QUALITATIVE CHANGES IN CASHEW APPLE PRODUCTS IN STORAGE WITH SPECIAL REFERENCE TO VITAMIN C.

BY

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THESIS

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1996

D E C L A R A T I O N

I hereby declare that this thesis entitled "**Qualitative changes in cashew apple products in storage with special reference to Vitamin C**" is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

College of Agriculture,
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C E R T I F I C A T E

Certified that this thesis entitled **"Quatitative Changes in cashew apple products in storage with special reference to vitamin C"** is a record of research work done independently by **Miss. SREEJA. K.C.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma fellowship or associateship to her.

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Introduction

INTRODUCTION

Fruits are nature's gift, ready to eat which are blest with vitamins and minerals in plenty. The fruits are the chief source of vitamins and minerals which helps in the maintenance of proper health, and resistance to disease. It also contains good source of minerals like calcium, magnesium, phosphorous, potassium, iron and sulphur, in sufficient amounts. The daily per capita consumption of fruits in India is 40g as against 120g recommended by the Diet Advisory Committee of Indian Council of Medical Research (Panday, 1991).

There is a scope for earning handsome foreign exchange through production of fruits. India has emerged as number one in the world map of fruit production putting Brazil behind (Ghosh, 1995). During 1992-93 the area under fruit in India was 3.29 million hectors and the estimated production was about 33 million tonnes (Farm guide, 1993). In Kerala the area under fruit cultivation was 2.4 lakh hectors and the production was about 5.2 lakh tones (Farm guide, 1995).

Though there is high level of production of fruits in India, lack of post harvest technology and linkages, result in a national loss of Rs 5000 crores per annum. (Rajkumar, 1995). Sethi (1993) had stated that 20 to 30 per cent of the fruits produced in this country were not utilized due to post harvest problems.

Processed products are of immense value because of their peculiar taste and their ready to eat convenience. Rajya (1995) has informed that the production of processed fruits and vegetables increased by 30.28 per cent in the year 1992-93 and 23.66 per cent in the year 1993-94. The processed form of fruits exported, are juices of mango, pineapple and orange, canned slices of pineapple, fruit jams, pickles and chutneys; and as stated by Pandey (1991), 49.6 per cent of fruit juices 26.5 per cent of jam, 29.6 per cent pulp and 51.6 per cent of the pickles, chutneys and sliced in brine produced in India are exported. Tropical fruit juices, pulp and controlled dried fruits in the processed sector and non traditional fruits such as sapota, litchi, guava, custard apple, pomegranate, banana and cashew apple, in the fresh fruits sector, should draw more attention as popular export items.

Cashew apple (*Anacardium occidentale*) is an under exploited fruit. In Kerala, plenty of cashewapples are wasted due to unawareness about the effective preservation of the fruit.

Cashew was introduced to India in 16th century by the Portuguese, who were aware of the use of cashew in medicine, foods, beverages, and mainly to control soil erosion. Now, it is a major plantation crop of India. A good amount of foreign exchange is earning through the export of cashew kernel and cashew nut shell liquid. The production of cashew apple in India was about 27.95 lakh tones per year (Augustin 1994).

Cashew apple refer to the swollen pedicel to which the nut is attached. It is very rich in vitamin C and riboflavin. Though very juicy and sweet, it is not normally eaten because of its astringency.

The potentials of this fruit to develop commercial value added products like juice, squash, wine, liquor, jam, candy, lether and bars has given new imputs for utilising them. Since cashew cultivation is in hilly and rural areas, and the fruits are available in plenty during seasons the rural women can concentrate on the preparation of processed products from cashew apple fruit using low cost technology, which will be an income generating activity to them.

The present study is a comprehensive exploration on the qualitative changes that occur in cashew apple products with special reference to vitamin C during storage. The study also looks into the organoleptic and the shelf life qualities of the products during storage.

Review of Literature

REVIEW OF LITERATURE

Literature pertaining to the study entitled **"Qualitative changes in cashew apple products in storage with special reference to vitamin C"** is reviewed under the following headings.

2.1 Importance of fruits

2.2 Need for processing fruits.

2.3 Fruit based products.

2.4 Cashew apple and its importance.

2.5 Shelf life qualities of fruit based products.

2.1 Importance of fruits.

Rao (1991) reported that India with a population over 860 million, produces about 74 million tonnes of horticultural produces. He also announced that the fruits and vegetables are the only source of essential nutrients especially vitamin C and B carotene and their intake in a majority of our population are already below the adequate levels. Ghosh (1995) announced that the Indian Fruit Industry has progressed against various odds. In the last three decades (1961-91), there was an area expansion by 172 per cent while the production increase was 320 per cent. According to Kumar and Pramod (1993) considerable efforts are needed to make new products from underexploited fruits and vegetables competitive in the world market with respect to nutritional and microbial quality as well as zero level chemical constituents.

2.2 Need for Processing Fruits.

Processing is a method of reducing post harvest loss of perishable foods, like fruits (Siddappa, 1967). Rao (1989) had defined processing as, adding value to conventional and innovative basic food items, through various permutations and combinations providing protection, preservation, packaging, convenience, carriage and disposability. Poonia et al (1994) is of view that fruit processing helps to imitigate the problems of underemployment during off season in Agriculture Sector. Herald (1992) announced that though processed convenient foods has been found attractive, consumers were choosy about health, taste and price of the product.

Anvilla et al (1993) pointed out that the consumption of processed food is likely to increase in the future. Mathur et al (1993) reported that during the last one decade there was a substantial progress in the quality and quantity of the products produced by Indian food industries and it was mainly due to many indigenous development in the field of food technology. Shaw et al (1993) opined that Indian food technology is built up around the four major requirements of which the first one is to insure availability of perishable products for a longer period and second to make food available during the period of scarcity, thirdly to preserve fruits and vegetables in sugar syrups and lastly to make a large varietv of fermented and unfermented beverages. Kaushal (1989) had emphasized on the rise in demand

for processed fruits and vegetables because of increase defense requirements and urbanisation trend. Das and Jain (1989) opined that the processed food relevant to Indian context should be marketed in a manner, that would benefit the consumer, the farmer and the society.

2.3 Fruit based products.

According to Siddappa et al (1986) fruit preservation may be broadly classified into physical and chemical methods. The physical method includes preservation using low temperature, by heat application, dehydration and irradiation. The chemical method includes addition of acid, salting or brining, addition of sugar, addition of chemical preservatives and fermentation. Among all these methods, preservation by addition of sugar and application of heat is highly important method in the case of fruit.

Bhatia et al (1956) had studied the preparation of jack fruit squash and its storage. Pruthi and Lal (1959) had standardised different fruit powders with avacado, banana, mango and guava. Menzen (1980) studied the suitability of major tropical fruits for processing and the fruits selected were pineapple, cashew apple, banana, guava, papaya, mango and passionfruit. Beerh and Rama (1983) had standardised a method for candy from pear, with good colour, taste, and acceptability. Thirumaran et al (1986) organised a simple processing technique for the preparation of papaya candy. Sajjan (1989) had studied

nutritional and keeping quality of processed date palm fruits. Bhatia and Narinder (1991) evaluated different varieties of ber for candy making and found acceptable.

Farkas and Lazar (1969) described that an increased sugar content in the concentrated fruit and when dried, they form the candy of food industry. Ronald and Cruess (1956) prepared candy from figs, pears and peaches and observed considerable deerease in weight of fruit. Anti et al (1966) found that candies are good space foods. Sheeja (1995) prepared candy from Karonda fruit and it was highly acceptable.

2.4 Cashew apple and its importance.

Cashew (*Anacardium Occidentale*) belongs to te family Anacardiaceae. It is believed to be a native of Central America and it was introduced into India from Brazil (Shanmugavelu and Mathava Rao, 1977). Based on growth pattern, cashew apple belongs to the group of plants where fruits show an exponential type of growth. The growth rate of nut is much faster than the fruit in early stages reported by Augustin et al (1982).

Total production of cashew apple in India during 1990-91 was estimated at about 23.50 tonnes, in Kerala, it was about 11,36,800 tonnes (Vijaya Kumar, 1991). According to Augustinss (1994) anticipated production of cashew apple in Kerala is 12,12,800 tonnes. Potty (1992) reported that the yield of fruit is calculated from the yeilu of nuts (the yield of nuts multiplied by 7). He also reported that the fruits are harvested

by hand paicking and the season started from the middle of February and extended till the end of May or the beginning of June.

Cashew apple is very rich in vitamin C and riboflavin. It is used for the cure of scurvy and diarrhoea. Cashew juice being a powerful diuretic, is given in uterine complaints and dropsy. It is useful for local application in neurological pain and rheumatism (Augustin, 1994). Loyokun et al (1986) found that cashew apple juice is a substrate for the growth of *saccharomyces cerevisiae*. The juice contained a mixture of fermented sugars including glucose, fructose, sucrose and high concentration of reducing sugars.

Nanjundaswamy et al (1984) had reported that cashew apple is a soft but fibrous juicy fruit, possess exotic flavour. Fruit weight is about 26 to 50 grams and yeild of juice is 60 to 70 per cent. The juice is rich in vitamin C and it ranges from 120 to 200 mg/100 grams. Tannin content is between 0.30 to 0.50 per cent. According to Rao (1984) it contains 10.70 per cent reducing sugar with 0.30 per cent acid, pH of 4 0.30 per cent protein. Nagaraja and Namboothiri (1986) had reported that cashew apple contains 5.50 to 7.70 per cent total sugar. According to Nambiar et al (1990) and Nguyen et al (1995), cashew apple juice is rich in vitamin C and it is five times more than that of citrus fruit. Malade (1981) had analysed four types of cashew apple and reported that they had low level of

pectin, carbohydrates, free amino acids, crude protein and moderate levels of major cations, sulphur, phosphorous and iron; but high amount of sugar and vitamin C.

One of the major problem in the utilisation of cashew apple for edible purpose is its astringent principle which produces an unpleasant biting sensation on the tongue and throat (Nanjudaswamy et al, 1984). He also reported that astringent principle, can be removed by simple process like steaming, brine curing or by chemical treatment. An experiment conducted at college of Horticulture, Vellanikkara in 1978-79 to find out the most effective treatment for the removal of the phenolic compounds and other astringent materials in cashew apple revealed that a mixture of 0.40 per cent gelatin and 0.10 per cent calcium hydroxide was found to be effective. It was also revealed that polyvinyl pyroledone (PVP) at the rate of 1.40 gram per litre of juice can effectively be utilised to minimise the astringent taste (Anonymous, 1980). Singh et al (1993) reported that cashew apple juice were clarified by treating with calculated quantity of gelatin solution (10 per cent) to precipitate astringent materials like tannins.

Shanmugavelu and Rao (1977) reported that cashew apple could be best utilized for the preparation of syrup, juice and concentrate. Raju (1992) opined that cashew apple is a nutritious material which is presently wasted , as it is highly perishable and it can be used for making syrup, juice, RTS beverages, pickle, candy, jam, fermented and distilled alcoholic

beverages. Vaidehi (1994) had reported that cashew apple powder, cashew apple leather, candy, cashew soup powder can be developed at commercial level.

Maria (1982) studied the physical stability of cashew apple juice. Viera et al (1982) described the quality of concentrated cashew apple juice. In this experiment fruits of three stages of maturity were used. Good clarification and stability of the juice were achieved with a single centrifugation with added sulphurdioxide. Maciel and his associates (1986) analysed the volatile constituents of commercially processed and unprocessed cashew apple juice. Studies at CFTRI Mysore (1985) had shown that maximum sugar content and acidity of 0.39 to 0.42 per cent in cashew are highly desirable for processing.

According to Rao (1989) the cashew apple juice is a good media for alcoholic fermentation as it contains all nutrients for the growth of yeast. Dang et al (1979) stated that wine prepared from the combination of more than two varieties of cashew apple were found quite acceptable. Adeniye et al (1992) described the potentials of biodegraded cashewpomace for cake making. Cashewpomace flour was prepared from fresh cashew pomace, which was organoleptically acceptable. He also opiened that cashewpomace can be processed for alcohol and organic acid production.

Kulvadee et al (1990) found that when jam was made from cashew apple that had been kept in solution of brine and sodium

metabisulphate of different concentration, a residual sulphur off odour was observed. Jam held in brine solution for 3 days had a mild aroma, and at brine concentration of less than 5 per cent, a string salty taste occurred.

Natarajan (1979) announced that candy from cashew apple has not been introduced in India and hence it is still a novel product for our country. Edassery (1988) developed a simple process to prepare dry fruits of cashew apple which can advantageously be used in fruit breads and other bakery items and fruit salads. With characterestic nutritious content, better taste and texture they are considered to be superior to other dry fruits like figs, grapes and dates.

