
# QUALITY EVALUATION OF INDIAN GOOSEBERRY (*Emblica officinalis* Gaertn.) PRODUCTS

By

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**THESIS**

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# DECLARATION

I hereby declare that the thesis entitled **"Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products"** is a bona fide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

Vellanikkara
02.11.2002

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## CERTIFICATE

Certified that the thesis, entitled **"Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products"** is a record of research work done independently by **Miss.Saima, N.S.,** 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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We, the undersigned members of the Advisory Committee of **Miss.Saima, N.S.**, a candidate for the degree of **Master of Science in Home Science** with major in **Food Science and Nutrition**, agree that the thesis entitled **"Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products"** may be submitted by Miss.Saima, N.S., in partial fulfilment of the requirement for the degree.

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**SAIMA,N.S.**

*Affectionately dedicated to*
*my loving Valiyapappa*

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# *Introduction*

# INTRODUCTION

Fruits being a rich source of vitamins, minerals, organic acids and dietary fibre are considered as protective foods, have a special place in our daily diet (Bharwal, 1999). The annual fruit production in India is estimated to be 45.5 million tonnes (Negi, 2002). Inspite of the highest fruit production the average Indians do not get the basic daily requirement of fruits due to wastage and value destruction (Roy, 2001). Another reason behind the reduced per capita consumption of fruit is the high cost of many of the fruits available in the market which cannot be afforded by common man. Here comes the importance of indigenous minor or under exploited fruits.

India is enriched with a variety of delicious indigenous fruits which have great potential for processing into nutritious delicately flavoured products. The processing of the indigenous fruits like the bael, kiwi, phalsa, aonla, passion fruit, pomegranate, papaya, jamun, karonda etc. could help the even distribution of fruits from places of abundance to the place of scarcity, the availability of fruit products even during off season and at reasonable price there by improving the per capita availability as well as consumption (Roy and Pal, 2000). Fruits have been conferred a status of functional foods owing to their rich content of phytochemicals like ascorbic acid and bioflavanoids (Maini and Kaur, 2001). Therefore the products can be popularised by technical innovations as Health foods/Functional foods.

Among the various indigenous minor fruits Indian gooseberry could be an important fruit in near future due to its high nutritional and medicinal value, high productivity per unit area and suitability even in waste lands of arid and semi-

arid areas (Supe, 1992). It has already been recognised as the king of arid fruits (Wagh *et al.*, 1998).

The amla (aonla) (*Phyllanthus emblica* L. or *Emblica officinalis* Gaertn.) also known as Indian gooseberry is a minor sub-tropical deciduous tree belonging to the family Euphorbiaceaea. Amla is thought to be a native of India, Ceylon, Malayasia and China.

Indian gooseberry has been valued for its nutritional and therapeutic properties and is usually recommended for its synergistic effects in both the Ayurvedic and Unani systems of medicine (Haimanti *et al.*, 1990). It possess pronounced expectorant, antiviral, cardiotonic, hypoglycaemic and antioxidant activities (Kalra, 1988).

Indian gooseberry is a rich source of ascorbic acid and is a rare example of an edible material rich in tannin as well as ascorbic acid (Kalra, 1988). The fruit also contains sugars composed of fructose, glucose, sucrose and myoinositol, alkaloids, auxins, minerals and fibre.

Inspite of its high nutritional and medicinal value, consumers do not relish this fruit in fresh form because of its highly acidic and astringent nature (Premi *et al.*, 1999). Indian gooseberry retained more vitamin C after processing compared to other fruits (Nath, 1999). Vitamin C is increasingly recognised as a phytochemical with broad biological functions with properties of free radical scavenger (Rani *et al.*, 2001). Indian gooseberry being a rich source of vitamin C, it is nowadays gaining more priority for processing. Hence, value addition could be an effective tool to improve the consumption of this fruit. Hence, the present study was undertaken to evaluate the nutritional quality, acceptability and storage stability of different Indian gooseberry products.

# *Review of Literature*

# 2. REVIEW OF LITERATURE

Literature relevant to the study entitled "Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products" is reviewed in this chapter under the following sections.

1) Indian gooseberry (Aonla/Amla) in health and disease

2) Chemical constituents of amla fruit

3) Changes in chemical constituents in processed amla products

4) Standardization of the fruit products

5) Acceptability studies

## 2.1 Indian gooseberry (Aonla/Amla) in health and disease

Species of phyllanthus are used widely in ayurvedic and unani systems of medicine to maintain sound health and to treat a wide range of diseases (Haimanti *et al.*, 1990). Two main texts of ayurveda viz., Charakasamhita and Sushruta Samhita has mentioned the use of amalaki (amla) in various ayurvedic preparations (Swayamprakash, 1991). Aonla is reported to be the only fruit to fill the gap of astringent food recommended by the ayruvedic system of medicine for balanced diet and sound health (Supe, 1992). Parvathavarthini *et al.* (2000) also reported that *Emblica officinalis* is a common fruit employed in many disease conditions in Indian traditional systems of medicine. Amla fruit extract is used in the preparation of various homoeopathic medicines also (Selvarajan *et al.*, 2000).

The decoction from dried amla is used in fever and mixed with sugar and drunk in vertego (Drury, 1978). An experiment conducted by Mishra *et al.*

(1981) in rabbits showed a significant reduction in the mean serum cholesterol level when fed with 0.1 g of fresh amla daily for a period of 2 weeks. Vinayagamoorthy (1982) found that amla has very potent antibacterial activity against common urinary tract and wound pathogens. Zachariah (1984) reported that, of the 40 hyperhidrosis patients treated with water extracts of *E. officinalis* berries, 29 exhibited excellent results without any side effects. Animal studies carried out by Thakur and Mandal (1984) revealed the hypocholesterolemic and antiatherogenic effect of *Emblica officinalis.*

Aonla fruit acquired its therapeutic significance due to its unique compostion (Sethi, 1986). Aonla is a rich source of ascorbic acid and it appear that ascorbic acid as an antioxidant exerts an antihypertensive effect and may prevent cataract formation and ischaemic heart disease. Chawla *et al.* (1987) studied the effect of amalaki on patients of ulcer-dyspepsia and non-ulcer dyspepsia and concluded that it would be a suitable alternative to antacids in the management of the two types of dyspepsia. The exact nature of action of tannins in the human system is not clearly known. However, it is believed that the tannins have protein precipitant action and hence causes soothening effect in case of diarrhoea (Kalra, 1988). Amla being rich in tannin can be used in the treatment of diarrhoea. Sharma *et al.* (1990) reported that amalaki seed powder administered in a dose of 10 g in two divided doses after meals for 4 weeks gave satisfactory results in the management of Amalapitta (acidity)

Gopalan and Ram (1990) reported that it is a custom in many Hindu families to include amla in the diet especially in the first meal taken after a day of

fasting. Amla has been held in high esteem in indigenous medicine as acidic, cooling, retrigerant, diuretic, laxative and is also claimed that the dried fruits are useful in haemorrhage, diarrhoea and dysentery. Triphala, a popular ayurvedic preparation containing aonla is used in the treatment of headache, billousness, dyspepsia, constipation, piles, enlarged liver and ascites. A fermented liquor prepared from the *E.officinalis* fruit is used in jaundice, dyspepsia and cough while acute bacillary dysentery may be arrested by drinking a sherbet of amla with lemon juice. Haimanti *et al.* (1990) found that oral administration of aqueous extracts of *Phyllanthus emblica* fruits and *Phyllanthus miruri* leaves to mice significantly reduced the cytotoxic effects of lead nitrate and aluminium sulphate. Two main texts of ayurvedia viz, Charaka Samhita and Sushruta Samhita which were said to be written around 1500 BC has mentioned the use of amalaki in the treatment of pandu (anaemia) (Swayamprakash, 1991). The crude fruit extract from *E. officinalis* fruit was demonstrated to have the ability to counteract the toxic effects induced by lead and aluminium salts in hepatic and renal tissues of animals (Roy *et al.,* 1991). Shaw *et al.* (1992) suggested the use of amalaki seed powder for the management of amalapitta. A herbal eye drops preparation developed by Paul *et al.* (1992) from *Emblica officinalis* exhibitted a pronounced effect on different types of corneal ulcer cases especially vial keratitis without producing any side effects.

Sethi (1993) found that aonla possess valuable antiscorbutic property in the fresh as well as dried form. Sethi and Anand (1993) reported that polyphenols especially tannic acid in amla is supposed to have therapeutic role. Triphala – a popular ayurvedic preparation obtained mainly from amla could be used as a blood

purifier and purgative (Mehta *et al.*, 1993). Sankaranarayanan and Jolly (1993) found that the total extracts of the dried powdered combination of the fruits of *E. officinalis, M. Charantia* and rhizomes of C. longa posses high hypoglycaemic activity. Navayosa – Louha – an iron containing compound drug prescribed in the treatment of anaemia has *E. officinalis* as one among its major components (Suresh and Kumari, 1994). Bombarde and Bombarde (1994) reported that the herbal drugs used in diabetic patients include *E. officinalis.* Roy (1994) also opined that aonla can be used to cure diabetes. Oral administration of powdered fruits of *Phyllanthus emblica* enhanced natural killer cell activity and antibody dependent cellular cytotoxicity in Dalton's lymphoma ascites tumour inoculated mice thereby enhancing their life span by 35 per cent (Suresh and Vasudevan, 1994).

Jeena and Kuttan (1996) reported that the aqueous extracts of *Emblica officinalis* have prominent antioxidant effect. The antioxidant activity of Chyavanaprash is mainly attributed to its major component *Emblica officinalis* used upto 63 per cent in its preparation. Fruits of *P. emblica* is highly valued in the Unani and Ayurvedic system of medicine for their anti– pyretic, antioxidative, laxative, tonic, antibacterial and antiviral properties (Varrier, 1995). In addition to these the properties of fruits are also extended to digestive, stomachic, alterant, alexeteric and trichogenous. He also found that they are useful in vitiated conditions of tridosa, diabetes, cough, asthma, cephalagian, ophthalmopathy, colic, flatulence, skin diseases, leprosy, jaundice and cardiac haemorrhages. Physical and clinical evaluation carried out by Paranjpe and Kulkarni (1995) revealed that sundervati – an ayurvedic preparation consisting of *E. officinalis* fruits and some

herbs is effective in the treatment of patients with acne vulgaris. Shibnath *et al.* (1996) studied the active constituents of *E. officinalis* and arrived at the conclusion that the fruits of *E. officinalis* Gaertn. do not contain free or conjugated forms of L-ascorbic acid indicating that the pharmacological properties of fruits are not due to the presence of vitamin C. Low molecular weight hydrolysable tannins are now thought to be responsible for the antioxidant activity of fruits. They isolated four hydrolysable tannins, the novel emblicans A and B and the known punigluconin and pedunculagin from the fresh pericarp of aonla fruits. Jeena and Kuttan (1996) reported that *E. officinalis* is a non-toxic fruit with no reported toxicity and is a major ingredient of chyavanaprash. Kuttan *et al.* (1996) showed that *Emblica officinalis* Gaertn. in chyavanaprash inhibited the sarcoma developed by 75 per cent with a subsequent increase in life span. Chyavanaprash is widely used as an anabolic, immunomodulator and memory enhancer (Shishoo *et al.*, 1997). Dietary supplementation with extract from the fruit of *Emblica officinalis* Gaertn. to mice *in vivo* significantly reduced the cytotoxic effects of an known carcinogen – 3,4 – benzo (a) pyrene (Nandi *et al.*, 1997). Basharat (1998) evaluated the medicinal properties of various species of phyllanthus and reported that *P. emblica* fruits have many properties including uses as a laxative, carminative and to treat urinary discharges, thirst, leprosy, constipation, inflammation, anaemia, poisoning, piles and incipient blindness. The leaves are used as an aphrodisiac and to treat asthma, bronchitis, leucorrhoea and vomiting. Chyavanaprash which is mainly constituted by *E. officinalis* is reported to possess good free-radical scavenging activity (Shishoo *et al.*, 1998). A comparative study made by them showed that fresh amla fruits and freeze dried amla powder exhibited very good free radial scavenging

activity comparable with that of ascorbic acid. Sharma and Yadav (1998) reported that Triphala – an ayurvedic preparation containing aonla is used in the treatment of headache, biliousness, dyspepsia, constipation, piles, enlarged liver and ascites. Parvathavarthini *et al.* (2000) found that *E. officinalis* can be used for controlling gastric acidity, gastric ulcer and peptic ulcer. The amla fruit extract is used in a number of ayurvedic and homoeopathic preparations which are said to prevent greying and falling of hair (Selvarajan *et al.*, 2000).

Amla preserve is reported to have an immense medicinal importance (Nair and Jain, 1982). The use of amla, apple and carrot murabba as curative or for toning human system in the unani system of medicine has been reported by Beerch *et al.* (1984). Pandey (1989) also reported the same.

Kuttan *et al.* (1996) opined that incorporation of amla products in daily menu could reduce the incidence of malignancy. Singh *et al.* (1999) found amla preserve to be an important product in the indigenous system of medicine in India. They further reported that amla murabba has beneficial effects in reducing the cholesterol content of blood and in improving the eye sight.

## 2.2 Chemical constituents of amla fruit

Aonla could be an important fruit in near future due to its high nutritional and medicinal value, high productivity per unit area, and suitability even in wastelands of arid and semi-arid areas (Supe, 1992). Jeena and kuttan (1996) found that *Emblica officinalis* Gaertn. is a non-toxic fruit with no reported toxicity. Aonla (*Emblica officinalis* Gaertn.) has already been recognized as the king of arid fruits (Wagh *et al.*, 1998).

Tripathi *et al.* (1988) analysed the composition of amla fruits and reported that it contained 84.36 per cent moisture. But Sharma and Yadav (1998) and Geetha and Sarojini (1998) reported that it contained only 81.2 per cent moisture. Premi *et al.* (1999) estimated the moisture content of different varieties of aonla and rated Desi variety with the lowest content of 80.98 per cent and Chakaiya with the highest content of 87.17 per cent.

Aonla is highly regarded for its high vitamin C. content and its vitamin C content as high as 300-1000 mg per 100 g of edible portion (Sethi, 1986 and Salunkhe *et al.,* 1991). Some varieties of amla like the Chakaiya cultivar are reported to contain as much as 789 mg of ascorbic acid per 100 g of the fruit (Supe, 1992). According to Pareek and Sharma (1993) the vitamin C content of aonla varied from 625 mg to 1800 mg 100 $g^{-1}$ fruit. Roy (1994) and Parvathi and Anbu (1997) opined that aonla is one of the richest known natural source of vitamin C. Basharat (1998) evaluated different Phyllanthus species and reported that *P. emblica* fruits are probably the richest known natural source of vitamin C. The special attributes of the fruit is its capacity to retain vitamin C even in a dried state which is not possible in other fruits (Selvarajan *et al.,* 2000).

Sreekumar *et al.* (1984) analysed the nutrient content of different Phyllanthus emblica cultivars in the Western Ghats and found that Chambakad large is superior in vitamin C content. Supe (1992) reported that the Chakaiya variety of amla contain 789 mg ascorbic acid per 100 g. Srivastava *et al.* (1997) analysed the genetic diversity in aonla and observed that ascorbic acid content varied from 422 – 600 mg 100 $g^{-1}$ pulp among the available genotypes. Shishoo

*et al.* (1997) found that the pericarp of larger varieties of amla fruit contained 2.915 mg vitamin C per gram of pulp while that of smaller varieties contained 3.775 mg $g^{-1}$.

In amla vitamin C is present in a stable form (Kalra, 1988). The fruit contain a chemical substance which prevents the oxidation of vitamin C in it rendering the fruit a rich source of vitamin C in the fresh as well as dry condition (Gopalan and Ram, 1990). Experiments carried out by Supe (1992) revealed that the chemical substance which retards the oxidation of vitamin C is leucoanthocyanin. Roy (1994) also reported that the chemical substances which prevents the oxidation of vitamin C in amla are the polyphenols. Hanif (1996) and Sharma and Yadav (1998) reported that since amla contains a tannin with gallic acid, ellagic acid and glucose in its molecule, it prevents or retards the oxidation of vitamin C and renders a valuable antiscorbutic condition in amla and its products. Parvathi and Anbu (1997) reported that vitamin C in aonla is heat stable compared to that in other fruits because it contains a chemical substance which partially protects the vitamin from destruction on heating and drying.

Roy *et al.* (1987) showed that vitamin C from amla syrup has better bioavailability than synthetic vitamin C Gopalan and Ram (1990) also opined that vitamin C from amla is readily assimilated by the human system. Studies carried out by Mathur (1997) also obtained a similar result. Aonla fruit based beverages are easily digestible, highly refreshing and invigourating. The amla fruit beverage particularly blended Ready To Serve beverage can provide a very nutritious and delicious cold drink (Singh and Kumar, 1995).

Nizamuddin *et al.* (1982) extracted a pectin with D-galacturonic acid, D-arabinosyl, D-xylosyl, L-rhamnosyl, D-glucosyl, D-mannosyl and D-galactosyl residues from aonla fruit. Tripathi *et al.* (1988) estimated the pectin content of aonla to be 0.54 per cent. Aonla is regarded as a rich source of pectin (Parvathi and Anbu, 1997).

Gupta and Bopiah (1986) reported that amla fruits contain 0.7 per cent of total ash which comprises calcium, phophorus and iron. Kalra (1988) also obtained a similar composition. Comparison of nutritive value of amla with apple showed that amla fruits contained considerably higher concentration of most minerals (Barthakur and Arnold, 1991). Chauhan *et al.* (1991) found that the aonla fruit is a poor source of mineral compared to the other fruits studied. Pareek and Sharma (1993) opined that aonla is a rich source of calcium. They reported that the fruits contain 0.05 per cent calcium, 0.02 per cent phosphorus and 1.2 per cent iron in the fresh state. According to Gopalan *et al.* (1994) aonla fruit contains 50 mg of calcium, 20 mg of phosphorus and 1.2 mg of iron per 100 gram of fruit. Amla being rich in ascorbic acid the bioavailability of iron from the fresh fruit as well as its products is very high (Manay and Shadaksharaswamy, 1998). According to Selvarajan *et al.* (2000), 100 g of amla pulp contains 1.2 g of iron.

Nizamuddin *et al.* (1982) identified the sugars present in *Emblica officinalis* as D-glucose, D-fructose, and myoinositol. Singh *et al.* (1987) evaluated the physiochemical composition of different cultivars of aonla and found that the total sugar content varied from 6.96 per cent to 9.78 per cent. Kalra (1988) reported that among different varieties the reducing sugar content varied from 3.05 to 7.23 per cent and total sugar from 7.0 to 9.6 per cent.

Amla is a rare example of an edible material which is rich in tannins as well as ascorbic acid (Kalra, 1988). He estimated the tannin content and found that the fruit contains 1.1 to 4.45 per cent tannins on fresh weight basis along with other polyphenolic compounds like phloroglucinol, pyrogallol and catechol. Trigalloyl glucose, terchebin, corilogin and ellagic acid also have been isolated from amla fruit. According to Premi *et al.* (1999) tannic acid content of different varieties of aonla showed a variation of 3.18 to 3.57 per cent.

Singh *et al.* (1987) estimated the fibre content of different cultivars of aonla and found that it varied from 2.20 to 3.25 per cent. Geetha and Sarojini (1998) reported that fresh amla contains 3.4 per cent of fibre.

Gupta and Bopiah (1986) found that amla fruit contains 0.5 per cent of protein. But Kalra (1988) and Tripathi *et al.* (1988) reported that amla fruit contain 0.9 per cent of protein on fresh weight basis. Two amino acids serine and β-alanine in traces have been detected in amla fruit. A comparison of the protein and amino acid content of amla and apple showed that amla contained 3 times as much protein and a considerably higher concentration of amino acids as apple (Barthakur and Arnold, 1991). Glutamic acid, proline, aspartic acid, alanine and lysine constituted 29.6, 14.6, 8.1, 5.4 and 5.3 per cent respectively of the total amino acids. The concentration of each amino acid except cysteine was much higher than in apples. According to Selvarajan *et al.* (2000) amla contain only 0.5 per cent of protein.

Amla contains oxalic acid to the extent of 126.9 mg 100 $g^{-1}$ (Kalra, 1988). The presence of mucic acid also has been reported. Tripathi *et al.* (1988) found that amla fruit has a pH of 2.5. Different cultivars of aonla exhibited a variation in their acidity. It ranged from 1.9-2.5 per cent (Srivastava *et al.*, 1997).

Gopalan *et al.* (1994) reported that 100 g of amla fruit contains 0.03, 0.01, 0.2 and 256 mg of thiamine, riboflavin, niacin and choline respectively along with 9 µg of carotene. According to Selvarajan *et al.* (2000) 100 g of amla pulp contain 0.3 g of vitamin B.

Amla fruit also contains auxins (2 non-acidic and 3 acidic auxins) and alkaloids (phyllantidine and phyllantine). The seed oil of amla comprise 64.8 per cent of linolenic acid and loosely resembles linseed oil (Kalra, 1988). Gopalan *et al.* (1994) reported that 100 g of amla fruits yield 58 kcal of energy.

## 2.3 Changes in chemical constituents in processed amla products

Retention of more vitamin C even after processing contributes a high nutritive value to the amla products. Method of preparation significantly affects the ascorbic acid content of the amla products. Gupta and Bopiah (1986) showed that lowering the process temperature to about 40°C improved the vitamin C content of amla preserve. During storage of 10 weeks ascorbic acid in amla juice was found to be unchanged (Metha and Rathore, 1987). The storage study of amla candy, preserve, jam, dehydrated product and juice for 135 days showed that the ascorbic acid content decreased from 112.28 to 84.6 mg 100 $g^{-1}$ in preserve, 55.72 to 39.36 mg 100 $g^{-1}$ in jam, 108.62 to 88.6 mg 100 $g^{-1}$ in candy, 298.31 to 130.24 mg 100 $ml^{-1}$ in juice and 178.65 to 131.68 mg 100 $g^{-1}$ in dehydrated amla during storage. Thus it exhibited a decreasing trend in the nutrient content with the increase in storage period (Tripathi *et al.*, 1988). Sethi and Anand (1989) reported a loss of 75.82 per cent of ascorbic acid from fruits during processing. But amla preserve still remains a rich source of this vitamin. Preparation of preserve by

conventional method from fresh fruits initially containing 964 mg of ascorbic acid per 100 gram gave a product which retained about 40 per cent of original vitamin C in both fruit and syrup taken together. The dried amla powder is reported to loose only 20 per cent of its vitamin C in 375 days when kept in refrigerator and about 2/3 when stored at ordinary temperature (Gopalan and Ram, 1990). Salunkhe *et al.* (1991) found that the ascorbic acid content of stored fruits generally decreased more rapidly at higher storage temperature. Rao (1992) reported that vitamin C content was retained in amla squash while Giri (1993) observed that the dried and powdered fruits of amla were rich in ascorbic acid. No loss in vitamin C content occurred when amla fruits were stored at 0°C whereas storage at 25 to 37°C caused 30 to 70 per cent loss at the end of 3 months (Giri, 1993). Results of the study carried out by Ramasastry (1994) also supports this finding. He observed a loss in vitamin C content to the extent of 27, 50 and 80 per cent when stored at 37°C for 3, 6 and 10 months respectively. He further concluded that dried and powdered amla fruit stored in glass containers, retained more ascorbic acid than that in other type of containers. Singh and Kumar (1995) found that the aonla jam exhibited better nutritive quality than apple jam and aonla pickle was more nutritious than lime and lemon pickle. Verma and Gupta (1996) investigated the effect of pretreatment on the quality of open sundried amla and found that ascorbic acid retention after drying was highest (64%) in sliced samples compared to pricking, blanching, flaking etc. Parvathi and Anbu (1997) reported that fresh aonla fruits contain 600 mg of vitamin C per 100 g while aonla squash provides 500 mg ascorbic acid per 100 ml. Determination of vitamin C content of *Phyllanthus emblica* and chyavanaprash was done by Shishoo *et al.* (1997). They

concluded that vitamin C was exceptionally stable in fresh and dried amla fruits but all the three market samples of chyavanaprash tested contained no vitamin C. The fruit pulp is reported to contain as much as 920 mg of vitamin C per 100 ml (Manay and Shadaksharaswamy, 1998). Aonla honey spread developed by Sehgal and Singh (1999) was found to have high content of vitamin C.

Tripathi *et al.* (1988) evaluated the change in pectin content of amla preserve, candy, jam and dehydrated product during storage and found that it remained stable in dehydrated product and showed a decreasing trend in all the other products. The pectin content of preserve decreased from 0.11 to 0.08 per cent while in jam it was from 0.52 per cent to 0.42 per cent and in candy it decreased from 0.34 to 0.28 per cent during the storage.

Kalra (1988) reported that retention of tannin in amla products is quite high. Tripathi *et al.* (1988) investigated the change in tannin content of different amla products on storage. They found a decreasing trend in the tannin content of amla preserve, jam, and candy while that of amla juice and dehydrated amla exhibited an increasing trend. The tannin content decreased from 0.32 to 0.29 per cent in preserve, 0.18 to 0.14 per cent in jam and 0.22 to 0.20 per cent in candy, while it increased from 0.32 to 0.42 per cent in juice and 2.23 to 2.42 per cent in dehydrated product.

According to Tripathi *et al.* (1988) the total sugar along with non-reducing sugar decreased in dehydrated amla (12.19% to 12.16%) during storage while the total sugar continued to increase during storage in amla preserve (65.58% to 66.76%), jam (61.45% to 61.55%), Candy (65.51% to 66.97%) and juice (2.89% to 2.98%).

Tripathi *et al.* (1988) evaluated the change in T.S.S of amla preserve, candy, jam, juice and dehydrated product on storage and found that the T.S.S. remained stable in preserve, juice and dehydrated product while it showed a decrease from 70° to 68° brix in jam and 78° to 77° brix in candy. Studies carried out by Srivastava *et al.* (1997) found that the T.S.S. of different cultivars of aonla varied from 8.0 to 14 per cent.

Kalra (1988) observed a fibre content of 2.28 per cent in amla preserve.

Tripathi *et al.* (1988) observed a decreasing trend in the protein content of amla preserve, candy, jam, dehydrated product and juice on storage.

Roy and Rudre (1988) found that the pH of amla products were slightly higher than the fresh fruit and did not change during the storage period. This is in agreement with the results obtained by Tripathi *et al.* (1988). Kolkarni (1991) investigated the changes during fermentation of amla in brine and reported that acidity increased from 0.77 per cent to 1.44 per cent in 8 per cent salt solution during 20 days of fermentation.

## 2.4 Standardization of the fruit products

Consumers always demand for new products, nutritious and also delicately flavoured. The indigenous fruits of India have an important role to play in satisfying the demand for natural foods (Roy, 1994).

Like many other minor fruits fresh aonla is also not consumed by many people because of its strong astringent taste (Kalra, 1988). To improve its consumption an effective way is to process it into acceptable products (Roy, 1994). According to Nath (1999) value addition through processing would be the only effective tool for economical utilization of aonla fruit.

Murabba or preserve is an important traditional fruit product of India. Murabbas of amla, apple and carrot are of considerable commercial importance (Beerch *et al.*, 1984). Gopalan and Ram (1990) opined that aonla is much esteemed for preserve making. Studies carried out by Roy (1994) also revealed that amla occupies an important place in preserve industry.

Sethi (1980) standardized a method to prepare semi-dry amla preserve segments of 56° brix by dipping them in solution containing glycerol, sucrose and preservatives like potassium sorbate and potassium metabisulphite. Ram (1983) developed a methodology to prepare aonla preserve. The process involved pricking the fruits followed by steeping in 2 per cent alum and 5 per cent sodium sulphate solution. The fruits were then kept in alternate layers with sugar. The sugar syrup was then concentrated by boiling and addition of more sugar until it reached 70° to 72° brix concentration and the preserve was ready for use within 15 to 20 days.

Gupta and Bopiah (1986) developed an easy way to prepare amla preserve with high vitamin C content. The process involved softening of the fruits by boiling with 2 per cent alum solution for 4 to 5 minutes followed by dipping in luke warm sugar syrup. The thin syrup was concentrated gradually by boiling and adding more sugar until it attained the required consistency.

Singh *et al.* (1999) recommended a minimum sugar concentration of 60° brix and process temperature below 40°C to obtain a well accepted stable preserve from aonla. The product should be stored for atleast 60 days before consumption.

Attempts were made to standardize preserves from some other fruits also. Efforts made by Rani and Bhatia (1986) to standardize the procedure for

preparing preserve and an intermediate moisture product from Bagugosha pear was found to be successful. Dan (1987) prepared jack fruit preserve from deseeded bulbs in the same way as other preserves. In order to reduce the loss of immature mangoes Pruthi (1992) developed a technology to process it into preserve. Sethi (1993) developed preserves from jack fruit and wood apple. Ramteke *et al.* (1999) standardized two types of mango preserve one by dipping the mango slices in sugar syrup and another by dipping the slices in salt solution. Emerald (2000) made mango preserve in a different way. According to Singh *et al.* (1999) some of the well known fruit preserves in India, other than amla preserve are those from apple, bael, ber, cherry and vegetable preserve from carrot.

Ram (1983) developed the technology to standardize amla candy. The process involved thorough pricking of the fruit followed by steeping in alum and sodium sulphate solution. They were then kept in alternate layers with sugar and the concentration of sugar syrup was increased at definite intervals until it reached the required consistency of 70° to 72° brix and left for 20 days. After that the fruits were taken out of the syrup, coated with sugar and served. Gupta and Bopiah (1986) and Sethi (1993) introduced some slightly different procedures for preparing aonla candy. Chadha (1990) and Roy (1994) also reported that aonla can be processed into delicious candies. Parvathi and Anbu (1997) developed a method for the homescale preparation of aonla candy.

Raju (1992) opined that cashew apple can be processed into nutritious candy. Sethi (1993) processed various under-exploited fruits like ber, karonda, bael, jack fruit, wood apple and aonla into delicious candies. Gupta (1993) standardized a method for the preparation of ber fruit candy. Eswaran and Anuradha (1998) also successfully tried the processing of ber fruit into candy.

A technology for preparing tutifruiti from aonla was developed by Ram (1983). The process involved pricking and steeping of the fruit in alum and sodium sulphate solution followed by cutting into small pieces. The fruit pieces and sugar were then kept in alternate layers. The concentration of sugar syrup was increased until it reached the required consistency. After 20 days the sugar was drained off and the fruit pieces were partially dehydrated in an oven.

Sethi (1986) advocated drying of amla pulp to yield an organoleptically accepted product for use in curries and soup preparations as a nutritional supplement. Studies carried out by Kalra (1988) resulted in obtaining a standardized recipe for preparing dehydrated amla.

Gupta and Bopiah (1986) and Chadha (1990) reported that aonla could be processed into dried chips and powder. While Roy (1994) developed dried shreds from aonla. Throne (1995) standardized the process for preparing a dehydrated product and dehydrated amla.

Roy and Rudre (1988) reported that attempts made to prepare a vitamin C concentrate from amla juice by spray drying were not successful as the powder was found to be extremely sticky. Their later studies showed that by using sodium chloride in 1:1 ratio to have a 20 to 25 per cent concentrate and then spray dried gave a better powder.

Pruthi (1992) utilized immature mangoes for preparing a sundried acidifying condiment – amchur. Dehydrated products like mango cereal flakes, mango powder and strained baby food from ripe mangoes and amchur from immature mangoes were developed by Ramteke *et al.* (1999).

Pavunny *et al.* (1993) developed the methodology to prepare dehydrated ripe banana, halwa, sweet and banana fruit bar while Joshi *et al.* (1993a) developed dried sapota pieces and powder. Prasad *et al.* (1998) obtained a dehydrated product – anardana from pomegranate juice. A new technology to develop intermediate moisture mango slices was introduced by Mishra and Tomar (2000).

Morton (1985) standardized an Indian gooseberry pickle recipe in which the fruits were cooked in boiling water and then processed. Gopalan and Ram (1990) opined that aonla is much esteemed for pickle preparation. Chadha (1990) showed that aonla fruits can be used for preparing chutney also. Singh and Kumar (1995) standardized the procedure for making aonla pickle through a new process. A recipe for the homescale preparation of aonla pickle was developed by Parvathi and Anbu (1997). Nath (1999) suggested processing of aonla fruit into pickle to make it available round the year.

Banana peel scrapping was utilized for preparing fruit cheese by Maini *et al.* (1993). Kulkarni (1994) processed West Indian Cherry into chikki (toffee). Parvathi and Anbu (1997) prepared thokku from aonla fruit which could be easily practised at home on a small scale. Ripe mango was also found suitable for preparing thokku (Ramteke *et al.*, 1999).

Gupta and Bopiah (1986) developed emblic sauce from the aonla fruit while Kaur and Khurdiya (1993) developed sauce from green mangoes. Sethi (1993) also standardized procedures to prepare sauce from aonla, ber, kiwi and karonda fruits.

Sehgal and Singh (1999) developed an amla-honey spread in 50:50 ratio with a pH 3.0 and 0.2 per cent pectin.

Swamy and Gowda (1978) standardized the procedure for preparation of clarified amla juice. Ram (1983) developed a technology to process amla into squash. It involved the mixing of amla pulp with sufficient quantity of sugar, water and citric acid. Kalra (1988) standardized the preparation of amla squash, syrup, juice and concentrate. Standardisation of Indian gooseberry nectar and Ready To Serve beverage was carried out by Andrew in 1991. The process involved blending the amla pulp with pineapple pulp for preparing nectar and beverage. Sethi (1993) developed fermented beverages from aonla. Singh and Kumar (1995) also standardized procedures for the preparation of pulp, blended Ready To Serve beverage, squash and syrup from aonla. Parvathi and Anbu (1997) developed the methodology for homescale preparation of squash. Nath (1999) put forward the processing of aonla fruit into nectar, squash and syrup as an effective method to make the fruit available round the year.

Thirumaran *et al.* (1992) standardized papaya Ready To Serve beverage while Aruna *et al.* (1997) standardized papaya nectar. Tiwari (2000) developed a blended Ready To Serve beverage from papaya and guava pulps, having 15 per cent pulp, 14° brix T.S.S. and 0.3 per cent acidity as citric acid.

Thakur and Barwal (1998) developed a squash of 45° brix from unmarketable kiwi fruit. Vaidya *et al.* (1999) evaluated kiwi fruit for processing and found that quality nectars and squash can be prepared from juice of processing grade kiwi fruit.

Dan (1987) standardized a beverage from jack fruits by diluting the syrup from the jack fruit preserve with chilled water and citric acid added to taste. Ramdas (1988) reported that passion fruit can be used in the preparation of squashes, cordials and syrups. Studies carried out by Hoang *et al.* (1989) showed that pulp and delicious beverages can be prepared from dropped green mangoes which are usually discarded. Thirumaran *et al.* (1992) standardized the preparation of fermented carrot based Ready To Serve beverage. Manan *et al.* (1992) made pulp, squash, nectar and Ready To Serve beverage from apricot. Raju (1992) opined that cashew apple can be used for making syrup, juice, Ready To Serve beverage, and fermented and distilled alcoholic beverages. Sethi (1993) developed fermented beverages from indigenous under exploited fruits like ber, karonda, bael, jack fruit and wood apple. Joshi *et al.* (1993b) reported that raw and ripe karonda fruits have high processing potential since it can be made into good quality unfermented beverages like Ready To Serve drink, squash and syrup. Pavunny *et al.* (1993) standardized the processing techniques in different varieties of banana to prepare clarified juice and wine. Kulkarni (1994) processed West Indian Cherry into squash whereas Kotecha *et al.* (1995) prepared Ready To Serve beverage and wine from custard apple. Pomegranate is also an important and favourite table fruit which is much esteemed for preparing squash. Gothwal *et al.* (1998) developed squash, nectar and Ready To Serve beverage from plum pulp. Sethi and Maini (1998) found that various health drinks like aonla cocktail, apricot appetizer, bael squash, ber squash, grapefruitade, jack fruit sherbat, jamun syrup, karonda spiced beverage, phalsa syrup and pomegranate appetizer can be developed from the respective under exploited fruits. Studies carried out by Roy *et al.* (1999) revealed

the great potential of jamun to be processed into wine, vinegar and other beverages like squash, Ready To Serve beverage etc. Ramteke *et al.* (1999) reported that ripe as well as raw mango can be processed into beverages.

