the nectar will retain the flavour of the pulp as reported by Goldthwaite (1909).

5.3.3.4 Overall quality

The overall quality of nectar was influenced by both the pulp and total soluble soilds levels. The highest score of 2.692 was found in 25 per cent pulp. It may be the optimum level of pulp which might have contributed towards the quality of nectar. Similarly, $30^{o}B$ total soluble solids content nectar samples showed the highest score. It may be due to the higher strength of syrup which contributed towards the development of better viscosity to the product. The 25 per cent pulp level with $30^{o}B$ total soluble solids was found to be best among all the other recipes. Roy and Singh (1979c) reported that 35 per cent pulp with $25^{o}B$ total soluble solids was found to be the best nectar in bael fruit.

5.3.4 Changes in visual characters of wood apple nectar

The highest colour retention in wood apple nectar during initial storage of 45 days was not affected by the storage conditions. The colour was adjudged excellent upto 45 days of storage. But colour change was noticed after 60 days of storage. This might be due to degradation of colouring pigments present in nectar. Similar observation in the change of colour was established by the earlier workers (Waskar and Khurdiya, 1987) in phalsa nectar.

The flavour and taste of wood apple nectar was found to be best during storage. The sugar present in nectar could be responsible for retaining the flavour of the pulp as reported by Goldthwaite (1909). There was no microbial spiolage of wood apple nectar during the storage period. Similar results were reported by Roy and Singh (1979d) in bael fruit nectar.

5.4 Wood apple jelly

5.4.1 Chemical composition of wood apple jelly

The chemical constituents of wood apple jelly were found to be non significant. This could be due to the fact that the quantity of pulp used for the preparation of jelly was constant for all the recipes which inturn contributed almost similar composition among the recipes.

5.4.2 Changes in chemical composition of wood apple jelly

5.4.2.1 Total soluble solids

The storage of wood apple jelly resulted in a slight increase in its total soluble solids content. A similar magnitude of increase in total soluble solids was observed by Ramanjaneya (1981) in guava jelly.

5.4.2.2 Acidity

The storage of wood apple jelly reduced the total acidity during storage. This reduction in acidity was about 35 to 38 per cent in different recipes. The breakdown of acidity during storage of product in presence of sugar is a usual phenomenon as reported by Bhatia et al., (1956). The results obtained in the present investigation are in line with earlier observation made by Ramanjaneya (1981) in guava jelly.

5.4.2.3 Sugars

During the storage of wood apple jelly, there was increase in reducing sugars and total sugars and reduction in non reducing sugars. This could be due to the hydrolysis of polysaccharides and inversion of non reducing sugars to reducing sugars. The results obtained in this investigation corroborate the results obtained by Murulikrishna (1967) and Ramanjaneya (1981).

5.4.2.4 Ascorbic acid

Ascorbic acid content of wood apple jelly was almost same among the recipes before and after the storage period. This could be due to the fact that the pulp used for the preparation of jelly was constant for all the recipes. But a reduction in ascorbic acid of 10 to 30 per cent was noticed after the storage period. It might be due to oxidation of ascorbic acid present in the jelly samples during storage. Similar observations were made by Muralikrishna (1967) and Ramanjaneya (1981) in guava jelly.

5.4.3 Organoleptic quality of wood apple jelly

5.4.3.1 Appearance

Among the jelly samples prepared from different levels of total soluble solids, the jelly prepared out of 63^{O}B total soluble solids recorded the highest score for its appearance. This could be due to the influence of sugar which helps to improve appearance and texture of jelly at its best with 63^{O}B. The weak and tender jely was a result of lower sugar concentration (60^{O}B). However, tough and stiff jelly formed with the addition of sugar to 69^{O}B level. These findings are similar to the results obtained by Lal Singh (1922).

5.4.3.2 Aroma and taste

There was considerable change with respect to aroma and taste of jelly in the samples with variation in total soluble solids. It was shown that jelly prepared from 63^{O}B was adjudged superior to the rest of the recipes. This high quality may be due to the more appropriate sugar-acid ratio which might have increased the taste and palatability of the jelly.