2.5 Shelf life qualities of fruit based products.

Pruthi (1985) studied the role of vitamin C in the discolouration of processed products and has reported that there was 10-15 per cent loss of ascorbic acid during storage period. Jellineck (1985) had reported that there was a loss of ascorbic acid in processed food products under the influence of atmospheric oxygen.

Upretty et al (1963) analysed the vitamin C content of orange, lemon and beal squashes during storage. All the three types of fruits squashes showed gradual loss in their ascorbic acid content. Prasad et al (1968) reported that after storage for one year at room temperature the retention of ascorbic acid

was 55.20 per cent, 46.20 per cent and 19.00 per cent, respectively in amla juice, squash and ready to serve beverage. Palaniswami and Muthu Krishnan (1974) announced that there was a loss of ascorbic acid during the storage of citrus juice for seven months.

Jain et al (1987) reported that during storage of squashes made from phalsa, kaphal and litchi, vitamin C content showed a continous fall as the storage period advanced. Sandhu et al (1988) pointed out that the rate of loss of ascorbic acid in kinnow orange juice and concentrate was directly propotional to storage temperature. Tripathi et al (1989) studied the various chemical changes related to processing in different amla products like preserve, jam, juice, candy and dehydrated amla. The loss in ascorbic acid content during processing and storage was very significant in all the products.

Thirumaran (1993) reported that packed tomato concentrate during storage showed decrease in ascorbic acid content. It was about 28.70 per cent. Bhatia and Narander (1992) observed there was decrease in ascorbic acid in ber candy during storage. Khurdiya and Lotha (1994) found that a reduction in ascorbic acid content on storage of citrus fruit juice and squashes. Muralidhar and Dhawan (1994) also reported reduction in ascorbic acid content in lemon juice during storage.

Anand (1970) studied the effect of certain pretreatments on the loss of tannins and vitamin C in amla preserve. It was

found that soaking and blanching resulted in heavy loss of these constituents. But soaking of the fruit resulted in gradual loss of acids, tannins and vitamin C. Wasker et al (1987) reported that there was a reduction in total phenolics in phalsa beverage throughout the storage. Tripathi et al (1988) reported that tannin content decrease in amla jam preserve and candy. Koning and Dietrich (1992) found that polyphenol decreased during secondary fermentation but remained constant during maturation. Vyas et al (1982) reported that tannin content was more in plum wine fermented with skin.

Mehta and Bajaj (1983) had reported that the citrus juice during storage of eighth month showed slight increase in pH. Bawa and Saini (1987) indicated that there was increase of pH from 4.20 to 4.50 at high temperature of citrus juice. Tripathi et al (1988) stated that during storage of amla juice little change in pH was found. Negligible to slight change in pH was reported by Renote et al (1993) in Kinnowjuice during storage.

Mehta and Bajaj (1983) found that decrease in acidity in commercial kinnow and Blood red orange squash stored at 37^{o}C for 9 weeks. Augustin et al (1982) reported that six month old cashew liquor subjected to different ageing methods, acidity had a negative influence. Vilasachandran and Damodaran (1984) reported that there is increase in acidity during storage of cashew apple juice. Augustin (1992) announced that there is an increase in acidity of wine kept in room temperature. Riji (1995) reported that there was a slight decrease in the acidity

through out the storage periods of dehydrated pineapple products. Diju (1995) reported that there was a steady increase in acidity in passion fruit products such as RTS, wine and jelly during six months storage. Earlier studies by Singh and Mathur (1953) exhibited an increase in total soluble solids content in cashewapples at different temperature and increase was greater at high temperature. Kalra and Revathi (1981) reported that guava pulp stored at different temperatures showed an increase in total soluble solids content. Monthly analysis of citrus juice stored over a period of eight months by Mehta and Bajaj (1983) showed a slight increase of 1.03 in total soluble solids. Storage evaluation of amlajuice revealed that total soluble solids content increased by one per cent with storage period (Tripathi et al 1988). He also found that total soluble solids of candy decreased in dried amla products while in dehydrated amla remained unchanged. Storage studies conducted by Thirumaran et al (1993) observed a decline in total soluble solids in tomato juice concentrate and fermented carrot based RTS. Sheeja (1995) reported that total soluble solids of karonda candy remain constant during the storage period of 8 months.

Mehta and Bajaj (1983) found that an increase in reducing sugar was observed in citrus juice stored for eight months at room temperature. Vilasachandran et al (1984) showed decrease in reducing sugar during storage of cashew apple juice. Wasker et al (1987) observed an increase in reducing sugar in phalsa beverage. Lee and Naggy (1988) reported that during storage of commercially

canned juice there was subsequent increase in reducing sugar. According to Mir and Nath (1993) storage of mango bars for 90 days increased the reducing sugar. Deena (1994) reported that reducing sugars of osmotic dehydrated banana products increase with storage. Riji (1995) found that there was a gradual increase in reducing sugar in partially dehydrated pinapple products during storage of four months.

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

Tripathi et al (1988) reported that organoleptic evaluation of stored amla jam indicated increase in acceptability with storage. Bhatnagar (1991) found that keeping quality of water melon jam was good under ambient storage condition for a period of six months. Storage studies conducted by Joshi (1993) revealed that karonda jam and jelly were organoleptically acceptable for a period of one year. Sheeja (1994) reported that organoleptic evaluation of papaya jam during storage showed decrease in acceptability with increase in storage period. Deena (1994) also reported that a gradual decline in the overall acceptability during storage of osmotic dehydrated banana products. Riju (1995) reported that the products like RTS, wine and jelly prepared from passion fruit were organoleptically

acceptable. Alian and Murerige (1980) developed a recipe for wine using pineapple canning waste and was organoleptically acceptable. Khurdiya and Roy (1984) developed a recipe for wine using jamun which was organoleptically acceptable.

Beerh and Rama (1983) standardised a method for candy from pear. It had good colour, taste and acceptability. Organoleptic evaluation of amla candy and dehydrated amla showed that acceptability decreased with storage (Tripathi et al, 1988).

Sheeja (1994) reported that organoleptic evaluation of papaya candy showed decrease in acceptability with storage. According to sheeja (1995) reported that karonda products like jelly, wine, and candy were organoleptically acceptable and maintained good quality on storage under ambient conditions. Angela et al (1987) dehydrated blue berry products had a good texture, flavour and overall acceptability and had a shelf life of 16-64 months.

Spoilage of foods may be defined as a food that has been damaged or injured, so as to make it undesirable for human consumption (Hassan, 1992). Allin et al (1986) reported that spore forming bacilli is the most prevalent one among the bacilli species identified in food product. Bhatnagar (1991) found that no activity of microorganisms upto six months of storage of water melon jam. Kadam et al (1991) observed that complete absence of microorganism in pomegranate wine during storage period of eight months. Sheeja (1995) reported that there was complete absence

of microorganisms in [illegible] jelly, canned karonda and wine during storage of six months. Bindhu (1995) reported that osmotically dehydrated jack fruit products of soft and firm flesh varieties had a stability of five months.

Materials and Methods

MATERIALS AND METHODS

The study entitled **"Qualitative changes in cashew apple products in storage with special reference to Vitamin C"** was conducted at Department of Home Science, College of Agriculture, Vellayani.

3. Plan of action

3.1 Collection of cashew apples

Cashew apples needed for the study were procured from local farms and markets in Kerala and Tamilnadu. The collected fruits included red as well as yellow varieties. Fully ripe and sound cashewapples were selected and cleaned thoroughly before preparation of different products.

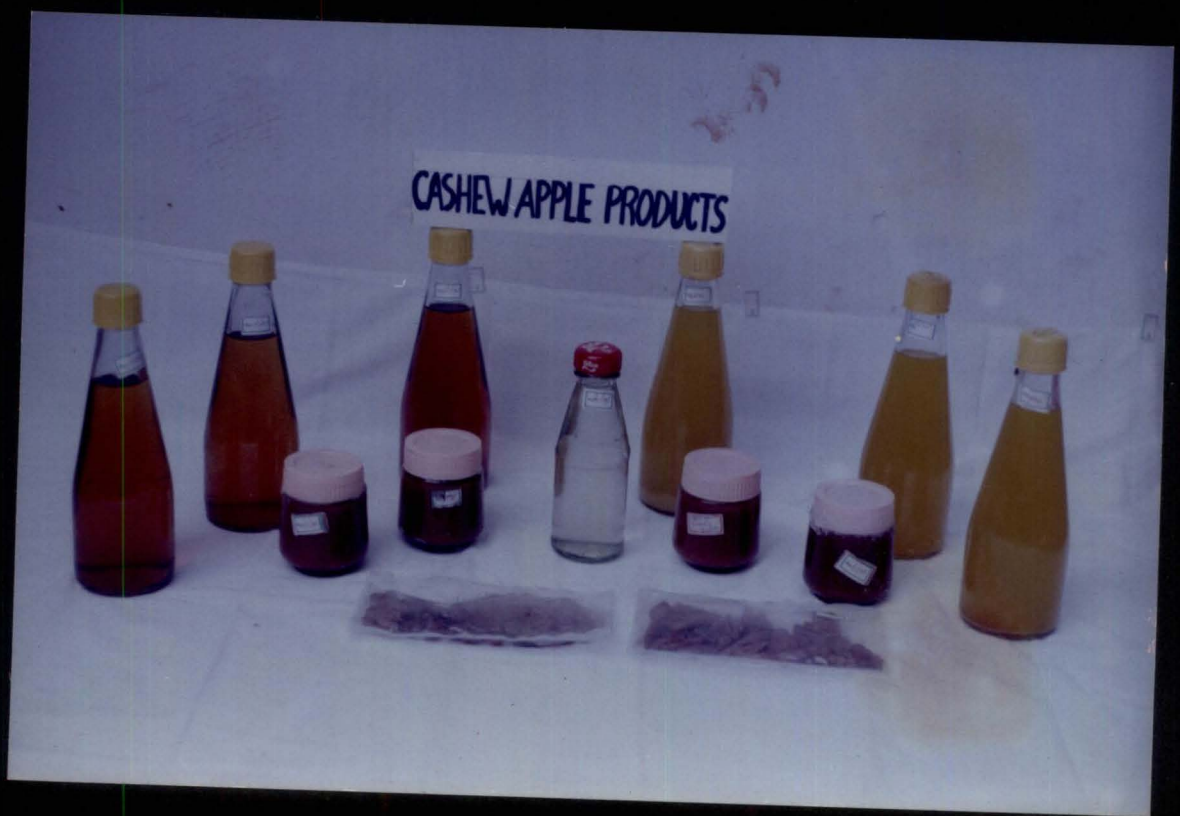
3.2 Processing technique

3.2.1 Extraction of juice

The cashew apple juice was extracted using a juice extractor.

3.2.2 Clarification of cashew apple juice

Cashew apple contains astringent and acrid principles which produce an unpleasant biting sensation on the tongue and throat when eaten as such (Mandal, 1992). Studies conducted by Augustin (1982) showed that polyvinylpyroledone (PVP) was found very effective in removing the astringent and acrid principles in


CASHEW APPLE PRODUCTS

cashew apple juice. Hence PVP was selected for the clarification of cashew apple juice by adding PVP 1.4 g/kg of juice.

3.3 Preparation of cashew apple products

3.3.1 Cashew apple clarified juice

Fruit juice is a natural juice pressed out of a fruit. (Shakunthala., 1995). Cashew apple juice was clarified using polyvinylpyrrolidone (PVP). The method standardised by central Food Technological Research Institute (CFTRI, 1990) was followed, for the preparation of clarified cashew apple juice and is given in Flowchart II.

3.3.2 Cashew apple Squash

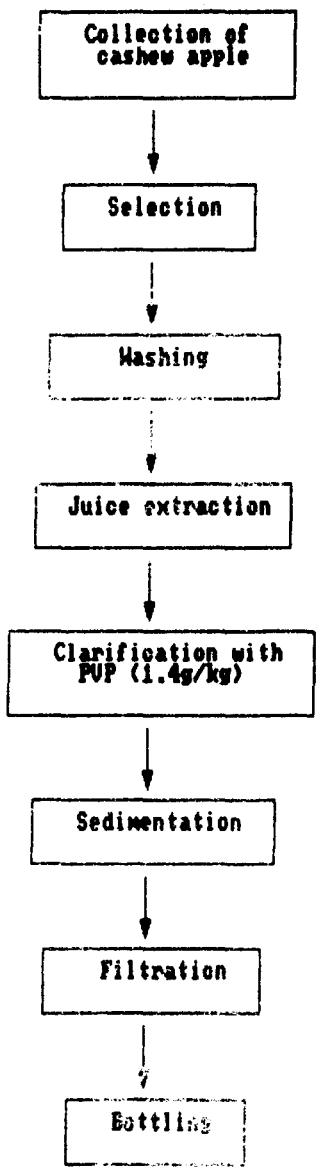
Squash is a type of fruit beverage containing at least 25 per cent fruit juice or pulp and 50 per cent total soluble solids. Cashew apple squash was prepared by the method suggested by CFTRI (1990), and the procedure is given in Flowchart III.