Bachman(1985) standardized the recipe for preparing jam and jelly from aonla fruit. Gopalan and Ram (1990) opined that aonla being rich in pectin is highly useful in making jams and jellies. Throne (1995) developed a blended jelly from Indian gooseberry and guava extracts. Singh and Kumar (1995) standardized a different procedure for the preparation of aonla jam. Parvathi and Anbu (1997) reported that aonla jam can be prepared at home scale. Nath (1999) suggested the processing of aonla fruit into products like jam to make it available all round the year.

Ramdas (1988) reported that passion fruit can be used in the preparation of jellies. Joshi and Attri (1990) developed the technology to prepare karonda jam and jelly while Bhatnagar developed the technology to process watermelon rind into jam. Raju (1992) reported that cashew apple can be used for making nutritious jam. Maini *et al.* (1993) utilized banana peel scrapping for preparing jam while Sethi (1993) developed jam from ber, karonda, bael, jackfruit, aonla and wood apple. Joshi *et al.* (1993b) showed that karonda fruits can be made into quality jam and jelly. Kulkarni (1994) standardized jam out of West Indian cherry. Pomegranate (Prasad *et al.*, 1998), plum (Gothwal *et al.*, 1998) and kiwi fruits (Vaidya *et al.*, 1999) were found to be suitable for jam preparation. Cape gooseberry (rasbari) and jamun were processed into jam and jelly by Singh (1999) and Roy *et al.* (1999) respectively.

Ram (1983) standardized Indian gooseberry-custard jelly and Bachman (1985) standardized the recipe for preparing Indian gooseberry biscuit and salad. Pritam and Nimmi (1991) developed some non-sugar based products from Indian gooseberry which included samosa, pakoda, pachadi and mixed uppuma.

Singh and Pathak (1989) evaluated five varieties of *Emblica officinalis* for processing and found that cultivars differ for their processing qualities. The cultivars Kanchan and Krishna were suitable for candy, Banarasi was suitable for drying and Chakaiya for products like pickle, chutney and syrup. Naik and Chundawat (1993) standardized the procedure for processing two newly developed amla varieties namely Anand-1 and Anand-2 into products like preserve, pickle, dried flakes, brined amla and chyavanaprash. Nath and Sharma (1998) reported that the cultivar Chakaiya was suitable for preparing beverages (nectar, squash and syrup) and jam whereas Banarasi proved its suitability for candy and pickle preparation.

Amla in fresh or dehydrated state is widely used in the preparation of some ayurvedic drugs. Roy *et al.* (1987) standardized a vitamin C rich herbal extract from amla with a vitamin C content of 8.71 mg 10 $ml^{-1}$ syrup. Arogyawardani, chyavanaprash, triphala and ashokarishta are some of the popular ayurvedic drugs in which amla fruit is one among the major constituents (Kalra, 1988). Paul *et al.* (1992) developed a herbal eye drop preparation with *Emblica officinalis* as a main component. Maini (1997) also reported that minor fruits like amla, hadhad and bheda are widely used in several ayurvedic preparations.

## 2.5 Acceptability studies

Quality is the ultimate criterion of the desirability of any food product. Sensory evaluation plays a significant role in determining quality of foods especially fruits and their products (Kapse *et al.*, 1985). Sensory testing is the most reliable method to determine a new product's acceptance. Stability evaluation which is an important phase of product development can also be studied through sensory evaluation (Rao *et al.*, 1997).

Sensory evaluation is a unique technique that harnesses human behavioural instincts of perception, learning, cognition, psychophysics and phsychometrics for evaluation of quality of foods (Rao *et al.*, 1997). Manay and Shadaksharaswamy (1998) defines sensory evaluation as a method which measures, analyses and interpretes the quality of food as they are perceived by the senses of sight, smell, taste, touch and hearing.

Rao *et al.* (1997) opined that the information obtained through sensory evaluation may be utilized for setting standards, quality control, assessment of process variation, cost reduction, product improvement, new product development, analysis of market and correlating sensory with chemical, physical and instrumental methods.

Swaminathan (1974) suggested mid afternoon as the best time for acceptance studies. Manay and Shadaksharaswamy (1998) suggested the best time for sensory testing as an hour after any normal meal i.e., midmorning or mid afternoon, when the judges are neither too well fed nor too hungry.

Products developed from indigenous fruits like aonla can be popularized by technical innovations as 'health foods' having nutritional and medicinal properties, delicate flavour and attractive colour (Sethi, 1993). Roy (1994) also reported that minor fruits have great potentiality to be processed into nutritious and delicately flavoured widely accepted products thereby improving their consumption.

Aonla, a minor fruit is seldom consumed fresh because of its strong astringent taste but studies reveal that its products are widely accepted. Tripathi *et al.* (1988) reported amla preserve as a traditional product widely relished by the Indians. Their studies showed that the preserve had maximum acceptability after 45 days which did not change upto 135 days. Amla jam also exhibited a similar period of acceptability. Experiments carried out by Singh *et al.* (1999) concluded that preserve should preferably be stored at least for 60 days before consumption. Sensory evaluation of the amla-honey spread developed by Sehgal and Singh (1999) revealed that it had a sweet-sour fruit smell and pleasing taste and best acceptable upto 90 days of storage.

Rao (1992) reported that the squash and Ready To Serve beverage prepared from amla juice were palatable when ginger and other flavouring agents were blended.

Acceptability studies done by Lal and Siddappa (1991) on amla jam, preserve, candy, juice and dehydrated product showed that amla preserve and candy had high acceptability while the dehydrated product was moderately accepted. Naik and Chundawat (1993) compared the acceptability of different

aonla products and found that chyavanaprash was rated to be superior and on par with preserve followed by pickle, dried flakes and brined preserve. Different aonla products like aonla pulp, blended Ready To Serve beverage, squash, syrup, jam, candy and pickle were rated on the basis of acceptability. All the products were well accepted but blended Ready To Serve beverage got the highest score as compared to squash and syrup (Singh and Kumar, 1995).

Sethi and Anand (1990) standardized the effect of blanching of amla fruits prior to processing and found that blanching improved the acceptability of the product. The blanching prevented non-enzymatic browning and retained better colour of the processed product during storage because of higher degree of inactivation of polyphenoloxidase thereby improving the product's acceptance. Studies carried out by Thakur and Barwal (1998) showed that squash of 45° brix from unmarketable kiwi fruit had highest taste, flavour and acceptability score during storage period. Singh *et al.* (1999) found that use of sugar solution with a minimum concentration of 60° brix and temperature below 40°C for the preparation of amla preserve improved its acceptability by minimising non-enzymatic browning of the product.

Kumar *et al.* (1992) reported that aonla fruits can be stored at least 3 months in 15 per cent salt solution with minimum quality loss. But fruits preserved in 10 per cent salt solution were spoiled within 20 days (Premi *et al.*, 1999).

The acceptability of stored amla products were better than the fresh ones (Prasad *et al.*, 1988). The acceptability of amla preserve and candy improved all throughout the storage while acceptability of amla jam improved upto five months

of storage and then declined. Joshi and Attri (1990) found that karonda jam and jelly were organoleptically acceptable and could be successfully stored under ambient conditions for a period of one year. Apricot squash developed by Manan *et al.* (1992) was highly acceptable upto a period of six months. Pavunny *et al.* (1993) assessed the keeping quality of various banana based products. Gothwal *et al.* (1998) studied the storage stability and acceptability of plum pulp, squash, nectar, jam and Ready To Serve beverage and found that their quality was satisfactory upto 9 months storage at room temperature (13-42°C). Attri *et al.* (1998) showed that sand pear juice blended with temperate fruit juice can be stored at room temperature for 6 months without any quality change.

Premi *et al.* (1999) reported that pickling of aonla is widely practised at homescale. But commercially aonla pickle is manufactured at a very small scale because of development of white specks which leads to softening and browning during storage. According to Nath (1999) aonla preserve and candy can be stored for 11-12 months with acceptable quality whereas pickle, shred and jam remains acceptable for 8 months, squash and syrup for 6 months and nectar for 4 months. After 4 months nectar turns brown. Tiwari (2000) studied the sensory quality of blended Ready To Serve beverage from papaya and guava pulps at initial and after 6 months of storage at room temperature and found their quality to be acceptable.

Anandswamy (1981) found that polypropylene pouches could be a satisfactory packaging material for mango jam but with less quality compared to other packaging materials like glass jars. Guava pulp stored in ordinary and food grade polyethylene pouches did not exhibit any quality change upto 3 months of

storage at room temperature with the incorporation of $SO_2$ (Tandon and Kalra, 1984). Bagugosha preserve packed in glass jars and intermediate moisture product in polyethylene bags showed satisfactory shelflife and quality for about 40 weeks under ambient conditions (Rani and Bhatia, 1986). Ramasastry (1994) found that dried and powdered amla fruit stored in glass containers retained more organoleptic quality at room temperature. Mahadeviah *et al.* (1994) found that mango pulp, banana pulp and pineapple slices stored in tinplate cans were more acceptable than those stored in flexible pouches and glass jars. The reduced acceptability was due to browning of the product stored in them. Browning was more in flexible pouches followed by glass jars and tin plate cans. Storage studies conducted on plum pulp, squash, nectar, jam and Ready To Serve beverage in glass bottles had shown that the quality of all these products was satisfactory upto 9 months of storage at room temperature (Gothwal *et al.*, 1998).

Irwandi *et al.* (1998) investigated the effects of type of packaging material and length of storage on quality of Durian fruit leather and concluded that polypropylene films satisfactorily maintain the quality of the product upto 12 weeks at 27°C. Sharma *et al.* (1998) found that candied apples could be safely packed and stored in glass jars without much quality loss for more than 6 months. Premlatha *et al.* (1999) found polypropylene packaging to be suitable for the long term storage of papaya and jack fruit based products. Jackfruit bar stored in polypropylene bags obtained high scores in organoleptic evaluation (Krishnaveni *et al.*, 1999). Anjankar and Kalaivanan (2000) opined that polypropylene and its copolymers are safe and save cost of storage and transportation of food products.

Sethi and Anand (1990) studied the market samples of amla preserve and reported that the microorganisms associated with its contamination were *Saccharomyces polymorphus* and *Bacillus cereus*. Bhajekar and Kulkarni (1991) reported that Schizosaccharomyces pombe is responsible for spoilage in amla preserved in syrup. Yeasts and moulds are found to be responsible for the spoilage of brined preserves (Suresh and Ethiraj, 1993).

# *Materials and Methods*

# 3. MATERIALS AND METHODS

The methods followed and the materials used in the evaluation of nutritive value, organoleptic qualities and shelf life of Indian gooseberry products are given under the following heads:

3.1 Selection of the sample
3.2 Selection of area and judges for the acceptability studies
3.3 Development of score cards
3.4 Preparation of products for acceptability studies
3.5 Acceptability studies
3.6 Storage studies
3.7 Chemical analysis
3.8 Microbiological study
3.9 Statistical analysis
3.10 Analysis of yield and cost ratio

## 3.1 Selection of the sample

The locally available Chambakad variety of Indian gooseberry was selected for the study. The samples were collected from the same tree in two lots from a local household.

## 3.2 Selection of area and judges for the acceptability studies

### 3.2.1 Preliminary study

For conducting the study 120 individuals were selected from Thrissur district by using multistage random sampling with design - schools/colleges as first stage unit, class/division as second stage unit and individual respondent as ultimate unit. Thus, the panel comprised of 40 students from high school (13-16 years), 40 college students (17-24 years), 40 college staff (25-35 years) with an equal distribution of male and female from elite, rural and urban communities (Total 120).

### 3.2.2 Detailed study

A series of acceptability trials were carried out among sixty individuals using triangle tests (Swaminathan, 1974) to select a panel of 30 judges for the detailed study.

## 3.3 Development of score cards

Separate score cards were developed for different products depending on the quality attributes to be assessed. Products with similar quality attributes were included in the same score card. Sensory evaluation was carried out using score cards based on a five point hedonic scale. The score cards developed for the study are presented in Appendix-I.

## 3.4 Preparation of products for acceptability studies

Eighteen Indian gooseberry products were prepared to carry out the acceptability studies. Indian gooseberries collected were subjected to two types of pre treatments namely salt treatment and alum treatment followed by sugar treatment. The purpose of the treatment was to remove the astringency of the fruit.

*Salt treatment*

The Indian gooseberry fruits were washed thoroughly and kept in 15 per cent salt solution for two days. Products like mixed uppuma, pachady, pakoda, samosa, pickle and dehydrated product were prepared from this pretreated gooseberries.

*Alum treatment*

The fruits were washed thoroughly and pricked well with a stainless steel fork and kept in two per cent alum and 0.5 per cent sodium sulphate solution for 3-4 hours. Then these gooseberries were washed well repeatedly in clean water. Products like candy, preserve and tutifruiti were prepared from this pretreated gooseberry.

*Sugar treatment*

The alum treated gooseberry fruits were washed thoroughly and kept in 30 per cent sugar solution for three days. Then products like beverage, nectar, biscuits, custard jelly, salad, jam, jelly, gooseberry-guava jelly and squash were prepared from the alum and sugar treated gooseberries. The products were prepared as per the standard recipes given in Appendix-II.

### 3.5 Acceptability studies

The acceptability of the eighteen gooseberry products were carried out using the score cards on 120 individuals selected for the preliminary study. The most acceptable six products (with highest scores) after preliminary screening were selected for the detailed study. The most accepted products were tutifruiti, candy, preserve, jelly, samosa and Indian gooseberry salad.

### 3.6 Storage studies

Storage studies were carried out on the selected acceptable products viz., tutifruiti, preserve, jelly, salad, samosa and candy periodically for six months in different packaging systems of glass containers, polypropylene bottles and polypropylene bags. All the storage studies were conducted under ambient temperatures and refrigerated conditions.

### 3.7 Chemical analysis

The six Indian gooseberry products selected after preliminary screening in their fresh state as well as storage under different packaging and temperature conditions and fresh and treated Indian gooseberry were analysed for different chemical constituents at monthly intervals for a period of six months like:

1) Moisture
2) Sugar

3) Tannin
4) Vitamin C
5) Fibre
6) Iron

### 3.7.1 Moisture

Moisture content was estimated according to the method of A.O.A.C. (1980). Ten grams of the fruit/fruit product was weighed into a moisture box and dried in an oven at 100 to 105°C for moisture estimation.

### 3.7.2 Sugar

The sugar content was determined colorimetrically as soluble sugars and expressed in g 100 $g^{-1}$ fresh weight of sample (Sadasivam and Manickam, 1992). The fruit/fruit product (0.02 to 0.5 g) was homogenized in hot 80 per cent methanol and the supernatant obtained was used for sugar estimation.

### 3.7.3 Tannin

The tannin content was determined as tannic acid by colorimetric method (Sadasivam and Manickam, 1992). One gram of sample was boiled with 80 ml of water, made upto 100 ml and the extract used for tannin estimation.

### 3.7.4 Vitamin C

The vitamin C content was estimated by the method suggested by Sadasivam and Manickam (1992). One gram of the sample was extracted with four per cent oxalic acid, made upto 100 ml and the supernatant used for vitamin C estimation.

### 3.7.5 Fibre

The crude fibre content was determined by acid-alkali digestion method suggested by Sadasivam and Manickam (1992) and expressed as g 100 $g^{-1}$. Two grams of the dried and powdered sample was used for the estimation.

### 3.7.6 Iron

The iron content was estimated by Atomic Absorption Spectrophotometric method using the diacid extract prepared from the sample (Perkin-Elmer, 1982).

## 3.8 Microbiological study

The keeping quality of the selected Indian gooseberry products stored under different conditions and packaging systems was determined by assessing their microbial load at monthly intervals for a period of six months. The total count of fungi and bacteria was estimated by the routine procedure of serial dilution to determine the microbial load of the samples. Nutrient agar medium was used for estimating bacterial count and Rose-Bengal-Agar medium for fungi count.

## 3.9 Statistical analysis

The effect of storage period and packaging systems on the chemical constituents and organoleptic qualities of the products were statistically analysed through Duncan's Multiple Range Test (DMRT) at 5 per cent level of significance.

## 3.10 Analysis of yield and cost ratio

The final product yield was computed by taking into consideration the quantity of Indian gooseberry and other ingredients required to prepare a definite quantity of the product. Cost of the required quantity of each ingredient was considered while computing the total cost of production of the final product. Yield and cost ratio was calculated thereafter.

# *Results*

# 4. RESULTS

The results of the study entitled "Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products" are presented in this chapter under the following heads.

4.1 Acceptability studies

4.1.1 Preliminary study
4.1.2 Detailed storage studies

4.1.2.1 Chemical composition
4.1.2.2 Organoleptic evaluation
4.1.2.3 Microbial study

4.2 Yield and cost ratio

## 4.1 Acceptability studies

### 4.1.1 Preliminary study

Eighteen Indian gooseberry products namely beverage, nectar, mixed uppuma, pachadi, pakoda, samosa, biscuit, custard jelly, pickle, Indian gooseberry salad, jam, jelly, Indian gooseberry-guava jelly, candy, preserve, tutifruiti, squash and dehydrated product were prepared and its acceptability was assessed using score cards on selected 120 individuals for the preliminary study. The mean scores obtained for each product for the five quality attributes studied are presented in Tables 1, 2 and 3.

When the mean scores for the two quality attributes viz. appearance and colour was analysed the maximum mean score of 4.61 and 4.46 respectively were obtained for amla tutifruiti and the lowest mean score of 3.38 and 3.16 respectively were obtained for the dehydrated product.

Table 1. Mean scores for organoleptic evaluation of 15 Indian gooseberry products

| Sl. No. | Products | Mean scores | | | | | Total mean scores |
|---|---|---|---|---|---|---|---|
| | | Appearance | Colour | Flavour | Texture | Taste | |
| 1 | Candy | 4.43 | 4.22 | 3.99 | 4.17 | 3.62 | 20.43 |
| 2 | Preserve | 4.54 | 4.45 | 4.00 | 4.24 | 3.96 | 21.19 |
| 3 | Tutifruiti | 4.61 | 4.46 | 4.25 | 4.38 | 4.28 | 21.98 |
| 4 | Jam | 4.14 | 3.78 | 3.58 | 3.48 | 2.72 | 17.70 |
| 5 | Jelly | 4.50 | 4.43 | 4.17 | 4.17 | 3.91 | 21.18 |
| 6 | Salad | 4.33 | 4.26 | 3.85 | 4.40 | 4.07 | 20.91 |
| 7 | Pakoda | 3.96 | 3.76 | 3.63 | 3.29 | 3.04 | 17.68 |
| 8 | Samosa | 4.40 | 4.37 | 4.37 | 4.08 | 3.62 | 20.84 |
| 9 | Pickle | 4.15 | 3.94 | 3.91 | 3.41 | 2.80 | 18.21 |
| 10 | Mixed Uppuma | 4.21 | 4.02 | 3.91 | 3.95 | 3.56 | 19.65 |
| 11 | Biscuit | 4.46 | 4.18 | 4.01 | 3.97 | 3.78 | 20.40 |
| 12 | Custard Jelly | 4.36 | 4.31 | 4.15 | 3.94 | 3.63 | 20.39 |
| 13 | Pachadi | 4.07 | 4.07 | 3.88 | 3.87 | 3.40 | 19.29 |
| 14 | Indian gooseberry - Guava jelly | 4.42 | 4.23 | 3.74 | 3.93 | 3.27 | 19.59 |
| 15 | Dehydrated product | 3.38 | 3.16 | 3.10 | 3.02 | 2.67 | 15.33 |

Maximum score of each quality = 5
Maximum total score = 25

Table 2. Mean scores for organoleptic evaluation of Indian gooseberry Squash and Nectar

| Sl. No. | Products | Mean scores | | | | | Total mean score |
|---|---|---|---|---|---|---|---|
| | | Appearance | Consistency | Colour | Flavour | Taste | |
| 1 | Squash | 4.11 | 3.77 | 3.58 | 3.07 | 2.39 | 16.92 |
| 2 | Nectar | 4.17 | 3.74 | 3.52 | 3.63 | 2.87 | 17.93 |

Table 3. Mean scores for organoleptic evaluation of Indian gooseberry beverage

| Sl. No. | Products | Mean scores | | | | | Total mean scores |
|---|---|---|---|---|---|---|---|
| | | Appearance | Clarity | Colour | Flavour | Taste | |
| 1 | Beverage | 4.05 | 3.75 | 3.93 | 4.14 | 3.87 | 19.74 |

The character flavour obtained a maximum score of 4.37 for samosa and a minimum score of 3.07 for squash.

The maximum score of 4.40 and minimum of 3.02 was obtained for Indian gooseberry salad and dehydrated product respectively when the character texture was analysed.

The mean scores for the quality attribute - taste varied from 2.39 to 4.28. Tutifruiti scored the highest while squash scored the lowest.

Squash and nectar obtained the mean scores of 3.77 and 3.74 respectively when the quality attribute consistency was evaluated.

Beverage obtained a mean score of 3.75 for the character clarity.

When all the characters were analysed together to find out the overall acceptability of the eighteen recipes, it was found that tutifruiti scored the highest total mean score of 21.98 and the dehydrated product scored the lowest 15.33. The six Indian gooseberry products namely tutifruiti, preserve, jelly, salad, samosa and candy which obtained the highest total mean scores of 21.98, 21.19, 21.18, 20.91, 20.84 and 20.43 respectively were selected to carry out the storage studies.

### 4.1.2 Detailed storage studies

#### 4.1.2.1 Chemical composition

##### 4.1.2.1.1 Chemical composition of fresh and treated Indian gooseberry and selected products

The fresh Indian gooseberry, sugar and salt treated fruits and the selected six products in the fresh stage were analysed to determine their chemical composition and the results are presented in Table 4.

Table 4. Chemical composition of fresh and treated Indian goosberry and selected products

| Sl. No. | Item | Moisture (%) | Sugar (g 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
|---|---|---|---|---|---|---|---|
| 1 | Fresh | 81.30 | 4.75 | 576 | 3.27 | 3.01 | 1.00 |
| 2 | Sugar treated | 56.73 | 5.55 | 533 | 2.01 | 3.05 | 0.70 |
| 3 | Salt treated | 36.47 | 2.23 | 485 | 1.68 | 3.03 | 0.77 |
| 4 | Candy | 31.00 | 59.15 | 522 | 2.97 | 2.39 | 0.95 |
| 5 | Preserve | 29.90 | 61.38 | 544 | 2.41 | 2.87 | 0.96 |
| 6 | Tutifruiti | 30.96 | 57.40 | 480 | 1.87 | 2.43 | 0.76 |
| 7 | Jelly | 18.70 | 69.39 | 352 | 0.82 | 0.40 | 0.54 |
| 8 | Samosa | 21.16 | 11.89 | 69 | 0.14 | 1.43 | 0.21 |
| 9 | Salad | 78.60 | 34.54 | 560 | 0.39 | 3.33 | 0.89 |

The moisture content decreased from 81.3 per cent in the fresh fruit to 18.7 per cent in the processed form - jelly. Moisture content was more in sugar treated sample (56.73%) when compared to salt treated samples (36.47%) [Fig.1(a)].

Samosa was found to have the lowest sugar content (11.89 g 100 $g^{-1}$) and jelly had the highest sugar content (69.39 g 100 $g^{-1}$) [Fig.1(a)].

The fresh fruit had a mean vitamin C content of 576 mg 100 $g^{-1}$. Sugar and salt treated fruits were observed to have a lower vitamin C content i.e., 533 mg and 485 mg 100 $g^{-1}$ respectively. Among products samosa showed the least vitamin C content (69 mg 100 $g^{-1}$) and the highest vitamin C content was observed in salad (560 mg 100 $g^{-1}$) [Fig.1(b)].

The tannin content of fresh gooseberry was found to be 3.27 mg 100 $g^{-1}$ which showed a reduction during processing. Salt treated samples contained less tannin (1.68 mg 100 $g^{-1}$) when compared to sugar treated sample (2.01 mg 100 $g^{-1}$).

**Fig. 1. Chemical composition of fresh and treated Indian gooseberry and selected products**

**Fig. 1(a). Moisture and sugar content of the fresh and treated Indian gooseberry and selected products**

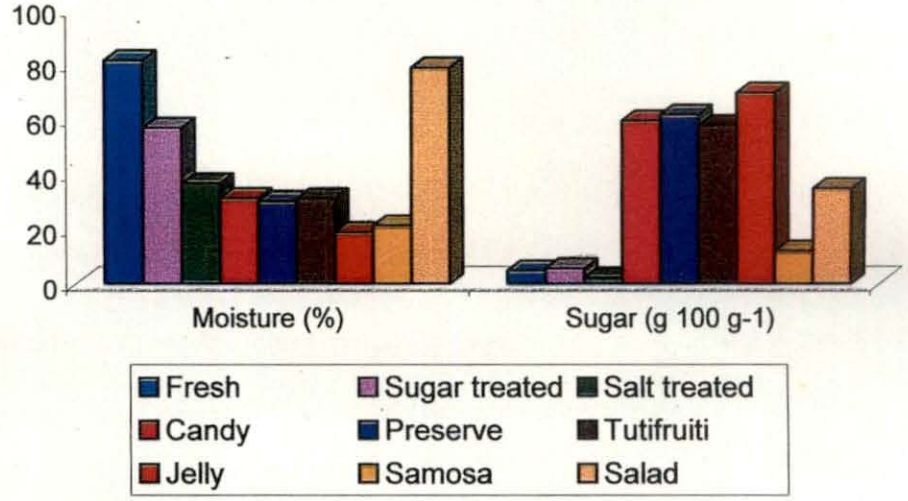



**Fig. 1(b). Vitamin C content of the fresh and treated Indian gooseberry and selected products**

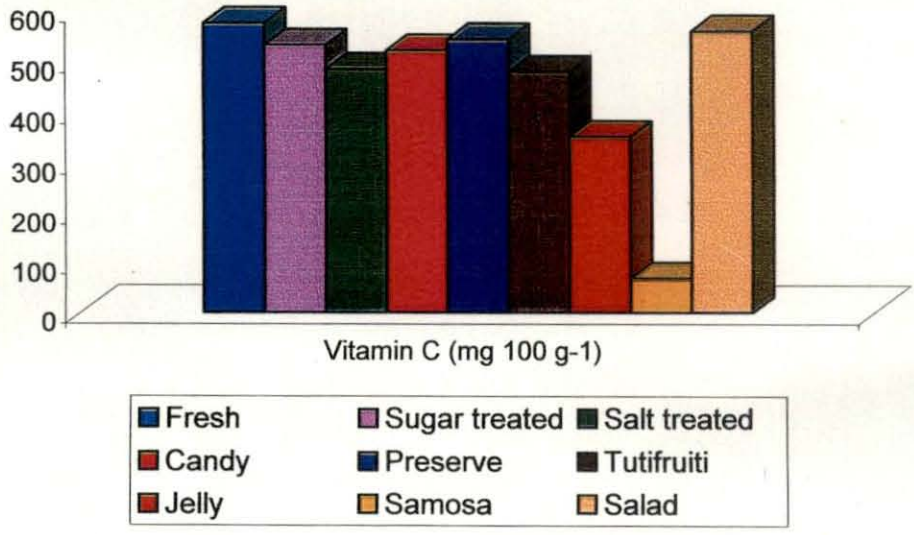


**Fig. 1(c). Tannin and Iron contents of the fresh and treated Indian gooseberry and selected products**

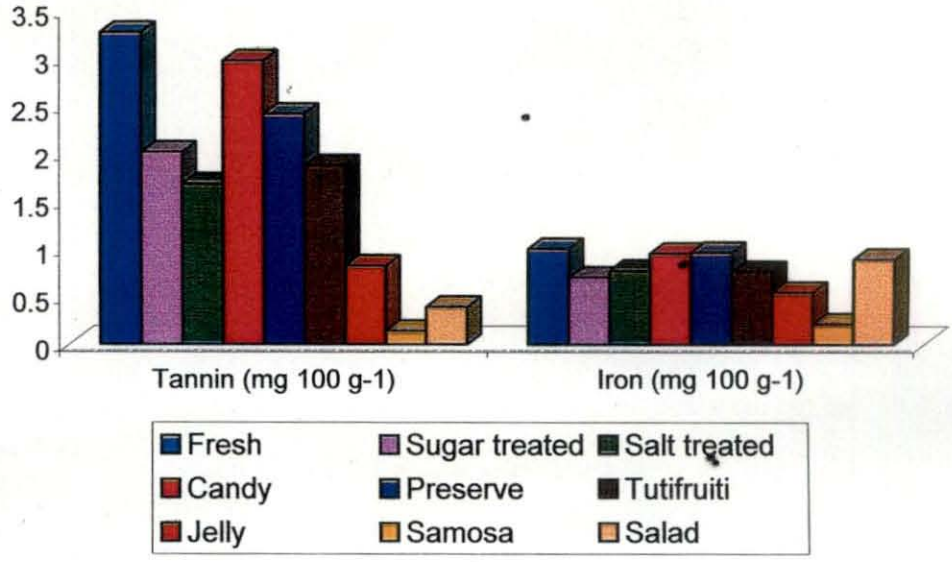
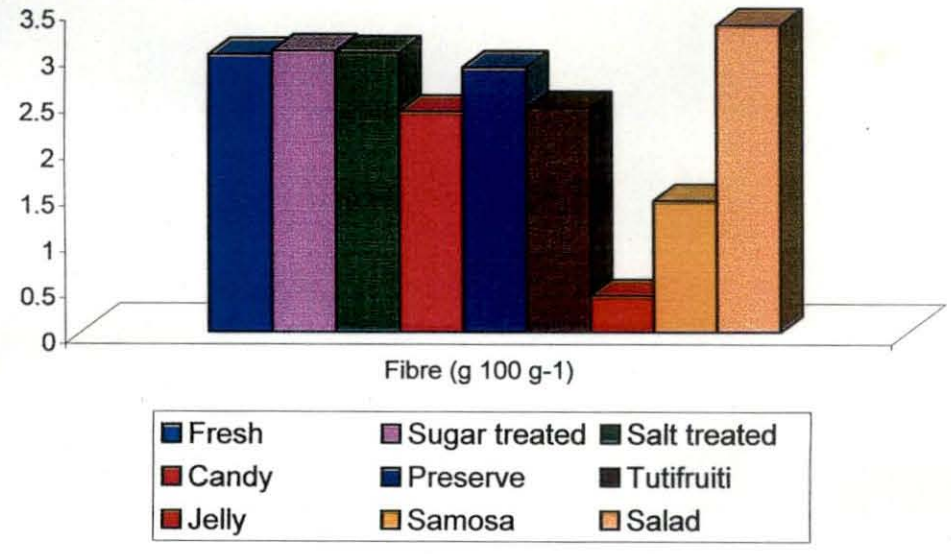



**Fig. 1(d). Fibre content of the fresh and treated Indian gooseberry and selected products**



Among products the salt treated product samosa showed the least tannin (0.14 mg 100 $g^{-1}$) followed by salad (0.39 mg 100 $g^{-1}$) [Fig. 1(c)].

There was a slight increase in the fibre content from fresh fruits (3.01 g 100 $g^{-1}$) to sugar treated (3.05 g 100 $g^{-1}$) and salt treated (3.03 g 100 $g^{-1}$) samples. Among products salad showed maximum fibre content (3.33 g 100 $g^{-1}$) and least fibre content was observed in jelly (0.40 g 100 $g^{-1}$) [Fig.1(c)].

Fresh fruit was found to have an iron content of 1.0 mg 100 $g^{-1}$. Iron content was found to decrease with treatments. Sugar treated sample contained 0.70 mg 100 $g^{-1}$ whereas salt treated samples contained higher iron content (0.77 mg 100 $g^{-1}$). Among products preserve retained maximum iron (0.96 mg 100 $g^{-1}$) and the least iron was found in samosa (0.21 mg 100 $g^{-1}$) [Fig.1(c)].

4.1.2.1.2 Changes in chemical composition during storage of amla products

Storage studies were carried out at monthly intervals for a period of six months on the selected six products stored in different packaging systems viz., glass bottles, polypropylene bottles and polypropylene bags under refrigerated and ambient conditions.

Among the six products selected viz., tutifruiti, preserve, candy, jelly, samosa and salad; two products namely salad and samosa were found to get spoiled by the next day and were omitted from the detailed storage study. The storage study was carried out in the remaining four products only.

The changes in the chemical constituents of candy stored in glass bottle, polypropylene bottle and polypropylene bag under refrigerated and ambient conditions were analysed at monthly intervals for six months. Changes in the chemical constituents of candy stored in glass bottle is presented in Table 5.

Table 5. Changes in the chemical constituents of candy stored in glass bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 30.40 | 28.1 | 29.8 | 27.3 | 28.6 | 26.4 | 27.7 | 25.7 | 26.7 | 24.9 | 25.87 | 23.9 |
| Sugar (g 100 $g^{-1}$) | 58.81 | 56.15 | 60.25 | 57.00 | 61.6 | 58.5 | 62.25 | 59.45 | 63.8 | 60.85 | 65.2 | 61.25 |
| Tannin (mg 100 $g^{-1}$) | 2.81 | 2.91 | 2.76 | 2.86 | 2.72 | 2.82 | 2.70 | 2.78 | 2.65 | 2.76 | 2.63 | 2.74 |
| Vitamin C (mg 100 $g^{-1}$) | 491 | 501 | 437 | 453 | 368 | 400 | 320 | 341 | 245 | 267 | 155 | 197 |
| Fibre (g 100 $g^{-1}$) | 2.27 | 2.17 | 2.00 | 2.10 | 1.87 | 1.87 | 1.73 | 1.50 | 1.60 | 1.30 | 1.63 | 1.07 |
| Iron (mg 100 $g^{-1}$) | 0.93 | 0.95 | 0.93 | 0.93 | 0.91 | 0.91 | 0.90 | 0.90 | 0.87 | 0.87 | 0.85 | 0.85 |

As evidenced in Table 5 moisture content of the candy stored in glass bottle under ambient condition decreased from 30.4 to 25.87 per cent. Under refrigerated condition moisture content was low which varied from 28.1 to 23.9 per cent over a period of six months. Sugar content was high in products stored under ambient condition and decreased from 58.81 g 100 $g^{-1}$ for the first month to 65.2 g 100 $g^{-1}$ for the 6$^{th}$ month of storage. A gradual decrease in the tannin content was observed during storage. Tannin was low in products stored under ambient condition when compared to refrigerated storage. Tannin content decreased from 2.81 mg 100 $g^{-1}$ for the first month under ambient storage to 2.63 mg 100 $g^{-1}$ for the sixth month. Similarly under refrigerated storage it decreased from 2.91 mg 100 $g^{-1}$ for the first month to 2.74 mg 100 $g^{-1}$ for the 6$^{th}$ month.

A declining trend in vitamin C content was observed during storage both under ambient and refrigerated storage condition. But vitamin C retention was more in refrigerated storage. Under ambient storage vitamin C decreased from 491 mg 100 $g^{-1}$ for the first month to 155 mg 100 $g^{-1}$ by the 6$^{th}$ month. But under refrigerated storage it decreased from 501 to 197 mg 100 $g^{-1}$ by the end of the 6$^{th}$ month.

There was a gradual reduction in the fibre content of stored products in glass bottles under ambient condition from the first month (2.27 g 100 $g^{-1}$) to the 5$^{th}$ month (1.60 g 100 $g^{-1}$). But during the 6$^{th}$ month the fibre content of product increased to 1.63 g 100 $g^{-1}$. But the reduction in the fibre content was gradual under refrigerated storage which decreased from 2.17 to 1.07 g 100 $g^{-1}$.

There was not much variation in iron content stored under ambient and refrigerated conditions. But iron was found to be decreasing with storage time. It

decreased from 0.93 to 0.85 mg 100 $g^{-1}$ under ambient and from 0.95 to 0.85 mg 100 $g^{-1}$ under refrigerated storage for a period of six months.