5.4.3.3 Flavour

The maximum score of 1.091 was recorded for the product with 63^{O}B total soluble solids compared to the other recipes. This could be the optimum level which retains the maximum amount of flavour contributed by the pulp. Goldthwaite (1909) reported that sugar is considered essential to keep the flavour of jelly at its best.

5.4.3.4 Overall quality

The highest score of 1.181 was found in 63°B total soluble solids recipes. This highest score for the jelly with 63°B may be due to the fact that jelly might have acquired best qualities like texture, flavour, appearance and taste. In the sample with 69°B total soluble solids produced tough and darker jelly. Campbell (1920) noticed that the excess of sugar produced stiffness in the product and contrary to this, lower sugar content gave a softness to the jelly.

5.4.4 Changes in visual characters of wood apple jelly

The storage of wood apple jelly did not result in any change in colour. This could be due to the fact that the wood apple jelly contains considerably more of ascorbic acid.

The observations made in the present investigation showed that there was not considerable change in respect of taste and flavour. The best quality of jelly was maintained in glass containers as reported by Johnson and Toledo (1975). Similar observations were made by Ramanjenaya (1981) in guava jelly.

The present investigation also showed that there was no microbial spoilage of jelly during storage. This is due to presence of high concentration of total soluble solids which prevented the growth of microorganisms by osmosis (Frazier and Westhoff 1978).

SUMMARY

VI SUMMARY

The investigations on chemical composition, organoleptic evaluation and storage studies of wood apple products were carried out at the Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore, during the year 1990.

Following are the important findings that have emanated from the present investigations.

6.1 Wood apple squash

As the squash was prepared from three different levels of (per cent) pulp, the chemical compositions such as crude fibre, crude protien, calcium, phosphorus content of finished product was maximum in case of 45 per cent pulp level. The organoleptic qualities such as appearance, flavour, taste, aroma and overall quality of squash was found best in 45 per cent pulp level. The squash prepared with 45 per cent pulp, $40^{O}B$ total soluble solids and 1.25 per cent acidity was found as the best combination of pulp and total soluble solids by organoleptic evaluation.

The storage stability of squash was found unaltered during the storage period of 90 days with respect to colour, taste and flavour and there was no microbial spoilage. During the storage period there was a slight increase in total soluble solids and total sugars. However, reducing sugars increased drastically in the samples. Acidity, non reducing sugars and ascorbic acid content of squash were found to decrease in their contents during storage.

6.2 Wood apple nectar

The nectar prepared from 30 per cent pulp level was found to be highest in calcium, phosphorus, crude fibre and crude protein. The organoleptic evaluation of nectar showed that the recipe with 25 per cent pulp, 30^{o}B total soluble solids and 0.4 per cent acidity was the best combination with respect to appearance, flavour, taste, aroma and overall quality.

During the storage of nectar, the colour was unaltered upto 45 days of storage but a slight change in colour was noticed after 60 days of storage. The taste and flavour were unchanged and there was no spoilage in nectar during 90 days of storage.

A slight increase in total soluble solids, total sugars, reducing sugar and decrease in non reducing sugar, organic acids and ascorbic acid were found during the storage period of 90 days.

6.3 Wood apple jelly

The chemical composition of jellies prepared with different recipes were found to contain more of calcium, phosphorus, crude fibre and crude protein. It was clear from organoleptic evaluation that jelly with 63^{O}B total soluble soilds, 50 per cent pulp and 1.00 per cent acidity had the best quality attributes, viz., appearance, flavour, taste, aroma and overall quality.

The storage stability of jelly was found unaltered during the storage period of 90 days with respect to colour, taste and flavour and there was no microbial spoilage. During the storage it was also observed that there was an increase in total soluble solids, total sugars and reducing sugars and decrease in non reducing sugars, acidity and ascorbic acid.

It is concluded from the results that the best wood apple squash can be prepared with 45 per cent pulp having 40^{O} Brix and 1.25 per cent of acidity. However, for preparing the best quality nectar the recommended recipe obtained from the study is 25 per cent pulp, 0.4 per cent acidity with 30° Brix. In order to prepare wood apple jelly of excellent quality, the following recipe is recommended: 30 per cent pulp, 1.0 per cent acidity and 63° Brix. These recipes are highly palatable and acceptable as indicated by the organoleptic evaluation.

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