3.3.3 Cashew apple wine

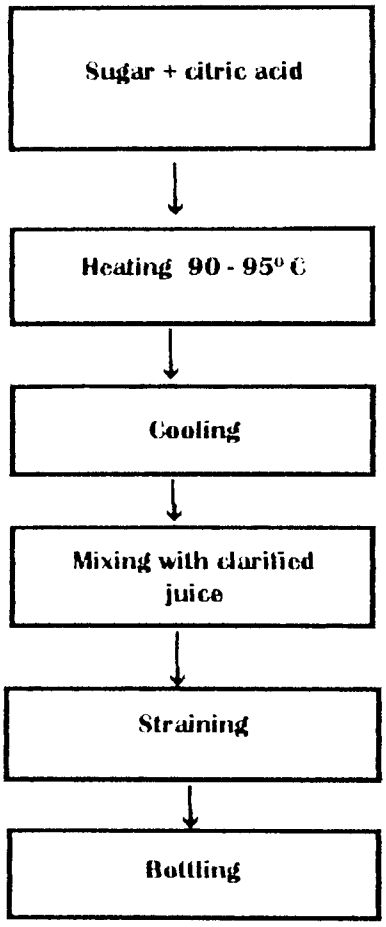
Wine is prepared from complete or partial fermentation of fruit and contains essential elements, some vitamins, sugars, acids, phenolics and is preferable to distilled liquor for stimulatory and healthful properties (Gasteineace, *et al*, 1979). Flowchart IV details the preparation of cashew apple wine.

FIG I

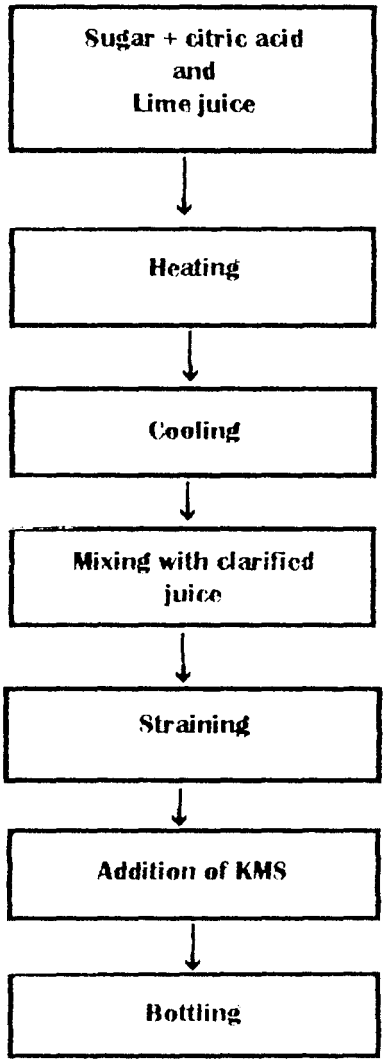
FLOW CHART FOR THE CLARIFICATION OF CASHEW APPLE JUICE

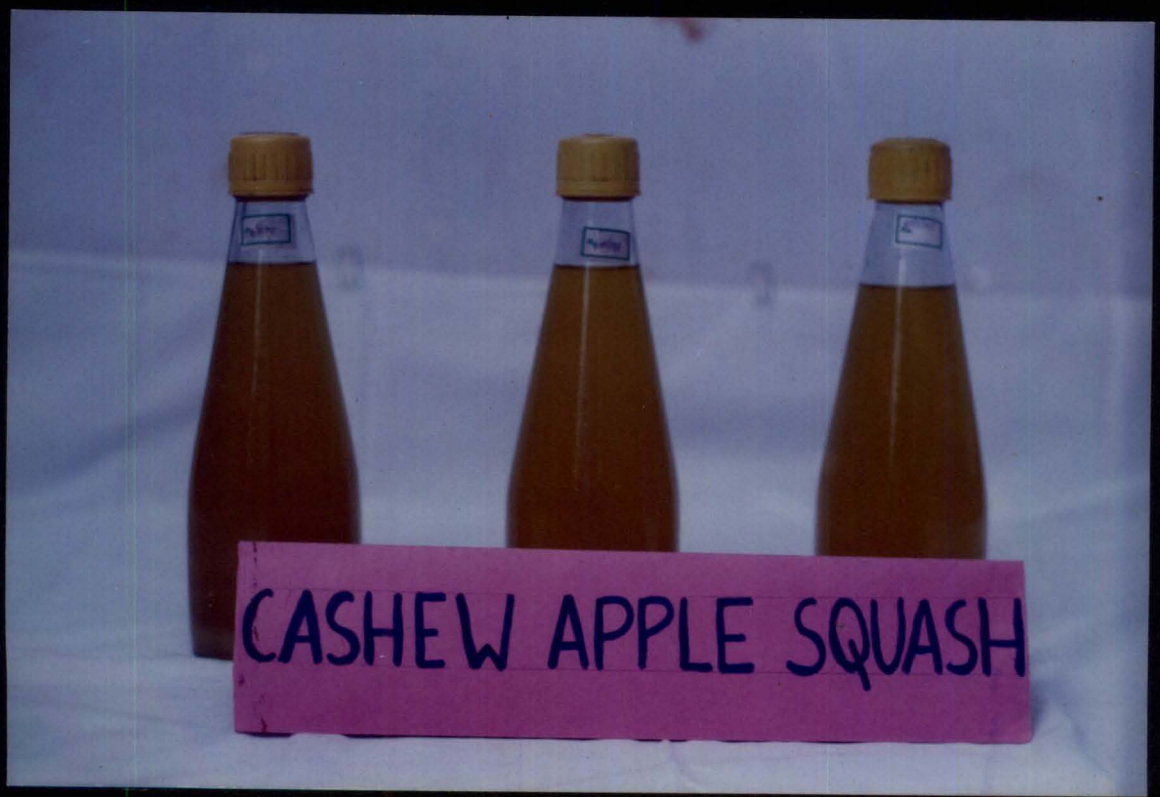


FLOW CHART FOR THE PREPARATION OF CLARIFIED JUICE



FLOW CHART FOR THE PREPARATION OF SQUASH

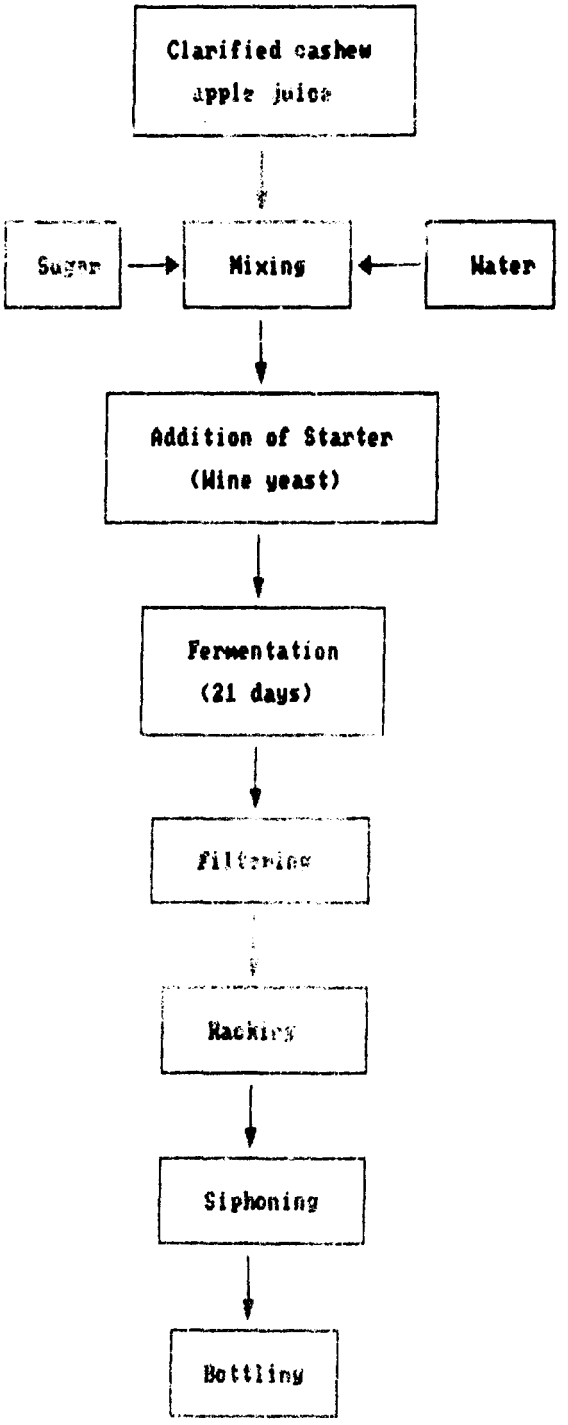



CASHEW APPLE SQUASH


CASHEW APPLE WINE

FIG IV

FLOW CHART FOR THE PREPARATION OF CASHEW APPLE WINE



3.3.4 Cashew apple Jam

Cashew apple jam was prepared by boiling the whole fruit pulp with sugar to a moderately thick consistency without retaining the shape ofthe fruit as suggested by Cruess, (1966). The preparation of jam is given in flowchart V.

3.3.5 Cashew apple Candy

Lal *et al* (1986) have defined candy as "a fruit impregnated with cane sugar and glucose, and subsequently drained and dried. The details of the candy preparation is given in flowchart VI.

3.4 Chemical and nutritional evaluation of cashew apple fruit and cashew apple products.

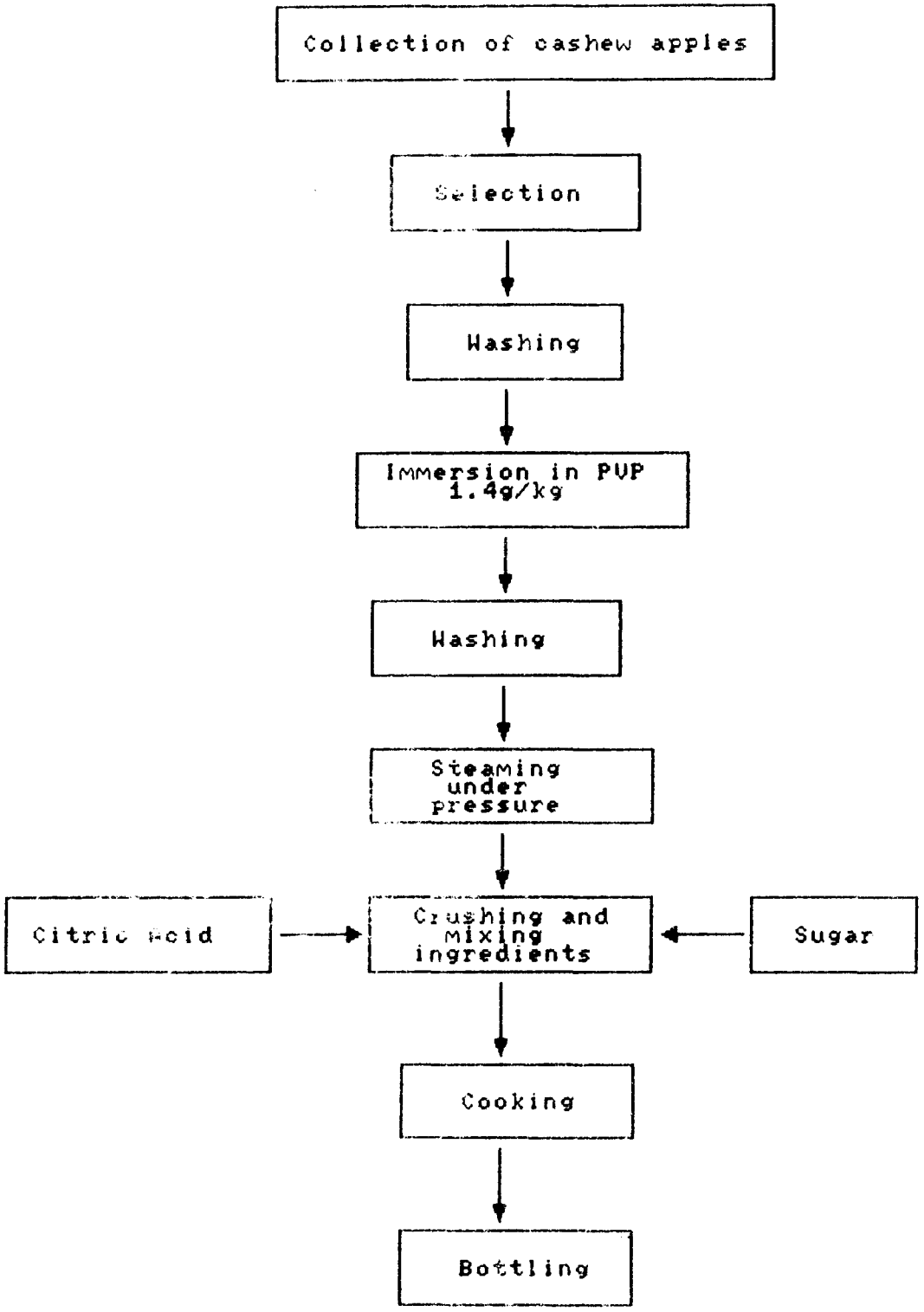
Fresh cashew apple fruits were analysed for different chemical constituents such as vitamin C, total phenolics, total soluble solids and reducing sugars. The pH and acidity of the pulp were also ascertained.