The changes in the chemical constituents of candy stored in glass bottles under ambient and refrigerated conditions are illustrated in Fig.2 and 3 respectively.

Changes in the chemical constituents of candy stored in polypropylene bottle are presented in Table 6.

As observed from the table the moisture content of candy under ambient condition reduced from 31.3 to 27.0 per cent. Under refrigerated condition the moisture content was low which reduced from 26.5 to 21.1 per cent over a period of six months. Higher sugar content was observed in products stored under ambient condition and varied from 58.21 g 100 $g^{-1}$ to 64.05 g 100 $g^{-1}$ with the advance of the storage period. Under refrigerated condition the sugar content varied from 53.95 g 100 $g^{-1}$ for the first month to 62.15 g 100 $g^{-1}$ for the six month of storage. Tannin content decreased from 2.82 mg 100 $g^{-1}$ for the first month of 2.64 mg 100 $g^{-1}$ for the sixth month under ambient condition. Similarly under refrigerated storage it decreased from 2.84 mg 100 $g^{-1}$ for the $1^{st}$ month to 2.63 mg 100 $g^{-1}$ for the $6^{th}$ month of storage.

A declining trend in the vitamin C content was observed under both storage. Vitamin C retention was more in the samples stored under refrigerated condition. Under ambient condition the vitamin C content reduced from 475 mg 100 $g^{-1}$ for the first month to 123 mg 100 $g^{-1}$ for the $6^{th}$ month of storage. Under refrigerated condition, the vitamin C reduced from 491 mg 100 $g^{-1}$ to 181 mg 100 $g^{-1}$ by the end of the $6^{th}$ month of storage.

**Fig. 2. Changes in the chemical constituents of candy stored in glass bottle under ambient condition**

**Fig. 2(a). Changes in the Moisture, Sugar and Fibre contents of candy stored in glass bottle under ambient condition**

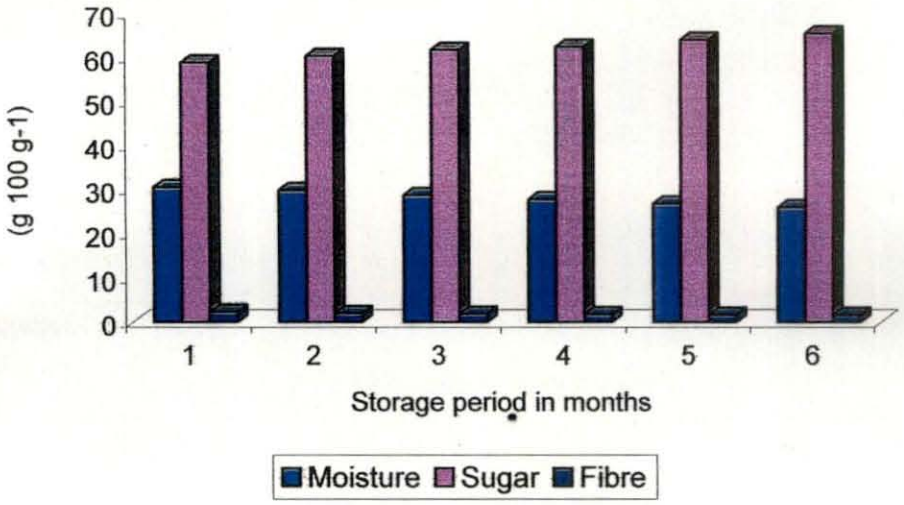



**Fig. 2(b). Changes in the Vitamin C content of candy stored in glass bottle under ambient condition**

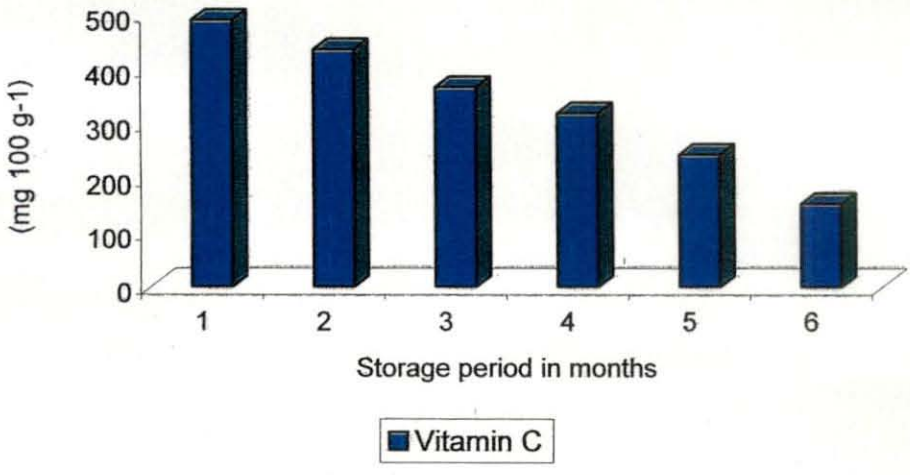


**Fig. 2(c). Changes in the Tannin and Iron contents of candy stored in glass bottle under ambient condition**

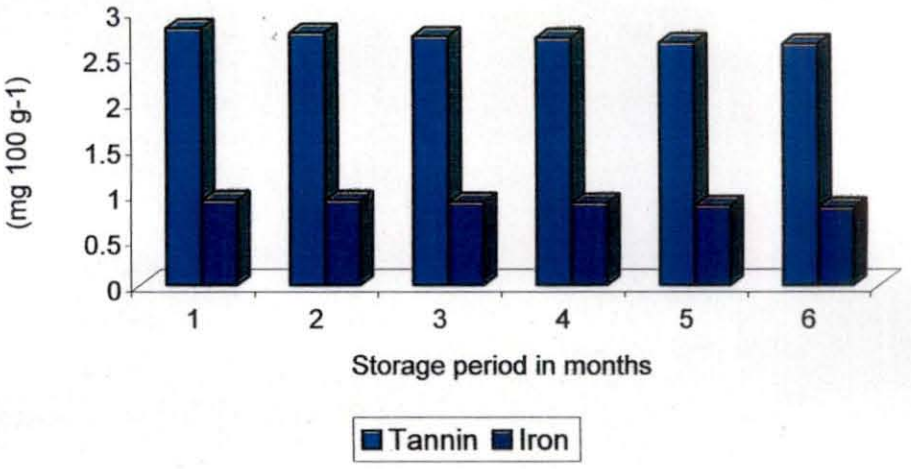



**Fig. 3. Changes in the chemical constituents of candy stored in glass bottle under refrigerated condition**

**Fig. 3(a). Changes in the Moisture, Sugar and Fibre contents of candy stored in glass bottle under refrigerated condition**

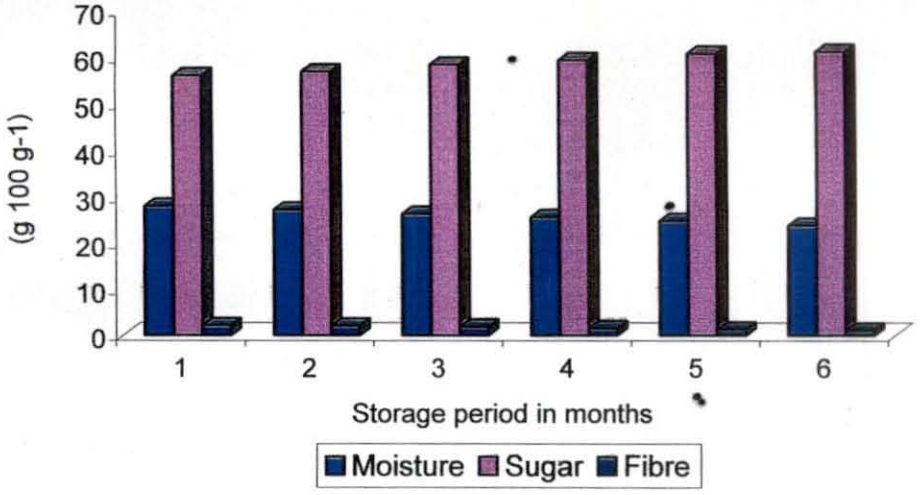


**Fig. 3(b). Changes in the Vitamin C content of candy stored in glass bottle under refrigerated condition**

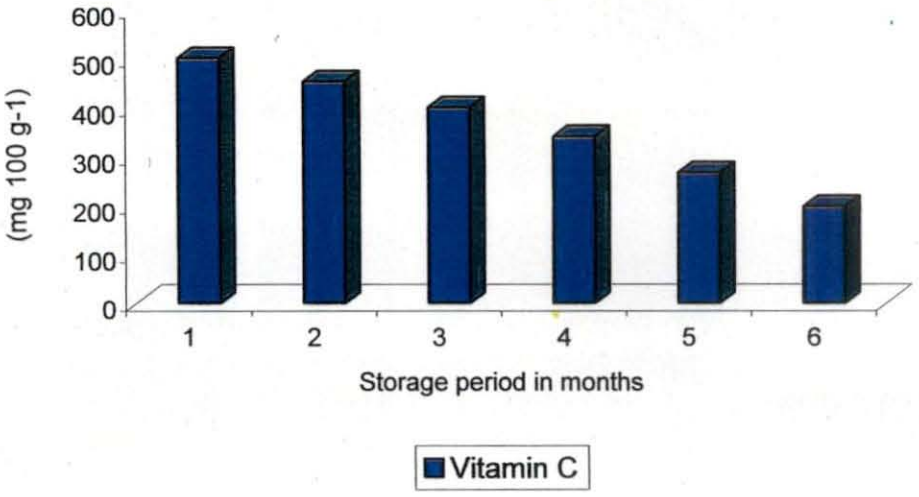



**Fig. 3(c). Changes in the Tannin and Iron contents of candy stored in glass bottle under refrigerated condition**

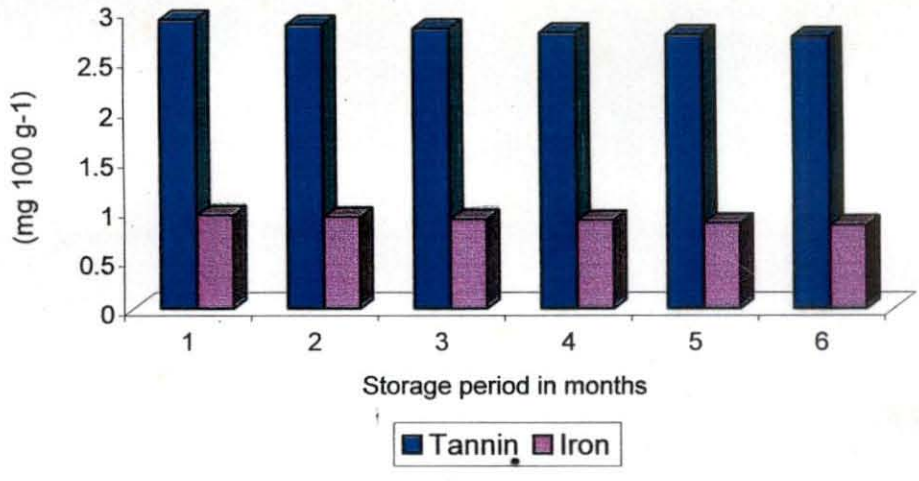


Table 6. Changes in the chemical constituents of candy stored in polypropylene bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 31.3 | 26.5 | 30.7 | 25.7 | 29.7 | 24.4 | 28.7 | 23.0 | 28.0 | 22.0 | 27.0 | 21.1 |
| Sugar (g 100 $g^{-1}$) | 58.21 | 53.95 | 59.25 | 55.0 | 61.05 | 56.8 | 62.20 | 58.95 | 62.8 | 61.9 | 64.05 | 62.15 |
| Tannin (mg 100 $g^{-1}$) | 2.82 | 2.84 | 2.78 | 2.80 | 2.75 | 2.76 | 2.73 | 2.73 | 2.69 | 2.69 | 2.64 | 2.63 |
| Vitamin C (mg 100 $g^{-1}$) | 475 | 491 | 416 | 453 | 357 | 373 | 293 | 293 | 197 | 224 | 123 | 181 |
| Fibre (g 100 $g^{-1}$) | 2.23 | 2.30 | 2.03 | 2.07 | 1.83 | 1.80 | 1.60 | 1.50 | 1.37 | 1.63 | 1.27 | 1.47 |
| Iron (mg 100 $g^{-1}$) | 0.95 | 0.93 | 0.95 | 0.93 | 0.93 | 0.91 | 0.89 | 0.89 | 0.86 | 0.86 | 0.83 | 0.84 |

There was a gradual reduction in the fibre content of candy stored under both refrigerated and ambient condition. Under ambient condition the fibre content decreased from 2.23 g 100 $g^{-1}$ for the 1st month to 1.27 g 100 $g^{-1}$ for the 6th month of storage. Under refrigerated condition it decreased from 2.30 g 100 $g^{-1}$ for the first month to 1.47 g 100 $g^{-1}$ for the 6th month of storage.

Not much variation was observed in the iron content under ambient and refrigerated storage condition. But the iron content of the stored samples was found to reduce gradually with the advance of the storage period. The iron content reduced from 0.95 to 0.83 mg 100 $g^{-1}$ under ambient and from 0.93 mg 100 $g^{-1}$ to 0.84 mg 100 $g^{-1}$ under refrigerated condition for a period of 6 months.

Changes in the chemical constituents of candy stored in polypropylene bag are presented in Table 7.

It is evident from the table that the moisture content of the candy stored in polypropylene bag under ambient condition decreased from 29.3 per cent to 24.3 per cent over a period of six months storage.

Sugar content was high in samples stored under ambient condition and varied from 58.45 g 100 $g^{-1}$ for the 1st month to 64.1 g 100 $g^{-1}$ for the 6th month. Under refrigerated condition sugar content varied from 54.25 g 100 $g^{-1}$ for the 1st month to 60.35 g 100 $g^{-1}$ for the 6th month of storage.

A declining trend in the vitamin C content was observed in candy stored under both ambient and refrigerated conditions with the advance of the storage period. Stored product under refrigerated condition was found to retain more vitamin C compared to the candy stored under ambient condition. Under ambient condition the vitamin C reduced from 464 mg 100 $g^{-1}$ for the 1st month to 91 mg

Table 7. Changes in the chemical constituents of candy stored in polypropylene bags under ambient and refrigerated conditions

| Chemical constituents | Storage period in months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 29.30 | 27.60 | 28.60 | 26.70 | 27.00 | 25.20 | 26.30 | 23.90 | 25.50 | 22.90 | 24.30 | 21.70 |
| Sugar (g 100 $g^{-1}$) | 58.45 | 54.25 | 59.30 | 55.00 | 60.95 | 56.10 | 62.20 | 57.10 | 63.60 | 58.95 | 64.10 | 60.35 |
| Tannin (mg 100 $g^{-1}$) | 2.81 | 2.85 | 2.78 | 2.79 | 2.74 | 2.74 | 2.73 | 2.72 | 2.67 | 2.70 | 2.64 | 2.66 |
| Vitamin C (mg 100 $g^{-1}$) | 464 | 475 | 384 | 400 | 299 | 336 | 251 | 261 | 149 | 197 | 91 | 160 |
| Fibre (g 100 $g^{-1}$) | 2.40 | 2.23 | 2.27 | 2.07 | 2.03 | 1.83 | 1.73 | 1.47 | 1.50 | 1.50 | 1.33 | 1.37 |
| Iron (mg 100 $g^{-1}$) | 0.92 | 0.93 | 0.92 | 0.92 | 0.90 | 0.90 | 0.88 | 0.88 | 0.85 | 0.86 | 0.82 | 0.84 |

100 $g^{-1}$ for the 6th month of storage. Similarly under refrigerated condition it reduced from 475 mg 100 $g^{-1}$ to 160 mg 100 $g^{-1}$ by the end of the storage period.

A gradual reduction in the fibre content was observed in the candy stored under both ambient and refrigerated conditions with the advance of the storage period. Under ambient condition the fibre content reduced from 2.40 g 100 $g^{-1}$ for the first month to 1.33 g 100 $g^{-1}$ for the 6th month of storage. Under refrigerated condition it reduced from 2.23 g 100 $g^{-1}$ to 1.37 g 100 $g^{-1}$ by the end of the 6th month of storage.

A gradual reduction in the iron content of the candy stored in polypropylene bag was observed with storage time irrespective of the storage condition. But there was not much variation in iron content between ambient and refrigerated conditions. Under ambient condition the iron content reduced from 0.92 mg 100 $g^{-1}$ for the 1st month to 0.82 mg 100 $g^{-1}$ for the 6th month of storage. Under refrigerated condition it reduced from 0.93 mg 100 $g^{-1}$ to 0.84 mg 100 $g^{-1}$ for the 6th month of storage.

The effect of storage on the chemical constituents of candy stored under ambient condition was statistically analysed through Duncan's Multiple Range Test (DMRT) and the results are presented in Table 8.

Table 8. Effect of storage periods on the chemical constituents of candy stored under ambient condition

| Storage period (months) | Mean values | | | | | |
|---|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | $30.33^{a}$ | $58.49^{f}$ | $2.81^{a}$ | $477^{a}$ | $2.30^{a}$ | $0.93^{a}$ |
| 2 | $29.70^{b}$ | $59.60^{e}$ | $2.77^{b}$ | $412^{b}$ | $2.10^{b}$ | $0.93^{a}$ |
| 3 | $28.43^{c}$ | $61.20^{d}$ | $2.74^{c}$ | $341^{c}$ | $1.91^{b}$ | $0.91^{b}$ |
| 4 | $27.57^{d}$ | $62.22^{c}$ | $2.72^{d}$ | $288^{d}$ | $1.69^{c}$ | $0.89^{c}$ |
| 5 | $26.73^{e}$ | $63.40^{b}$ | $2.67^{e}$ | $197^{e}$ | $1.49^{d}$ | $0.86^{d}$ |
| 6 | $25.72^{f}$ | $64.45^{a}$ | $2.64^{f}$ | $123^{f}$ | $1.41^{d}$ | $0.83^{e}$ |

Values having different superscripts differ significantly at 5 per cent level.

A significant variation was observed in the moisture, sugar, tannin and vitamin C content of the stored product with the storage period. Significant variation in the fibre content was observed between the 1st and 2nd month and 3rd and 4th month of storage. Iron content did not vary significantly during the first two months of storage but significant variation was observed during the rest of the storage periods.

The effect of storage on the chemical constituents of candy stored under refrigerated condition was statistically analysed through DMRT and the results are presented in Table 9.

Table 9. Effect of storage periods on the chemical constituents of candy stored under refrigerated condition

| Storage period (months) | Mean values | | | | | |
|---|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | 27.40 $^{a}$ | 54.78 $^{d}$ | 2.87 $^{a}$ | 489 $^{a}$ | 2.23 $^{a}$ | 0.94 $^{a}$ |
| 2 | 26.57 $^{b}$ | 55.67 $^{cd}$ | 2.82 $^{b}$ | 436 $^{b}$ | 2.00 $^{a}$ | 0.93 $^{a}$ |
| 3 | 25.33 $^{c}$ | 57.13 $^{bc}$ | 2.77 $^{c}$ | 370 $^{c}$ | 1.83 $^{b}$ | 0.91 $^{b}$ |
| 4 | 24.20 $^{d}$ | 58.50 $^{b}$ | 2.74 $^{d}$ | 299 $^{d}$ | 1.49 $^{c}$ | 0.89 $^{b}$ |
| 5 | 23.27 $^{e}$ | 60.57 $^{a}$ | 2.72 $^{e}$ | 229 $^{e}$ | 1.48 $^{c}$ | 0.86 $^{c}$ |
| 6 | 22.23 $^{f}$ | 61.25 $^{a}$ | 2.68 $^{f}$ | 180 $^{f}$ | 1.30 $^{c}$ | 0.84 $^{d}$ |

Values having different superscripts differ significantly at 5 per cent level.

The moisture, tannin and vitamin C of the stored candy exhibited significant variation throughout the storage period. The variation in the sugar content was not significant during each month of storage, but significant variation was observed as the storage period advanced. No significant reduction in the fibre content was observed during the first and second months of storage. From second month onwards a significant reduction was observed up to 4th month of storage, but a significant reduction in the fibre content was observed for the entire period of storage. No significant reduction in the iron content was observed between 1st and

2nd month and 3rd and 4th month of storage. Significant variation was observed between 2nd and 3rd, 4th and 5th and 6th month of storage under refrigerated condition.

The effect of different packaging systems on the chemical constituents of the stored candy was studied and the results are presented in Table 10.

The moisture and vitamin C content of the candy stored in glass bottle, polypropylene bottle and polypropylene bag varied significantly both under ambient and refrigerated storage conditions. Under ambient storage maximum moisture was found in products stored in polypropylene bottle (29.23%) followed by glass bottle (28.18%). Least moisture was found in products stored in polypropylene bag (26.83%). Under refrigerated storage moisture was low in products stored in polypropylene bottle (23.78%) followed by polypropylene bag (24.67%). Maximum moisture was found in products in glass bottle (26.05%).

Under ambient condition storage the sugar content was significantly high in glass bottle (61.99 g 100 $g^{-1}$) when compared to polypropylene bottle. But there was no significant variation in the sugar content in the samples stored in polypropylene bottles and bags. In refrigerated storage condition there was no significant variation in the sugar content between glass bottle (58.87 g 100 $g^{-1}$) and polypropylene bottle (58.13 g 100 $g^{-1}$). But the sugar content was significantly low in products stored in polypropylene bag (56.96 g 100 $g^{-1}$).

Under ambient condition a significant reduction in the tannin content was observed in candies stored in glass bottle (2.71 mg 100 $g^{-1}$) but no significant changes were observed in tannin content in products stored in polypropylene bottles (2.74 mg 100 $g^{-1}$) and polypropylene bags (2.73 mg 100 $g^{-1}$). Under

Table 10. Effect of packaging systems on the chemical constituents of candy stored under ambient and refrigerated conditions

| Package | Mean values | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Moisture (%) | | Sugar (g 100 $g^{-1}$) | | Tannin (mg 100 $g^{-1}$) | | Vitamin C (mg 100 $g^{-1}$) | | Fibre (g 100 $g^{-1}$) | | Iron (mg 100 $g^{-1}$) | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Glass bottle | 28.18 [b] | 26.05 [a] | 61.99 [a] | 58.87 [a] | 2.71 [b] | 2.81 [a] | 336 [a] | 360 [a] | 1.85 [ab] | 1.67 [a] | 0.89 [a] | 0.90 [a] |
| Polypropylene bottle | 29.23 [a] | 23.78 [c] | 61.26 [b] | 58.13 [a] | 2.74 [a] | 2.74 [b] | 310 [b] | 336 [b] | 1.72 [b] | 1.70 [a] | 0.90 [a] | 0.89 [a] |
| Polypropylene bag | 26.83 [c] | 24.67 [b] | 61.43 [b] | 56.96 [b] | 2.73 [a] | 2.74 [b] | 273 [c] | 305 [c] | 1.88 [a] | 1.75 [a] | 0.88 [b] | 0.89 [a] |

Values having different superscripts differ significantly at 5 per cent level.

refrigerated condition products in glass bottle showed significantly high tannin content (2.81 mg 100 $g^{-1}$) when compared to candy stored in polypropylene bottle (2.74 mg 100 $g^{-1}$) and polypropylene bag (2.74 mg 100 $g^{-1}$). But there was no significant variation in tannin content in polypropylene bottle and polypropylene bag.

Vitamin C retention was significantly high in glass bottles both under ambient (336 mg 100 $g^{-1}$) and refrigerated storage conditions (360 mg 100 $g^{-1}$) followed by products stored in polypropylene bottle. Vitamin C was significantly low in products stored in polypropylene bag both in ambient (273 mg 100 $g^{-1}$) and refrigerated storage condition (305 mg 100 $g^{-1}$).

Under ambient and refrigerated condition no significant variation was observed in fibre content with packaging systems. Under ambient condition there was no significant variation in iron content in glass bottle (0.89 mg 100 $g^{-1}$) and polypropylene bottle (0.90 mg 100 $g^{-1}$)but iron content was significantly low in candy stored in polypropylene bag (0.88 mg 100 $g^{-1}$). Under refrigerated condition no significant variation in iron content was observed with regard to packaging systems.

The changes in the chemical constituents of preserve stored in different containers at ambient and refrigerated conditions were evaluated at monthly intervals for a period of 6 months.

Changes in the chemical constituents of preserve stored in glass bottle are presented in Table 11.

It is evident from the table that there is a gradual reduction in the moisture content of the preserve stored in glass bottle in both ambient and

Table 11. Changes in the chemical constituents of preserve stored in glass bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 30.40 | 28.10 | 29.8 | 27.3 | 28.60 | 26.40 | 27.7 | 25.7 | 26.7 | 24.9 | 25.87 | 23.9 |
| Sugar ($g\ 100\ g^{-1}$) | 63.05 | 61.90 | 64.0 | 62.5 | 64.3 | 63.8 | 64.65 | 65.10 | 65.50 | 65.80 | 66.55 | 66.45 |
| Tannin ($mg\ 100\ g^{-1}$) | 2.38 | 2.42 | 2.37 | 2.39 | 2.36 | 2.37 | 2.33 | 2.34 | 2.30 | 2.31 | 2.29 | 2.28 |
| Vitamin C ($mg\ 100\ g^{-1}$) | 443 | 469 | 363 | 400 | 288 | 331 | 219 | 272 | 165 | 245 | 123 | 184 |
| Fibre ($g\ 100\ g^{-1}$) | 2.83 | 2.77 | 2.63 | 2.57 | 2.50 | 2.43 | 2.33 | 2.30 | 2.17 | 2.03 | 1.80 | 1.77 |
| Iron ($mg\ 100\ g^{-1}$) | 0.96 | 0.97 | 0.95 | 0.96 | 0.94 | 0.95 | 0.93 | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 |

refrigerated storage conditions by the end of the 6th month. But moisture retention was found to be more in products stored under ambient condition, when compared to refrigerated storage. Under ambient condition, moisture decreased from 30.4 to 25.87 per cent and under refrigerated condition this decreased from 28.1 to 23.9 per cent.

Under ambient condition of storage the sugar content of the product gradually increased which varied from 63.05 to 66.55 g 100 $g^{-1}$ by the end of 6th month. The same pattern was observed under refrigerated storage where the sugar content varied between 61.9 to 66.45 g 100 $g^{-1}$. But when compared to refrigerated storage, products under ambient storage had higher sugar content.

The tannin content of the product stored in glass bottle was found to be decreasing with storage period in both ambient and refrigerated storage conditions. Tannin content decreased from 2.38 mg 100 $g^{-1}$ to 2.29 mg 100 $g^{-1}$ under ambient storage. Under refrigerated storage the tannin content was higher than that of ambient stored products up to 5th month of storage which reduced from 2.42 mg 100 $g^{-1}$ to 2.31 mg 100 $g^{-1}$. But during the 6th month tannin content was low (2.28 mg 100 $g^{-1}$) in refrigerated product when compared to product stored under ambient condition (2.29 mg 100 $g^{-1}$).

Retention of vitamin C was more in products stored under refrigerated condition. But vitamin C gradually decreased with storage time irrespective of storage condition. It was observed that the mean vitamin C content of the preserve stored under ambient conditions in glass bottle reduced from 443 to 123 mg 100 $g^{-1}$, and under refrigerated storage conditions vitamin C reduced from 469 to 184 mg 100 $g^{-1}$.

The preserve stored in glass bottle exhibited a fibre content of 2.83 to 1.80 g 100 $g^{-1}$ when kept under ambient conditions for a period of 6 months. These values ranged between 2.77 to 1.77 g 100 $g^{-1}$ under refrigerated conditions. Fibre content was found to be decreasing with storage period but when compared to refrigerated storage conditions fibre retention was more in products stored under ambient condition.

It is clear from the table that the iron content of the preserve stored under ambient condition reduced from 0.96 to 0.90 mg 100 $g^{-1}$ and it reduced from 0.97 to 0.89 mg 100 $g^{-1}$ under refrigerated condition. Iron content was found to be decreasing with storage period under both ambient and refrigerated storage but when compared to ambient condition, products stored under refrigerated condition retained more iron.

The changes in the chemical constituents of preserve stored in glass bottles under ambient and refrigerated conditions are illustrated in Fig.4 and 5 respectively.

Changes in the chemical constituents of preserve stored in polypropylene bottle are presented in Table 12.

As revealed from the table the moisture content of preserve reduced from 31.3 to 27.0 per cent by the end of $6^{th}$ months under ambient storage. Similarly the moisture content reduced from 26.5 to 21.1 under refrigerated storage. When compared to products stored under refrigerated condition, product stored under ambient condition had higher moisture content.

Under ambient storage the product showed higher sugar content than the products kept under refrigerated storage. Under ambient condition storage the

**Fig. 4. Changes in the chemical constituents of preserve stored in glass bottle under ambient condition**

**Fig. 4(a). Changes in the Moisture, Sugar and Fibre contents of preserve stored in glass bottle under ambient condition**

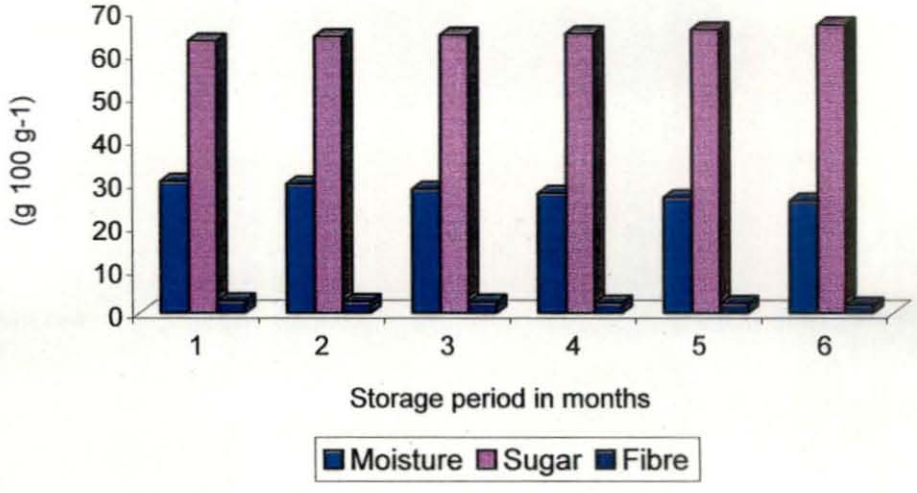



**Fig. 4(b). Changes in the Vitamin C content of preserve stored in glass bottle under ambient condition**

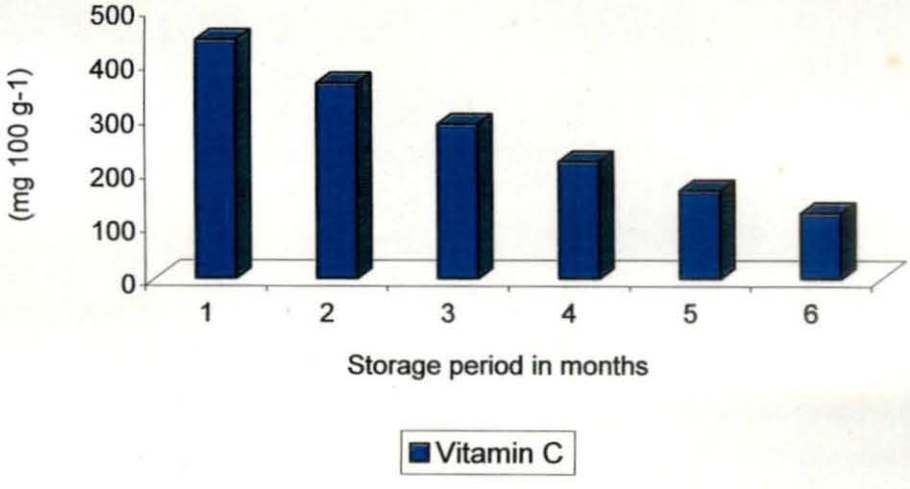


**Fig. 4(c). Changes in the Tannin and Iron contents of preserve stored in glass bottle under ambient condition**

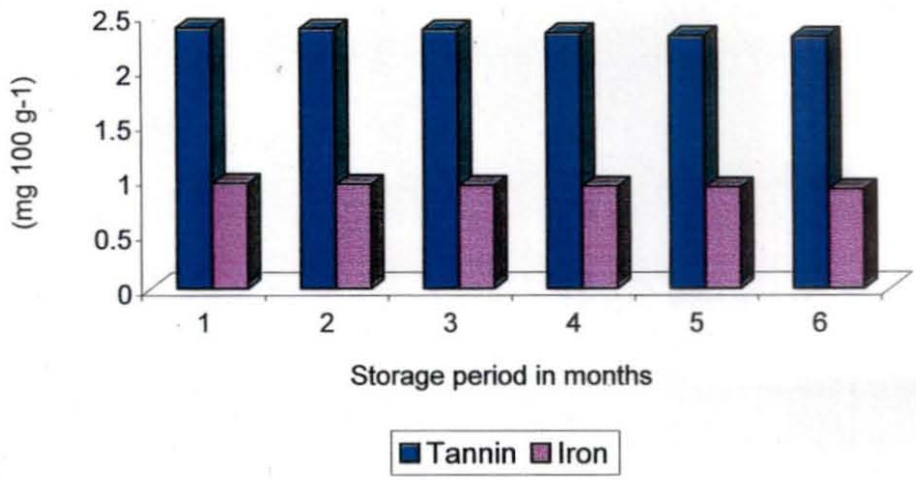



**Fig. 5. Changes in the chemical constituents of preserve stored in glass bottle under refrigerated condition**

**Fig. 5(a). Changes in the Moisture, Sugar and Fibre content of preserve stored in glass bottle under refrigerated condition**

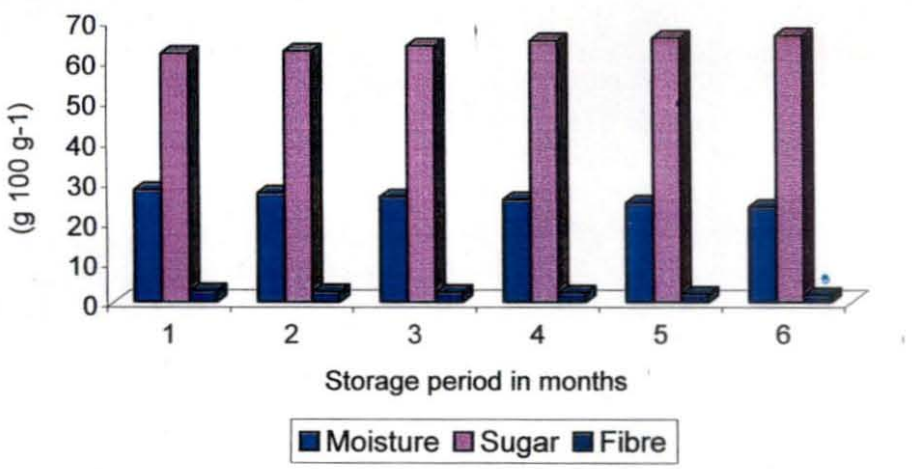


**Fig. 5(b). Changes in the Vitamin C content of preserve stored in glass bottle under refrigerated condition**

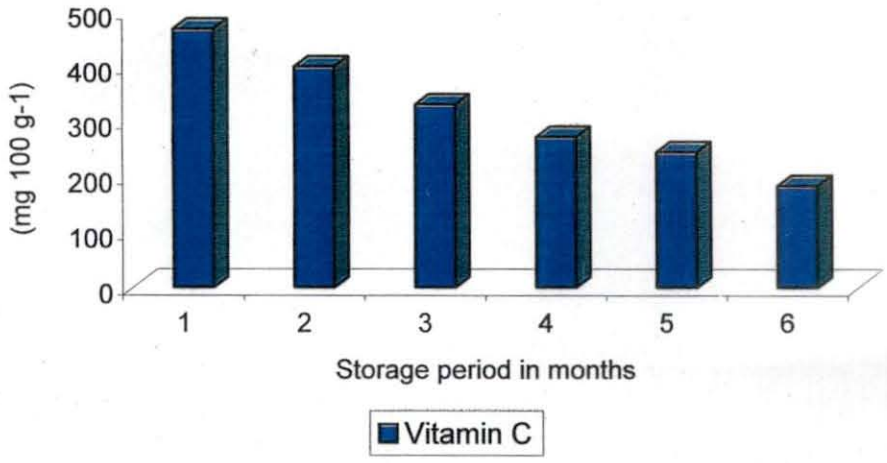



**Fig. 5(c). Changes in the Tannin and Iron contents of preserve stored in glass bottle under refrigerated condition**

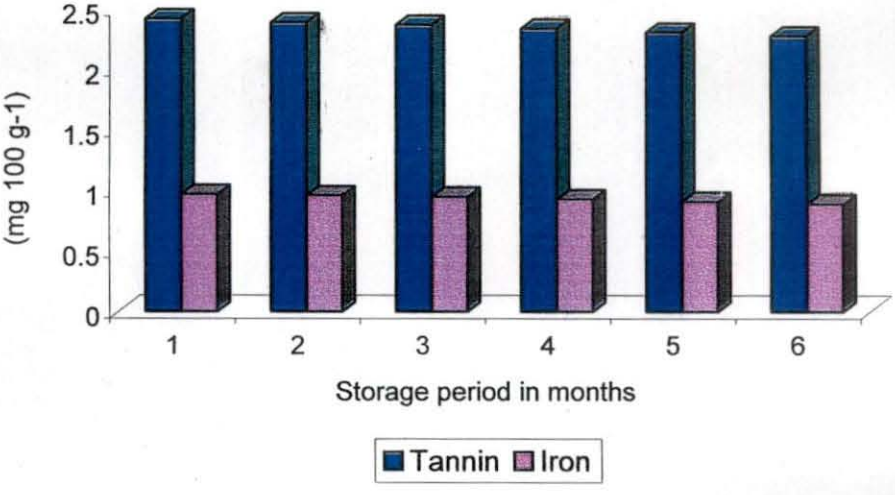


Table 12. Changes in the chemical constituents of preserve stored in polypropylene bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 31.30 | 26.50 | 30.70 | 25.70 | 29.70 | 24.40 | 28.70 | 23.00 | 28.00 | 22.00 | 27.00 | 21.10 |
| Sugar (g 100 $g^{-1}$) | 62.65 | 61.60 | 63.50 | 63.00 | 64.40 | 63.90 | 65.10 | 65.05 | 65.55 | 62.95 | 66.50 | 66.55 |
| Tannin (mg 100 $g^{-1}$) | 2.40 | 2.41 | 2.38 | 2.39 | 2.37 | 2.37 | 2.34 | 2.33 | 2.30 | 2.30 | 2.27 | 2.28 |
| Vitamin C (mg 100 $g^{-1}$) | 384 | 453 | 315 | 349 | 235 | 277 | 171 | 229 | 139 | 187 | 91 | 133 |
| Fibre (g 100 $g^{-1}$) | 2.73 | 2.67 | 2.50 | 2.57 | 2.40 | 2.27 | 2.13 | 2.0 | 1.87 | 1.77 | 1.80 | 1.63 |
| Iron (mg 100 $g^{-1}$) | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | 0.94 | 0.91 | 0.92 | 0.91 | 0.90 | 0.89 | 0.87 |

sugar content was found to be increasing as the storage period increased which ranged between 62.65 g 100 $g^{-1}$ for the 1st month and 66.50 g 100 $g^{-1}$ for the 6th month. Under refrigerated storage also the sugar content increased with storage period except for the 5th month where the sugar content reduced to 62.95 g 100 $g^{-1}$.

Tannin content was found to be decreasing with storage period; but with storage condition, ambient stored preserve contained less tannin than refrigerated products. Under ambient condition the tannin content varied between 2.40 to 2.27 mg 100 $g^{-1}$ by the 6th month and under refrigerated condition the values decreased from 2.41 to 2.28 mg 100 $g^{-1}$.

Retention of vitamin C was found to be higher in refrigerated products but vitamin C decreased with storage time. Under ambient storage vitamin C content of the product reduced from 384 mg 100 $g^{-1}$ to 91 mg 100 $g^{-1}$ by the end of 6 months and under refrigerated storage this reduction was from 453 to 133 mg 100 $g^{-1}$.

Fibre was also found to be decreasing with storage time. Fibre content was high in products stored under ambient condition except for the 2nd month where the refrigerated product showed higher fibre content (2.57 g 100 $g^{-1}$). Under ambient storage fibre content varied between 2.73 g 100 $g^{-1}$ to 1.80 g 100 $g^{-1}$ and under refrigerated storage their values ranged between 2.67 g 100 $g^{-1}$ to 1.63 g 100 $g^{-1}$.

The iron content was found to decrease gradually with storage period under both storage conditions but the iron content did not vary much with the storage. Under ambient condition the iron content ranged between 0.96 mg 100 $g^{-1}$ and 0.89 mg 100 $g^{-1}$ from the 1st to the 6th month of storage respectively. Under

refrigerated condition it decreased from 0.96 mg 100 $g^{-1}$ for the 1st month to 0.87 mg 100 $g^{-1}$ for the 6th month of storage.

The changes in the chemical constituents of the preserve stored in polypropylene bag are presented in Table 13.

As shown in the table the moisture content of the preserve stored under both ambient and refrigerated condition was observed to have a declining trend with the advance of the storage period. The product stored under ambient condition was found to possess higher moisture content ranging from 31.4 per cent for the 1st month to 25.8 per cent for the 6th month of storage. In the refrigerated preserve the moisture content reduced from 29.8 per cent to 22.5 per cent by the end of the 6th month of storage.

An increment in the sugar content of the preserve stored under both ambient and refrigerated conditions was observed as the storage period advanced. The ambient condition stored product had higher sugar content compared to the refrigerated preserve. Under ambient storage the increment was from 62.95 g 100 $g^{-1}$ to 66.60 g 100 $g^{-1}$ by the end of the 6th month of storage and under refrigerated condition it increased from 62.10 g 100 $g^{-1}$ for the 1st month to 66.55 g 100 $g^{-1}$ for the 6th month of storage.

The tannin content of the stored preserve was found to reduce gradually with the storage period under both storage conditions. The preserve stored under refrigerated condition was found to have lower tannin content compared to the preserve stored under ambient condition except for the 6th month of storage where the refrigerated preserve had a higher value of 2.28 mg 100 $g^{-1}$ against 2.26 mg 100 $g^{-1}$ in ambient condition stored product.

Table 13. Changes in the chemical constituents of preserve stored in polypropylene bags under ambient and refrigerated conditions

| Chemical constituents | Storage period in months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 31.40 | 29.80 | 29.60 | 27.80 | 28.30 | 26.30 | 27.20 | 25.00 | 26.60 | 23.90 | 25.80 | 22.50 |
| Sugar (g 100 $g^{-1}$) | 62.95 | 62.10 | 63.95 | 62.95 | 65.05 | 63.90 | 65.45 | 65.05 | 66.00 | 65.90 | 66.60 | 66.55 |
| Tannin (mg 100 $g^{-1}$) | 2.39 | 2.39 | 2.38 | 2.37 | 2.35 | 2.34 | 2.34 | 2.32 | 2.28 | 2.28 | 2.26 | 2.28 |
| Vitamin C (mg 100 $g^{-1}$) | 347 | 405 | 288 | 325 | 287 | 251 | 149 | 192 | 101 | 133 | 48 | 91 |
| Fibre (g 100 $g^{-1}$) | 2.70 | 2.67 | 2.43 | 2.50 | 2.23 | 2.57 | 2.13 | 2.07 | 1.93 | 1.90 | 1.63 | 1.67 |
| Iron (mg 100 $g^{-1}$) | 0.95 | 0.95 | 0.94 | 0.95 | 0.93 | 0.94 | 0.91 | 0.91 | 0.89 | 0.89 | 0.86 | 0.86 |

Under both ambient and refrigerated storage the vitamin C content of the preserve exhibited a steady reduction with the storage period. Vitamin C retention was higher in refrigerated condition stored product with values ranging from 405 mg 100 $g^{-1}$ for the 1st month to 91 mg 100 $g^{-1}$ for the 6th month of storage. In the ambient condition vitamin C reduced from 347 mg 100 $g^{-1}$ to 48 mg 100 $g^{-1}$ by the end of the 6th month of storage.

Under ambient condition the fibre content reduced from 2.70 g 100 $g^{-1}$ in the 1st month to 1.63 g 100 $g^{-1}$ for the 6th month of storage. Under refrigerated condition the fibre content exhibited a reducing trend with the storage period except for the 3rd month of storage. For the 1st, 4th and 5th month of storage the preserve stored under ambient condition was found to have higher fibre content but for the 2nd, 3rd and 6th month of storage the fibre content was high for the refrigerated product.

The iron content of the stored product reduced gradually with the storage period but with storage condition there was not much variation in the iron content except for the 2nd and 3rd month of storage where the refrigerated stored product exhibited slightly higher values. Under both ambient and refrigerated conditions the iron content varied from 0.95 mg 100 $g^{-1}$ for the 1st month to 0.86 mg 100 $g^{-1}$ for the 6th month of storage.

The effect of storage on the chemical constituents of preserve stored under ambient condition was statistically analysed through DMRT and the results are presented in Table 14.

From the table it was clear that during every month there was a significant reduction in the moisture content of preserve which ranged from 31.03 to 26.22 per cent by the end of the 6th month.

Table 14. Effect of storage periods on the chemical constituents of preserve stored under ambient condition.

| Storage period (months) | Mean values | | | | | |
|---|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | 31.03 $^{a}$ | 62.75 $^{e}$ | 2.39 $^{a}$ | 391 $^{a}$ | 2.75 $^{a}$ | 0.96 $^{a}$ |
| 2 | 30.03 $^{b}$ | 63.82 $^{d}$ | 2.38 $^{ab}$ | 322 $^{b}$ | 2.52 $^{b}$ | 0.95 $^{ab}$ |
| 3 | 28.87 $^{c}$ | 64.58 $^{c}$ | 2.36 $^{b}$ | 237 $^{c}$ | 2.41 $^{c}$ | 0.94 $^{b}$ |
| 4 | 27.87 $^{d}$ | 65.07 $^{c}$ | 2.34 $^{c}$ | 179 $^{d}$ | 2.19 $^{d}$ | 0.92 $^{c}$ |
| 5 | 27.10 $^{e}$ | 65.68 $^{b}$ | 2.29 $^{d}$ | 135 $^{e}$ | 1.99 $^{e}$ | 0.91 $^{c}$ |
| 6 | 26.22 $^{f}$ | 66.53 $^{a}$ | 2.27 $^{e}$ | 87 $^{f}$ | 1.74 $^{f}$ | 0.88 $^{d}$ |

Values having different superscripts differ significantly at 5% level

A significant increase in the sugar content was observed from the first month (62.75 g 100 $g^{-1}$) to 3$^{rd}$ month (64.58 g 100 $g^{-1}$). During the 4$^{th}$ month the increase in sugar content was not significant (65.07 g 100 $g^{-1}$). But a significant increase in sugar content was observed for the 5$^{th}$ month (65.68 g 100 $g^{-1}$) and maximum for the 6$^{th}$ month (66.53 g 100 $g^{-1}$).

Though there was a reduction in tannin content with storage period, the reduction was not significant between the first (2.39 mg 100 $g^{-1}$) and 2$^{nd}$ month (2.38 mg 100 $g^{-1}$) and also between the 2$^{nd}$ and 3$^{rd}$ month (2.36 mg 100 $g^{-1}$). From the third month onwards a significant decrease in tannin content was observed till the end of six months.

A significant reduction in vitamin C and fibre content was observed during every month of storage. Iron content of the product was found to be decreasing with storage time but the reduction in iron content was not significant between the first (0.96 mg 100 $g^{-1}$) and 2$^{nd}$ month (0.95 mg 100 $g^{-1}$) and also between the 2$^{nd}$ and third month (0.94 mg 100 $g^{-1}$). A significant reduction in iron content was observed between 3$^{rd}$ and 4$^{th}$ month; but no significant reduction was

seen between 4th and 5th month. Again significant reduction in vitamin C was observed between 5th and 6th month of storage.

The effect of storage period on the chemical constituents of preserve stored under refrigerated storage condition was statistically analysed through DMRT and the results are presented in Table 15.

Table 15. Effect of storage periods on the chemical constituents of preserve stored under refrigerated condition.

| Storage period (months) | Mean values | | | | | |
|---|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | 28.13 [a] | 61.87 [d] | 2.41 [a] | 443 [a] | 2.70 [a] | 0.96 [a] |
| 2 | 26.93 [b] | 62.82 [cd] | 2.38 [b] | 358 [b] | 2.55 [b] | 0.95 [a] |
| 3 | 25.70 [c] | 63.87 [bc] | 2.36 [c] | 286 [c] | 2.42 [b] | 0.94 [a] |
| 4 | 24.57 [d] | 65.07 [b] | 2.33 [d] | 231 [d] | 2.12 [c] | 0.92 [b] |
| 5 | 23.60 [d] | 64.88 [b] | 2.29 [e] | 188 [e] | 1.90 [d] | 0.90 [e] |
| 6 | 22.50 [e] | 66.53 [a] | 2.28 [e] | 136 [f] | 1.69 [e] | 0.87 [d] |

Values having different superscripts differ significantly at 5% level

The moisture content of the stored sample reduced from 28.13 per cent to 22.50 per cent with significant difference between each month of storage except between the 4th and 5th months of storage.

A gradual increase in the sugar content of the stored preserve was observed but significant increase was only observed in the 5th and 6th month of storage. A gradual reduction in the tannin content was observed with storage period but the reduction was significant only up to the 5th month of storage. Tannin further reduced during 6th month but the reduction was not significant.

Significant reduction in the vitamin C content was observed during storage. At the end of the 1st month the preserve contained 443 mg 100 $g^{-1}$ vitamin C which significantly reduced to 136 mg 100 $g^{-1}$ at the end of the 6th month. A

significant reduction in the fibre content was also observed during each month of storage. No significant reduction in the iron content was observed up to the third month of storage but a significant reduction was observed between each month from the 3rd to the 6th month of storage.

The effect of different packaging systems on the chemical constituents of the stored preserve was studied and the results are presented in Table 16.

The moisture content of the preserve stored in polypropylene bottle varied significantly from the preserve stored in glass bottle and polypropylene bag under both ambient and refrigerated condition. The highest moisture content of 29.23 per cent under ambient and 26.05 per cent under refrigerated storage was observed in preserve stored in polypropylene bottle and glass bottle respectively.

Under ambient storage the sugar content of the preserve stored in polypropylene bottle (64.55 g 100 $g^{-1}$) and bag (64.99 g 100 $g^{-1}$) varied significantly whereas under refrigerated storage condition no significant variation in sugar content with packaging system was observed.

No significant variation in the tannin content of the stored preserve in glass bottle (2.33 mg 100 $g^{-1}$), polypropylene bottle (2.34 mg 100 $g^{-1}$) and polypropylene bag (2.33 mg 100 $g^{-1}$) under ambient condition was observed. But under refrigerated storage the tannin content of the stored preserve in polypropylene bag (2.33 mg 100 $g^{-1}$) was significantly low compared to the stored preserve in polypropylene and glass bottles (2.35 mg 100 $g^{-1}$).

The vitamin C retention during storage was significantly affected by the packaging systems. Stored preserve in glass bottle was found to retain the highest amount of vitamin C under both ambient (267 mg 100 $g^{-1}$) and refrigerated

Table 16. Effect of packaging systems on the chemical constituents of preserve stored under ambient and refrigerated conditions

| Package | Mean values | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Moisture (%) | | Sugar (g 100 $g^{-1}$) | | Tannin (mg 100 $g^{-1}$) | | Vitamin C (mg 100 $g^{-1}$) | | Fibre (g 100 $g^{-1}$) | | Iron (mg 100 $g^{-1}$) | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Glass bottle | 28.18 $^{b}$ | 26.05 $^{a}$ | 64.68 $^{ab}$ | 64.26 $^{a}$ | 2.33 $^{a}$ | 2.35 $^{a}$ | 267 $^{a}$ | 317 $^{a}$ | 2.38 $^{a}$ | 2.31 $^{a}$ | 0.93 $^{a}$ | 0.93 $^{a}$ |
| Polypropylene bottle | 29.23 $^{a}$ | 23.78 $^{b}$ | 64.55 $^{b}$ | 63.84 $^{a}$ | 2.34 $^{a}$ | 2.35 $^{a}$ | 222 $^{b}$ | 271 $^{b}$ | 2.24 $^{b}$ | 2.15 $^{b}$ | 0.92 $^{a}$ | 0.92 $^{ab}$ |
| Polypropylene bag | 28.15 $^{b}$ | 25.88 $^{a}$ | 64.99 $^{a}$ | 64.42 $^{a}$ | 2.33 $^{a}$ | 2.33 $^{b}$ | 187 $^{c}$ | 233 $^{c}$ | 2.19 $^{b}$ | 2.23 $^{ab}$ | 0.91 $^{b}$ | 0.92 $^{b}$ |

Values having different superscripts differ significantly at 5 per cent level.

(317 mg 100 $g^{-1}$) conditions followed by polypropylene bottle (222 and 271 mg 100 $g^{-1}$ respectively) and bag (187 and 233 mg 100 $g^{-1}$ respectively).

Under ambient conditions stored preserve in the glass bottle was found to possess significantly high fibre content (2.38 g 100 $g^{-1}$) compared to the stored product in polypropylene bottle (2.24 g 100 $g^{-1}$) and polypropylene bag (2.19 g 100 $g^{-1}$). Under refrigerated storage significant variation was observed between the stored preserve in glass bottle and polypropylene bottle.

There was no significant variation in the iron content of the stored preserve in glass bottle (0.93 mg 100 $g^{-1}$) and polypropylene bottle (0.92 mg 100 $g^{-1}$) under ambient condition but the iron content was significantly low in stored preserve in polypropylene bag. Under refrigerated storage condition the iron content of the stored preserve in glass bottle (0.93 mg 100 $g^{-1}$) and polypropylene bag (0.92 mg 100 $g^{-1}$) varied significantly. Lowest iron content was observed in preserve stored in polypropylene bag under ambient condition (0.91 mg 100 $g^{-1}$).

The changes in the chemical constituents of tutifruiti preserved in different containers at ambient and refrigerated conditions were evaluated at monthly intervals for a period of 6 months.

Chemical changes of tutifruiti stored in glass bottle is presented in Table 17.

As evident from the table the moisture content of the stored tutifruiti was found to exhibit gradual reduction with the advance of the storage period. The refrigerated stored product had higher moisture compared to the ambient stored product. The moisture content reduced from 30.80 per cent for the first month to 25.20 per cent by the end of the $6^{th}$ month of storage under ambient condition.

Table 17. Changes in the chemical constituents of tutifruiti stored in glass bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 30.80 | 34.50 | 29.40 | 33.70 | 28.30 | 32.90 | 27.10 | 31.60 | 26.10 | 30.80 | 25.20 | 30.20 |
| Sugar (g 100 $g^{-1}$) | 59.70 | 58.40 | 60.55 | 59.75 | 62.05 | 60.70 | 62.70 | 61.60 | 64.00 | 62.80 | 64.95 | 64.00 |
| Tannin (mg 100 $g^{-1}$) | 1.83 | 1.91 | 1.82 | 1.90 | 1.79 | 1.83 | 1.75 | 1.80 | 1.73 | 1.80 | 1.69 | 1.77 |
| Vitamin C (mg 100 $g^{-1}$) | 416 | 448 | 357 | 379 | 309 | 336 | 251 | 283 | 197 | 235 | 139 | 171 |
| Fibre (g 100 $g^{-1}$) | 2.23 | 2.37 | 2.13 | 2.20 | 2.03 | 1.90 | 1.87 | 1.77 | 1.77 | 1.63 | 1.60 | 1.43 |
| Iron (mg 100 $g^{-1}$) | 0.74 | 0.76 | 0.74 | 0.73 | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 | 0.68 | 0.66 | 0.67 |

Under refrigerated condition this reduced from 34.50 per cent to 30.20 per cent by the 6$^{th}$ month of storage.

The sugar content was found to increase gradually under both conditions with the storage period. The sugar content was higher in ambient condition stored tutifruiti ranging from 59.70 g 100 g$^{-1}$ for the 1$^{st}$ month to 64.95 g 100 g$^{-1}$ for the 6$^{th}$ month of storage compared to the refrigerated condition stored product with sugar content varying from 58.40 g 100 g$^{-1}$ to 64.0 g 100 g$^{-1}$ for the 6$^{th}$ month of storage.

The tannin content of the product stored under both conditions was found to be decreasing with the storage period. The tannin content reduced from 1.83 mg 100 g$^{-1}$ to 1.69 mg 100 g$^{-1}$ by the end of the 6$^{th}$ month of storage under ambient condition. Under refrigerated storage the tannin content was higher which ranged between 1.91 mg 100 g$^{-1}$ for the 1$^{st}$ month to 1.77 mg 100 g$^{-1}$ for the 6$^{th}$ month of storage.

Retention of vitamin C was more in refrigerated condition stored samples compared to the ambient stored product. But the vitamin C content reduced gradually with the storage period. It was observed that the vitamin C content of the tutifruiti under ambient storage reduced from 416 mg 100 g$^{-1}$ to 139 mg 100 g$^{-1}$ by the 6$^{th}$ month of storage and under refrigerated storage it reduced from 448 mg 100 g$^{-1}$ for the 1$^{st}$ month to 171 mg 100 g$^{-1}$ for the 6$^{th}$ month of storage.

Fibre content was found to exhibit a reducing trend with the advance of the storage period under both storage conditions. Fibre retention was more in the refrigerated stored tutifruiti for the 1$^{st}$ two months of storage but for the remaining

storage period, the ambient stored product had higher fibre content. Under ambient storage the fibre content decreased from 2.23 g 100 $g^{-1}$ to 1.60 g 100 $g^{-1}$ and under refrigerated storage it decreased from 2.37 g 100 $g^{-1}$ to 1.43 g 100 $g^{-1}$ after a period of 6 months.

There was not much variation in the iron content stored under ambient and refrigerated conditions. But, iron was found to be decreasing with the storage time. It decreased from 0.74 mg 100 $g^{-1}$ to 0.66 mg 100 $g^{-1}$ by the $6^{th}$ month of storage under ambient condition and from 0.76 to 0.67 mg 100 $g^{-1}$ by the $6^{th}$ month of storage under refrigerated condition.

The changes in the chemical constituents of tutifruiti stored in glass bottle under ambient and refrigerated conditions are illustrated in Fig.6 and 7 respectively.

The changes in the chemical constituents of tutifruiti stored in polypropylene bottle are presented in Table 18.

As revealed from the table moisture content of the tutifruiti under ambient condition decreased from 31.7 per cent to 25.90 per cent over a period of 6 months. Under refrigerated condition the moisture content was higher which decreased from 32.9 per cent to 28.5 per cent by the end of the $6^{th}$ month of storage.

The sugar content was found to increase with the storage period under both conditions. The sugar content was high in products stored under ambient condition and varied from 57.55 g 100 $g^{-1}$ for the $1^{st}$ month to 64.60 g 100 $g^{-1}$ for the $6^{th}$ month of storage.

**Fig. 6. Changes in the chemical constituents of tutifruiti stored in glass bottle under ambient condition**

**Fig. 6(a). Changes in the Moisture, Sugar and Fibre contents of tutifruiti stored in glass bottle under ambient condition**

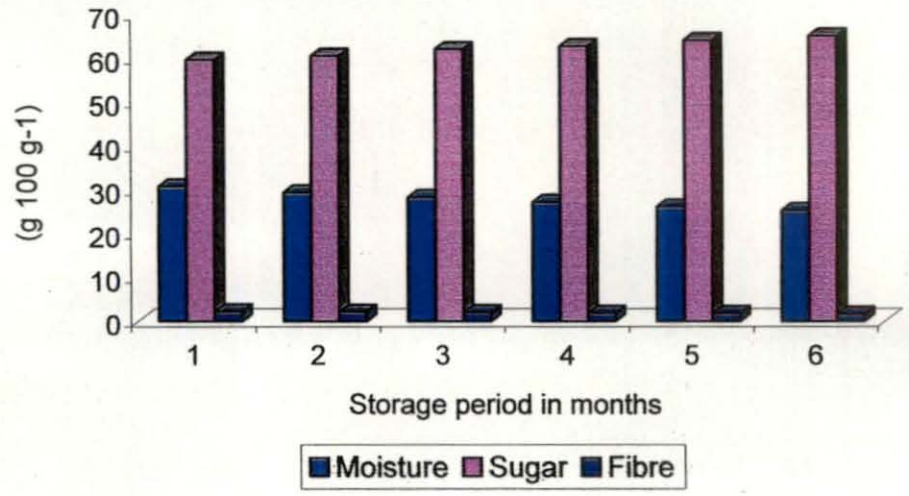



**Fig. 6(b). Changes in the Vitamin C content of tutifruiti stored in glass bottle under ambient condition**

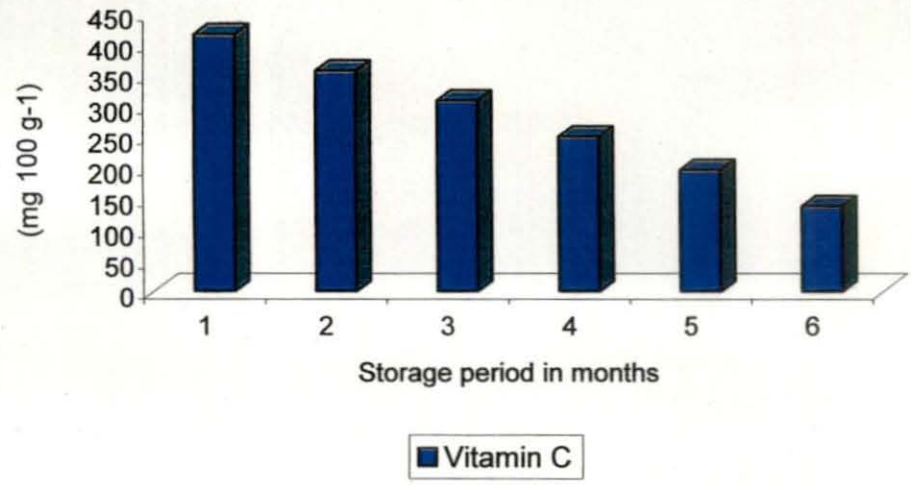


**Fig. 6(c). Changes in the Tannin and Iron contents of tutifruiti stored in glass bottle under ambient condition**

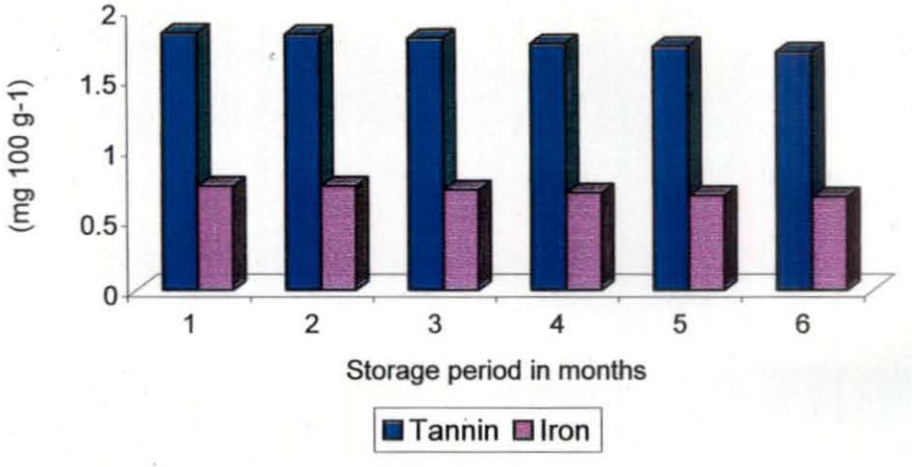



**Fig. 7. Changes in the chemical constituents of tutifruiti stored in glass bottle under refrigerated condition**

**Fig. 7(a). Changes in the Moisture, Sugar and Fibre contents of tutifruiti stored in glass bottle under refrigerated condition**

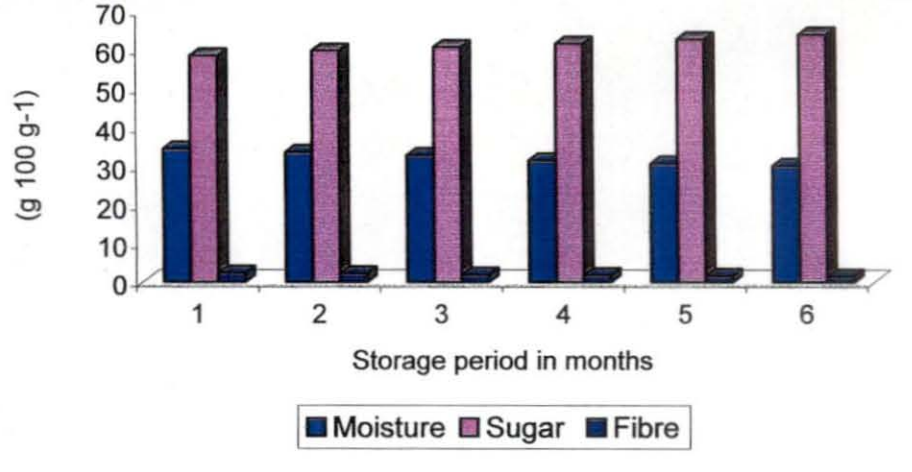


**Fig. 7(b). Changes in the Vitamin C content of tutifruiti stored in glass bottle under refrigerated condition**

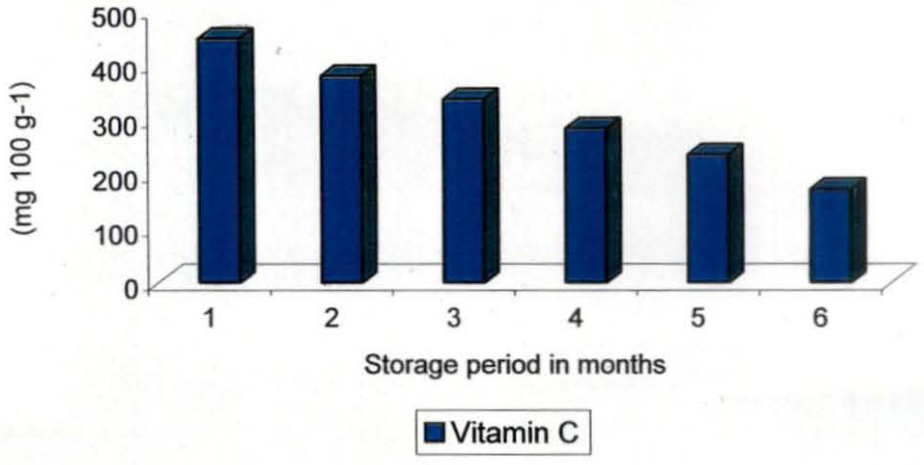



**Fig. 7(c). Changes in the Tannin and Iron contents of tutifruiti stored in glass bottle under refrigerated condition**

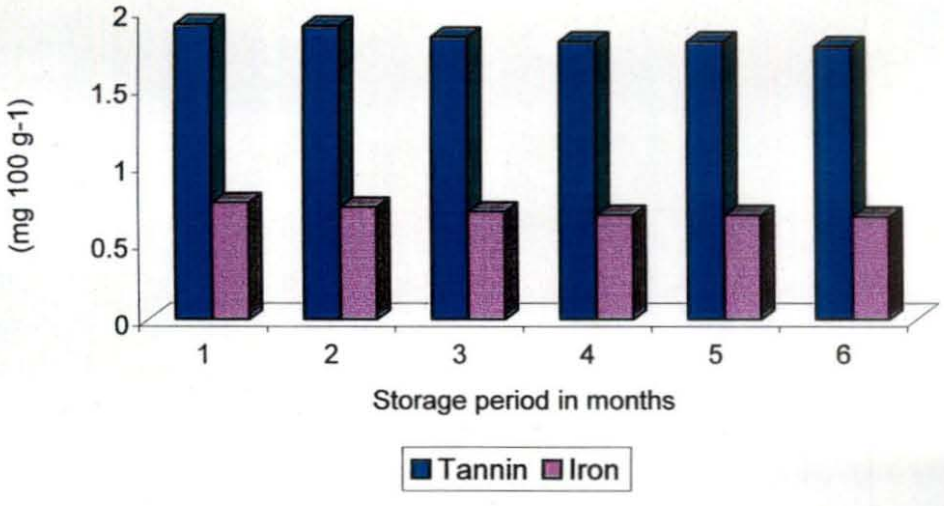


Table 18. Changes in the chemical constituents of tutifruiti stored in polypropylene bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 31.70 | 32.90 | 30.30 | 31.70 | 29.10 | 30.60 | 28.00 | 29.60 | 26.90 | 28.90 | 25.90 | 28.50 |
| Sugar (g 100 $g^{-1}$) | 57.55 | 59.00 | 59.90 | 59.25 | 61.00 | 60.00 | 62.20 | 61.00 | 63.35 | 62.05 | 64.60 | 63.15 |
| Tannin (mg 100 $g^{-1}$) | 1.82 | 1.91 | 1.82 | 1.91 | 1.78 | 1.88 | 1.76 | 1.87 | 1.73 | 1.85 | 1.71 | 1.78 |
| Vitamin C (mg 100 $g^{-1}$) | 410 | 437 | 320 | 341 | 273 | 315 | 208 | 245 | 160 | 187 | 112 | 133 |
| Fibre (g 100 $g^{-1}$) | 2.17 | 2.27 | 2.07 | 2.13 | 1.90 | 1.93 | 1.77 | 1.67 | 1.57 | 1.53 | 1.47 | 1.40 |
| Iron (mg 100 $g^{-1}$) | 0.74 | 0.75 | 0.72 | 0.72 | 0.72 | 0.70 | 0.69 | 0.68 | 0.67 | 0.67 | 0.64 | 0.64 |

A gradual decrease in the tannin content was observed during storage. Tannin was low in products stored under ambient storage when compared to refrigerated storage. The tannin content decreased from 1.82 mg 100 $g^{-1}$ for the first month to 1.71 mg 100 $g^{-1}$ for the 6$^{th}$ month of storage under ambient storage condition. Similarly under refrigerated storage the tannin content decreased from 1.91 per cent to 1.78 per cent for the 6$^{th}$ month of storage.

A declining trend in vitamin C content during storage was observed both under ambient and refrigerated storage conditions, but vitamin C retention was more in refrigerated storage. Under ambient storage the vitamin C varied from 410 mg 100 $g^{-1}$ for the 1$^{st}$ month to 112 mg 100 $g^{-1}$ for the 6$^{th}$ month of storage. Under refrigerated storage the vitamin C varied from 437 mg 100 $g^{-1}$ to 133 mg 100 $g^{-1}$ over the 6 months storage period.

A gradual reduction in the fibre content was exhibited by the products stored under both ambient and refrigerated conditions with the storage period. The gradual reduction under ambient storage condition was from 2.17 g 100 $g^{-1}$ for the 1$^{st}$ month to 1.47 g 100 $g^{-1}$ for the 6$^{th}$ month of storage. Under refrigerated condition it reduced from 2.27 g 100 $g^{-1}$ during the 1$^{st}$ month to 1.40 g 100 $g^{-1}$ by the end of the 6$^{th}$ month of storage. For the 1$^{st}$ three months of storage the refrigerated condition stored product was found to have higher fibre content compared to the ambient stored product. For the rest of the storage period product stored under ambient condition had the higher fibre content.

The iron content of the products stored under ambient and refrigerated conditions did not vary much but a slight reduction in the iron content was observed with the storage period. Under ambient storage the iron content decreased

from 0.74 mg 100 $g^{-1}$ for the 1st month to 0.64 mg 100 $g^{-1}$ for the 6th month of storage. Under refrigerated condition it decreased from 0.75 mg 100 $g^{-1}$ to 0.64 mg 100 $g^{-1}$ by the end of the storage period.

The changes in the chemical constituents of tutifruiti stored in polypropylene bag are presented in Table 19.