Freshly prepared cashew apple products viz, clarified juice, squash, wine, jam and candy were also analysed for vitamin C, total phenolics, total soluble solids and reducing sugars. The pH and acidity of all the products and the alcohol content of the wine were also determined.

FIG V

FLOW CHART FOR

PREPARATION OF CASHEW APPLE JAM



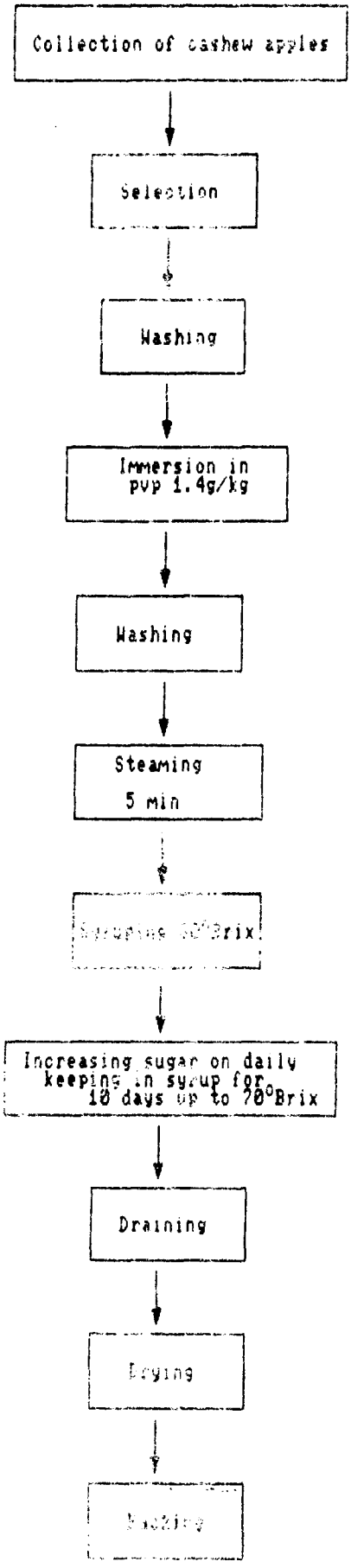

CASHEW APPLE JAM


CASHEW APPLE CANDY

FIG VI

FLOW CHART FOR THE

PREPARATION OF CASHEW APPLE CANDY



The cashew apple products were stored at ambient condition and the shelf stability of the products were studied for a period of six months. The parameters selected, to monitor the shelf life of the products were chemical, organoleptic and microbial changes.

Products like clarified juice, squash, wine, jam and candy were analysed at fortnightly intervals for vitamin C, at three month intervals for total phenolics, and monthly analysis was done for total soluble solids, reducing sugars pH and acidity. Alcohol content of wine was also determined at monthly interval. Total duration of the shelf life studies were six months. Following methods were adopted for the estimation of different chemical constituents.

3.4.1 Vitamin C

Vitamin C content was determined using the method suggested by Sadasivam *et al.* (1984)

3.4.2 Total Phenolics

Total phenol content was determined using the method suggested by Sadasivam *et al* (1984).

3.4.3 Total Soluble Solids

Jam and candy were ground separately using the mortar and pestle and was measured using a hand refractometer, juice, squash

and wine samples were used as such for analysis of TSS, Renganna (1977).

3.4.4 Reducing sugar

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

3.4.5 pH

The pH was measured using a digital pH meter (Renganna 1977).

3.4.6 Acidity

The acidity was estimated by the procedure suggested by Renganna (1987).

3.4.7 Alcohol

Alcohol content of the cashew apple wine was estimated by the procedure suggested by Hart (1971).

3.5 Organoleptic evaluation of the cashew apple products

Sensory quality is one of the criteria that determines the acceptability of any food products by the consumer and overall quality of a product in addition to quantity and nutritional attributes also depends on the sensory quality (Mehony, 1986). It is well recognised that, chemical indices of deterioration alone will not decide quality deterioration and it should be

correlated with sensory evaluation of stored products (Jellnick, 1969).

The acceptability trials on the products viz clarified juice, squash, wine, jam and candy were carried out at the laboratory, at the freshly prepared stage and the tests were repeated at monthly intervals with the same selected twenty panel members. Major quality attributes scored by the panel members were appearance, colour, flavor, taste, texture, strength, clarity and astringency. The judges were requested to score only one sample at a time. They were requested to score the second samples after washing their mouths. The testing was conducted between 15'00h and 16'00h, since this time is considered as the ideal time for conducting the acceptability trials (Swaminathan, 1974).

3.6 Microbial analysis of the cashew apple products

All the cashew apple products were tested for microbial contamination. Potato dextrose agar medium was used to culture fungi; maltose dextrose agar medium for yeast and nutrient agar medium to culture bacteria. Direct plating method was done for fungi and bacteria, and serial dilution method was used for culturing yeast. Tests to identify microbial contamination in all the products were conducted at monthly intervals.

Results and Discussion

RESULTS AND DISCUSSION

Results of the present investigation entitled **"Qualitative changes in cashew apple products in storage with special reference to vitamin C"** are discussed under the following headings.

4.1 Collection of cashew apples and preparation of cashew apple products.

4.2 Chemical and nutritional qualities of cashew apple fruit.

4.3 Chemical constituents and organoleptic qualities of cashew apple products.

4.4 Changes in chemical constituents, organoleptic qualities and microbial changes in cashew apple products during storage period.

4.1 Collection of cashew apple and preparation of cashew apple products

4.1.1 Collection of cashew apple

Red as well as yellow variety cashew apples were purchased from the local farms and markets in Kerala and Tamilnadu. Average fruit weight ranged from 25 to 40 grams. Nanjundaswamy *et al* (1984) have reported that the normal fruit weight may vary from 26 to 50 grams, The fruits purchased were cleaned with cold water to remove adhering impurities and non edible portion were eliminated by coring. After this the fruits were processed into different products.

4.1.2 Processing of cashew apple products

Fully ripe, sound fruits were used for the preparation of cashew apple jam and candy while juice extracted from fruits was used for the preparation of clarified juice, squash and wine.

4.1.3 Extraction of juice

Cashew apple juice was extracted by means of juice extractor. This was a mechanically operated pressing machine, in which the juice was pressed out from the fruits. Mandal (1992) reported that two kilogram cashewapple can give one litre juice and Chakraborthy (1961) had ascertained the efficiency of screw type extractor (68 per cent) for this purpose. In the present study, one litre juice was extracted from two and half kilogram cashew apple.

4.1.4 Removal of astringent principle of cashew apple

One of the major problems in cashew apple utilization for edible purpose is its astringent principle. The factors such as tannin and oily substances are the contributing factors of astringency which makes the cashew apple products less acceptable (Jain et al, 1954). Hence the astringent and acrid principles were removed before preparation of different products like juice, squash, wine, jam and candy.

In the present study Poly Vinyl Pyroledone (PVP) at the rate of 1.4 gram per litre of cashew apple juice was added, mixed

thoroughly by stirring and kept for clarification. The astringent principle was found to settle at the bottom of the container as a precipitate. The clear supernatent liquid was collected by decanting and was stored in clean, sterilized glass containers.

Studies have indicated that steaming the fruit for five minutes under pressure and subsequent washing of the fruits with cold water would remove the astringency, (Jain et al, 1954). Augustin (1984) has also pointed out that the juice extracted from steamed fruit had only slight astringency and had good flavour. Jain et al, (1954) also revealed that cooking the fruit for five minutes in boiling solution of two percent common salt lowered the astringency. However Augustin (1984) has observed that the fruit cooked in common salt solution was saltish in taste and lacked its characteristic flavour.

Mandal (1992) noticed that addition of 0.5 per cent of gelatin solution to the expressed juice reduced the astringent principle in cashewapple juice. Jain et al (1954) had also mentioned that by the addition of small quantities of gelatin to cashewapple juice, even the slight astringency could be eliminated.

In addition Chakraborthy (1961) described a method of removing astringent principles by precipitation with gelation followed by filtration through filter press. He also noted that

gelatin precipitation and clarification of the juice reduces the acidity. Augustin (1982) has declared that use of excess gelatin for clarification imparted a disagreeable odour. He also reported that Poly Vinyl Pyroledone could be successfully used for clarification and removal of astringency in cashew apple juice.

4.2 Chemical and nutritional qualities of cashew apple

4.2.1 Chemical composition

Fresh cashewapple was analysed for vitamin C, total phenol, total soluble solids and reducing sugars. The acidity and pH were also measured. The values obtained are presented in Table 1.

Table 1 Chemical composition of fresh cashew apple

Chemical constituents	Quantity
Vitamin C (mg/100g)	263.00
Total Soluble Solids (^{o}Brix)	11.20
Reducing sugar (per cent)	15.20
Total phenols (Per cent)	00.34
Acidity (per cent)	00.18
pH	03.10

From Table 1, it was found that the value obtained for vitamin C was 263.00 mg/100g. Dauer (1972) found that there was a high content of vitamin C in cashewapple juice as high as

350 mg/100g. Ascorbic acid content of cashewapple juice as reported by Rao (1984) was 265.50 mg/100g.

The presence of total soluble solids of fresh cashewapple juice was estimated to be 11.2^{o}Brix. Ghosh (1989) mentioned that the total soluble solids content of the juice of different types of cashewapples ranged from 13.10 per cent to 17.70 per cent. In the present study reducing sugars in cashew apple was found to be 15.20 per cent. Gopikumar and Aravindakshan (1985) reported that the reducing sugars in cashewapple juice significantly varied from 10.83 per cent to 14.16 per cent.

In the present investigation total phenol content was found to be 0.34 per cent. Sastri et al (1961) found that the major polyphenolic constituent of cashewapple juice was lucodelphenidin Pruthi and Sondhi (1982) reported that the total poly phenol content in cashew apple varied from 0.20 to 0.90 per cent.

Fresh cashew apple juice had an acidity of 0.18 per cent. Nanjundaswamy et al (1984) observed that acidity of fresh cashewapple juice was 0.19 per cent. The pH of cashewapple juice under investigation was 3.10. Rao (1984) reported that pH of cashewapple juice would range from 3.70 to 4.60.

Slight variations in the quality attributes of cashewapple observed in the present investigation when compared to similar studies may be due to the influence of agro-climatic differences and crop management.

4.3 Chemical constituents and organoleptic qualities of cashew apple products

4.3.1 Chemical composition of cashew apple products

Chemical composition of various products prepared from cashew apple namely clarified juice, squash, wine, jam and candy were determined before storage. The major components analysed in the products were vitamin C, total soluble solids, reducing sugars, total phenols, pH and acidity. Alcohol content of wine was also determined. Table 2 details the chemical composition of fresh cashew apple products.

Table 2 Chemical composition of fresh cashew apple products

Parameters	Clarified Juice	Squash	Wine	Jam	Candy
Vitamin C mg/100g	213.06	180.03	40.00	49.86	16.66
Total soluble solids (^{o}Brix)	10.30	53.80	19.60	28.20	31.80
Reducing sugar (per cent)	14.04	17.03	00.41	15.21	13.70
Total phenol (per cent)	00.31	00.27	00.33	00.16	00.12
Acidity (per cent)	00.14	00.33	00.70	00.17	00.59
pH	03.90	04.40	04.10	03.98	04.50
Alcohol (per cent)	-	-	08.70		

Data given in Table 2 revealed that clarified juice prepared from cashew apple had a vitamin C content of 213.06 mg/100g. The total soluble solids in this products was 10.30 ^{o}Brix, reducing sugars 14.04 per cent, total phenol 0.31 per cent, acidity 0.14 per cent, and pH 3.40. Chakraborthy et al, (1982) had reported that during brine curing and subsequent treatment with sugar syrup, ascorbic acid was lost completely and tannins were retained in the final product only in traces. Mannay (1995) had found that ascorbic acid is soluble in water and easily oxidised. It is susceptible to loss during cooking and processing.

As shown in Table 2, cashew apple squash had a vitamin C content of 180.03 mg, total soluble solids 53.80^{o}Brix, reducing sugar 17.03 per cent, total phenol 0.27 per cent acidity 0.33 per cent and pH 4.40.

Wine prepared from cashew apple had a vitamin C content of 40 mg/100g. It contained total soluble solids 19.6^{o}Brix, reducing sugars 0.41 per cent, total phenol 0.33 per cent and alcohol content 8.70 per cent. The pH and acidity of wine was 4.10 and 0.70 per cent respectively. Vyas et al, (1982) reported that wines prepared from plum had an acidity of 0.65 per cent, pH 3.60 and alcohol content of 6.50 per cent. Augustin (1994) observed that medium and sweet wines prepared from cashewapple had 0.007 to 0.19 percentage phenolics.

Table 3 Mean scores for the organoleptic evaluation of fresh cashew apple products

Products	Appearance	Taste	Flavour	Colour	Clarity	Strength	Texture
Clarified Juice	3.50	3.80	3.60	-	-	-	-
Squash	4.00	4.00	4.00	-	-	-	-
Wine	3.00	3.40	3.15	3.00	3.55	3.00	-
Jam	4.00	4.00	4.00	3.90	-	-	4.00
Candy	3.35	4.00	4.00	3.20	-	-	4.00

From Table 2 it is perceived that cashewapple jam had a vitamin C of 49.86 mg/100g, total soluble solids 28.20°Brix, reducing sugars 15.21 per cent, total phenol 0.16 per cent, acidity 0.17 and pH 3.98. A study on peach cultivars for jam preparation by Ranjan et al, (1994) revealed that pH of the jam varied with cultivars of fruit.

Cashew apple candy before storage showed a vitamin C content of 16.56 mg/100g, total soluble solids 31.80°Brix, reducing sugars 13.70 per cent, and total phenol 0.12 per cent, it recorded pH as 4.50 and acidity 0.59 per cent. From a study in amla preserve, Anand (1970) reported that soaking and blanching of the amla resulted in a heavy loss of vitamin C and tannins. Chavan et al (1991) found that ber candy had an acidity of 0.69 per cent, pH of 3.50 and total soluble solids of 72 per cent. Gupta (1983) recorded 40 to 45 per cent reducing sugars and 0.40 to 0.50 per cent acidity from same fruit candy.

4.2.2 Organoleptic evaluation of cashew apple products

The acceptability tests were applied to each product before storage. Table 3 depicts the means scores ascribed to various products before storage.

Table 3 depicts that clarified juice received a mean score of 3.50 for appearance mainly because it was very clear after clarification. It secured a mean score of 3.80 for taste, 3.60 for flavour and a mean score of 4 for astringency before storage.

For squash and jam, the parameters like taste, flavour and astringency secured a mean score of 4.00. The colour of jam was very acceptable, it recorded a mean score of 3.90 before storage.

A mean score of 3.00 for appearance, 3.00 for colour, 3.40 for taste 3.15 for flavour, 3.55 for clarity 3.00 for strength and 4.0 which is least for astringency were obtained for fresh wine. While for candy taste, flavour, texture and astringency attributes received a mean score of 4 and the score for appearance was 3.55 and 3.20 for colour.

4.4 Changes in chemical constituents, organoleptic qualities and microbial changes of cashew apple products during storage

4.4.1 Nutritional and chemical changes during storage

Chemical change occur when the products were stored for long periods. It brings out deleterious changes in fruit products. So assessment on chemical components were carried out periodically. The vitamin C content was assessed at fortnightly intervals, while the total phenol content was evaluated at three months intervals. The pH, acidity, total soluble solids, reducing sugars and alcohol content of wine were examined at monthly intervals to find out the storage stability of different cashew apple products.

Changes in vitamin C content of different cashew apple products during storage

Table 4 Changes in vitamin C content (mg/100g) during storage of different cashew apple products

Particulars of storage periods	clarified juice	Squash	Wine	Jam	Candy
Before storage	213.06	180.03	40.00	49.86	16.66
storage periods (Fortnight assessment)					
1	212.68	179.73	40.00	49.18	15.99
2	212.42	179.32	39.69	48.92	15.83
3	211.87	178.87	38.80	48.40	15.30
4	211.57	178.32	38.36	48.10	14.86
5	211.10	178.10	37.03	47.03	14.23
6	210.50	177.67	36.91	46.90	13.68
7	210.28	177.34	36.10	46.16	13.33
8	209.58	176.63	35.17	45.28	--
9	209.58	176.92	34.50	44.00	--
10	208.77	176.63	34.50	44.00	--
11	208.52	176.26	34.32	43.98	--
12	208.32	175.84	33.82	43.40	--
F	698.48**	460.90**	29862.18**	19901.82**	31860.20**
CD	0.16	0.04	0.04	0.04	0.05

** Significant at 1 per cent level

Analysis of vitamin C content of different cashewapple products like clarified juice, squash, wine, jam and candy, after a fortnight of preparation, revealed that there were significant differences between the time of preparation and the length of storage period. But in the case of wine, the vitamin C content at the time of preparation was on par with the one after fifteen days. After that there was significant reduction in the vitamin C content with the increasing storage periods.

Chakraborthy et al (1962) observed that during brine curing and subsequent treatment with syrup, ascorbic acid content of cashewapple was lost. Jain et al, (1987) showed a gradual loss in ascorbic acid content during storage of orange, lemon and bael which might be assigned to the variation in temperature and oxidative processes. Loss in ascorbic acid during storage of different amla products like preserve, candy, jam, juice and dehydrated amla, was reported by Tripathi et al (1988).

Shah et al, (1992) found that ascorbic acid decreased from 5.30 mg/100g in Halman pulp to 1.40 mg/100g after 24 weeks storage. Similar decrease in ascorbic acid was shown in Narmoopulp. Thirumaran et al. (1993) observed a decrease in vitamin C of about 28.70 per cent in tomato concentrates during storage. Saini et al, (1995) found that ascorbic acid content decreased in sand pear juice concentrates during storage over a period of 28 weeks.

Changes in Total soluble solids (T.S.S) (^{o}Brix) content in different cashewapple products during storage

Table 5 Changes in Total soluble solids ^{o}Brix during storage of different cashew apple products.

Particulars of storage period	Clarified juice	Squash	Wine	Jam	Candy
Before storage	10.33	53.80	19.60	28.20	31.80
Storage periods (Monthly interval)					
1	10.60	53.80	19.30	28.60	31.10
2	10.80	54.20	18.40	29.00	30.80
3	11.00	54.40	16.20	29.60	30.20
4	11.20	54.80	15.80	30.00	30.00
5	11.60	55.20	15.00	30.60	--
6	12.00	55.80	14.60	30.80	--
F	178.22**	724.15**	1000.57**	598.90**	248.57**
CD	0.115	0.081	0.188	0.109	0.106

** Significant at 1 per cent level

Monthly analysis of total soluble solids content of clarified juice (10.33 to 12.00), squash (53.80 to 55.80), and jam (28.20 to 30.80) revealed an increase with increase in storage time. However the reduction in total soluble solids was significant only in wine (19.60 to 14.60) and candy (31.80 to 30.00).

Jain et al. (1984) reported a rise in total soluble solids in orange, lemon and beal squashes during storage. While no appreciable changes in phalsa, Kaphal and litchi squashes were noted. Hassan et al. (1992) observed an increase in total soluble solids in apple juice concentrate. Grewal (1992) also found an increase in total soluble solids in pear juice on storage.

Kadam et al. (1992) found a decline in total soluble solids during storage of pomegranate wine over a period of eight months. They had also reported a decrease in total soluble solids during storage of ber wine. Bhatta (1986) observed that a decline in total soluble solids in pear candy and Tripathi et al. (1988) observed similar results in amla candy after 45 days storage.

Conversion of part of unfermented sugar to alcohol during storage could be attributed to low level of total soluble solids in wine on storage.

Changes in reducing sugar content (per cent) of different cashew apple products during storage

Table 6 depicts the changes in reducing sugar content clarified juice (14.04 to 15.54 per cent) squash (17.03 to 17.35 per cent), jam (15.21 to 15.76 per cent) and candy (13.70 to 14.15 per cent). In all the four products the reducing sugar content increased with an increase in storage period. But in wine, the reducing sugar decreased from 0.41 to 0.19 per cent.

Table 6 Changes in reducing sugar per cent during storage of different cashew apple products

Particulars of storage period	Clarified juice	Squash	Wine	Jam	Candy
Before storage	14.04	17.03	0.41	15.21	13.70
Storage periods (Monthly interval)					
1	14.33	17.08	0.40	15.20	13.80
2	14.60	17.12	0.32	15.30	13.94
3	14.83	17.19	0.29	15.38	14.04
4	15.02	17.23	0.26	15.52	14.15
5	15.30	17.28	0.23	15.60	--
6	15.54	17.35	0.19	15.76	--
F	6904.24**	377.22**	827.34**	1664.60**	8322.10**
CD	0.002	0.002	0.001	0.001	0.001

** Significant at 1 per cent level

Jain et al. (1987) noted an increasing trend in reducing sugars in phalsa, Kaphal, litchi, orange, lemon and bale squashes during in stored kinnow RTS, by Wasker (1987) in phalsa beverage and by Saini et al, (1995) in sand pear juice. The increase in reducing sugar content increased during storage may be due to inversion of non reducing sugars present in fresh products (Grewal, 1992).

Changes in total phenol content (per cent) of different cashew apple products during storage

Table 7 Changes in total phenol content (per cent) during storage of different cashew apple products

Particulars of storage periods	Clarified juice	Squash	Wine	Jam	Candy
Before storage	0.31	0.27	0.33	0.16	0.12
Storage periods (Three months interval)					
1	0.26	0.23	0.27	0.11	0.08
2	0.20	0.18	0.23	0.08	0.06
3	0.16	0.15	0.21	0.04	--
F	257.30**	126.35**	84.00**	133.33**	85.77**
CD	0.001	0.001	0.001	0.001	0.001

** Significant at 1 per cent level

The cashew apple products were analysed for total phenol content at three month intervals. It was found that total phenol content was decreased during storage in clarified juice (0.31 to 0.16 per cent) squash (0.27 to 0.15 per cent) wine (0.33 to 0.21 per cent) jam (0.16 to 0.04 per cent), and candy (0.12 to 0.03 per cent).

Findings in decrease in phenol content was observed in amla preserve, jam and candy by Jain et al. (1983). During brine curing and subsequent treatment with syrup, phenol content of

cashew apple were retained in the final products only in traces, as reported by Chakrabarthy et al. (1962). Singh et al. (1976) observed a drecrease in tannin content during storage of apple cider. While Vyas et al. (1982) observed an increase in tannin content in plum wine when fermented with skin. Shah et al. (1992) showed that polyphenols declined during storage of canned peach and apricot pulp.

Changes in acidity in different cashewapple products during storage

Table 8 Changes in acidity (per cent) during storage of different cashew apple products

Particulars of storage period	Clarified juice	Squash	Wine	Jam	Candy
Before storage	0.14	0.33	0.70	0.17	0.59
Storage duration (Monthly interval)					
1	0.14	0.33	0.70	0.18	0.57
2	0.15	0.37	0.71	0.19	0.56
3	0.18	0.37	0.74	0.21	0.54
4	0.18	0.37	0.75	0.24	0.51
5	0.20	0.40	0.76	0.26	--
6	0.21	0.41	0.79	0.28	--
F	176.86**	180.13**	227.17**	299.49**	145.02**
CD	0.0066	0.0076	0.0076	0.0076	0.0066

** Significant at 1 per cent level

products have been made by Deb et al, (1960), Prasad et al, (1968), Mehta and Rathore (1976), Sastry et al, (1959), Srivastava et al, (1969) and Jain et al, (1983).

Bhatia (1986) reported a decrease in acidity during storage of pear candy. Similar findings were reported by Tripathi et al, (1988) and Chavan et al. (1991) in ber candy.

Change in pH in different cashew apple products during storage.

Table 9 Changes in pH during storage of different cashew apple products

Particulars of storage periods	Clarified juice	Squash	Wine	Jam	Candy
Before storage of the products	3.40	4.40	4.10	3.985	4.50
Storage duration (Monthly interval)					
1	3.30	4.30	4.10	3.96	4.52
2	3.30	4.30	4.00	3.92	4.56
3	3.20	4.36	3.80	3.90	4.59
4	3.10	4.32	3.70	3.86	4.60
5	3.10	4.28	3.60	3.84	--
6	3.10	4.22	3.50	3.80	--
F	1304.07**	558.76**	2985.43**	478.80**	26.25**
CD	0.0037	0.0077	0.0121	0.0077	0.0021

** Significant at 1 per cent level

Monthly analysis of acidity of different cashew apple products like clarified juice (0.14 to 0.21 per cent), squash (0.33 to 0.41 per cent), wine (0.70 to 0.79 per cent) and jam (0.17 to 0.28 per cent) revealed an increasing trend in the acidity values with increase in storage periods. But in candy (0.59 to 0.51 per cent) it showed a decreasing trend was observed. The lowered value in acidity may be due to interaction between organic constituents of products and enzymes.