As expressed in the table the moisture content exhibited a reducing trend with the advance of the storage period. Under ambient condition the moisture content decreased from 33.60 per cent to 27.80 per cent by the end of the 6th month of storage and under refrigerated storage the content decreased from 32.80 to 28.60 per cent by the end of the 6th month of storage. Moisture retention was higher in the ambient stored product compared to the refrigerated stored product up to the 4th month of storage. But for the 5th and 6th month of storage the refrigerated stored product exhibited comparatively higher content.

The sugar content of the stored product was found to increase with the storage period with the ambient condition stored product having higher content compared to the refrigerated product. The sugar content under ambient condition storage ranged from 58.8 g 100 $g^{-1}$ to 63.85 g 100 $g^{-1}$ and under refrigerated condition it ranged from 58.8 g 100 $g^{-1}$ to 63.05 g 100 $g^{-1}$ by the 6 months storage.

The tannin content of the stored tutifruiti was observed to reduce gradually with the storage period with the refrigerated stored product having comparatively higher tannin content. The tannin content of the ambient condition stored tutifruiti decreased from 1.81 mg 100 $g^{-1}$ to 1.68 mg 100 $g^{-1}$ by the end of the storage period. Under refrigerated storage the tannin content decreased from

Table 19. Changes in the chemical constituents of tutifruiti stored in polypropylene bags under ambient and refrigerated conditions

| Chemical constituents | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 33.60 | 32.80 | 32.60 | 31.60 | 31.30 | 30.50 | 30.20 | 30.10 | 28.90 | 29.30 | 27.80 | 28.60 |
| Sugar (g 100 $g^{-1}$) | 58.80 | 58.80 | 60.10 | 59.55 | 61.25 | 60.30 | 62.15 | 61.10 | 63.05 | 62.50 | 63.85 | 63.05 |
| Tannin (mg 100 $g^{-1}$) | 1.81 | 1.90 | 1.78 | 1.90 | 1.74 | 1.89 | 1.72 | 1.87 | 1.70 | 1.83 | 1.68 | 1.80 |
| Vitamin C (mg 100 $g^{-1}$) | 400 | 421 | 309 | 315 | 219 | 277 | 176 | 235 | 133 | 171 | 85 | 96 |
| Fibre (g 100 $g^{-1}$) | 2.23 | 2.23 | 2.03 | 2.07 | 1.93 | 1.80 | 1.73 | 1.77 | 1.50 | 1.50 | 1.40 | 1.37 |
| Iron (mg 100 $g^{-1}$) | 0.74 | 0.74 | 0.71 | 0.72 | 0.70 | 0.70 | 0.68 | 0.68 | 0.66 | 0.65 | 0.63 | 0.62 |

1.90 during the 1st month of storage to 1.80 mg 100 $g^{-1}$ by the end of the 6th month of storage.

The vitamin C content of the stored product was found to reduce with the advance of the storage period under both storage conditions. The refrigerated sample exhibited higher vitamin C content which ranged from 421 mg 100 $g^{-1}$ for the 1st month to 96 mg 100 $g^{-1}$ for the 6th month, compared to the vitamin C content of the sample stored under ambient condition which ranged from 400 mg 100 $g^{-1}$ for the 1st month to 85 mg 100 $g^{-1}$ for the 6th month of storage.

There was a gradual reduction in the fibre content of the stored samples over the storage period. The refrigerated stored product was found to possess slightly higher fibre content during the 2nd and 4th month of storage compared to the ambient condition stored tutifruiti. During the 3rd and 6th month of storage the product under ambient storage was found to have higher content compared to the refrigerated storage product. Fibre content was same in the products during the 1st and 5th month of storage under ambient and refrigerated storage.

The ambient and refrigerated stored tutifruiti did not exhibit much variation in the iron content but it decreased from 0.74 mg 100 $g^{-1}$ in the 1st month to 0.63 mg 100 $g^{-1}$ by the 6th month under ambient storage and from 0.74 mg 100 $g^{-1}$ in the 1st month to 0.62 mg 100 $g^{-1}$ for the 6th month of storage under refrigerated condition.

The effect of storage period on the chemical constituents of tutifruiti stored in different packaging systems under ambient condition was statistically analysed through DMRT and the results are presented in Table 20.

Table 20. Effect of storage periods on the chemical constituents of tutifruiti stored under ambient condition

| Storage period (month) | Mean value | | | | | |
|---|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | 32.03 [a] | 58.68 [f] | 1.82 [a] | 409 [a] | 2.21 [a] | 0.74 [a] |
| 2 | 30.77 [b] | 60.18 [e] | 1.81 [a] | 329 [b] | 2.08 [b] | 0.72 [b] |
| 3 | 29.57 [c] | 61.43 [d] | 1.77 [b] | 267 [c] | 1.95 [c] | 0.71 [b] |
| 4 | 28.43 [d] | 62.35 [c] | 1.74 [c] | 212 [d] | 1.79 [d] | 0.69 [c] |
| 5 | 27.30 [e] | 63.47 [b] | 1.72 [d] | 164 [e] | 1.61 [e] | 0.67 [d] |
| 6 | 26.30 [f] | 64.47 [a] | 1.69 [e] | 112 [f] | 1.49 [f] | 0.64 [e] |

Values having different superscripts vary significantly at 5% level

It is evident from the table that a significant reduction in the moisture, vitamin C and fibre content and a significant increment in the sugar content was observed during every month of storage. The significant reduction in the moisture content was from 32.03 per cent for the first month to 26.30 per cent by the 6$^{th}$ month. For vitamin C content it was from 409 mg 100 $g^{-1}$ to 112 mg 100 $g^{-1}$ and for fibre from 2.21 g 100 $g^{-1}$ to 1.49 g 100 $g^{-1}$ by the end of 6$^{th}$ month of storage.

Though there was a reduction in the tannin content with the storage period, the reduction was not significant between the first (1.82 mg 100 $g^{-1}$) and 2$^{nd}$ (1.81 mg 100 $g^{-1}$) month of storage. From 2$^{nd}$ month onwards a significant decrease in tannin content was observed till the end of 6$^{th}$ month.

A significant reduction in the iron content was observed between the 1$^{st}$ and 2$^{nd}$ month of storage. But the reduction was not significant between the 2$^{nd}$ (0.72 mg 100 $g^{-1}$) and 3$^{rd}$ (0.71 mg 100 $g^{-1}$) month of storage. Significant reduction was observed between each month of storage from the 3$^{rd}$ month onwards till the 6$^{th}$ month.

The effect of storage period on the chemical constituents of tutifruiti stored in different packaging systems under refrigerated condition was statistically analysed through DMRT and the results are presented in Table 21.

Table 21. Effect of storage periods on the chemical constituents of tutifruiti stored under refrigerated condition

| Storage period (month) | Mean value | | | | | |
|---|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Fibre (g 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | $33.40^{a}$ | $58.73^{f}$ | $1.91^{a}$ | $436^{a}$ | $2.29^{a}$ | $0.75^{a}$ |
| 2 | $32.33^{b}$ | $59.52^{e}$ | $1.90^{a}$ | $345^{b}$ | $2.13^{b}$ | $0.72^{b}$ |
| 3 | $31.33^{c}$ | $60.33^{d}$ | $1.87^{b}$ | $309^{c}$ | $1.88^{c}$ | $0.70^{c}$ |
| 4 | $30.43^{d}$ | $61.23^{c}$ | $1.85^{c}$ | $254^{d}$ | $1.74^{d}$ | $0.68^{d}$ |
| 5 | $29.67^{e}$ | $62.45^{b}$ | $1.82^{d}$ | $197^{e}$ | $1.55^{e}$ | $0.67^{d}$ |
| 6 | $29.10^{f}$ | $63.40^{a}$ | $1.78^{e}$ | $133^{f}$ | $1.40^{f}$ | $0.64^{e}$ |

Values having different superscripts vary significantly at 5% level

It is clear from the table that the moisture, vitamin C and fibre exhibited a significant reduction and the sugar content showed a significant increase during every month of storage.

The tannin content of the product stored was found to reduce gradually with the storage time. The reduction was not significant between the 1st (1.91 mg 100 $g^{-1}$) and 2nd (1.90 mg 100 $g^{-1}$) month of storage but from the 2nd month onwards the reduction between every month was significant up to the end of the storage period.

Significant reduction in the iron content was observed between every month of storage up to the 4th month. But the reduction in the iron content was not significant between the 4th (0.68 mg 100 $g^{-1}$) and 5th (0.67 mg 100 $g^{-1}$) month of storage. The reduction between the 5th and 6th month of storage was observed to be significant.

The effect of packaging systems on the chemical constituents of tutifruiti stored under ambient and refrigerated conditions was statistically analysed through DMRT and the results are presented in Table 22.

The moisture content of tutifruiti stored under ambient condition was observed to vary significantly between the packages, with tutifruiti stored in polypropylene bag retaining the maximum moisture content (30.73%) followed by polypropylene bottle (28.65%). The least moisture content was for product kept in glass bottle (27.82%). Under refrigerated condition the moisture content was significantly high in the glass bottle (32.28%). But the moisture content did not vary significantly between the stored product in polypropylene bottle (30.37%) and polypropylene bag (30.48%).

Under ambient condition storage the sugar content was significantly high in product stored in glass bottle (62.33 g 100 $g^{-1}$). The sugar content of the samples stored in the polypropylene bottle (61.43 g 100 $g^{-1}$) and bag (61.53 g 100 $g^{-1}$) did not vary significantly. Under refrigerated storage condition also the sugar content of the glass bottle (61.21 g 100 $g^{-1}$) was significantly high when compared to product in polypropylene bottle (60.74 g 100 $g^{-1}$) stored tutifruiti. But no significant variation was observed in the sugar content of the stored product in polypropylene bottle and bag (60.88 g 100 $g^{-1}$). Under ambient condition tannin content was significantly low in tutifruiti (1.74 mg 100 $g^{-1}$) stored in polypropylene bag. No significant change in tannin content was observed in the polypropylene bottle (1.77 mg 100 $g^{-1}$) and glass bottle (1.77 mg 100 $g^{-1}$).

Under refrigerated condition a significant low tannin content was observed in tutifruiti stored in glass bottle (1.84 mg 100 $g^{-1}$). The tannin content of

Table 22. Effect of packaging systems on the chemical constituents of tutifruiti stored under ambient and refrigerated condition

| Package | Mean values | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Moisture (%) | | Sugar (g 100 $g^{-1}$) | | Tannin (mg 100 $g^{-1}$) | | Vitamin C (mg 100 $g^{-1}$) | | Fibre (g 100 $g^{-1}$) | | Iron (mg 100 $g^{-1}$) | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Glass bottle | $27.82^{c}$ | $32.28^{a}$ | $62.33^{a}$ | $61.21^{a}$ | $1.77^{a}$ | $1.84^{b}$ | $278^{a}$ | $309^{a}$ | $1.94^{a}$ | $1.88^{a}$ | $0.70^{a}$ | $0.70^{a}$ |
| Polypropylene bottle | $28.65^{b}$ | $30.37^{b}$ | $61.43^{b}$ | $60.74^{b}$ | $1.77^{a}$ | $1.87^{a}$ | $247^{b}$ | $276^{b}$ | $1.83^{b}$ | $1.82^{b}$ | $0.69^{ab}$ | $0.69^{ab}$ |
| Polypropylene bag | $30.73^{a}$ | $30.48^{b}$ | $61.53^{b}$ | $60.88^{ab}$ | $1.74^{b}$ | $1.87^{a}$ | $220^{c}$ | $252^{c}$ | $1.80^{b}$ | $1.79^{b}$ | $0.68^{b}$ | $0.68^{b}$ |

Values having different superscripts differ significantly at 5% level

the stored tutifruiti did not vary significantly in polypropylene bottle (1.87 mg 100 $g^{-1}$) and bag (1.87 mg 100 $g^{-1}$).

Vitamin C retention was significantly high in tutifruiti stored in glass bottle under both ambient (278 mg 100 $g^{-1}$) and refrigerated (309 mg 100 $g^{-1}$) storage conditions. Lowest vitamin C content was observed in the product stored in polypropylene bag under both ambient (220 mg 100 $g^{-1}$) and refrigerated (252 mg 100 $g^{-1}$) conditions. The vitamin C was significantly low in products stored in polypropylene bottle both in ambient (247 mg 100 $g^{-1}$) and refrigerated storage condition (276 mg 100 $g^{-1}$).

Tutifruiti stored in glass bottle was found to have significantly high fibre content under both ambient (1.94 g 100 $g^{-1}$) and refrigerated (1.88 g 100 $g^{-1}$) conditions. But no significant variation was observed in fibre content in stored product in polypropylene bottle and bag under both ambient and refrigerated storage.

There was no significant variation in the iron retention in glass bottle (0.70 mg 100 $g^{-1}$) and polypropylene bottle (0.69 mg 100 $g^{-1}$) under ambient condition. But the iron content was significantly low in polypropylene bag (0.68 mg 100 $g^{-1}$) compared to the glass bottle. Under refrigerated storage iron was significantly high in glass bottle (0.70 mg 100 $g^{-1}$) compared to the polypropylene bag (0.68 mg 100 $g^{-1}$). No significant variation was observed in iron content of tutifruiti stored in glass bottle and polypropylene bottle (0.69 mg 100 $g^{-1}$) and polypropylene bottle and bag.

Changes in the chemical constituents of jelly stored in glass bottle are presented in Table 23.

Table 23. Changes in the chemical constituents of jelly stored in glass bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 18.40 | 18.70 | 18.00 | 17.90 | 17.40 | 17.40 | 16.80 | 16.70 | 16.40 | 16.30 | 15.80 | 15.70 |
| Sugar (g 100 $g^{-1}$) | 69.80 | 68.85 | 70.65 | 69.70 | 71.15 | 70.45 | 71.65 | 71.05 | 71.90 | 71.95 | 72.25 | 72.15 |
| Tannin (mg 100 $g^{-1}$) | 0.76 | 0.82 | 0.77 | 0.78 | 0.76 | 0.77 | 0.72 | 0.76 | 0.73 | 0.73 | 0.69 | 0.68 |
| Vitamin C (mg 100 $g^{-1}$) | 320 | 331 | 272 | 299 | 224 | 240 | 192 | 208 | 144 | 144 | 64 | 75 |
| Fibre (g 100 $g^{-1}$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Iron (mg 100 $g^{-1}$) | 0.55 | 0.56 | 0.53 | 0.54 | 0.51 | 0.49 | 0.48 | 0.48 | 0.47 | 0.47 | 0.46 | 0.45 |

As shown in the table the moisture content of the jelly stored under ambient condition reduced gradually from 18.4 to 15.8 per cent by the end of the 6$^{th}$ month of storage. Under refrigerated storage it reduced from 18.7 per cent to 15.7 per cent by the 6$^{th}$ month of storage. The moisture content of the jelly stored in ambient condition was higher than the content of the refrigerated product except for the 1$^{st}$ month of storage when the moisture content of the refrigerated jelly was 18.7 per cent compared to a lower content of 18.4 per cent in the jelly stored under ambient condition.

The sugar content was found to increase with the storage period under both ambient and refrigerated storage. The sugar content was slightly higher in the product under ambient storage.

A gradual reduction in the tannin content was observed with the advance of the storage period with the refrigerated condition stored product having higher content except for the 6$^{th}$ month of storage. For the 6$^{th}$ month of storage jelly stored under ambient condition showed higher value (0.69 mg 100 $g^{-1}$) compared to the refrigerated condition (0.68 mg 100 $g^{-1}$). Under ambient storage the tannin content reduced from 0.76 mg 100 $g^{-1}$ for the 1$^{st}$ month to 0.69 mg 100 $g^{-1}$ for the 6$^{th}$ month and under refrigerated storage the content decreased from 0.82 mg 100 $g^{-1}$ to 0.68 mg 100 $g^{-1}$ over the storage period.

A steady reduction in the vitamin C content of the stored jelly was observed with the refrigerated product showing higher vitamin C retention. The vitamin C content reduced from 320 mg 100 $g^{-1}$ for the 1$^{st}$ month to 64 mg 100 $g^{-1}$ by the 6$^{th}$ month of storage under ambient condition and under refrigerated storage

it reduced from 331 mg 100 $g^{-1}$ to 75 mg 100 $g^{-1}$. No fibre content was observed in jelly.

Not much variation in the iron content was observed with the storage of the product but a gradual reduction was observed with the storage period. Under ambient storage the iron content decreased from 0.55 mg 100 $g^{-1}$ to 0.46 mg 100 $g^{-1}$ and under refrigerated storage 0.56 mg 100 $g^{-1}$ to 0.45 mg 100 $g^{-1}$ by the $6^{th}$ month of storage.

The changes in the chemical constituents of jelly stored in glass bottles under ambient and refrigerated conditions are illustrated in Fig.8 and 9 respectively.

The changes in the chemical constituents of jelly stored in polypropylene bottles under ambient and refrigerated conditions are presented in Table 24.

The moisture content was found to show a declining trend with the advance of the storage period under both storage conditions with the refrigerated product having higher moisture content. The moisture content under ambient condition decreased from 18.5 per cent for the $1^{st}$ month to 15.9 per cent for the $6^{th}$ month and under refrigerated storage it decreased from 18.7 per cent for the $1^{st}$ month to 16.0 per cent by the end of the $6^{th}$ month of storage.

A slight increase in the sugar content was observed with the advance of the storage period. The ambient stored product was observed to have higher sugar content ranging from 69.65 g 100 $g^{-1}$ during the first month to 71.25 g 100 $g^{-1}$ by the $4^{th}$ month of storage. For the $5^{th}$ month the refrigerated sample had higher content 71.90 g 100 $g^{-1}$ against 71.20 g 100 $g^{-1}$ in the ambient stored sample. A

**Fig. 8. Changes in the chemical constituents of jelly stored in glass bottle under ambient condition**

**Fig. 8(a). Changes in the Moisture and Sugar contents of jelly stored in glass bottle under ambient condition**

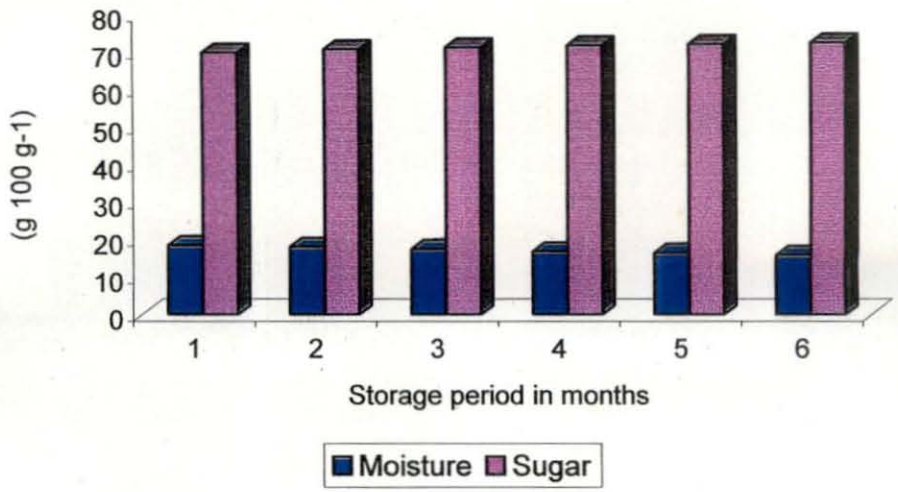



**Fig. 8(b). Changes in the Vitamin C content of jelly stored in glass bottle under ambient condition**

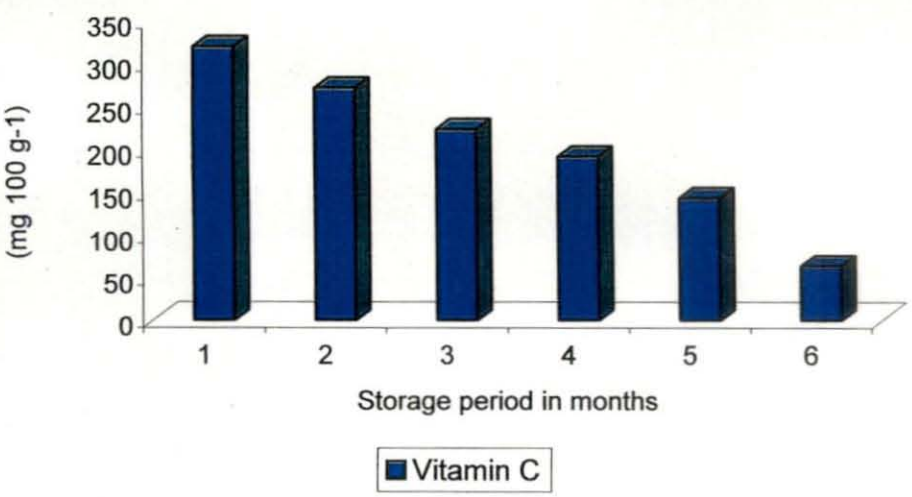


**Fig. 8(c). Changes in the Tannin and Iron contents of jelly stored in glass bottle under ambient condition**

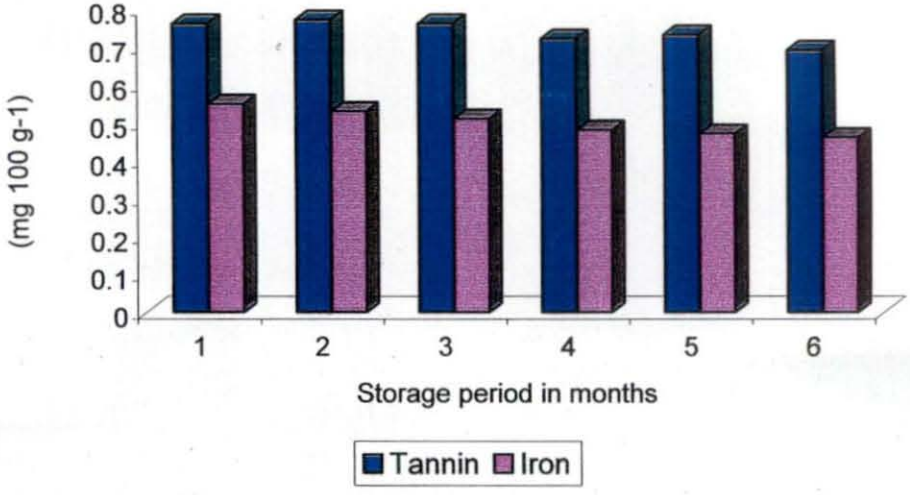



**Fig. 9. Changes in the chemical constituents of jelly stored in glass bottle under refrigerated condition**

**Fig. 9(a). Changes in the Moisture and Sugar contents of jelly stored in glass bottle under refrigerated condition**

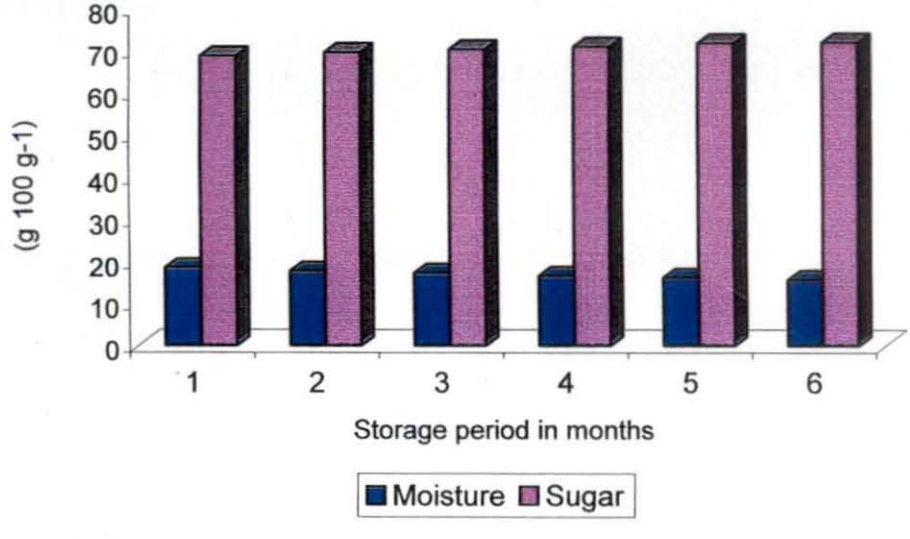


**Fig. 9(b). Changes in the Vitamin C content of jelly stored in glass bottle under refrigerated condition**

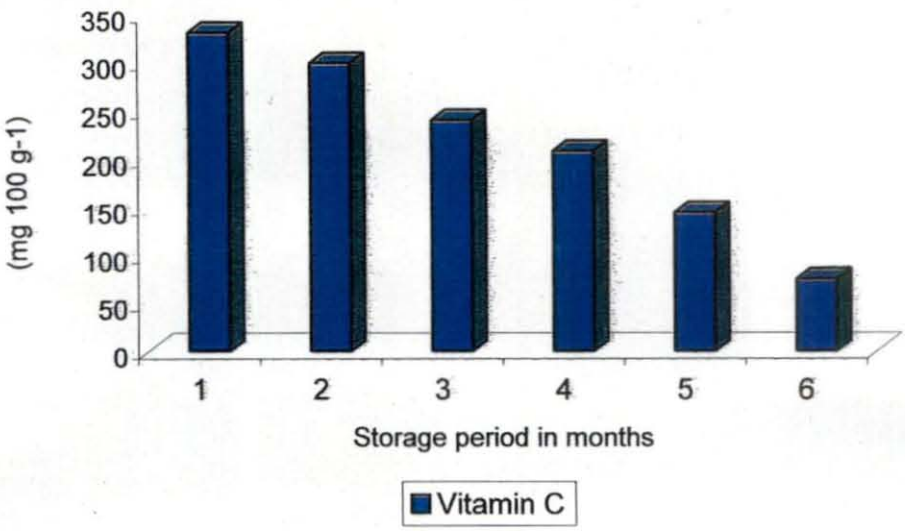



**Fig. 9(c). Changes in the Tannin and Iron contents of jelly stored in glass bottle under refrigerated condition**

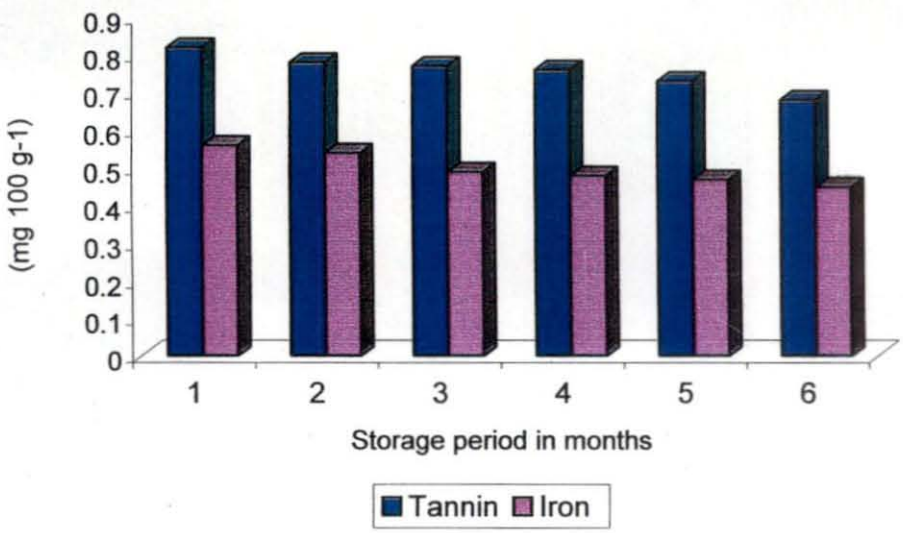


Table 24. Changes in the chemical constituents of jelly stored in polypropylene bottles under ambient and refrigerated conditions

| Chemical constituents | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 18.50 | 18.70 | 17.60 | 17.80 | 17.30 | 17.30 | 16.60 | 16.70 | 16.30 | 16.60 | 15.90 | 16.00 |
| Sugar (g 100 $g^{-1}$) | 69.65 | 69.40 | 70.20 | 70.05 | 70.80 | 70.45 | 71.25 | 71.20 | 71.20 | 71.90 | 71.65 | 72.40 |
| Tannin (mg 100 $g^{-1}$) | 0.75 | 0.81 | 0.75 | 0.80 | 0.74 | 0.77 | 0.73 | 0.75 | 0.72 | 0.73 | 0.70 | 0.68 |
| Vitamin C (mg 100 $g^{-1}$) | 320 | 325 | 261 | 288 | 213 | 224 | 165 | 192 | 112 | 123 | 59 | 59 |
| Fibre (g 100 $g^{-1}$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Iron (mg 100 $g^{-1}$) | 0.54 | 0.54 | 0.51 | 0.52 | 0.50 | 0.48 | 0.47 | 0.47 | 0.46 | 0.46 | 0.43 | 0.43 |

similar variation was observed during 6th month also. The sugar content of the refrigerated product ranged between 69.40 g 100 $g^{-1}$ and 72.40 g 100 $g^{-1}$ during the 6 months storage.

A gradual reduction in the tannin of the stored jelly was observed with the advance of the storage period. The ambient condition stored jelly was found to have a lower tannin ranging from 0.75 to 0.70 mg 100 $g^{-1}$ by the end of the storage period compared to the product kept under refrigerated storage where tannin decreased from 0.81 to 0.68 mg 100 $g^{-1}$.

There was a decline in the vitamin C of the stored jelly as the storage progressed, with refrigerated product having higher vitamin C retention. In the ambient condition stored jelly vitamin C reduced from 320 mg 100 $g^{-1}$ during the 1st month to 59 mg 100 $g^{-1}$ by the 6th month of storage. In the refrigerated storage vitamin C decreased from 325 mg 100 $g^{-1}$ during the 1st month to 59 mg 100 $g^{-1}$ by the 6th month of storage.

There was not much variation in the iron content of the stored jelly with the storage condition. But a gradual reduction in the iron content was observed with the storage period.

The changes in the chemical constituents of jelly stored in polypropylene bag under ambient and refrigerated conditions was studied and the result is given in Table 25.

The moisture content was found to reduce gradually in the product stored under both conditions. Jelly stored under ambient condition had a moisture content ranging between 18.7 per cent for the 1st month and 15.6 per cent for the

Table 25. Changes in the chemical constituents of jelly stored in polypropylene bags under ambient and refrigerated conditions

| Chemical constituents | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Moisture (%) | 18.70 | 18.70 | 17.60 | 18.00 | 16.90 | 17.30 | 16.10 | 16.40 | 15.70 | 15.80 | 15.60 | 15.30 |
| Sugar (g 100 $g^{-1}$) | 69.90 | 69.15 | 70.30 | 69.90 | 70.95 | 70.55 | 71.30 | .70.95 | 71.90 | 71.55 | 72.55 | 72.15 |
| Tannin (mg 100 $g^{-1}$) | 0.77 | 0.81 | 0.75 | 0.78 | 0.74 | 0.75 | 0.74 | 0.74 | 0.73 | 0.72 | 0.68 | 0.68 |
| Vitamin C (mg 100 $g^{-1}$) | 315 | 331 | 240 | 293 | 192 | 203 | 144 | 165 | 96 | 101 | 37 | 43 |
| Fibre (g 100 $g^{-1}$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Iron (mg 100 $g^{-1}$) | 0.52 | 0.55 | 0.51 | 0.51 | 0.48 | 0.47 | 0.47 | 0.47 | 0.44 | 0.45 | 0.44 | 0.47 |

6th month of storage. It reduced from 18.7 per cent to 15.3 per cent over the storage period under refrigerated storage.

Under both storage conditions the sugar content of the stored product increased gradually. The ambient stored product had a comparatively higher sugar content which ranged from 69.90 g 100 $g^{-1}$ during the 1st to 72.55 g 100 $g^{-1}$ for the 6th month of storage. For jelly under refrigerated storage the sugar content varied from 69.15 g 100 $g^{-1}$ for the first month to 72.15 g 100 $g^{-1}$ by the end of the storage period.

Tannin content was found to reduce gradually with the storage period under both conditions of storage. The refrigerated product was observed to have higher retention when compared to ambient stored product except for the 5th month of storage when the ambient stored jelly had higher content (0.73 mg 100 $g^{-1}$) than the refrigerated jelly (0.72 mg 100 $g^{-1}$). The tannin content ranged from 0.77 to 0.68 mg 100 $g^{-1}$ under ambient storage and from 0.81 to 0.68 mg 100 $g^{-1}$ under refrigerated storage by the 6th month of the storage period.

Vitamin C of the stored product was found to decline with the storage period under both conditions. The refrigerated sample was observed to have higher vitamin C retention where this ranged from 331 mg 100 $g^{-1}$ for the 1st month to 43 mg 100 $g^{-1}$ by the last month of storage. Under ambient storage vitamin C varied from 315 mg 100 $g^{-1}$ for the first month to 37 mg 100 $g^{-1}$ for the 6th month of storage.

Not much variation in the iron content was observed with the storage condition but the content gradually reduced as the storage period increased. Under ambient storage it ranged from 0.52 mg 100 $g^{-1}$ for the 1st month to 0.44 mg 100 $g^{-1}$

for the 6th month. Under refrigerated storage it ranged from 0.55 mg 100 $g^{-1}$ to 0.47 mg 100 $g^{-1}$ over the storage period.

The effect of storage period on the chemical constituents of jelly stored under ambient condition was statistically analysed through DMRT and the results are presented in Table 26.

Table 26. Effect of storage periods on the chemical constituents of jelly stored under ambient condition

| Storage period (month) | Mean value | | | | |
|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | 18.53 [a] | 69.70 [e] | 0.76 [a] | 318 [a] | 0.54 [a] |
| 2 | 17.73 [b] | 70.30 [d] | 0.76 [a] | 258 [b] | 0.52 [b] |
| 3 | 17.20 [c] | 70.97 [c] | 0.75 [ab] | 210 [c] | 0.50 [c] |
| 4 | 16.50 [d] | 71.40 [b] | 0.73 [bc] | 167 [d] | 0.47 [d] |
| 5 | 16.13 [de] | 71.67 [b] | 0.73 [c] | 117 [e] | 0.46 [de] |
| 6 | 15.77 [e] | 72.15 [a] | 0.69 [d] | 53 [f] | 0.44 [e] |

Values having different superscripts vary significantly at 5% level

It is evident from the table that the moisture content reduced significantly between the 1st, 2nd, 3rd and 4th month of storage. No significant reduction was observed between the 4th (16.50%) and 5th (16.13%) month of storage and 5th and 6th (15.77%) month of storage.

A significant increment in the sugar content was observed with the storage time. A significant increase was observed between every month of storage up to the 4th month. But no significant increment was found between the 4th (71.40 g 100 $g^{-1}$) and 5th (71.67 g 100 $g^{-1}$) month of storage. A significant increment in sugar content from 71.67 g 100 $g^{-1}$ for the 5th to 72.15 g 100 $g^{-1}$ for the 6th month was also observed.

Even though there was a significant reduction in tannin content with the advance of the storage period, no significant variation was observed between every

month of storage up to the 5th month of storage. The tannin content significantly reduced from 0.73 mg 100 $g^{-1}$ for the 5th month to 0.69 mg 100 $g^{-1}$ by the 6th month of storage.

A significant reduction in vitamin C was observed between every month of storage. Iron content reduced significantly only up to the 4th month of storage. No significant reduction in iron was seen between the 4th (0.47 mg 100 $g^{-1}$) and 5th (0.46 mg 100 $g^{-1}$) and 6th (0.44 mg 100 $g^{-1}$) month of storage.

The effect of storage period on the chemical constituents of jelly stored under refrigerated condition was statistically analysed through DMRT and the results are given in Table 27.