Jain et al, (1983) announced a decrease in acidity during storage of squashs made from phalsa, kaphal and letchi, similar pattern of decrease in acidity was observed by Palaniswamy and Muthukrishnan (1974) in lemon squash after seven months of storage.

Vilasachandran et al. (1984) reported that acidity increased corresponding to the increment in storage days of cashewapple juice Massoodi et al, (1992) reported that the acidity values showed a decreasing trend with storage of perlette grape juice. The difference in acidity during storage is found to be the contributing factor for the decrease in pH.

Kadam et al, (1992) found that acidity of pomegranate wine and ber wine increased from 0.71 to 0.75 during storage. Tripathi et al. (1959) reported a rise in acidity in amla jam during storage. Similar observations in various fruit based

Table 9 revealed that the pH of stored clarified juice, squash, wine and jam were significantly lower, when compared to pH level of fresh products among the various products tested pH was significantly higher only in candy.

Palaniswamy (1974) reported that in lemon squash, there was an increase in pH after storage for seven months. Similar pattern of increase in pH was announced by Jain et al (1987) in squash made from phalsa, Kaphal and litchi. Mehta and Bajaj (1983) also found a slight rise in pH of citrous juice during storage for eight months. Studies on chemical characteristics of pear candy by Bhataia (1986) had indicated an increase in pH on storage studies on pomegranate wine by Kadam et al, (1992) indicated only slight changes in pH (3.50 to 3.48) during storage for a period of eight months. Vyas et al, (1982) also observed an unnoticeable decline in pH in plum wine.

Increase in pH in dried product was reported by Paul (1986), Bawan et al. (1987) and Torregian (1993).

Changes in alcohol content of wine during storage

Table 10 Changes in alcohol content (per cent) in cashew apple wine during storage

Inital value	Alcohol content at monthly interval					
	1	2	3	4	5	6
8.70	10.30	10.90	12.00	12.75	12.75	14.00

Table 10 shows that alcohol content of wine increases during storage. After six months of storage it was found to increase from 8.70 per cent to 14.00 per cent. An increase in alcohol content was noticed in pomegranate wine by Kadam et al, (1992) during a storage period of eight months. Same trend was observed in ber wine as reported by the same authors. Sheeja (1995) has also reported an increase in alcohol content in karonda wine during storage.

Rate of change in chemical constituents in cashew apple products during storage

Regression analysis was done to find out the rate of change in chemical constituents in cashew apple product during storage. Table 11 depicts the rate of change in different chemical constituents in cashew apple products during storage periods. From the table it was noticed that vitamin C in various cashew apple products diminished during the course of storage period. Fresh sample of cashewapple was found to contain 263 mg/100g vitamin C. The rate of change of vitamin C was found to decrease as -0.41 mg/100g, -0.34 mg/100g, -0.56 mg/100g, -0.54 mg/100g and -0.53 mg/100g in clarified juice, squash, wine, jam and candy respectively after a period of six months storage.

Palaniswami and Muthukrishnan (1974) have reported that ascorbic acid gets easily destroyed by heat and oxidation. They observed loss of ascorbic acid 24.77 mg/100g in citrus juice

during a period of seven months storage. Ravi and Verma (1990) have also reported that ascorbic acid is highly soluble in water and is susceptible to enzymatic and nonenzymatic oxidations and its stability decreases with an increase in temperature and pH. Mannay (1995) also mentioned that ascorbic acid is soluble in water and that it gets easily oxidised.

The present study showed that total soluble solids content in clarified juice (+0.26), squash (+0.33) and jam (+0.46) increased during storage but in wine (-0.93) and candy (-0.45) it was found to be decresing. Singh and Mathur (1953) observed an increase in total soluble solids content in cashewapple at different temperatures and the increase was greater at higher temperature. Monthly analysis of citrous juice stored over a period of eight months showed a slight increase of 1.03° Brix in total soluble solids as reported by Mehta and Bajaj (1983). Evaluation of stored amla juice revealed that total soluble solids content was increased by one per cent. (Tripathi et al. 1988). Whole tomato concentrate stored for a period of eight months indicated an increase of 4.84° Brix in total soluble solids (Sethi 1994). Jain et al, (1985) reported that total soluble solids showed gradual increase during the entire storage period in fruit squashes prepared from lemon, orange and bael. Storage evaluation in dried amla products revealed that total soluble solids in candy decreased after 45 days (Tripathi et al. 1988).

Reducing sugars of clarified juice (+0.24 per cent) squash (+0.0529 per cent) jam (+0.0925 per cent) and candy (+0.11 per cent) was found to rise but in wine (-0.37 per cent) was found to decrease. Jain et al, (1985) observed an increase in percentage of reducing sugars in squashes prepared from orange, lemon and beal. Sethi (1985) also found that reducing sugar content increased in litchi juice. Shah and Bhatia (1983) observed an increase in the reducing sugar concentration in culled apple juice and jam. The increase is attributed to the inversion of nonreducing sugar to reducing sugar by hydrolysis during storage. Saini et al. (1995) found that reducing sugar content increased in sand pear juice during storage. During storage of cider the concentration of reducing sugar was observed to reduce by Singh and Manjerker, (1976).

In the present study a reduction in phenol content was noticed in clarified juice -0.24, squash (-0.19)), wine (-0.18), jam (-0.17) and candy (-0.13) during storage. Jain et al. (1983) observed a decline in phenol content in amla preserve, jam and candy. Polyphenol content was noted to reduce during the secondary fermentation but remained approximately constant during maturation. The composition of wine was found to be affected by maturation as reported by Koning and Dietrich (1992). Shah and Bains (1992) also found that polyphenols decreased during storage of apricot pulp.

The pH of clarified juice, squash, wine, and jam were found to decrease during storage but in candy it was found to increase. Shah and Bhatia (1983) reported that pH decreased during storage of culled apple juice and jam which probably due to changes in acidity. Chemical analysis by Thirumaran et al (1990) showed a decreasing trend in pH of tomato juice concentrate and in fermented carrot based RTS during storage. A similar decrease in pH was noticed in tomato concentrate by Sethi (1994) also. Upasana and Bhatia (1985) observed an increase in pH in stored pear candy which has corroborated the observations with regard to decrease in titrable acidity.

The acidity showed an increasing trend in clarified juice (+0.01) squash (+0.01) wine (+0.01) and jam (+0.02) but in candy it was found to decrease. Palaniswamy et al (1974) also observed similar increase in acidity in mango pulp and squash during storage. Shah and Bhatia (1983) found that acidity of culled apple juice and jam increased during storage. Analysis of citrus juice stored over a period of eight months at room temperature showed an increase of 37.25 per cent in total acidity as quoted by Mehta and Bajaj (1983) in amla jam. Tripathi et al (1980) had noticed an increase in acidity of 0.03 per cent during 135 days of storage. However Upasana and Bhatia (1985) found a decrease in titrable acidity in pear candy. Increase in acidity may be due to the formation of organic acid by ascorbic acid degradation as reported by Sethi (1985).

4.4.2 Organoleptic evaluation of cashew apple products.

Sensory evaluation of the food is assumed to have increasing significance, as this provides information which may be utilised for the development of a product and its improvement. Jellinick (1986) mentioned that sensory quality is one of the criterion for acceptability of any product by the consumer. Rajalekshmi et al (1989) described sensory analysis as a scientific discipline used to evoke, measure, analyse and interpret reactions to those characteristics on foods and materials as perceived by the sense of sight, smell, taste, touch and hearing".

The products prepared from cashewapple were studied in detail for their acceptability by conducting sensory evaluation tests. Major quality attributes studied were, appearance, colour, taste, flavour, texture or clarity, strength and astringency.

According to Kramer (1970) among the various quality attributes, taste is the primary and most important one. In the various quality attribute test, the first evaluation goes to the taste followed by flavour, texture and colour, as reported by Rolls (1981).

Tejinder (1994) described that flavour is the unique character of odour and taste. Flavour is an important factor

which enriches the consumer's preference to a particular food. (Renganna, 1986)

Christensen (1985) mentioned that the consumers's preference for appearance is one of the major factors leading to the increasing demand of the products. So it is essential to keep the appearance of the product attractive.

Texture is the property of food which is associated with the sense of feed or touch experienced by the finger or the mouth. (Renganna, 1981). Jellinick (1986) reported that the first impression of food is usually visual and major part of our willingness to accept a food depend upon its colour.

John (1984) described that astringency is not a taste or odour sensation and it must often be included in flavour evaluation because it is a property common to many foods.

Organoleptic evaluation of cashew apple products during storage

On storage, fruit products are subjected to change in quality. Quality is a degree of excellence and a composite characteristic determining acceptability (Mohini and Surjeet, 1993).

Changes in organoleptic qualities of clarified juice during storage

Table 12 Mean scores for the organoleptic evaluation of clarified juice

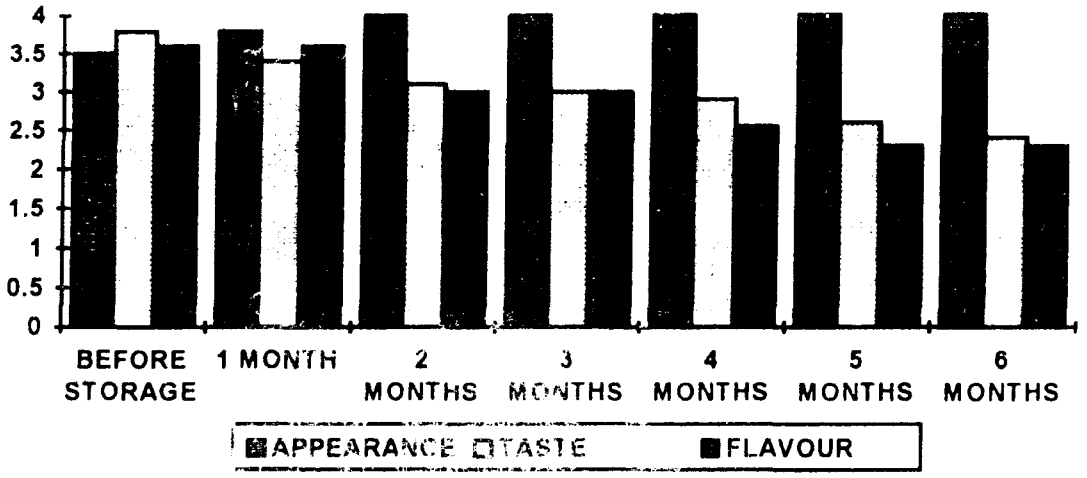
Particulars of storage periods	Parameters		
	Appearance	Taste	Flavour
Before storage	3.50	3.80	3.60
Storage periods (Monthly interval)			
1	3.80	3.40	3.60
2	4.00	3.10	3.00
3	4.00	3.00	3.00
4	4.00	2.90	2.55
5	4.00	2.60	2.30
6	4.00	2.40	2.30
F	11.89**	28.83**	35.58**
CD	0.15	0.25	0.26

** Significant at 1 per cent level

Major quality attributes studied were appearance, taste, and flavour. Table 12, depicts the mean score of clarified juice during storage.

It was found that the score obtained for appearance increased over a period of six months. A significant increase in values between the initial and final evaluation intervals were observed. Maximum score was attained during the sixth month of storage.

MEAN SCORE FOR THE ORGANOLEPTIC EVALUATION OF CLARIFIED JUICE



Unlike appearance, taste showed a decreasing trend, when the period of storage increased. The score obtained during fourth, fifth and sixth months were significantly lower when compared to the initial values recorded. There was a reduction in flavour during storage, with a mean score of 3.60, intially and which was reduced to a mean score of 2.30, after sixth months.

According to Nirakanth (1982) flavour change can be attributed to alteration in chemical composition.