Table 27. Effect of storage periods on the chemical constituents of jelly stored under refrigerated condition

| Storage period (month) | Mean value | | | | |
|---|---|---|---|---|---|
| | Moisture (%) | Sugar (g 100 $g^{-1}$) | Tannin (mg 100 $g^{-1}$) | Vitamin C (mg 100 $g^{-1}$) | Iron (mg 100 $g^{-1}$) |
| 1 | 18.70 [a] | 69.13 [f] | 0.81 [a] | 329 [a] | 0.55 [a] |
| 2 | 17.90 [b] | 69.88 [e] | 0.79 [b] | 293 [b] | 0.52 [b] |
| 3 | 17.33 [c] | 70.48 [d] | 0.76 [c] | 222 [c] | 0.48 [c] |
| 4 | 16.60 [d] | 71.07 [c] | 0.75 [c] | 188 [d] | 0.47 [cd] |
| 5 | 16.57 [d] | 71.80 [b] | 0.73 [d] | 123 [e] | 0.46 [d] |
| 6 | 15.67 [e] | 72.23 [a] | 0.68 [e] | 59 [f] | 0.43 [e] |

Values having different superscripts vary significantly at 5% level

It is clear from the table that the moisture content of the jelly reduced significantly with the storage period. The reduction was significant between every month of storage up to the 4th month. The reduction was not significant between the 4th (16.60%) and 5th (16.57%) months but it significantly reduced to 15.67 per cent by the 6th month of storage.

A significant increase in the sugar content was observed with the advance of the storage period, and the variation in sugar content between every month of storage was also found to be significant.

Tannin reduced significantly with the storage period. A significant decrease was observed between every month except for the 3rd and 4th month of storage.

Vitamin C content was found to reduce significantly between every month of storage from the 1st to the 6th month.

The iron content of the stored jelly reduced significantly between every month up to the 3rd month. No significant reduction was observed between the 3rd (0.48 mg 100 $g^{-1}$) and 4th (0.47 mg 100 $g^{-1}$) and 4th and 5th (0.46 mg 100 $g^{-1}$) month of storage. But the iron content reduced significantly from the 5th to the 6th month (0.43 mg 100 $g^{-1}$) of storage.

The effect of different packaging systems on the chemical constituents of jelly stored under ambient and refrigerated conditions was analysed statistically through DMRT and the results are presented in Table 28.

As shown in the table under ambient storage significant variation in moisture content of stored jelly was observed only between glass bottle (17.13%) and polypropylene bag (16.77%). No significant variation was observed in moisture content of the products stored in glass bottle and polypropylene bottle (17.03%) and polypropylene bottle and polypropylene bag. Under refrigerated storage no significant variation in the moisture content was observed with the packaging systems.

Under ambient storage the sugar content of jelly stored in polypropylene bottle (70.79 g 100 $g^{-1}$) was significantly low compared to the product in glass bottle (71.23 g 100 $g^{-1}$) and polypropylene bag (71.15 g 100 $g^{-1}$). Under refrigerated storage significant increase in the sugar content was observed in the

Table 28. Effect of packaging systems on the chemical constituents of jelly stored under ambient and refrigerated condition

| Package | Mean values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Moisture (%) | | Sugar (g 100 $g^{-1}$) | | Tannin (mg 100 $g^{-1}$) | | Vitamin C (mg 100 $g^{-1}$) | | Iron (mg 100 $g^{-1}$) | |
| | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated |
| Glass bottle | 17.13 $^{a}$ | 17.12 $^{a}$ | 71.23 $^{a}$ | 70.69 $^{b}$ | 0.74 $^{a}$ | 0.76 $^{a}$ | 203 $^{a}$ | 216 $^{a}$ | 0.50 $^{a}$ | 0.50 $^{a}$ |
| Polypropylene bottle | 17.03 $^{ab}$ | 17.18 $^{a}$ | 70.79 $^{b}$ | 70.90 $^{a}$ | 0.73 $^{a}$ | 0.76 $^{a}$ | 188 $^{b}$ | 202 $^{b}$ | 0.49 $^{b}$ | 0.48 $^{b}$ |
| Polypropylene bag | 16.77 $^{b}$ | 17.08 $^{a}$ | 71.15 $^{a}$ | 70.71 $^{ab}$ | 0.74 $^{a}$ | 0.75 $^{a}$ | 171 $^{c}$ | 189 $^{b}$ | 0.49 $^{b}$ | 0.47 $^{c}$ |

Values having different superscripts differ significantly at 5% level

product stored in glass bottle (70.69 g 100 $g^{-1}$) when compared to polypropylene bottle (70.90 g 100 $g^{-1}$). But no significant variation was observed between the polypropylene bottle and polypropylene bag (70.71 g 100 $g^{-1}$).

Variations in the tannin content of the stored jelly with the different packaging systems was not significant.

Under ambient condition significant variation in the vitamin C content was observed with different packaging systems. The jelly stored in glass bottle was found to retain the maximum vitamin C content (203 mg 100 $g^{-1}$) which was significantly higher than the other packaging systems. Under refrigerated storage also jelly stored in glass bottle retained a significant level of vitamin C content (216 mg 100 $g^{-1}$) compared to the polypropylene bottle (202 mg 100 $g^{-1}$). The variation in vitamin C observed between the products in polypropylene bottle and polypropylene bag (189 mg 100 $g^{-1}$) was not significant.

The iron content of jelly stored in glass bottle (0.50 mg 100 $g^{-1}$) was significantly high when compared to the products in polypropylene bottle and polypropylene bag under ambient condition. But no significant variation was observed in iron content of the products in polypropylene bottle and polypropylene bag. The different packaging systems were found to have significant effect on the iron content of the stored jelly under refrigerated condition. Products stored in glass bottle was found to have the maximum iron content (0.50 mg 100 $g^{-1}$) followed by polypropylene bottle (0.48 mg 100 $g^{-1}$) and polypropylene bag (0.47 mg 100 $g^{-1}$).

4.1.2.2 Changes in organoleptic qualities during storage of amla products in different packaging systems under ambient and refrigerated conditions

The organoleptic qualities viz., appearance, colour, flavour, texture and taste of the selected products stored in glass bottles, polypropylene bottles and polypropylene bags were evaluated at monthly intervals for a period of six months both in ambient and refrigerated conditions. The effect of storage period on quality criterias varied from product to product. Each attribute was assigned a maximum score of 5.

The changes in the acceptability of candy stored in glass bottle under ambient and refrigerated condition were evaluated at monthly intervals for a period of six months and the results are presented in Table 29.

As revealed from the table the mean scores for appearance of candy stored in glass bottle gradually increased up to 4$^{th}$ month in both ambient and refrigerated storage, but from the 5$^{th}$ month onwards the mean scores showed a decline. Under ambient storage the mean scores increased from 3.47 in the first month to 4.07 in the 4$^{th}$ month which reduced to 3.27 in the 5$^{th}$ and a minimum score of 2.73 for the 6$^{th}$ month. For refrigerated storage the mean scores varied from 3.23 in the first month to 4.10 for the 4$^{th}$ month. The minimum scores were for the 6$^{th}$ month (2.67). But when compared to refrigerated storage candy stored in ambient condition showed better appearance except for the 4$^{th}$ and 5$^{th}$ month where products under refrigerated storage had higher mean scores.

Regarding the colour of the candy stored in glass bottle, under ambient storage there was a gradual increase in the mean scores from the 1$^{st}$ month (3.57) to a maximum of 3.37 for the 4$^{th}$ month which then reduced to 3.13 for the 5$^{th}$ and

Table 29. Organoleptic evaluation of candy stored in glass bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.47 | 3.23 | 3.83 | 3.53 | 4.03 | 3.93 | 4.07 | 4.10 | 3.27 | 3.53 | 2.73 | 2.67 |
| Colour | 3.57 | 3.33 | 3.60 | 3.27 | 3.77 | 3.90 | 3.37 | 3.50 | 3.13 | 3.20 | 2.50 | 3.07 |
| Flavour | 3.13 | 3.23 | 3.33 | 3.30 | 3.43 | 3.30 | 3.73 | 3.63 | 3.43 | 3.40 | 3.07 | 2.90 |
| Texture | 2.67 | 2.27 | 3.83 | 3.67 | 4.27 | 3.97 | 3.87 | 3.80 | 4.17 | 4.27 | 4.00 | 4.03 |
| Taste | 2.50 | 2.67 | 3.30 | 3.27 | 4.10 | 3.97 | 3.33 | 3.97 | 2.70 | 3.33 | 2.63 | 3.10 |

to a minimum of 2.50 for the 6th months. Under refrigerated storage, the initial score for the first month (3.33) reduced to 3.27 for the 2nd month which then scored a maximum of 3.90 for the 3rd month and then gradually reduced to a minimum score of 3.07 for the 6th month.

Mean scores for flavour was found to be increasing in both ambient and refrigerated storage up to 4th month which then reduced to a minimum during the 6th month. Under ambient condition the scores for flavour varied from 3.13 in the first month to 3.73 in the 4th month and a minimum score of 3.07 for the 6th month. Under refrigerated storage mean scores for flavour varied from 3.23 in the first month to 3.63 in the 4th month and a minimum score of 2.90 for the 6th month. Flavour of candy was more acceptable under ambient storage except for the first month.

Texture of the candy stored in glass bottle under ambient condition gradually improved from the 1st month (2.67) to a maximum score of 4.27 for the 3rd month. For the 4th month the scores reduced to 3.87 but for the 5th and 6th month the scores for texture obtained higher values of 4.17 and 4.00 respectively. The minimum score was for the 1st month (2.67). Under refrigerated storage maximum score for texture was for the 5th month (4.27) followed by the 6th month (4.03). Minimum score for the texture under refrigerated storage was also for the first month (2.27).

Regarding the taste of candy stored in glass bottles under ambient and refrigerated conditions the scores were found to be gradually increasing from the 1st month to the 3rd month which then reduced. Under ambient storage the scores for taste for the 1st month (2.50) increased to a maximum score of 4.10 during the

3rd month and 3.33 for the 4th month. The mean score was 2.63 for the 6th month, the minimum score for taste being 2.50 for the 1st month. Under refrigerated storage taste increased from 1st month (2.67) to 3.97 for the 3rd and 4th month followed by 3.33 for the 5th month which then reduced to 3.10 for the 6th month. Here also the minimum score for taste being 2.67 for the first month. The candy stored in glass bottle showed better taste under refrigerated condition except for the 2nd and 3rd month of storage where the mean score for taste was higher for candy stored in ambient condition (3.30 and 4.10 respectively).

The changes in the acceptability of candy stored in glass bottle under ambient and refrigerated conditions are illustrated in Fig.10 and 11 respectively.

The changes in the acceptability of candy stored in polypropylene bottle under ambient and refrigerated condition was evaluated at monthly intervals for a period of 6 months and the results are presented in Table 30.

Under ambient storage condition mean scores for appearance increased from 3.40 for the 1st month to a maximum score of 3.97 for the 3rd month of storage which then reduced to a minimum score of 2.73 for the 6th month. Under refrigerated storage maximum score for appearance was for the 4th month (3.97) and a minimum score of 2.40 for the 6th month.

Mean scores for the colour of candy in polypropylene bottle stored under ambient condition showed gradual decline by the 6th month. Maximum score of 3.70 for the 1st month decreased to a minimum score of 2.37 for the 6th month. Under refrigerated condition the acceptability of the product with regard to colour varied with different storage periods. Maximum score for colour was for the first month (3.83) followed by 4th month (3.77) and then 3rd month (3.57). Minimum

Table 30. Organoleptic evaluation of candy stored in polypropylene bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.40 | 3.67 | 3.73 | 3.33 | 3.97 | 3.70 | 3.57 | 3.97 | 2.87 | 3.20 | 2.73 | 2.40 |
| Colour | 3.70 | 3.83 | 3.67 | 3.53 | 3.50 | 3.57 | 3.00 | 3.77 | 2.87 | 3.13 | 2.37 | 2.23 |
| Flavour | 3.33 | 3.07 | 3.07 | 3.03 | 3.03 | 3.10 | 3.17 | 3.47 | 3.27 | 3.80 | 2.70 | 2.83 |
| Texture | 2.73 | 2.60 | 3.73 | 3.73 | 4.33 | 4.20 | 4.17 | 4.13 | 4.53 | 4.37 | 4.23 | 3.90 |
| Taste | 2.67 | 2.23 | 3.07 | 3.80 | 3.70 | 3.67 | 3.00 | 3.43 | 2.43 | 3.07 | 2.23 | 3.20 |

**Fig. 10. Organoleptic evaluation of candy stored in glass bottle under ambient condition**

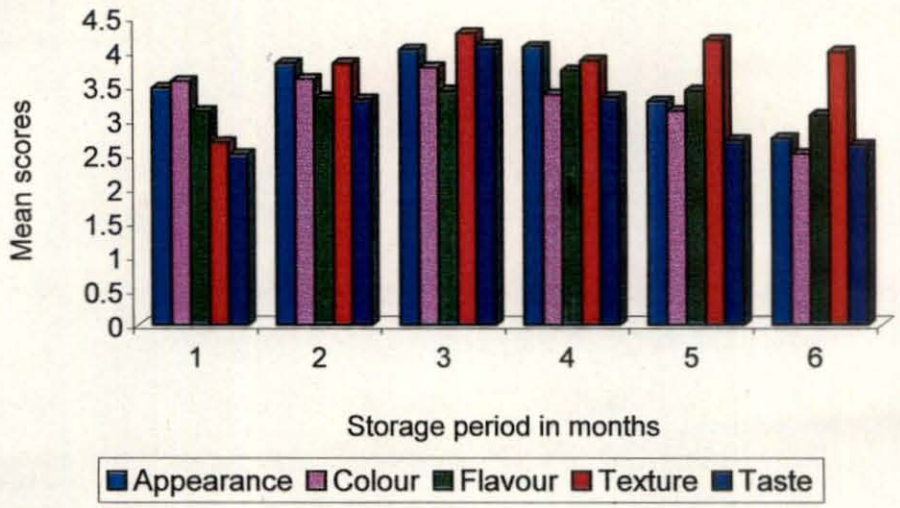
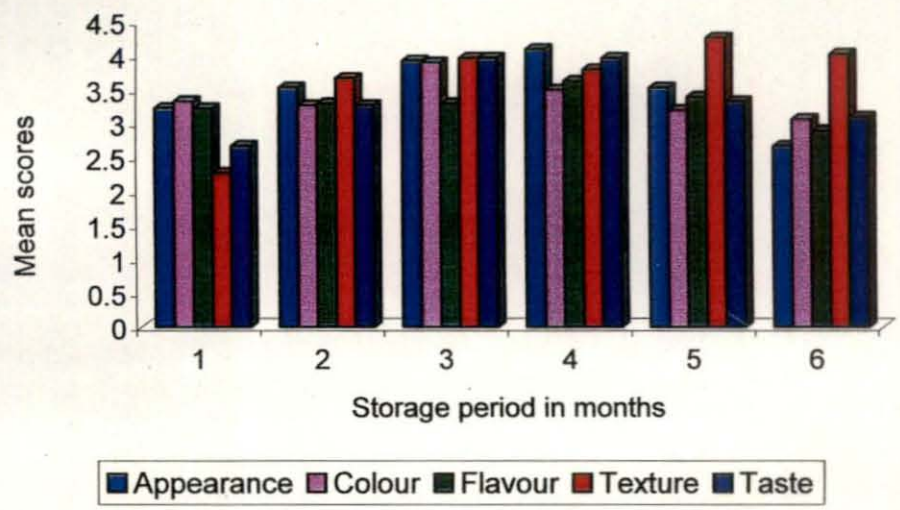



**Fig. 11. Organoleptic evaluation of candy stored in glass bottle under refrigerated condition**



score for colour was for the 6th month (2.23). Colour of the products stored in polypropylene bottle was more acceptable under refrigerated condition except for the 2nd and 6th month of storage where products stored under ambient condition secured high scores (3.67 and 2.37 respectively) for colour.

Mean score for flavour under ambient condition storage was maximum for the first month (3.33) which reduced to3.03 by the 3rd month. For the 4th month the score increased to 3.17 and by the 5th month 3.27. Minimum score for flavour was for the 6th month (2.70). Under refrigerated condition maximum score for flavour was for the 5th month (3.80) and the minimum score was for the 6th month (2.83). Flavour was more acceptable under refrigerated storage condition except for the 1st and 2nd month where the product stored under ambient condition secured higher scores (3.33 and 3.07 respectively) for flavour.

Regarding texture of candy stored in polypropylene bottle under ambient storage condition maximum score was for the 5th month (4.53) followed by the 3rd month (4.33). The minimum score for texture was for the 1st month (2.73). Under refrigerated storage maximum score for texture was for the 5th month (4.37) followed by the 3rd month (4.20). The minimum score for texture was for the first month (2.60).

Taste of the stored candy in polypropylene bottle under ambient condition was found to increase with storage time up to 3rd month which then reduced. The mean score of 2.67 for taste for the first month increased to a maximum score of 3.70 in the 3rd month which then reduced to a minimum score of 2.23 by the 6th month. Under refrigerated condition maximum score for taste was for the 2nd month (3.80) which then showed a gradual decrease. The minimum

score for taste was for the first month (2.23). During 2nd, 4th, 5th and 6th month of storage refrigerated products secured higher scores for taste when compared to ambient condition stored products.

The changes in the acceptability of candy stored in polypropylene bag under ambient and refrigerated condition was evaluated at monthly intervals for a period of 6 months and the results are presented in Table 31.

Appearance of candy under ambient storage condition secured the highest score during the 3rd month (3.90) and the least score was for the 6th month (2.20). Under refrigerated condition also the maximum score was for the 3rd month (3.83) and the least score was for the 6th month (2.63). Higher scores for appearance was observed in products under ambient storage up to 3rd month and from 4th to 6th month refrigerated products secured higher scores.

Regarding colour there observed a gradual increase in the mean scores up to 3rd month which then decreased. Under ambient storage condition the mean score of 3.50 increased to a maximum score of 4.03 by the 3rd month which then gradually reduced to a minimum score of 2.13 by the 6th month. Under refrigerated condition also maximum score for colour was for the 3rd month (3.83) and the minimum score was for the 6th month (2.53). For the first three months mean scores for colour was higher for the products stored in ambient condition but for the 4th, 5th and 6th month refrigerated products secured higher mean score for colour.

Under ambient storage condition of candy in polypropylene bag the mean score for flavour for the 1st month (2.67) increased to 3.00 by the 2nd month but reduced to 2.83 during the 3rd month and a maximum score of 3.13 was attained during the 4th month. The minimum score was for the 6th month (2.47). Under refrigerated condition the flavour gradually increased to a maximum score

Table 31. Organoleptic evaluation of candy stored in polypropylene bag (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.67 | 3.60 | 3.60 | 3.57 | 3.90 | 3.83 | 3.13 | 3.80 | 2.53 | 2.80 | 2.20 | 2.63 |
| Colour | 3.50 | 3.27 | 3.73 | 3.27 | 4.03 | 3.83 | 3.10 | 3.57 | 2.60 | 2.67 | 2.13 | 2.53 |
| Flavour | 2.67 | 2.90 | 3.00 | 3.07 | 2.83 | 3.33 | 3.13 | 3.27 | 2.77 | 3.13 | 2.47 | 2.67 |
| Texture | 3.00 | 2.77 | 3.73 | 3.67 | 4.33 | 4.23 | 4.43 | 4.10 | 4.53 | 4.40 | 4.40 | 3.50 |
| Taste | 2.77 | 2.47 | 3.60 | 3.83 | 3.77 | 3.63 | 2.50 | 3.67 | 2.33 | 3.10 | 1.97 | 2.53 |

of 3.33 for the 3rd month which then gradually reduced to 2.67 by the 6th month. When compared to product stored under ambient condition, products stored under refrigerated conditions in polypropylene bag secured higher scores through out the storage period.

Regarding texture of the product under ambient condition storage, the mean scores gradually increased from 3.00 for the 1st month to a maximum score of 4.53 by the 5th month. Under refrigerated condition also the maximum score for texture was for the 5th month (4.40) and the minimum score was for the 1st month (2.77). Mean scores for texture was higher for product stored under ambient condition throughout the storage period in polypropylene bag.

Taste of product under ambient storage in polypropylene bag gradually increased from a mean score of 2.77 for the 1st month to a maximum of score of 3.77 by the 3rd month and then reduced to a minimum of 1.97 by the 6th month. Under refrigerated condition, maximum score for taste was 3.83 for the 2nd month and the minimum score was for the 1st month (2.47).

The effect of storage period on the organoleptic qualities of candy stored under ambient condition was analysed statistically through DMRT and the results are presented in Table 32.

Table 32. Effect of storage periods on the organoleptic qualities of candy stored under ambient condition

| Storage period (month) | Mean scores | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | 3.51 $^{a}$ | 3.59 $^{a}$ | 3.04 $^{a}$ | 2.80 $^{c}$ | 2.65 $^{cd}$ |
| 2 | 3.72 $^{ab}$ | 3.67 $^{a}$ | 3.13 $^{a}$ | 3.76 $^{b}$ | 3.32 $^{b}$ |
| 3 | 3.97 $^{a}$ | 3.77 $^{a}$ | 3.10 $^{a}$ | 4.31 $^{a}$ | 3.86 $^{a}$ |
| 4 | 3.59 $^{ab}$ | 3.16 $^{b}$ | 3.34 $^{b}$ | 4.16 $^{a}$ | 2.94 $^{bc}$ |
| 5 | 2.89 $^{c}$ | 2.87 $^{b}$ | 3.16 $^{b}$ | 4.41 $^{a}$ | 2.49 $^{cd}$ |
| 6 | 2.55 $^{c}$ | 2.33 $^{c}$ | 2.75 $^{c}$ | 4.21 $^{a}$ | 2.28 $^{c}$ |

Values having different superscripts vary significantly at 5% level

It is evident from the table that the quality attribute - appearance of candy had a significant increase from the 1st to the 3rd month where it secured the highest mean score of 3.97. Variation in the mean score between 1st and 2nd month was not significant. A decrease in the mean scores was observed from 4th month onwards but the decrease was not significant between the 3rd and 4th month but by the 5th month the reduction was significant. The decrease in the mean scores for appearance from the fifth month was not significant. Eventhough there was an increase in the mean scores for colour up to the 3rd month, the increase was not statistically significant. A significant decrease in the mean scores for colour was observed between products stored for three months and four months and also between fifth and sixth months of storage.

There observed no significant difference with regard to flavour of the product up to 5th month but a significant decrease in flavour was observed by 6th month of storage.

Regarding texture of candy significant increase in mean scores was observed only up to the 3rd month of storage. A significant increase in taste was observed only up to 3rd month of storage.

Effect of storage period on the organoleptic qualities of candy stored under refrigerated condition was studied and the results are presented in Table 33.

Table 33. Effect of storage periods on the organoleptic qualities of candy stored under refrigerated condition

| Storage period (month) | Mean scores | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | $3.50^{bc}$ | $3.48^{ab}$ | $3.07^{bc}$ | $2.55^{d}$ | $2.46^{d}$ |
| 2 | $3.48^{bc}$ | $3.36^{ab}$ | $3.13^{ab}$ | $3.69^{c}$ | $3.63^{ab}$ |
| 3 | $3.82^{ab}$ | $3.77^{a}$ | $3.24^{ab}$ | $4.13^{ab}$ | $3.76^{a}$ |
| 4 | $3.96^{a}$ | $3.61^{a}$ | $3.46^{a}$ | $4.01^{abc}$ | $3.69^{a}$ |
| 5 | $3.18^{c}$ | $3.00^{bc}$ | $3.44^{a}$ | $4.35^{a}$ | $3.17^{bc}$ |
| 6 | $2.57^{d}$ | $2.61^{c}$ | $2.80^{c}$ | $3.81^{bc}$ | $2.94^{c}$ |

Values having different superscripts vary significantly at 5% level

Under refrigerated storage a gradual increase in the mean scores for appearance was noted up to the 4th month but the increase was significant only between 1st and 4th month. From 4th month onwards a gradual decrease in the mean scores noted was significant.

There was no significant variation with regard to colour up to 4th month of storage but a significant decrease in the acceptance of colour was observed between 4th and 5th month of storage.

Regarding flavour, a gradual increase was noted with storage period up to 4th month but significant increase was only between first and 4th month of storage. From 4th month a significant decrease in flavour was noted by the 6th month of storage.

Texture showed a significant improvement up to the 3rd month. From 3rd to 5th month there was no significant variation in texture, but a significant decrease was observed by 6th month of storage.

Regarding taste a significant increase was noted during the 2nd month of storage. From 2nd month to 4th month no significant variation in the taste was observed. But a significant decrease in taste was observed between 4th and 5th month of storage.

The effect of the different packaging systems used for the storage viz., glass bottle, polypropylene bottle .and polypropylene bag on the organoleptic qualities of candy stored under ambient and refrigerated condition was studied and the results are presented in Table 34.

Appearance, with regard to packaging systems showed no significant difference between glass bottle and polypropylene bottle and polypropylene bag

Table 34. Effect of packaging systems on the organoleptic qualities of candy stored under ambient and refrigerated conditions

| Package | Mean scores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Appearance | | Colour | | Flavour | | Texture | | Taste | |
| | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated |
| Glass bottle | 3.57[a] | 3.50[a] | 3.32[a] | 3.38[a] | 3.35[a] | 3.29[a] | 3.80[b] | 3.67[a] | 3.09[a] | 3.39[a] |
| Polypropylene bottle | 3.38[ab] | 3.38[a] | 3.19[a] | 3.34[a] | 3.10[b] | 3.22[ab] | 3.95[ab] | 3.82[a] | 2.85[a] | 3.23[a] |
| Polypropylene bag | 3.17[b] | 3.37[a] | 3.18[a] | 3.19[a] | 2.81[c] | 3.06[b] | 4.07[a] | 3.78[a] | 2.82[a] | 3.21[a] |

Values having different superscript differ significantly at 5% level

but a significant difference was noted in the appearance of candy stored in glass bottle and polypropylene bag under ambient storage condition. No significant variation was observed in appearance under refrigerated condition with regard to packaging system. There was no significant difference in colour both under ambient and refrigerated storage with different packaging systems. With regard to flavour under ambient condition a significant variation was noted between the packaging systems. The maximum flavour was for products stored in glass bottle followed by polypropylene bottle but under refrigerated condition there was no significant variation in flavour in products stored in glass bottle and polypropylene bottle but a significant variation in flavour was observed in products in glass bottle and polypropylene bag, the maximum flavour being in products in glass bottle. A significant increase in the texture was noted for products in polypropylene bag when compared to glass bottle under ambient storage condition but under refrigerated storage the variations observed in texture was not significant with regard to packaging systems. No significant variation in the taste of the candy stored in different packaging systems was observed under both ambient and refrigerated storage.

The changes in the acceptability of preserve stored in glass bottle under ambient and refrigerated conditions were evaluated at monthly intervals for a period of 6 months and the results are presented in Table 35.

As evident from the table the mean scores for appearance of the preserve stored in glass bottle under ambient storage reduced from 3.47 in the 1$^{st}$ month to 3.43 in the second month. From the 2$^{nd}$ month onwards a gradual increase in the mean score was found with a maximum of 4.67 by the 6$^{th}$ month. The mean

Table 35. Organoleptic evaluation of preserve stored in glass bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.47 | 3.37 | 3.43 | 3.40 | 3.77 | 3.47 | 4.07 | 3.93 | 4.27 | 4.40 | 4.67 | 4.73 |
| Colour | 3.23 | 3.30 | 3.43 | 3.30 | 3.70 | 3.73 | 3.70 | 3.70 | 3.90 | 4.20 | 4.40 | 4.43 |
| Flavour | 3.23 | 3.03 | 3.17 | 3.30 | 3.17 | 3.23 | 3.17 | 3.30 | 3.23 | 3.43 | 3.30 | 3.30 |
| Texture | 3.40 | 3.03 | 3.27 | 2.93 | 3.57 | 3.10 | 3.83 | 3.67 | 4.00 | 4.17 | 4.23 | 4.40 |
| Taste | 2.93 | 2.30 | 3.67 | 3.13 | 3.87 | 3.27 | 3.80 | 3.57 | 4.23 | 4.03 | 4.67 | 4.53 |

score increased gradually from a minimum of 3.37 in the first month to a maximum score of 4.73 for the 6th month under refrigerated condition. The acceptability in terms of appearance was higher in the ambient condition stored product up to the 4th month of storage and then for the 5th and 6th month the refrigerated product was found to have higher score for appearance.

The mean score obtained for colour was minimum for the first month (3.23) which increased to a maximum of 4.40 by the 6th month of storage under ambient condition. Under refrigerated storage the mean scores were same for the 1st (3.30) and 2nd month (3.30) of storage and then increased to a mean score of 3.73 by the 3rd month. During the 4th month a decrease in the mean score was noted (3.70) and then a gradual increase to 4.20 for the 5th and 4.43 for the 6th month. The stored preserve showed better colour under refrigerated storage except for the 2nd and 4th month of storage. During the 2nd month preserve stored under the ambient condition obtained higher mean score (3.43) compared to the refrigerated product (3.30).

Regarding the quality, flavour the mean score obtained during the 1st month (3.23) reduced to 3.17 for the 2nd month and then remained the same up to the 4th month and then increased during the 5th month (3.23) with a maximum score of 3.30 by the 6th month under ambient condition. Under refrigerated condition the mean score for the first month (3.03) increased to 3.30 for the 2nd month and then reduced to 3.23 for the 3rd month. An increase was observed during 4th and 5th month and then reduced to 3.30 by the 6th month of storage. The stored product showed better flavour under refrigerated storage from the 2nd to the 5th month but

for the 1st month the product stored in ambient condition had better flavour and for the 6th month the product did not vary in their acceptability with regard to flavour.

The mean score for texture reduced from 3.40 in the 1st month to a minimum of 3.27 in the 2nd month and then a gradual increase in the score was observed reaching a maximum score of 4.23 by the 6th month of storage under ambient condition. Under refrigerated condition the mean score reduced from 3.03 in the first month to a minimum of 2.93 in the 2nd month and then onwards an increasing trend was seen attaining the maximum score of 4.40 by the 6th month. A better acceptability for texture was observed in preserve stored in ambient condition up to the 4th month of storage but during the 5th and 6th month the texture of the refrigerated product was more acceptable.

A gradual increase in the mean score for taste was observed with the advance of the storage period under ambient condition except for the 4th month where the mean score reduced to 3.80 from 3.87 in the 3rd month. Under refrigerated storage the mean score showed a gradual increase from the 1st to the 6th month of storage. Both under ambient and refrigerated conditions the minimum and maximum scores were obtained during the 1st and 6th month of storage respectively. Products stored under ambient condition was more acceptable with regard to taste when compared to the refrigerated products.

The changes in the acceptability of preserve stored in glass bottle under ambient and refrigerated conditions are illustrated in Fig.12 and 13 respectively.

The changes in the acceptability of preserve stored in polypropylene bottle under ambient and refrigerated storage conditions was evaluated at monthly intervals for a period of 6 months and the results are presented in Table 36.

**Fig. 12. Organoleptic evaluation of preserve stored in glass bottle under ambient condition**

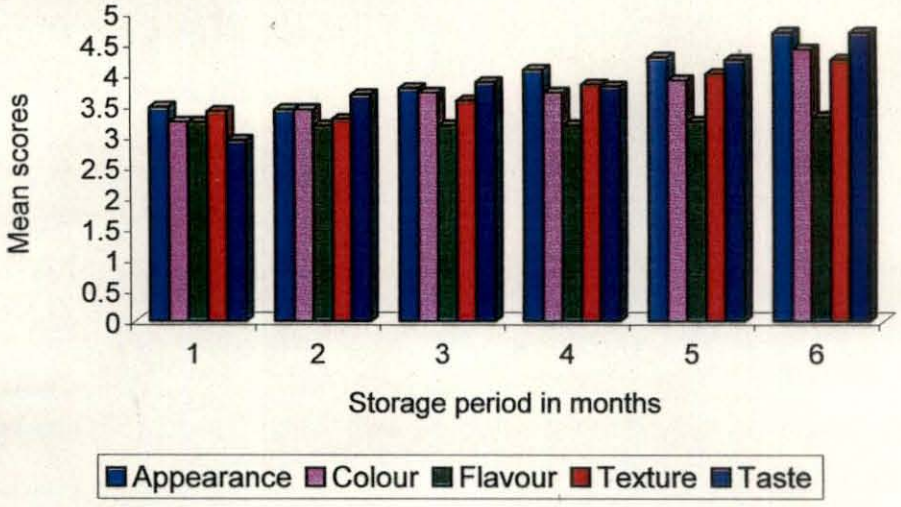



**Fig. 13. Organoleptic evaluation of preserve stored in glass bottle under refrigerated condition**

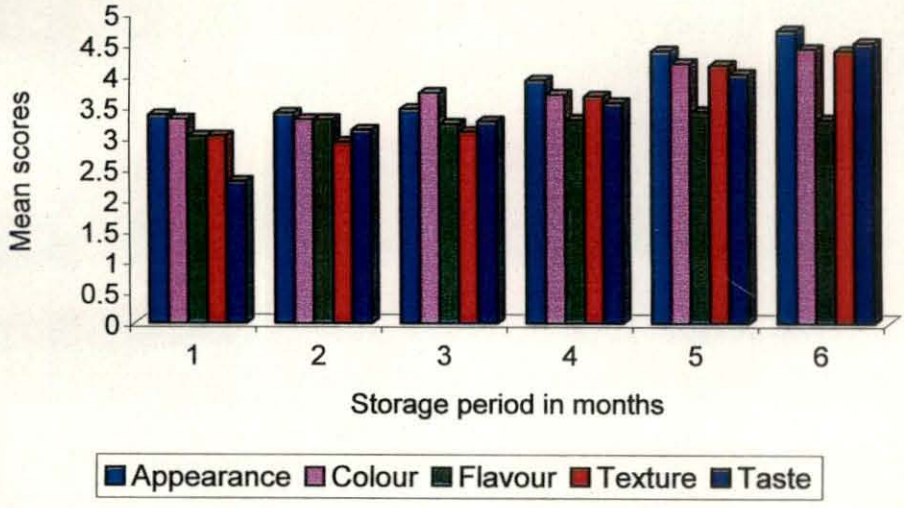


Table 36. Organoleptic evaluation of preserve stored in polypropylene bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.47 | 3.43 | 3.67 | 3.60 | 3.80 | 4.03 | 4.10 | 4.07 | 4.00 | 4.17 | 4.43 | 4.33 |
| Colour | 3.33 | 3.20 | 3.57 | 3.17 | 3.57 | 3.67 | 3.97 | 3.70 | 3.80 | 4.07 | 4.23 | 4.43 |
| Flavour | 2.93 | 3.07 | 3.13 | 3.53 | 3.20 | 3.70 | 3.00 | 3.33 | 3.23 | 3.27 | 3.27 | 3.30 |
| Texture | 3.27 | 3.27 | 3.37 | 3.03 | 3.77 | 3.20 | 3.90 | 3.57 | 4.33 | 4.63 | 4.40 | 4.40 |
| Taste | 2.77 | 2.47 | 3.10 | 3.07 | 3.57 | 3.57 | 3.57 | 3.50 | 4.13 | 4.10 | 4.13 | 4.30 |

As shown in the table the mean score for appearance increased from a minimum of 3.47 for the 1st month to a maximum of 4.43 by the 6th month, under ambient condition. Under refrigerated condition also a similar trend was observed with minimum score of 3.43 for the 1st month and 4.33 for the 6th month. The appearance of the stored product was more acceptable under ambient storage condition except for the 3rd and 5th month of storage where the refrigerated samples had higher scores.

Regarding colour of the preserve stored under ambient condition the minimum mean score (3.33) was for the 1st month which increased to a maximum score (4.23) by the 6th month. Under refrigerated condition the mean score reduced to a minimum of 3.17 during the 2nd month from 3.20 during the 1st month. From the 2nd month onwards a gradual increase in the score was observed with the maximum score of 4.43 for the 6th month. The colour of the product stored under ambient condition obtained higher mean scores during the 1st, 2nd and 4th month of storage but for the 3rd, 5th and 6th month of storage the refrigerated product had higher scores.

Mean scores for the flavour of the preserve stored under ambient condition increased gradually from a minimum of 2.93 for the 1st month to 3.20 by the 3rd month and it reduced to 3.00 in the 4th month. Then onwards it increased to 3.23 by the 5th month and the maximum of 3.27 by the 6th month. Under refrigerated condition also the mean scores gradually increased from a minimum of 3.07 in the 1st month to a maximum of 3.70 in the 3rd month and then reduced to 3.33 in the 4th and to 3.27 in the 5th month. But for the 6th month the mean score increased to 3.30. The refrigerated product was found to have better flavour throughout the storage.

Regarding the texture of the preserve stored under ambient condition the mean scores increased gradually from a minimum in the first month (3.27) to a maximum by the 6th month (4.40). The mean score for texture for preserve stored under refrigerated condition was 3.27 for the 1st month which reduced to a minimum of 3.03 in the 2nd month. This then gradually increased to a maximum of 4.63 by the 5th month. For the 6th month it reduced to 4.40. The texture of the product stored in ambient condition obtained higher scores compared to the refrigerated samples during storage except for the 5th month when the refrigerated product obtained higher score.

The taste of the product stored in ambient condition was found to have a minimum mean score of 2.77 during the 1st month which increased to 4.13 by the 5th and 6th month of storage. For the refrigerated product the mean score for taste was 2.47 for the 1st month which gradually increased to 3.57 for the 3rd month. For the 4th month it reduced to 3.50 but then increased to 4.10 by the 5th and obtained a maximum score of 4.30 by the 6th month. The score for taste was higher in the ambient stored product during the 1st, 2nd, 4th and 5th month of storage but during the 6th month the refrigerated product had higher scores. During the 3rd month there was no change in the acceptability of the product stored under ambient and refrigerated conditions.

The changes in the acceptability of preserve stored in polypropylene bag under ambient and refrigerated condition was evaluated at monthly intervals for a period of 6 months and the results are presented in Table 37.

It is clear from the table that the mean scores for appearance was minimum during the 1st month (3.33) which increased to a maximum of 4.17 by

Table 37. Organoleptic evaluation of preserve stored in polypropylene bag (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.33 | 3.50 | 3.70 | 3.17 | 3.70 | 3.73 | 3.87 | 3.63 | 4.17 | 4.30 | 4.13 | 4.50 |
| Colour | 2.93 | 3.17 | 3.57 | 3.23 | 3.67 | 3.83 | 3.83 | 3.77 | 4.33 | 4.00 | 3.93 | 4.30 |
| Flavour | 3.03 | 3.27 | 3.17 | 3.33 | 3.27 | 3.13 | 3.27 | 3.27 | 3.33 | 3.10 | 3.03 | 3.23 |
| Texture | 3.27 | 2.57 | 3.47 | 2.80 | 4.03 | 3.27 | 4.33 | 3.47 | 4.47 | 4.00 | 4.67 | 4.40 |
| Taste | 3.03 | 2.37 | 3.40 | 2.67 | 3.70 | 3.50 | 3.63 | 3.70 | 4.17 | 3.80 | 3.90 | 4.77 |

the 5th month and then reduced to 4.13 by the 6th month. Under refrigerated storage the minimum score (3.17) was obtained for the 2nd month and the maximum (4.50) was for the 6th month. The appearance of the refrigerated product was better during the storage except for the 2nd and 4th month where the product stored in ambient condition was better accepted.

The mean scores for colour of the preserve stored under ambient condition was found to increase gradually with the advance of the storage period up to the 5th month. The minimum score was for the 1st month (2.93) and maximum for the 5th month (4.33). For the 6th month it reduced to 3.93. For the refrigerated product the mean score gradually increased from a minimum of 3.17 for the 1st month to 3.83 by the 3rd month. It reduced to 3.77 by the 4th month and then increased to a maximum score of 4.30 by the 6th month. For the 1st, 3rd and 6th month of storage the refrigerated product obtained higher scores whereas for the 2nd, 4th and 5th months product stored in ambient condition obtained higher scores with regard to colour.

The flavour of the preserve, stored in ambient condition was found to increase gradually with the storage period up to the 5th month with maximum mean score (3.33). Under refrigerated storage the minimum score was for the 5th month and maximum (3.33) for the 2nd month.

Regarding the texture of the product the mean scores increased gradually from a minimum of 3.27 for the 1st month to a maximum of 4.67 by the 6th month and 2.57 to 4.40 by the 6th month under ambient and refrigerated storage conditions respectively. The texture of the ambient stored preserve was better accepted throughout the storage period.

The mean scores for taste gradually increased from a minimum of 3.03 in the first month to 3.70 by the 3rd month and then reduced to 3.63 during the 4th month. For the 5th month the taste score increased to a maximum of 4.17 and then reduced to 3.90 by the 6th month. The mean scores of the refrigerated product gradually increased from the minimum score of 2.37 for the first month to 4.77 by the 6th month. The preserve stored in ambient condition was found to have better taste except for the 4th and 6th month of storage where the refrigerated product scored higher.

The effect of storage period on the organoleptic qualities of preserve stored under ambient condition was statistically analysed through DMRT and the results obtained are presented in Table 38.

Table 38. Effect of storage periods on the organoleptic qualities of preserve stored under ambient condition

| Storage period (month) | Mean scores | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | $3.42^{e}$ | $3.16^{d}$ | $3.06^{a}$ | $3.31^{c}$ | $2.91^{d}$ |
| 2 | $3.60^{de}$ | $3.52^{cd}$ | $3.16^{a}$ | $3.37^{c}$ | $3.39^{c}$ |
| 3 | $3.76^{cd}$ | $3.65^{bc}$ | $3.21^{a}$ | $3.79^{b}$ | $3.71^{b}$ |
| 4 | $4.01^{bc}$ | $3.83^{abc}$ | $3.15^{a}$ | $4.02^{b}$ | $3.67^{bc}$ |
| 5 | $4.15^{ab}$ | $4.01^{ab}$ | $3.26^{a}$ | $4.27^{a}$ | $4.18^{a}$ |
| 6 | $4.41^{a}$ | $4.19^{a}$ | $3.20^{a}$ | $4.43^{a}$ | $4.23^{a}$ |

Values having different superscripts vary significantly at 5% level

It is clear from the table that eventhough there was a gradual increase in the mean scores obtained for appearance with each month a significant increase in the mean scores for appearance was observed in the 3rd month and between 3rd and 5th month. The effect of storage on the colour of the product also showed a monthly increase in the mean scores but the increase in mean score was only significant between 1st and 3rd month and between 3rd and 6th month.

No significant variation in the flavour of the preserve was observed with the storage period. There was a monthly increase in the mean scores for texture of the product but significant increase was observed only between 2nd and 3rd month and 4th and 5th month.

Regarding the taste of the product there was a significant increase in the mean scores from the 1st to the 3rd month of storage but a decrease in the mean score obtained for 4th month was not significant but a significant increase was observed for the 5th month but an increase in the mean score during the 6th month of storage was not significant.

The effect of storage period on the organoleptic qualities of preserve stored under refrigerated condition was statistically analysed through DMRT and the results obtained are presented in Table 39.

Table 39. Effect of storage periods on the organoleptic qualities of preserve stored under refrigerated condition

| Storage period (month) | Mean scores | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | $3.43^{c}$ | $3.22^{d}$ | $3.12^{a}$ | $2.96^{c}$ | $2.38^{e}$ |
| 2 | $3.39^{c}$ | $3.23^{d}$ | $3.39^{a}$ | $2.92^{c}$ | $2.96^{d}$ |
| 3 | $3.74^{bc}$ | $3.74^{c}$ | $3.35^{a}$ | $3.19^{c}$ | $3.45^{c}$ |
| 4 | $3.88^{b}$ | $3.72^{c}$ | $3.30^{a}$ | $3.57^{b}$ | $3.59^{c}$ |
| 5 | $4.29^{a}$ | $4.09^{b}$ | $3.27^{a}$ | $4.27^{a}$ | $3.98^{b}$ |
| 6 | $4.52^{a}$ | $4.39^{a}$ | $3.28^{a}$ | $4.40^{a}$ | $4.53^{a}$ |

Values having different superscripts vary significantly at 5% level

As shown in the table the mean scores for appearance did not vary significantly up to the 3rd month of storage. But significant increase in the mean scores was observed between the 1st and 4th month of storage and also between the 4th and 5th month of storage.

For the 1st two months of storage the mean score for colour did not vary significantly. But between the 2nd and 3rd month the score significantly increased from 3.23 to 3.74 by the 3rd month. A reduction in the mean score during the 4th month was not significant but a significant monthly increase in the mean scores was observed from 4th month onwards. The mean scores for flavour did not vary significantly with the storage period.

For the first 3 months changes in the texture of the stored product was not significant but the acceptability of texture significantly increased from 3rd month to 5th month of storage.

The mean scores for taste was found to increase significantly between every month of storage up to the 3rd month. An increase in the mean scores for the 4th month was not significant but from 5th month onwards taste increased significantly.

The effect of different packaging systems used for the storage viz., glass bottle, polypropylene bottle and polypropylene bag on the organoleptic qualities of preserve stored under ambient and refrigerated condition was studied and the results are presented in Table 40.

As revealed from the table the different packaging systems were found to have no significant effect on the appearance, colour and flavour of the preserve stored under both ambient and refrigerated conditions.

Under ambient storage the texture of preserve stored in glass bottle and polypropylene bottle did not vary significantly. But the acceptability of texture in polypropylene bag was significantly high when compared to the product stored in glass bottle and polypropylene bottle. Under refrigerated storage there was no

Table 40. Effect of packaging systems on the organoleptic qualities of preserve stored under ambient and refrigerated conditions

| Package | Mean scores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Appearance | | Colour | | Flavour | | Texture | | Taste | |
| | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated |
| Glass bottle | 3.95[a] | 3.88[a] | 3.73[a] | 3.78[a] | 3.21[a] | 3.27[a] | 3.72[b] | 3.55[ab] | 3.86[a] | 3.47[a] |
| Polypropylene bottle | 3.91[a] | 3.94[a] | 3.75[a] | 3.71[a] | 3.13[a] | 3.37[a] | 3.84[b] | 3.68[a] | 3.55[b] | 3.50[a] |
| Polypropylene bag | 3.82[a] | 3.81[a] | 3.71[a] | 3.72[a] | 3.18[a] | 3.22[a] | 4.04[a] | 3.42[b] | 3.64[b] | 3.47[a] |

Values having different superscripts differ significantly at 5% level

significant variation in the texture of the products in glass bottle and polypropylene bottle but the mean score significantly reduced for the product stored in polypropylene bag when compared to glass bottle and polypropylene bottle.

Preserve stored in glass bottle under ambient condition was found to have the best taste compared to the product stored in the other packaging systems. No significant variation was observed between the products in polypropylene bottle and polyprolylene bag. Under refrigerated storage condition there was no significant variation in taste with the packaging systems.

The changes in the acceptability of the tutifruiti stored in glass bottle under ambient and refrigerated condition was evaluated at monthly intervals for a period of six months and the results are presented in Table 41.

As observed from the table the mean score for the appearance of tutifruiti stored under ambient condition gradually increased from a minimum of 3.33 in the 1$^{st}$ month to 4.23 by the 4$^{th}$ month of storage, then reduced to 4.20 for the 5$^{th}$ month and increased to the maximum score of 4.70 by the 6$^{th}$ month of storage. Under refrigerated storage the mean scores gradually increased from a minimum of 3.07 during the 1$^{st}$ month to the maximum score of 4.63 by the 6$^{th}$ month. The tutifruiti stored in ambient condition showed better taste throughout the storage period.

The mean score for colour was found to increase gradually with the storage period under both conditions with the ambient stored product having higher scores. The minimum score was for the 1$^{st}$ month under both ambient (3.23) and refrigerated (2.67) conditions and the maximum score was for the 6$^{th}$ month of storage (4.67 and 4.60 respectively).

Table 41. Organoleptic evaluation of tutifruiti stored in glass bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.33 | 3.07 | 3.47 | 3.37 | 3.83 | 3.57 | 4.23 | 3.97 | 4.20 | 4.20 | 4.70 | 4.63 |
| Colour | 3.23 | 2.67 | 3.73 | 3.47 | 3.90 | 3.77 | 4.27 | 3.90 | 4.40 | 4.17 | 4.67 | 4.60 |
| Flavour | 3.10 | 3.03 | 3.13 | 2.90 | 3.17 | 3.10 | 3.23 | 3.20 | 3.03 | 3.13 | 3.17 | 3.23 |
| Texture | 3.17 | 2.77 | 3.50 | 2.80 | 3.67 | 3.17 | 4.00 | 3.70 | 4.20 | 4.07 | 4.70 | 4.40 |
| Taste | 3.17 | 2.23 | 3.40 | 3.20 | 4.03 | 3.73 | 4.40 | 3.80 | 4.47 | 4.27 | 4.63 | 4.37 |

Regarding the flavour of the stored product under ambient condition the minimum mean score (3.03) was for the 5th month and maximum mean score (3.23) was for the 4th month. The mean score under ambient condition gradually increased up to the 4th month than reduced during the 5th month and then increased by the 6th month. Under refrigerated storage for the first month the mean score for flavour was 3.03 which reduced to a minimum of 2.90 by the 2nd month and then onwards increased till 4th month. By the 5th month the mean score reduced to 3.13 and then increased to 3.23 by the 6th month.

The mean scores for texture was found to increase gradually from the first to the 6th month of storage under both ambient and refrigerated storage. The minimum scores of 3.17 and 2.77 and maximum scores of 4.70 and 4.40 was found in the 1st and 6th month of storage under both ambient and refrigerated conditions respectively. The texture of the product stored under ambient condition was better accepted throughout the storage period.

With regard to taste also a similar trend of gradual increment in the mean scores was observed with the advance of the storage period both in the ambient and refrigerated storage conditions and the taste was more acceptable for products kept in ambient conditions.

The changes in the acceptability of tutifruiti stored in glass bottle under ambient and refrigerated conditions are illustrated in Fig.14 and 15 respectively.

The changes in the acceptability of the tutifruiti stored in polypropylene bottle under ambient and refrigerated condition was evaluated at monthly intervals for a period of six months and the results are presented in Table 42.

**Fig. 14. Organoleptic evaluation of tutifruiti stored in glass bottle under ambient condition**

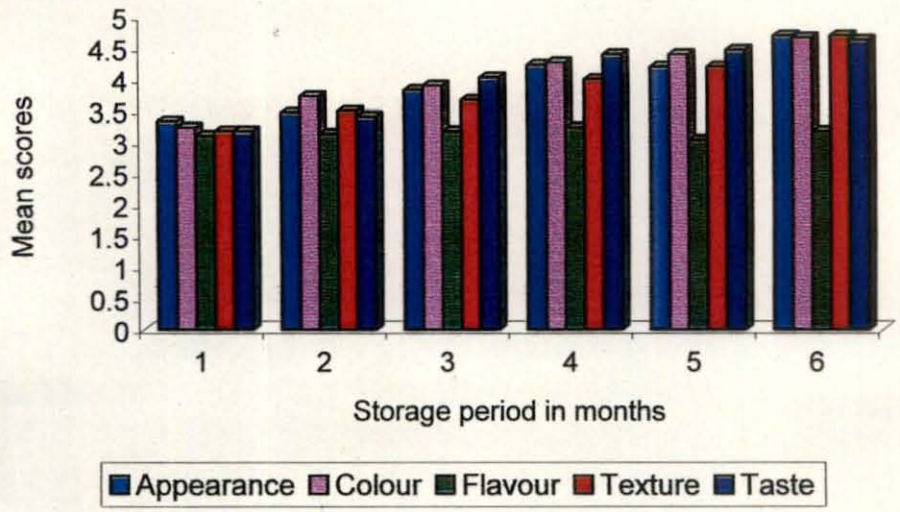



**Fig. 15. Organoleptic evaluation of tutifruiti stored in glass bottle under refrigerated condition**

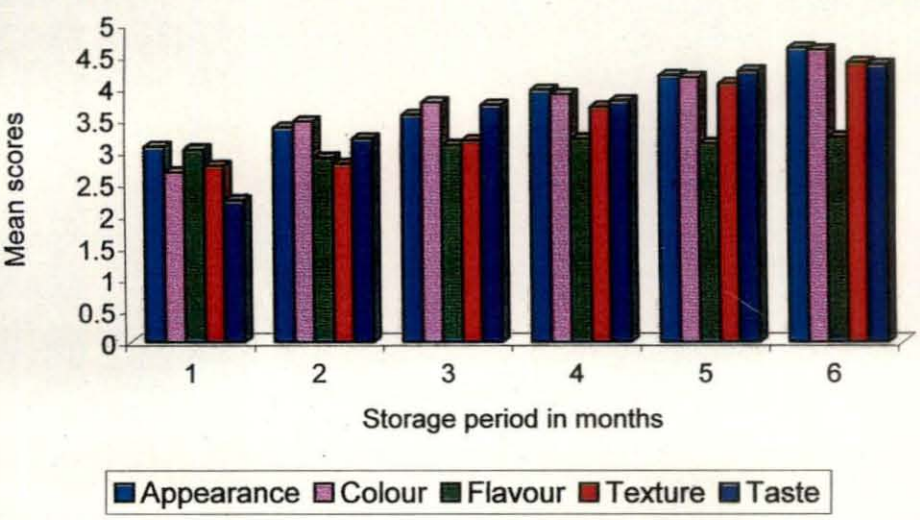


Table 42. Organoleptic evaluation of tutifruiti stored in polypropylene bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.33 | 3.37 | 3.70 | 3.43 | 3.93 | 3.43 | 4.13 | 4.10 | 4.30 | 4.17 | 4.30 | 4.13 |
| Colour | 3.13 | 3.13 | 3.80 | 3.60 | 3.77 | 3.43 | 3.97 | 3.90 | 4.33 | 4.03 | 4.10 | 3.97 |
| Flavour | 2.97 | 2.83 | 2.83 | 3.20 | 3.00 | 3.23 | 3.17 | 3.20 | 2.93 | 3.17 | 3.03 | 2.87 |
| Texture | 3.30 | 3.23 | 3.07 | 2.90 | 3.57 | 3.03 | 3.97 | 3.77 | 3.87 | 3.97 | 3.90 | 3.70 |
| Taste | 3.17 | 2.33 | 3.33 | 3.23 | 3.70 | 3.17 | 3.87 | 3.77 | 4.03 | 3.83 | 3.93 | 3.70 |

Under ambient storage condition the mean score for appearance gradually increased from a minimum score of 3.33 for the 1st month to a maximum score of 4.30 by the 5th month and remained the same for the 6th month also. Under refrigerated condition the mean score was 3.37 for the 1st month which gradually increased to a maximum score of 4.17 by the 5th month. For the 6th month it reduced to 4.13. The scores for appearance was observed to be higher in stored products under ambient conditions except for the 1st month where the refrigerated sample obtained a higher score.

Under ambient storage conditions, the colour of the product was found to have a minimum mean score of 3.13 during the 1st month which increased to 3.80 by the 2nd month. During the 3rd month it reduced to 3.77 and then increased gradually for the 4th and 5th months of storage. The maximum score (4.33) was observed during the 5th month which reduced to 4.10 by the 6th month. Under refrigerated condition the mean score for colour was the minimum (3.13) during the 1st and the maximum (4.03) during the 5th month of storage. Colour of tutifruiti was more acceptable under ambient condition storage compared to refrigerated storage.

Under ambient condition the minimum score for flavour was for the 1st month (2.97) and maximum score was for the 4th month (3.17). Under refrigerated condition the score for flavour gradually increased to a maximum of 3.23 by the 3rd month. The minimum score was for the first month.

Under both ambient and refrigerated storage the mean scores for texture reduced to a minimum of 3.07 and 2.90 respectively during the 2nd month of storage. For the refrigerated product the mean score increased gradually from the

2nd month onwards up to the 5th month which then reduced to 3.70 by the 6th month. Texture was found to be more acceptable for products stored under ambient conditions except for the 5th month where refrigerated products got a higher score.

The mean score for the taste of the tutifruiti stored under ambient condition showed gradual increase with the storage period up to the 5th month and then reduced by the 6th month. The minimum score of 3.17 and 2.33 was obtained during the 1st month both under ambient and refrigerated condition respectively. The maximum score 4.03 and 3.83 was obtained during the 5th month under ambient storage condition and refrigerated storage condition respectively. The taste of the ambient stored tutifruiti was better all throughout the storage compared to the refrigerated tutifruiti.

The changes in the acceptability of tutifruiti stored in polypropylene bag under ambient and refrigerated condition was evaluated at monthly intervals for a period of six months and the results are presented in Table 43.

The mean scores for appearance was found to be increasing with the storage period under ambient storage. The minimum (3.30) and maximum scores (4.10) was obtained during the 1st and 6th month of storage respectively. Under refrigerated storage the mean scores were same for the 1st and 2nd month of storage which increased to 3.90 by the 3rd and 4.03 by the 4th month. For the 5th month it reduced to 3.87 and then increased to a maximum score of 4.30 by the 6th month. The appearance of tutifruiti stored in ambient condition was more acceptable during the 1st, 2nd and 5th months of storage but for the 3rd, 4th and 6th months, appearance was better for the refrigerated products.

Table 43. Organoleptic evaluation of tutifruiti stored in polypropylene bag (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.30 | 3.13 | 3.50 | 3.13 | 3.70 | 3.90 | 4.00 | 4.03 | 4.07 | 3.87 | 4.10 | 4.30 |
| Colour | 3.13 | 3.13 | 3.43 | 3.37 | 3.90 | 3.50 | 4.00 | 3.93 | 4.13 | 3.83 | 3.90 | 4.13 |
| Flavour | 3.03 | 2.87 | 3.20 | 3.10 | 3.07 | 3.10 | 3.07 | 3.27 | 2.97 | 3.10 | 2.77 | 3.03 |
| Texture | 3.27 | 3.10 | 3.20 | 2.83 | 3.40 | 3.40 | 3.77 | 3.90 | 3.93 | 4.00 | 3.90 | 4.03 |
| Taste | 2.73 | 2.57 | 3.50 | 3.17 | 3.80 | 3.23 | 3.73 | 3.73 | 3.67 | 4.13 | 3.30 | 4.13 |

For the entire storage period the mean score for colour of the stored tutifruiti increased gradually from a minimum (3.13) to a maximum of 4.13 under refrigerated conditions but for the ambient stored product the gradual increment in the score was observed only up to the 5th month where it showed the maximum score 4.13 which then reduced to 3.90 by the 6th month. More acceptable colour was observed in the ambient condition stored tutifruiti from the 2nd to the 5th month of storage. During the 1st month similar scores were obtained for the products under both conditions but during the 6th month the refrigerated product had the higher score 4.13 than the ambient condition (3.90) stored product.

The mean score for the flavour of tutifruiti stored under ambient condition was maximum for the 2nd month (3.20) which then reduced gradually to a minimum of 2.77 by the 6th month. Under refrigerated storage the mean scores increased gradually from a minimum of 2.87 for the 1st month to a maximum of 3.27 by the 4th month and then onwards reduced to 3.03 by the 6th month of storage. The flavour of the tutifruiti stored under refrigerated condition obtained higher scores except for the 1st and 2nd month of storage where the ambient condition stored tutifruiti exhibited better flavour.

Regarding the texture the mean score of the ambient storage tutifruiti reduced from 3.27 for the 1st month to a minimum of 3.20 for the 2nd month. A gradual increment in the mean score was observed then onwards up to the 5th month where it secured the maximum score 3.93. After that it decreased to 3.90 by the 6th month of storage. In the refrigerated product the mean score for texture reduced from 3.10 for the 1st month to a minimum of 2.83 by the 2nd month which then gradually increased with the storage period to attain a maximum score of 4.03

by the 6th month. During the 1st and 2nd month of storage the texture was more acceptable for tutifruiti in ambient condition. For the 4th, 5th and 6th month of storage the texture was more acceptable in refrigerated product.

Under ambient storage condition the mean scores for taste gradually increased from a minimum of 2.73 for the 1st month to a maximum of 3.80 by the 3rd month and then onwards reduced gradually up to the end of the storage period. Under refrigerated storage the mean score for taste increased from a minimum of 2.57 during the 1st month to a maximum score of 4.13 by the 5th and 6th month of storage. The taste of the tutifruiti stored in ambient condition was better up to the 3rd month of storage. For the 4th month no variation was observed but for the 5th and 6th month the refrigerated tutifruiti was found to have better taste.

The effect of storage period on the organoleptic qualities of tutifruiti stored under ambient condition was statistically analysed through DMRT and the results are presented in Table 44.

Table 44. Effect of storage periods on the organoleptic qualities of tutifruiti stored under ambient condition

| Storage period (month) | Mean scores | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | 3.32 $^{c}$ | 3.16 $^{d}$ | 3.03 $^{a}$ | 3.20 $^{d}$ | 3.02 $^{c}$ |
| 2 | 3.56 $^{c}$ | 3.65 $^{c}$ | 3.05 $^{a}$ | 3.34 $^{cd}$ | 3.41 $^{bc}$ |
| 3 | 3.82 $^{b}$ | 3.86 $^{bc}$ | 3.08 $^{a}$ | 3.59 $^{bc}$ | 3.84 $^{ab}$ |
| 4 | 4.12 $^{a}$ | 4.08 $^{ab}$ | 3.16 $^{a}$ | 3.88 $^{ab}$ | 4.00 $^{a}$ |
| 5 | 4.19 $^{a}$ | 4.29 $^{a}$ | 2.98 $^{a}$ | 4.05 $^{a}$ | 4.06 $^{a}$ |
| 6 | 4.37 $^{a}$ | 4.22 $^{a}$ | 2.99 $^{a}$ | 4.18 $^{a}$ | 3.95 $^{a}$ |

Values having different superscripts vary significantly at 5% level

As revealed from the table eventhough three was a monthly increase in the mean scores obtained for appearance with the storage period significant increase was observed only between the 2nd, 3rd and 4th month of storage.

Significant increase in the acceptability of the stored tutifruiti in terms of colour was observed between the 1st and 2nd month of storage and also between the 2nd and 4th month of storage but no significant difference was observed thereafter.

No significant variation was observed in the mean scores obtained for flavour under ambient condition storage. Though there was a monthly increase in the mean scores for texture significant increase was found only between 1st and 3rd month and 3rd and 5th month of storage. Regarding taste of the product, significant increase was found only between 1st and 3rd month of storage.

The effect of storage period on the organoleptic qualities of tutifruiti stored under refrigerated condition was statistically analysed through DMRT and the results are presented in Table 45.

Table 45. Effect of storage periods on the organoleptic qualities of tutifruiti stored under refrigerated condition

| Storage period (month) | Mean scores | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | $3.19^{c}$ | $2.98^{d}$ | $2.91^{b}$ | $2.73^{c}$ | $2.38^{c}$ |
| 2 | $3.31^{bc}$ | $3.48^{c}$ | $3.07^{ab}$ | $2.95^{bc}$ | $3.20^{b}$ |
| 3 | $3.63^{b}$ | $3.57^{bc}$ | $3.14^{ab}$ | $3.25^{b}$ | $3.38^{b}$ |
| 4 | $4.03^{a}$ | $3.91^{ab}$ | $3.22^{a}$ | $3.79^{a}$ | $3.77^{a}$ |
| 5 | $4.08^{a}$ | $4.01^{a}$ | $3.13^{ab}$ | $3.97^{a}$ | $4.08^{a}$ |
| 6 | $4.35^{a}$ | $4.23^{a}$ | $3.04^{ab}$ | $4.04^{a}$ | $4.07^{a}$ |

Values having different superscripts vary significantly at 5% level

The mean scores obtained for the appearance of the stored tutifruiti was found to exhibit a significant increase between the 1st and 3rd month and between 3rd and 4th month of storage.

Regarding colour significant increase in the mean score was observed between the 1st and 2nd month and 2nd and 4th month of storage. But for the rest of the storage period no significant variation was observed between the consecutive months of storage.

Significant increase in the flavour of the product was observed only between the first and 4th month of storage. Significant increase in the mean scores for texture was seen between the 1st and 3rd month and between the 3rd and 4th month of storage. For the rest of the storage period no significant increase was observed with regard to texture.

There was found to be a gradual increase in taste with storage period but significant increase was noted during 1st and 2nd month and 3rd and 4th month. After 4th month the increase in the mean scores for taste was not significant.

The effect of different packaging systems used for the storage viz., glass bottle, polypropylene bottle and polypropylene bag on the organoleptic qualities of tutifruiti stored under ambient and refrigerated condition was studied and the results are presented in Table 46.

As revealed from the table with regard to appearance of the product under ambient condition no significant difference was noted between glass bottle and polypropylene bottle but a significant decrease in the mean scores was observed with polypropylene bag.

No significant variation was observed under refrigerated condition. Under ambient storage condition the colour and texture of the stored tutifruiti was most acceptable when stored in glass bottle. Significant variation with regard to packaging system was observed only between the glass bottle and polypropylene

Table 46. Effect of packaging systems on the organoleptic qualities of tutifruiti stored under ambient and refrigerated conditions

| Package | Mean scores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Appearance | | Colour | | Flavour | | Texture | | Taste | |
| | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated |
| Glass bottle | 3.96[a] | 3.80[a] | 4.03[a] | 3.76[a] | 3.14[a] | 3.09[a] | 3.87[a] | 3.49[a] | 4.02[a] | 3.60[a] |
| Polypropylene bottle | 3.95[a] | 3.77[a] | 3.85[ab] | 3.68[a] | 2.99[a] | 3.08[a] | 3.67[ab] | 3.34[a] | 3.67[b] | 3.34[a] |
| Polypropylene bag | 3.78[b] | 3.73[a] | 3.75[b] | 3.65[a] | 3.02[a] | 3.08[a] | 3.58[b] | 3.54[a] | 3.46[b] | 3.49[a] |

Values having different superscripts differ significantly at 5% level

bag under ambient condition. Under refrigerated condition the different packaging systems were found to have no significant effect on the colour and texture of the stored product. No significant variation was observed in flavour in different packaging systems under both ambient and refrigerated conditions. Taste of tutifruiti stored in glass bottle under ambient condition was significantly high when compared to the other packaging systems but under refrigerated conditions significant variation was not observed in taste with respect to packaging systems.

The changes in the acceptability of the jelly stored in glass bottle under ambient and refrigerated condition was evaluated at monthly intervals for a period of six months and the results are presented in Table 47.

As shown in the table the mean scores for appearance of the jelly stored in glass bottle under ambient condition ranged between 3.83 for the first month and 3.80 for the third month. The mean scores were decreasing to a minimum score of 2.73 by the sixth month. Under refrigerated condition maximum score for appearance was for the third month (3.90) and the minimum score was for the sixth month (2.87). The acceptability of the product in terms of appearance was better in the ambient stored product during the 1$^{st}$ and 2$^{nd}$ and 5$^{th}$ month of storage. During the 3$^{rd}$, 4$^{th}$ and 6$^{th}$ month the refrigerated sample was more acceptable compared to the ambient stored product.

Under both ambient and refrigerated storage conditions the minimum mean score for colour was obtained during the 6$^{th}$ month (2.53 and 2.43 respectively) and maximum during the 3$^{rd}$ month (3.87 and 4.20) of storage. Under both storage conditions the mean scores for colour were found to reduce gradually with the storage period after the 3$^{rd}$ month of storage. Better colour was observed

Table 47. Organoleptic evaluation of jelly stored in glass bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.83 | 3.57 | 3.57 | 3.37 | 3.80 | 3.90 | 3.47 | 3.80 | 3.30 | 3.23 | 2.73 | 2.87 |
| Colour | 3.50 | 4.07 | 3.87 | 3.63 | 3.87 | 4.20 | 3.17 | 3.43 | 3.07 | 2.90 | 2.53 | 2.43 |
| Flavour | 3.63 | 3.80 | 3.77 | 3.50 | 3.77 | 4.10 | 3.67 | 3.43 | 3.33 | 2.87 | 2.67 | 2.97 |
| Texture | 3.93 | 3.77 | 4.00 | 3.67 | 4.17 | 3.97 | 4.10 | 3.90 | 3.60 | 3.53 | 3.17 | 3.37 |
| Taste | 2.57 | 3.07 | 2.93 | 2.67 | 3.67 | 3.83 | 3.10 | 3.00 | 2.33 | 2.17 | 2.07 | 2.20 |

in the refrigerated product during the 1st, 3rd and 4th month of storage and during the 2nd, 5th and 6th month of storage the ambient stored product was found to have better colour.

Flavour was found to have a mean score of 3.63 in the first month which increased to a maximum of 3.77 by the 2nd and 3rd month and then onwards reduced gradually to obtain a minimum score of 2.53 by the 6th month when stored under ambient condition. But in the refrigerated jelly the mean score reduced from 3.80 in the first month to 3.50 in the 2nd month and increased to a maximum of 4.10 by the 3rd month. Then onwards a gradual reduction in the mean score was obtained with the minimum score of 2.87 by the 5th month. By the 6th month the mean score increased to 2.97.

Under ambient storage condition the mean score for texture increased gradually from the 1st month (3.93) to a maximum of 4.17 by the 3rd month and then reduced gradually with the storage period attaining a minimum score of 3.17 by the 6th month. But for the refrigerated product the mean score reduced to 3.67 by the 2nd month and then increased to a maximum of 3.97 by the 3rd month. From 3rd month onwards the scores reduced gradually to a minimum of 3.37 by the 6th month. The texture of jelly stored in ambient condition was better except for the 6th month of storage.

Regarding taste of the jelly stored under ambient condition the mean score increased gradually from the 1st month to a maximum score of 3.67 by the 3rd month and then gradually reduced to a minimum score of 2.07 by the 6th month. The mean score for taste was 3.07 for the 1st month which reduced to 2.67 by the 2nd month under refrigerated condition. The maximum score was obtained during

the 3rd month (3.83) and then reduced gradually reaching a minimum score of 2.20 by the 6th month of storage. The taste of the jelly stored under refrigerated condition was more acceptable during the 1st, 3rd and 6th month of storage and during the 2nd, 4th and 5th months the taste of jelly stored under ambient condition was found to be better.

The changes in the acceptability of jelly stored in glass bottle under ambient and refrigerated conditions are illustrated in Fig.16 and 17 respectively.

The changes in the acceptability of the jelly stored in polypropylene bottle under ambient and refrigerated condition was evaluated at monthly intervals for a period of six months and the results are presented in Table 48.

As shown in the table the mean scores for appearance was observed to increase from 3.83 for the 1st month to a maximum (4.00) by the 2nd month and reducing gradually thereafter with the storage period to a minimum score of 2.47 by the 6th month of storage. For the refrigerated product the maximum mean score was observed during the first month (3.97) which then reduced to 3.47 by the 2nd month and increased to a maximum score of 3.83 by the 3rd month. But thereafter a declining trend in the mean score was seen with the advance of storage. The refrigerated product was found to have better appearance throughout the storage period except for the 2nd month where jelly stored in ambient condition obtained higher mean score (4.00).