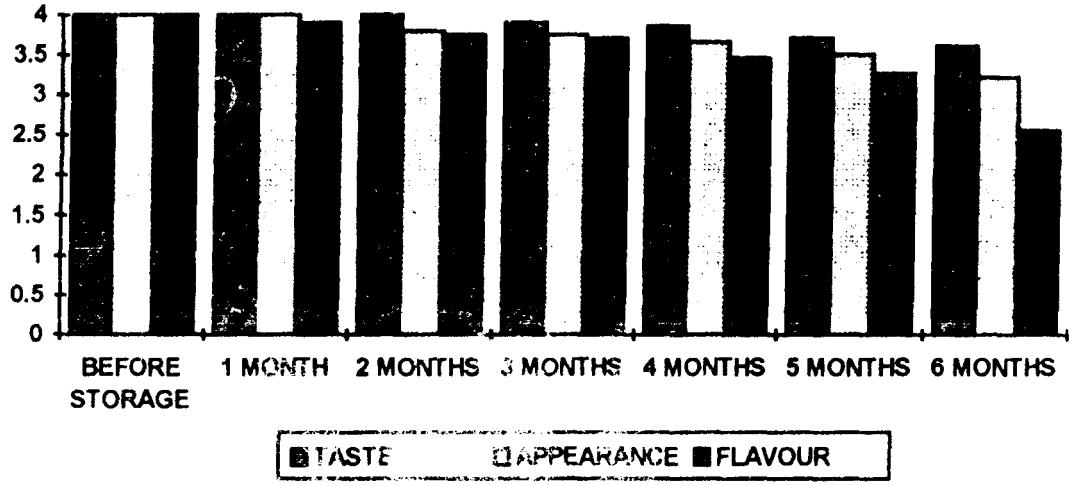
Changes in Organoleptic qualities of cashew apple squash during storage

Table 13 Mean scores for the organoleptic evaluation of squash

Particulars of Storage periods	Parameters Appearance	Taste	Flavour
Before storage	4.00	4.00	4.00
Storage Periods (Monthly intervels)			
1	4.00	4.00	3.90
2	3.80	4.00	3.75
3	3.75	3.90	3.70
4	3.65	3.85	3.45
5	3.50	3.70	3.25
6	3.20	3.60	2.55
F	10.91**	5.09**	28.01**
CD	0.24	0.19	0.26

** Significant at 1 per cent level

MEAN SCORE FOR THE ORGANOLEPTIC EVALUATION OF SQUASH



The parameters studied were appearance, taste and flavour. The mean scores obtained during the six month storage period are presented in Table 13.

It was observed that the scores for appearance decreased over a period of six months. There was a significant difference between the scores obtained, at the time of preparation and at different intervals. Taste and flavour of squash also showed a decreasing trend. Parekh et al. (1961) reported flavour deterioration in stored orange squash. Heating resulted in maximum loss of flavour because of oxidation of volatile oils and lipid fractions. Prasad et al. (1968) reported that squash prepared from amla juice was highly acceptable with respect to aroma and taste though they were bland in flavour.

Changes in organoleptic qualities of cashew apple wine during storage.

The quality of wine depends upon the chemical composition of the fruit, the type of yeast used and the temperature of fermentation (Vyas et al. 1991). During ageing of wine, several changes occur. In the present study, major attributes like appearance, taste, flavour, colour, clarity and strength of cashewapple wine were studied.

Table 14 Mean scores for the orgaroleptic evaluation of Wine

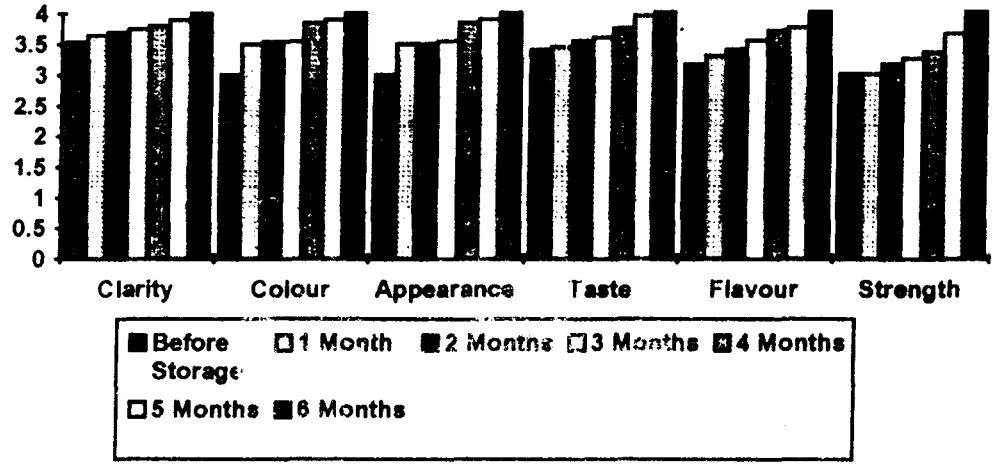
Particulars of Storage periods	Parameters					
	Appearance	Taste	Flavour	Colour	Clarity	Strength
Before Storage	3.00	3.40	3.15	3.00	3.55	3.00
Storage Periods (Monthly - intervals)						
1	3.50	3.45	3.30	3.50	3.65	3.00
2	3.50	3.55	3.40	3.55	3.70	3.15
3	3.55	3.60	3.55	3.55	3.75	3.25
4	3.85	3.75	3.70	3.85	3.80	3.35
5	3.90	3.95	3.75	3.90	3.90	3.65
6	4.00	4.00	4.00	4.00	4.00	4.00
F	15.93**	6.12**	9.24**	15.75**	2.73*	23.23**
CD	0.23	0.26	0.26	0.23	0.25	0.21

** Significance at 1 per cent level.
* Significance at 5 per cent level.

As shown in Table 14, appearance of wine received maximum scores in the sixth month of storage. Vyas et al (1991) found an increase in appearance of culled apple wine during storage.

Taste characteristic of wine increased during storage. The highest score was obtained during the sixth month of storage. Vyas et al, (1991) reported that during storage of wine, its harsh taste and yeasty odour diminishes. According to Patel (1978) the taste characteristic of wine is affected not only by

MEAN SCORE FOR THE ORGANOLEPTIC EVALUATION OF WINE



alcohol, aldehydes and esters present in it, but also due to the presence of phenolic substances.

In the case of flavour, the scores increased during storage. The mean scores obtained before storage was 3.15, after six months it attained a mean score of 4.00. Flavour is usually attributed to the aromatic alcohol present in the product. Colour of wine was also found to improve during storage. Augustin (1994) reported that the colour and flavour of cashewapple wine were influenced by the phenolic percentage and alcoholic fermentation. The colour changes could be assumed to be due to oxidation reduction reaction of anthyocyanin and tannin present in the fruit (Vyas et al. 1991) Rao (1978) reported that the astringency and colour of wine attributed to the phenolic constituents present in it. The clarity of wine attained the highest score in the sixth month of storage. It is also evident that the wine strength increased during the course of storage. A slow and steady increase in strength was noted. The strength of wine is due to its alcohol content.

Changes in Organoleptic qualities of cashew apple jam during storage

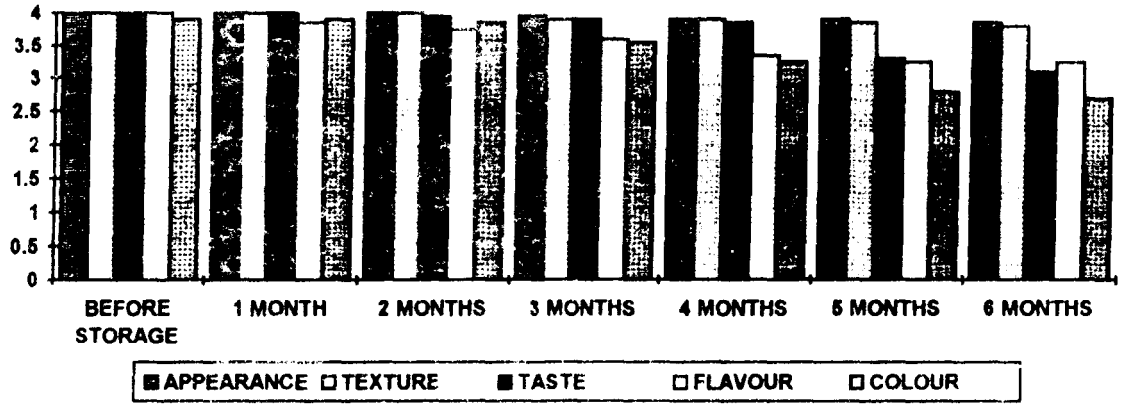
Table 15 Mean scores for the orgaroleptic evaluation of Jam

Particulars of storage period	Parameters				
	Appearance	Taste	Flavour	Colour	Texture
Before Storage	4.00	4.00	4.00	3.90	4.00
Storage Periods (Monthly - intervals)					
1	4.00	4.00	3.85	3.90	4.00
2	4.00	3.95	3.75	3.85	4.00
3	3.95	3.90	3.60	3.55	3.90
4	3.90	3.85	3.35	3.25	3.90
5	3.90	3.30	3.25	2.80	3.85
6	3.85	3.10	3.25	2.70	3.80
F	1.38^{NS}	32.14^{**}	9.68^{**}	29.14^{**}	1.86^{NS}
CD	0.14	0.18	0.27	0.26	0.16

NS Not significant
** Significant at 1 per cent level

Table 15 depicts that the appearance of jam slowly diminished as the storage interval advanced. Taste attributes viz flavour and colour were also found to decline with an extension of storage period. Texture of jam showed no significant difference. Astringency remained constant throughout the period. Thirumaran et al, (1986) observed that the

MEAN SCORE FOR THE ORGANOLEPTIC EVALUATION OF JAM



organoleptic evaluation of papaya jam, revealed that the product was acceptable up to six months. Bhatnager (1991) prepared jam from watermelon rind and it was highly acceptable with a shelf life of six months.

Changes in organoleptic qualities of candy during storage

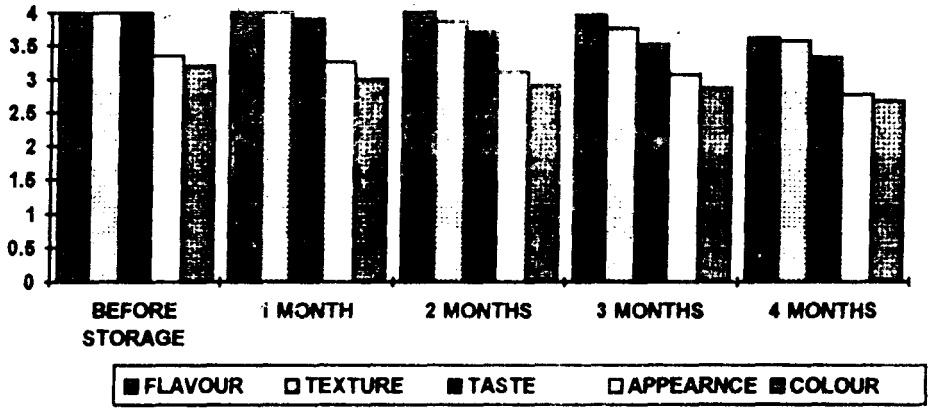
Table 16 Mean scores for the organoleptic evaluation of candy

Particulars of storage periods	Parameters				
	Appearance	Taste	Flavour	Colour	Texture
Before storage	3.35	4.00	4.00	3.20	4.00
Storage periods (Monthly interval)					
1	3.25	3.90	4.00	3.00	4.00
2	3.10	3.70	4.00	2.90	3.85
3	3.05	3.50	3.95	2.85	3.75
4	2.75	3.30	3.60	2.65	3.55
5	-	-	-	-	-
6	-	-	-	-	-
F	10.63**	28.73**	12.32**	15.38**	11.02**
CD	0.24	0.25	0.15	0.22	0.21

** Significant at 1 per cent level

Major quality attributes studied in the present investigation were appearance, taste, flavour, colour texture and astringency. Mean score for the organoleptic qualities of cashewapple candy during the storage period of six months are presented in Table 16.

MEAN SCORE FOR THE ORGANOLEPTIC EVALUATION OF CANDY



From the results it was observed that the appearance of candy decreased with the advancement in the period of storage. The appearance of candy due to fading of colour and shrinkage of fruit. Ketesz (1980) reported that appearance of pear candy decreased with increase in storage periods.

Taste of candy declined during storage. It has been reported by Tripathi et al. (1988) that a decrease in taste occur in amla candy during storage. Flavour of cashewapple candy maintained the maximum level upto third month of storage.

Low scores were obtained for candy for colour before storage as well as during storage. The fading of colour on storage was due to the oxidation-reduction reaction which resulted in bleaching of colour pigments. Karim (1992) reported similar reduction of colour in chikku leather during storage. Studies conducted by Bengtsson (1964), Pawar et al. (1985) and Kalra (1990) had revealed that heat application may stabilize the colour and texture and that it also helps to remove the raw of bitter taste.

In the case of texture of candy highest score was obtained initially. It declined further during storage. Tripathi et al. (1983) reported that acceptability of candy and dehydrated products decreased with storage. Jayaraman and Gupta (1991) reported that papaya and jackfruit candy are rated higher in appearence, flavour and texture.

4.4.3 Assessment of microbial in changes in cashewapple products

The changes brought about in foods by way of breakdown of protein, carbohydrate and fats and also of amino acids called microbial spoilage (Samoon, 1992). Keeping quality of products depends upon the microbial contamination. The presence of flavour and a loss of appetitizing appearance indicated microbial decay brought by the action of microorganisms.

Products like clarified juice, squash, wine, jam and candy were assessed for microbial contamination during the early months of storage. All the produces except candy were found to be free from contamination

On viewing under the microscope candy showed colonies of *Aspesgillus, penicillium* and yeast which confirmed the presence of microbial decay from fifth month onwards. The presence of these microorganisms may be the cause of deterioration of the dried products. Since the product failed to maintain quality attributes like colour, appearance texture, flavour and taste, the storage study was discontinued after four month of storage.

Bhatnagar (1991) reported that no activity of microorganism were observed up to six months of storage in watermelon jam. Bhatnagar et al (1984) had observed that microbial attack on muskmelon jam during seventh month of storage. Analysis of decayed dried pomegranate by Kahtoni (1990) showed that the

organism responsible were Aspesgillus and Pencillium. Kadam et al (1991) found that complete absence of microorganism in pomegranate wine stored for eight month. Sheeja (1995) reported complete absence of microorganism in Karonda wine, candy and canned products during eight months storage study.

In the present study, it can be concluded that a drastic destruction of vitamin C was noticed in all products during storage. Total phenol content in the product also showed a decreasing trend. In clarified juice, squash and jam total soluble solids, and reducing sugars increased during storage, but in wine these constituents decreased during storage. It was observed that the alcohol content of wine also rose during the storage of six months. In candy the total soluble and acidity decreased while the reducing sugars and pH increased during six month storage period. In the case of organoleptic qualities all parameters were in decreasing trend in clarified juice, squash, jam and candy. But in wine the scores for all quality attributes raised during storage. The products were assessed for microbial contamination during storage period and was found that all the products were free from microbial contamination except candy. In candy species of yeast and fungus were detected during the fifth and sixth months of storage.

Summary

SUMMARY

The study entitled "**Qualitative changes in cashew apple products in storage with special reference to vitamin C**" was a comprehensive investigation aimed to find out the qualitative changes in different cashew apple products during storage with special reference to vitamin C. The study was also aimed at the organoleptic quality evaluation of the cashew apple products and the microbial contamination of the products during storage.

Cashew apple fruits were collected from Kerala and Tamilnadu. The processed products such as clarified juice, squash and wine were prepared from extracted cashew apple juice and products like jam and candy were prepared from whole fruit/ fruit pulp after removing the astringency by using PVP (Poly Vinyl Pyroledone) at the rate of 1.4 gram/kg. The standard procedures suggested by CFTRI and KAU were followed for the preparation of products.

Analysis of cashew apple fruit showed 263 mg of vitamin C, 0.34 per cent total phenols, 3.10 of pH 0.18 per cent acidity, 11.2^{o} Brix total soluble solids and 15.20 per cent reducing sugar. Because of high content of vitamin C in cashew apple fruit, the present investigation mainly given attention to the changes in vitamin C content in different products during storage.

Chemical analysis of the products at fortnightly, monthly and quarterly interval showed a decrease in vitamin C in all products. The vitamin C content of cashew apple products before storage was analysed and found that clarified juice got the highest value (213.06 mg) and for squash (180.03 mg), wine (40 mg), jam (49.86 mg) and candy (16.66 mg) respectively.

Before storage phenol content in different products such as clarified juice (0.31 per cent), squash (0.27 per cent) wine (0.33 per cent), jam (0.16 per cent) and candy got 0.12 per cent. pH of clarified juice (3.40), squash (4.40), wine (4.10), jam (3.98) and candy (4.50). Acidity of clarified juice was 0.14 per cent, squash (0.33 per cent) wine (0.70 per cent). Clarified juice got a total soluble solids of 10.30° Brix, squash (53.80° Brix), wine (19.60° Brix) jam (28.20° Brix) and candy (31.80° Brix). Reducing sugars in clarified juice was found 14.04 per cent, squash (17.03 per cent), wine (0.41 per cent), jam (15.21 per cent) and candy (13.70 per cent). Wine got an alcohol content of 8.70 per cent before storage.

Fortnight evaluation of vitamin C in different cashew apple products showed a drastic decrease during storage. Analysis of total phenol content with an interval of three months showed increasing trends in clarified juice, squash, wine, jam and candy.

Monthly evaluation of pH revealed that there was an increase in clarified juice, squash, wine and jam but in candy it was reduced. Acidity was lower in candy but in clarified juice, squash, wine and jam the value was increased with storage periods. Total soluble solids increased in clarified juice, squash and jam but it was lowered in candy. Reducing sugars was also showed same trend. Alcoholic content of wine also increased during storage.

Viewing the acceptability of the products it was observed that clarified juice got maximum score for appearance at sixth month, taste and flavour decreased with advanced storage periods.

For squash low scores were obtained for all the characters but at the fresh stage after processing, it was observed an excellent one. The change in character may be due to change in qualitive attributes. At the same time wine got maximum score at sixth month of storage and this in turn may be due to increased fermentation. During storage of wine an improvement in strength was noticed. Jam and candy showed a reduction in quality attributes during storage period.

Microbial analysis throughout the storage period showed complete absence of micro organisms in clarified juice, squash, wine and jam. But in candy colonies of Aspergillus species, Pencillium and yeast was detected on fifth month of storage.

To summarise, it is the time that active steps has to be taken for fullest exploitation of this gold mine. Cashew apple products can easily prepared by processing the fruit. It has proved that the products was organoleptically acceptable with a good shelflife. The products could be given a boost by distributing free samples to visitors and in arranging parties. Let us hope that cashew products will get attention in near future.

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Appendix

APPENDIX I

PROCEDURE FOR THE TRIANGLE TEST

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

EVALUATION CARD FOR THE TRIANGE TEST

Name of the product : Sugar solution

Note : Two of the three samples are identical

Identified the odd samples

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

APPENDIX II

SCORE CARD

CASHEW APPLE CLARIFIED JUICE

Name
Date
Time

Charateristics		1	2	3	4	5	6
1. Appearance							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
2. Colour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
3. Flavour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
4. Taste							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
5. Astringency							
No astringency	(4)						
Mild astringency	(3)						
Moderate astringency	(2)						
Strong astringency	(1)						

APPENDIX III

CASHEW APPLE SQUASH

Name
Date
Time

Charateristics		1	2	3	4	5	6
1. Appearance							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
2. Colour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
3. Flavour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
4. Taste							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
5. Astringency							
No astringency	(4)						
Mild astringency	(3)						
Moderate astringency	(2)						
Strong astringency	(1)						

APPENDIX IV

CASHEW APPLE WINE

Name
Date
Time

Charateristics		1	2	3	4	5	6
1. Appearance							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
2. Colour							
Wine red	(4)						
Redish brown	(3)						
Brown	(2)						
Dark brown	(1)						
3. Flavour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
4. Taste							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
5. Clarity							
Sparkling clear	(4)						
Clear	(3)						
Cloudy	(2)						
with precipitate	(1)						
6. Strength							
Very strong	(4)						
Strong	(3)						
Slightly strong	(2)						
Not at all strong	(1)						

APPENDIX V

CASHEW APPLE JAM

Name
Date
Time

Charateristics		1	2	3	4	5	6
1. Appearance							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
2. Colour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
3. Flavour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
4. Texture							
Very soft	(4)						
Soft	(3)						
Firm	(2)						
Hard	(1)						
5. Taste							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
6. Astringency							
No astringency	(4)						
Mild astringency	(3)						
Moderate astringency	(2)						
Strong astringency	(1)						

APPENDIX VI

CASHEW APPLE CANDY

Name
Date
Time

Charateristics		1	2	3	4	5	6
1. Appearance							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
2. Colour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
3. Flavour							
Very acceptable	(4)						
Acceptable	(3)						
Slightly acceptable	(2)						
Unacceptable	(1)						
4. Texture							
Very soft	(4)						
Soft	(3)						
Firm	(2)						
Hard	(1)						
5. Taste							
Very Good	(4)						
Good	(3)						
Fair	(2)						
Poor	(1)						
6. Astringency							
No astringency	(4)						
Mild astringency	(3)						
Moderate astringency	(2)						
Strong astringency	(1)						

QUALITATIVE CHANGES IN CASHEW APPLE PRODUCTS IN STORAGE WITH SPECIAL REFERENCE TO VITAMIN C.

BY

SREEJA K. C.

ABSTRACT OF THE THESIS

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ABSTRACT

The study entitled **"Qualitative changes in cashew apple products in storage with special reference to vitamin C"** is a comprehensive study aimed to find out the qualitative changes that occur in cashew apple products in storage with more attention to vitamin C.

Results of the study indicated that the fresh cashew apple had a vitamin C content of 263 mg/100g, total soluble solids 11.20^{o}Brix, reducing sugars 1.20 per cent, total phenol 0.34 per cent, acidity 0.18 per cent and pH of 3.10.

Before storage clarified juice prepared from cashew apple had a vitamin C content of 213.06 mg/100g, total soluble solids 10.30^{o}Brix, reducing sugars 14.04 per cent, total phenol 0.31 per cent, acidity 0.14 per cent and pH 3.40.

Organoleptic evaluation of clarified juice before storage received a mean scores of 3.50 for appearance, 3.80 for taste, 3.60 for flavour and 4 for astringency. For squash and jam, the parameters like taste, flavour and astringency secured the mean score for 4.00. The colour of jam recorded a mean score of 3.90 wine secured a mean score of 3.00 for appearance, 3.40 for taste, 3.15 for flavour, 3.00 for colour, 3.50 for clarity, 3.00 for strength and 4.00 for astringency. For candy taste, flavour, texture and astringency attributes revealed a mean score of 4.00 and the score for appearance was 3.35 and 3.20 for colour.

It was found that vitamin C content of different cashew apple products like clarified juice, squash, wine, jam and candy. fortnight analysis revealed that there was significant differences between the time of preparation and length of storage period. In the case of wine the vitamin C content and the time of preparation was on par with one after fifteen days. After that there was significant reduction in the vitamin C content with the increasing storage period.

Monthly analysis of total soluble solids and reducing sugars in clarified juice, squash and jam was found to increase with increased storage time. But it was decreased in wine. In candy, total soluble solid was lowered during storage of six months.

Total phenol content of all products showed decreasing trend. Monthly analysis of acidity of different cashew apple products like clarified juice, squash, wine and jam revealed an increasing trend. But in candy it showed a decreasing trend. pH of all products except candy were significantly lower after storage when compared to initial levels.

Alcohol content of wine increase during storage. Before storage it was 8.70 per cent, while after six months of storage it was to 14.00 per cent.

The rate of change of vitamin c was found to decrease as -0.41 mg/100g, -0.34 mg/100g, -0.56 mg/100g, -0.54 mg/100g and

-0.53 mg/100g in clarified juice, squash, wine, jam and candy respectively.

Total soluble solids in clarified juice (+0.26), squash (+0.33), and jam (+0.46) increased during storage, but in wine (-0.94) and candy (-0.45) was found to decrease. Reducing sugars of clarified juice (+0.24 per cent) squash (+0.05 per cent) jam (+0.[illegible] per cent) and candy (+0.11 per cent) was found to rise but in wine (-0.371 per cent) was found to decrease.

The rate of change of total phenol content in clarified juice (-0.034), squash (-0.019), wine (-0.018), jam (-0.017), candy (-0.013) was found to decrease during storage of six months.

pH of clarified juice, squash, wine and jam were found to decrease during storage but in candy it was found to increase. Acidity showed an increasing trend in clarified juice (+0.01), squash (+0.01), wine (+0.01) and jam (+0.02) but in candy it was found to decrease.

Organoleptic evaluation of clarified juice found that the score for appearance increased over a period of six months. Taste depicted a decreasing trend, when the period of storage increased. The scores obtained during fourth, fifth and sixth months were significantly lower when compared to the initial values recorded. There was reduction in flavour during

storage. For squash the scores for appearance, taste and flavour decreased over a period of six months.

Appearance of wine received maximum scores in the six months of storage. Highest score for taste was obtained during the sixth month of storage. The mean scores obtained for flavour before storage was 3.15, after six months it attained a mean score of 4.00. Strength of wine also measured during storage.

Appearance of jam slowly diminishing as the storage interval advance. Taste attributes, flavour and colour were also found to decline. Texture of jam showed no difference. Appearance, taste and colour of candy declined during storage. Flavour of cashew apple candy maintained the maximum level up to third month of storage. All products assessed for microbial contamination during early months of storage. All the products except candy were found to be free from contamination.