Under both ambient and refrigerated storage conditions the mean score for colour decreased from the 1st to the 2nd month and then by the 3rd month secured the maximum scores of 3.93 and 4.00 respectively. From the 3rd month onwards the mean scores were found to reduce gradually with the storage period

**Fig. 16. Organoleptic evaluation of jelly stored in glass bottle under ambient condition**

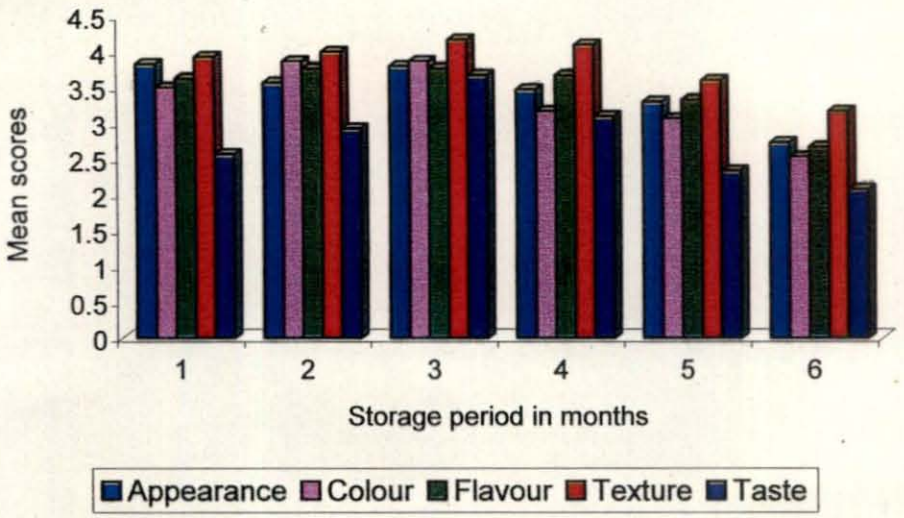



**Fig. 17. Organoleptic evaluation of jelly stored in glass bottle under refrigerated condition**

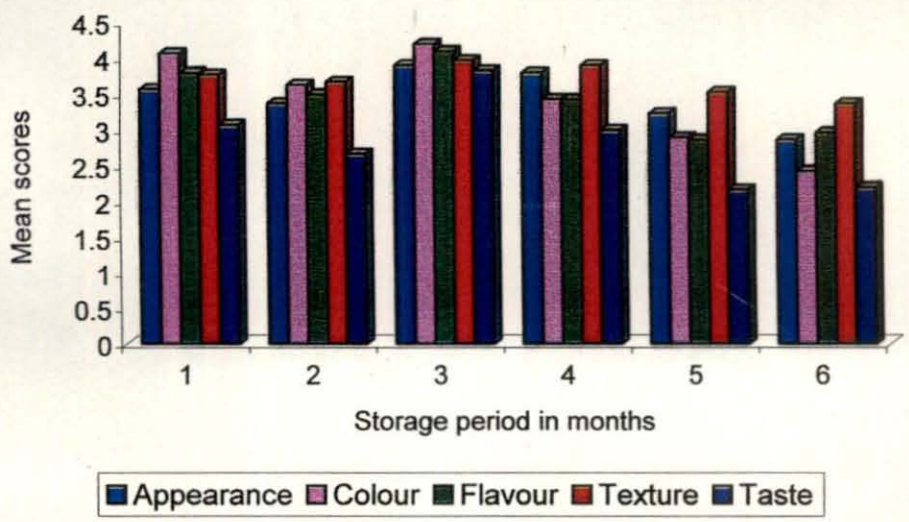


Table 48. Organoleptic evaluation of jelly stored in polypropylene bottle (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.83 | 3.97 | 4.00 | 3.47 | 3.37 | 3.83 | 3.27 | 3.70 | 2.87 | 2.90 | 2.47 | 2.67 |
| Colour | 4.03 | 3.90 | 3.57 | 3.70 | 3.93 | 4.00 | 3.17 | 3.30 | 2.90 | 2.70 | 2.27 | 2.53 |
| Flavour | 3.70 | 3.33 | 3.73 | 3.67 | 3.73 | 3.63 | 3.40 | 3.57 | 2.83 | 2.80 | 2.83 | 2.90 |
| Texture | 4.13 | 4.00 | 3.60 | 3.73 | 3.63 | 3.57 | 3.77 | 4.23 | 3.83 | 3.53 | 3.27 | 3.27 |
| Taste | 3.03 | 3.03 | 2.80 | 2.97 | 4.07 | 3.43 | 2.60 | 3.40 | 2.17 | 2.63 | 2.03 | 2.00 |

and attained a minimum of 2.27 and 2.53 under ambient and refrigerated condition respectively. The refrigerated product was found to have better colour except for the 1st and 5th month of storage.

The flavour of jelly stored under ambient condition was best accepted during the 2nd (3.73) and 3rd month (3.73) and thereafter the acceptability declined with the storage period. Under refrigerated storage the maximum acceptability was during the 2nd month (3.67) which then gradually reduced to the lowest acceptability level by the 5th month (2.80). The texture of the ambient stored jelly was found to be better during the 1st, 3rd and 5th month of storage. But for the 2nd and 4th month the texture of the refrigerated sample was better.

Under ambient and refrigerated storage conditions the maximum mean score for taste was found during the 3rd month (4.07 and 3.43 respectively) and minimum during the 6th month (2.03 and 2.00 respectively). From the 3rd month onwards gradual reduction in the mean score was observed with the storage period.

The changes in the acceptability of the jelly stored in polypropylene bag under ambient and refrigerated condition was evaluated at monthly intervals for a period of six months and the results are presented in Table 49.

The maximum score for appearance of the jelly stored under ambient condition was 3.67 by the 3rd month which reduced gradually with the storage period and attained a minimum of 2.20 by the 6th month. Under refrigerated storage maximum score was 3.67 for the 4th month and reduced to a minimum score of 2.53 by the 6th month. The refrigerated product was more acceptable during the 2nd, 4th, 5th and 6th month of storage but for the 1st and 3rd month jelly under ambient storage was more acceptable.

Table 49. Organoleptic evaluation of jelly stored in polypropylene bag (mean scores)

| Criteria | Storage period in month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated | Ambient | Refrige-rated |
| Appearance | 3.60 | 3.43 | 3.60 | 3.63 | 3.67 | 3.57 | 3.10 | 3.67 | 2.87 | 2.90 | 2.20 | 2.53 |
| Colour | 3.87 | 3.50 | 3.60 | 3.50 | 3.50 | 3.90 | 3.27 | 3.57 | 2.67 | 2.93 | 2.57 | 2.30 |
| Flavour | 3.10 | 3.17 | 3.43 | 3.67 | 3.27 | 3.60 | 3.10 | 3.53 | 2.57 | 2.83 | 2.50 | 2.53 |
| Texture | 3.77 | 3.67 | 3.60 | 3.47 | 3.97 | 3.73 | 4.27 | 4.13 | 3.67 | 3.53 | 3.27 | 3.17 |
| Taste | 2.97 | 3.03 | 2.93 | 2.70 | 3.47 | 3.63 | 2.80 | 2.93 | 2.10 | 2.20 | 1.73 | 1.83 |

Under ambient storage condition the colour of the jelly was best accepted during the 1st month (mean score 3.87). From the 1st to 6th month a gradual reduction in the acceptability was observed with the lowest score during the 6th month (2.57). Under refrigerated storage maximum score for colour (3.90) was for the 3rd month and reduced gradually to a minimum score of 2.30 by the 6th month of storage. Colour of the jelly was more acceptable under the ambient storage for the 1st, 2nd and 6th month of storage but for the 3rd, 4th and 5th month the colour of the refrigerated product was more acceptable.

Regarding flavour of the jelly stored under ambient and refrigerated conditions the mean scores increased from the 1st month to a maximum (3.43 and 3.67 respectively) by the 2nd month and then onwards decreased gradually with the storage time and attained the lowest scores 2.50 and 2.53 respectively by the 6th month. The flavour of the refrigerated jelly was more acceptable throughout the storage period.

The mean score for texture under both storage conditions was found to decrease by the 2nd month and then increased gradually during the 3rd and 4th month. The maximum score for flavour was obtained during the 4th month under both ambient (4.27) and refrigerated (4.13) storage condition. From the 4th month onwards the scores were found to reduce gradually reaching a minimum by the 6th month of storage. Throughout the storage period jelly stored under ambient condition was found to have a better texture.

Under both ambient and refrigerated storage conditions the mean scores of taste for the 1st month reduced by the 2nd month and then increased to a maximum of 3.47 and 3.63 respectively during the 3rd month of storage. Afterwards the mean scores reduced gradually attaining a minimum of 1.73 and 1.83 respectively by the 6th month of storage.

The effect of storage period on the organoleptic qualities of jelly stored under ambient condition was statistically analysed through DMRT and the results are presented in Table 50.

Table 50. Effect of storage periods on the organoleptic qualities of jelly stored under ambient condition

| Storage period (month) | Mean score | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | 3.75 [a] | 3.80 [a] | 3.48 [a] | 3.94 [a] | 2.86 [b] |
| 2 | 3.72 [a] | 3.68 [a] | 3.64 [a] | 3.73 [a] | 2.89 [b] |
| 3 | 3.61 [ab] | 3.77 [a] | 3.59 [a] | 3.92 [a] | 3.74 [a] |
| 4 | 3.28 [bc] | 3.20 [b] | 3.39 [a] | 4.05 [a] | 2.83 [b] |
| 5 | 3.01 [c] | 2.88 [b] | 2.91 [b] | 3.70 [a] | 2.20 [c] |
| 6 | 2.47 [d] | 2.46 [c] | 2.67 [b] | 3.24 [b] | 1.94 [c] |

Values having different superscripts vary significantly at 5% level

It is evident from the table that the appearance of the jelly had no significant reduction up to the 3rd month of storage. But it significantly reduced by 4th month and 6th month of storage.

There was no significant variation in the mean scores for colour of the stored jelly up to the 3rd month of storage. The mean score significantly reduced from 3.77 for the 3rd month to 3.20 by the 4th month. No significant reduction was observed between the 4th and 5th month of storage but the score significantly reduced to 2.46 by the 6th month.

The mean scores observed for the flavour of the jelly was not found to reduce significantly up to the 4th month of storage. Significant reduction was observed between the 4th and 5th month but no significant reduction was observed between the 5th and 6th month.

No significant variation in texture was observed between the storage periods up to the 5th month but the score for texture reduced significantly from 3.70 for the 5th month to 3.24 for the 6th month.

Regarding taste significant increase in the scores was observed between 2nd and 3rd month of storage. Maximum score for taste was observed for the 3rd month which then significantly reduced by the 5th month. No significant reduction in the scores was observed during the 6th month.

The effect of storage period on the organoleptic qualities of jelly stored under refrigerated condition was also statistically analysed through DMRT and the results are presented in Table 51.

Table 51. Effect of storage periods on the organoleptic qualities of jelly stored under refrigerated condition

| Storage period (month) | Mean score | | | | |
|---|---|---|---|---|---|
| | Appearance | Colour | Flavour | Texture | Taste |
| 1 | $3.66^{a}$ | $3.82^{ab}$ | $3.43^{a}$ | $3.81^{b}$ | $3.04^{b}$ |
| 2 | $3.49^{a}$ | $3.61^{bc}$ | $3.61^{a}$ | $3.62^{b}$ | $2.78^{b}$ |
| 3 | $3.77^{a}$ | $4.03^{a}$ | $3.78^{a}$ | $3.76^{b}$ | $3.63^{a}$ |
| 4 | $3.72^{a}$ | $3.43^{c}$ | $3.51^{a}$ | $4.09^{a}$ | $3.11^{b}$ |
| 5 | $3.01^{b}$ | $2.84^{d}$ | $2.83^{b}$ | $3.53^{bc}$ | $2.33^{c}$ |
| 6 | $2.69^{c}$ | $2.42^{e}$ | $2.80^{b}$ | $3.27^{c}$ | $2.01^{c}$ |

Values having different superscripts vary significantly at 5% level

As revealed from the table there was no significant variation in the appearance of the jelly up to the 4th month of storage. But from the 4th month onwards the scores were found to decrease significantly.

The reduction of mean scores for colour during the 2nd month of storage was not significant. Maximum score was for the 3rd month which then reduced significantly by the 6th month of storage.

No significant variation in the mean scores for flavour of the jelly was observed up to the 4th month of storage. Maximum score was for the 3rd month. A reduction in the mean score during the 4th month was not significant, but a reduction in the scores during 5th month was found to be significant. Further reduction in the mean scores by 6th month of storage was not significant.

Regarding texture of jelly no significant variation was observed up to the 3rd month of storage. Significant but a significant increase in the mean scores was observed during the 4th month (4.09) which was found to be the maximum score but the mean score significantly reduced by the 5th month but further reduction in the mean score for the 6th month was not significant.

Eventhough there was a reduction in the mean score for taste during the 2nd month, this was not significant. But a significant increase in the mean scores was noted for the 3rd month (3.63) which was the maximum score for taste. The mean score reduced significantly up to 5th month of storage, further reduction in the mean score for the 6th month of storage was not significant.

The effect of different packaging systems used for the storage viz., glass bottle, polypropylene bottle and polypropylene bag on the organoleptic qualities of jelly stored under ambient and refrigerated condition was studied and the results are presented in Table 52.

The appearance of jelly stored in glass bottle under ambient condition was found to vary significantly from the polypropylene bag with a maximum score for jelly in glass bottle. But there was no significant variation in the score between polypropylene bottle and polypropylene bag. The packaging systems were found to have no significant effect on the appearance of the jelly stored under refrigerated condition.

Table 52. Effect of packaging systems on the organoleptic qualities of jelly stored under ambient and refrigerated conditions

| Package | Mean scores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Appearance | | Colour | | Flavour | | Texture | | Taste | |
| | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated | Ambient | Refrigerated |
| Glass bottle | 3.45[a] | 3.46[a] | 3.34[a] | 3.44[a] | 3.47[a] | 3.45[a] | 3.83[a] | 3.70[a] | 2.78[a] | 2.82[a] |
| Polypropylene bottle | 3.30[ab] | 3.42[a] | 3.31[a] | 3.36[a] | 3.37[a] | 3.32[a] | 3.71[a] | 3.72[a] | 2.78[a] | 2.91[a] |
| Polypropylene bag | 3.17[b] | 3.29[a] | 3.25[a] | 3.28[a] | 3.00[b] | 3.22[a] | 3.76[a] | 3.62[a] | 2.67[a] | 2.72[a] |

Values having different superscripts vary significantly at 5% level

The quality attributes viz. colour, taste and texture were also found to have no significant effects with regard to packaging systems on storage. Regarding flavour under ambient condition storage no significant variation was observed in product stored in glass bottle and polypropylene bottle with a maximum score of 3.47 for glass bottle but a significant reduction in the mean scores was observed with jelly in polypropylene bag. Under refrigerated storage no significant variation was observed in flavour with regard to packaging systems.

4.1.2.3 Microbial study

The microbial load of the selected products viz., candy, preserve, tutifruiti and jelly stored in glass bottle, polypropylene bottle and polypropylene bag under ambient and refrigerated conditions was estimated in terms of total count at monthly intervals for a period of six months. All the four products were found to be free from any microbial load up to the end of six months of storage. The other two selected products viz., salad and samosa were found to get spoiled by the next day under both storage conditions and were deleted from the storage studies.

## 4.2 Yield and Cost Ratio

The yield and cost ratio of the selected six Indian gooseberry products was computed and the results are presented in Table 53. The ratio was computed taking into account only the quantity and cost of ingredients and the total yield of the final product. Existing market price of the product was used for comparison. Among the six products the candy was found to obtain the highest ratio (7.06) followed by salad (5.95), preserve (4.47), samosa (2.65), jelly (1.58) and tutifruiti (0.62).

Table 53. Yield and cost ratio of the selected Indian gooseberry products

| Sl.No. | Product | Total cost of ingredients (Rs.) | Yield of final product (kg) | Yield and cost ratio |
|---|---|---|---|---|
| 1 | Preserve | 50.00 | 2.14 | 4.47 |
| 2 | Candy | 50.00 | 1.87 | 7.06 |
| 3 | Tutifruiti | 50.80 | 0.52 | 0.62 |
| 4 | Jelly | 29.70 | 0.24 | 1.58 |
| 5 | Samosa | 181.00 | 4.80 | 2.65 |
| 6 | Salad | 206.80 | 4.92 | 5.95 |

# *Discussion*

# 5. DISCUSSION

The study on "Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products" was undertaken to evaluate different products of Indian gooseberry and to identify the acceptable products. This chapter presents a discussion on the major findings of the study and are presented under the following sections.

5.1 Acceptability studies
5.1.1 Preliminary study
5.1.2 Detailed storage study
5.1.2.1 Chemical composition
5.1.2.2 Organoleptic evaluation
5.1.2.3 Microbial study
5.2 Yield and Cost Ratio

## 5.1 Acceptability studies

### 5.1.1 Preliminary study

Eighteen Indian gooseberry products viz., candy, preserve, tutifruiti, jam, jelly, salad, pakoda, samosa, pickle, mixed uppuma, biscuit, custard jelly, pachadi, Indian gooseberry - Guava jelly, dehydrated product, squash, nectar and beverage were evaluated in the preliminary study using score cards.

Among the eighteen Indian gooseberry products evaluated for their acceptability tutifruiti and preserve obtained the highest mean scores (21.98 and 21.19% respectively) followed by jelly (21.18%), salad (20.91%), samosa (20.84%) and candy (20.43%). The acceptability studies carried out by Lal and

Siddappa (1991) on amla jam, preserve, candy, juice and dehydrated product also showed that amla preserve and candy scored high. An acceptability study conducted by George (2000) also revealed that among eight amla products maximum score was for amla preserve. In the present study dehydrated product obtained the lowest total mean score (15.33%). The dehydrated product was only moderately accepted in the study of Lal and Siddappa (1991). But Naik and Chundawat (1993) found that chyavanaprash was rated to be superior and on par with preserve followed by pickle, dried flakes and brined preserve.

The lower acceptability of jam, nectar and squash in the present study could be attributed to their astringent taste. The beverage was found to obtain a higher total mean score (19.74%) compared to squash (16.92%) and nectar (17.93%). A similar result was obtained by Singh and Kumar (1995) who reported that blended RTS beverage obtained the highest score compared to amla squash and syrup. Rao (1992) observed that amla juice was palatable when other flavouring agents were blended. The comparatively high score for beverage in this study may be due to the blending of pineapple juice with amla juice in its preparation.

The products pakoda and biscuit were found to obtain lower mean scores which may be due to their hard texture. The product pickle was found to obtain a total mean score of 18.21 per cent and moderately accepted but Singh and Kumar (1995) reported amla pickle to be a well accepted product. The mean scores obtained revealed that the lower acceptability of the Indian gooseberry - Guava jelly, custard jelly and jam were due to their peculiar taste and flavour.

The six gooseberry products viz., tutifruiti (21.98%), preserve (21.19%), jelly (21.18%), salad (20.91%), samosa (20.84%) and candy (20.43%) which obtained the highest total mean score were selected to carry out the detailed storage studies.

### 5.1.2 Detailed storage studies

#### 5.1.2.1 Chemical composition

*Chemical composition of fresh, pretreated and selected amla products*

The fresh fruit was found to possess 81.3 per cent moisture which was in accordance with the values reported by Sharma and Yadav (1998) and Geetha and Sarojini (1998) who reported the moisture content to be 81.2 per cent. The moisture content of the sugar treated sample was more (56.73%) compared to the salt treated sample (36.47%). This may be due to the process of pricking the fruits before the sugar treatment.

The fresh Indian gooseberry was found to have a sugar content of 4.75 g 100 $g^{-1}$ which was in accordance with the values obtained by Tripathi *et al.* (1988). Samosa was found to have the lowest sugar content and jelly the highest. The variation could be attributed to the ingredients used.

The tannin content of the fresh gooseberry was found to be 3.27 mg 100 $g^{-1}$ which was in agreement with the findings of Kalra (1988) who reported that the fruit contains 1.1-4.45 mg per cent tannins. According to Premi *et al.* (1999) the tannic acid content of different varieties of aonla showed a variation of 3.18 to 3.57 per cent. George (2000) reported the tannin content of fresh amla to be 2.27 mg 100 $g^{-1}$. In the present study the tannin content was found to be reducing during processing of amla. The tannin content was found to vary from 0.14 in samosa to 2.97 in candy.

The fresh fruit was found to have a vitamin C content of 576 mg 100 $g^{-1}$ which was in accordance with the values reported by Sethi (1986), Salunkhe *et al.* (1991) and Srivastava *et al.* (1997). But Pareek and Sharma (1993) and Supe (1992) reported higher vitamin C in fresh aonla fruits which varied from 625 mg to 1800 mg 100 $g^{-1}$. George (2000) also reported similar value for vitamin C in fresh aonla. Sreekumar *et al.* (1984) analysed the nutrient content of different *Phyllanthus emblica* cultivars in the Western Ghats and found that Chambakad large is superior in vitamin C content.

Among the different products (except for pretreated samples) salad had the highest vitamin C content (560 mg 100 $g^{-1}$). The lowest vitamin C content was in samosa (69 mg 100 $g^{-1}$). In the preparation of salad sugar treated amla was used which retained maximum vitamin C (533 mg 100 $g^{-1}$). The higher vitamin C content may be attributed to the presence of other vitamin C rich ingredients also. The maximum loss in samosa may be due to the frying involved in the preparation of the product. Manay and Shadaksharaswamy (1998) have reported that high temperatures used for processing have detrimental effects on the vitamin C content. Products like preserve and candy retained high amounts of vitamin C even after processing (544 and 522 mg 100 $g^{-1}$ respectively). Roy (1994) reported that the retention of vitamin C in amla products is due to the presence of polyphenolic substances present in the fruit. Supe (1992) reported the substance to be leucoanthocyanin whereas Hanif (1996) and Sharma and Yadav (1998) reported that the substance is a tannin with gallic acid, ellagic acid and glucose in its molecule. Among the different products prepared with amla, George (2000) observed that candy had the highest vitamin C retention.

The fresh fruit was found to contain 3.10 g 100 $g^{-1}$ fibre. Similar values were obtained by Singh *et al.* (1987), Geetha and Sarojini (1998), Gopalan *et al.* (1994) and George (2000). The sugar and salt treated fruits were found to have slightly higher fibre content than the fresh fruit. Salad was found to have the maximum fibre content (3.33 g 100 $g^{-1}$) and jelly the least (0.40 g 100 $g^{-1}$). The maximum fibre content in the salad may be due to the presence of other fibre rich fruits. The jelly was prepared from the fruit extract and this might be the reason for the low fibre in this product. But in the study carried out by George (2000), the preserve, candy and shred were found to have the highest fibre content and the jam the least content and jelly was found to have no fibre content.

The iron content of the fresh fruit was found to be 1.0 mg 100 $g^{-1}$. Similar pattern was obtained by Pareek and Sharma (1993), Gopalan *et al.* (1994), Selvarajan (2000) and George (2000) who reported that fresh amla contained 1.2 mg 100 $g^{-1}$ of iron. Maximum iron was retained in products like preserve (0.96 mg 100 $g^{-1}$), candy (0.95 mg 100 $g^{-1}$) and salad (0.89 mg 100 $g^{-1}$).

*Changes in the chemical composition during storage of amla products*

Storage studies were carried out in four products viz., candy, preserve, tutifruiti and jelly since two products, salad and samosa were highly perishable.

a) Candy

Changes in the chemical composition of candy stored in glass bottle, polypropylene bottle and polypropylene bag were studied both under ambient and refrigerated condition for a period of six months.

Under ambient storage condition (Table 8) a significant decrease in moisture, tannin and vitamin C in candy was observed whereas sugar content was increasing significantly with storage period. Fibre was found to be decreasing with storage period but significant reduction was observed only between 1st and 2nd, 3rd and 4th and 4th and 5th months of storage. Iron was also found to be decreasing with storage period but significant decrease was observed from 2nd month onwards. Moisture loss, temperature and light interaction may be the factors which contributed to the variation in vitamin C, sugar, fibre and tannin contents.

Under refrigerated condition also (Table 9) significant decrease in moisture, tannin and vitamin C in candy was observed. An increase in the sugar content was observed as in the case of ambient condition but under refrigerated condition the increase in sugar content was not significant during each month of storage. A significant reduction in iron was observed during the entire storage period. When compared to refrigerated storage moisture, sugar and fibre content of candy in ambient storage was high whereas tannin and vitamin C were more in refrigerated samples. The difference in ambient and refrigerated conditions may be due to the difference in moisture loss, temperature and light interaction.

In the present study vitamin C is found to reduce with the storage period. Tripathi *et al.* (1988) also reported that candy stored for four months had reduced vitamin C content. Singh *et al.* (1999) also obtained similar results. Gopalan and Ram (1990) revealed that 2/3rd of vitamin C in dried amla powder was lost when stored at room temperature for 375 days but under refrigerated storage only 20 per cent of vitamin C was lost. Giri (1993) also reported that no

loss in vitamin C content was observed when amla fruits were stored at 0°C whereas at 25-37°C, 30-70 per cent of vitamin C was lost by the end of the 3rd month. Similar retention in vitamin C content was observed by Salunkhe *et al.* (1991) and Ramasastry (1994) also. George (2000) also observed a significant reduction in vitamin C content of candy stored under ambient condition for a period of six months.

The increment in sugar content with the advance of storage period was also observed by Tripathi *et al.* (1988) in candy stored up to four months where the content increased from 65.51 per cent to 66.97 per cent. In the present study candy stored under ambient condition was found to have higher sugar content compared to the refrigerated product which could be attributed to the moisture loss and increased penetration of sugar from the syrup to the fruit at higher temperature.

The reduction in the tannin content with storage period under both conditions in the present study may be due to the leaching out of tannins from fruit tissue to the suspension medium or degradation/conversion of the tannins. This trend was in accordance with the results obtained by Tripathi *et al.* (1988) in candy stored up to four months. But George (2000) reported that there was no change in the tannin content of the candy up to six months of storage.

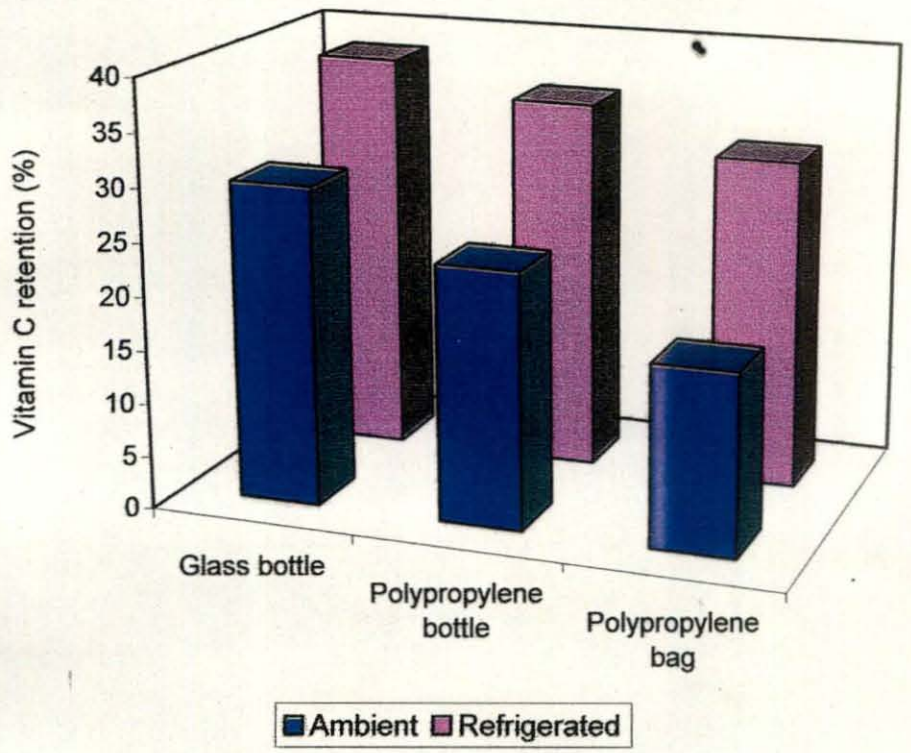
The reduction in the fibre content in the present study with storage might be due to the degradation of fibre from the fruit tissue. Kalra (1988) had reported the presence of 0.36 per cent of fibre in the syrup of stored amla preserve. But George (2000) observed no variation in the fibre content with the advance of the storage period.

The different packaging systems viz., glass bottle, polypropylene bottle and polypropylene bag were found to have significant effect on the moisture and vitamin C content of the candy stored under both ambient and refrigerated condition (Table 10). The highest moisture content was observed in polypropylene bottle (29.23%) under ambient storage and in glass bottle (26.05%) under refrigerated storage. The lowest moisture was observed in the polypropylene bag (26.83%) under ambient storage and in polypropylene bottle (23.78%) under refrigerated storage.

Regarding vitamin C, maximum retention was observed in the candy stored in glass bottle and least retention in polypropylene bag under both ambient and refrigerated storage (Fig.18). This result was in accordance with the conclusion obtained by Ramasastry (1994). He concluded that dried and powdered amla fruit stored in glass containers retained more ascorbic acid than that in other type of containers. Kumar and Manimegalai (2001) also observed that strawberry sauce packed in glass bottles exhibited a higher retention of ascorbic acid than the samples packed in polypropylene pouches.

Under both storage conditions the highest sugar content was observed in glass bottle. Under ambient storage the least sugar content was observed in polypropylene bottle (61.26 g 100 $g^{-1}$) and in refrigerated storage in polypropylene bag (56.96 g 100 $g^{-1}$). Alzamora *et al.* (1993) in their storage studies with pineapple chunks in glass bottle also showed a steady increase in sugar content with maximum when stored at 27°C.

**Fig. 18. Vitamin C retention in candy stored (six months) under ambient and refrigerated conditions in different packaging systems**



Under ambient condition a significant reduction in the tannin content was observed in candies stored in glass bottles but under refrigerated condition tannin content was significantly high in glass bottle compared to polypropylene bottle and polypropylene bag. But Dhaliwal and Hira (2001) in their study revealed that mixed juices can be stored in glass bottle at room temperature for a period of three months without any change in pH, acidity and tannins.

There was no significant variation in the fibre content of the product stored under both conditions with regard to packaging systems. No change was observed in the iron content of the candy stored under refrigerated condition with packaging systems.

b) Preserve

Changes in the chemical composition of preserve stored in glass bottle, polypropylene bottle and polypropylene bag were studied both under ambient and refrigerated condition for a period of six months.

Under ambient and refrigerated condition of storage a significant reduction in moisture, vitamin C, fibre and iron was observed in preserve stored for six months. There was a significant increase in sugar content under both storage conditions. Under ambient condition a significant reduction in tannin content was observed from the 3$^{rd}$ month of storage but under refrigerated storage significant reduction was observed from the first to fifth month of storage. George (2000) in her storage studies with amla preserve for a period of six months under ambient conditions observed a significant decrease in vitamin C and tannin content but there was no change in the fibre and iron content of the product.

A significant reduction in the vitamin C content of the stored preserve was also observed by Tripathi *et al.* (1988). Sethi and Anand (1989) reported a loss of 75 per cent of vitamin C from fruits during the preparation of preserve by conventional method. The lower vitamin C content of preserve stored under ambient condition in the present study could be attributed to the higher loss of vitamin C at higher temperature. Salunkhe *et al.* (1991) found that the ascorbic acid content of stored fruit generally decrease rapidly at higher storage temperature. The reduction in tannin content of the stored preserve with storage period in the present study was in agreement with the results obtained by Tripathi *et al.* (1988) who observed a significant reduction in tannin content of the stored preserve with the storage period which could be attributed to the leaching out and degradation of tannin into the syrup.

The increment in the sugar content of the preserve with the advance of the storage period as observed in the present study is in agreement with the result obtained by Tripathi *et al.* (1988). They found that the total sugar of the preserve increased from 65.58 per cent to 66.76 per cent by the $135^{th}$ day of storage. They further reported that the increment in the total sugar with the storage period may be attributed to increased degree of inversion of sugar on account of higher fixed acidity. The higher sugar content in the ambient condition stored preserve could be attributed to the moisture loss and higher penetration of sugar from the syrup to the fruit tissue at higher temperature.

The reduction in the fibre content of the preserve with the advance of the storage period may be due to the leaching out and degradation of the fibres.

Kalra (1988) reported a fibre content of 2.28 per cent in the fruit and 0.36 per cent in the syrup of the amla preserve.

The effect of different packaging systems on the chemical constituents of preserve stored under ambient and refrigerated conditions was evaluated for a period of six months and the different packaging systems were found to have varying effects on the chemical composition (Table 16).

Significant variation was observed only in the polypropylene bottle stored preserve under both conditions. Under ambient condition stored preserve significantly high moisture was retained in polypropylene bottle whereas under refrigerated conditions, product stored in polypropylene bottle exhibited significantly low moisture content.

Significant increase in sugar content of preserve was observed only between the polypropylene bottle (64.55 g 100 $g^{-1}$) and polypropylene bag (64.99 g 100 $g^{-1}$) under ambient storage. But under refrigerated condition no significant variation was observed with the packaging systems which may be due to the moisture retention and stability of the product.

Under ambient condition of storage the tannin in preserve was not found to vary significantly with the packaging systems. But under refrigerated storage significant reduction in tannin was observed in the preserve stored in polypropylene bag (2.33 mg 100 $g^{-1}$) which could be due to the degradation of the tannins.

The different packaging systems were found to have significant effect on the vitamin C content of the stored preserve under both conditions. Preserve

stored in glass bottle exhibited the maximum vitamin C content under both ambient and refrigerated storage (267 and 317 mg 100 $g^{-1}$ respectively) while the preserve in polypropylene bag exhibited the minimum content (187 and 233 mg 100 $g^{-1}$ respectively) (Fig.19).

Under both conditions the fibre content of preserve stored in glass bottle was found to be high.

Regarding the iron content under both ambient and refrigerated storage glass bottle stored preserve was observed to have a significantly higher content (0.93 and 0.94 mg 100 $g^{-1}$ respectively) compared to the polypropylene bag stored preserve (0.91 and 0.92 mg 100 $g^{-1}$ respectively).

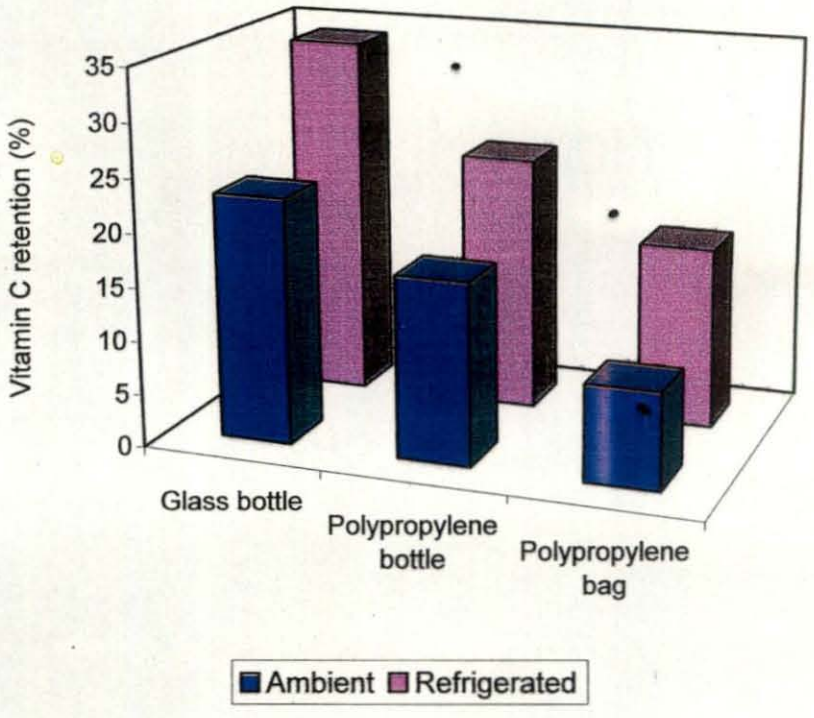
c) Tutifruiti

Changes in the chemical composition of tutifruiti stored in glass bottle, polypropylene bottle and polypropylene bag was studied both under ambient and refrigerated condition for a period of six months.

The moisture, vitamin C, fibre, tannin and iron content of the tutifruiti stored under ambient condition was found to reduce significantly and sugar content increase significantly with the storage period (Table 20). The tannin content exhibited a significant reduction with the storage period from the $2^{nd}$ month onwards. Iron content reduced significantly with the advance of the storage period except for the $2^{nd}$ and $3^{rd}$ month of storage.

In the refrigerated tutifruiti also the moisture, vitamin C, fibre, tannin and iron were found to reduce significantly with the advance of the storage period (Table 21). The sugar content was observed to increase significantly with the

**Fig. 19. Vitamin C retention in preserve stored (six months) under ambient and refrigerated conditions in different packaging systems**



storage period. The refrigerated tutifruiti exhibited comparatively higher moisture, tannin, vitamin C and iron content against the ambient condition stored tutifruiti. But the sugar content was higher in the ambient condition stored tutifruiti. For the 1st and 2nd month of storage the refrigerated tutifruiti exhibited higher fibre content but for the remaining period of storage the fibre content was higher in the ambient condition stored tutifruiti.

The reduction in the vitamin C and tannin content of the tutifruiti as observed in the present study was observed by Tripathi *et al.* (1988) also in some other amla products like the candy and preserve, the preparation of which was almost similar to that of tutifruiti. George (2000) also observed a reduction in the vitamin C content with storage in amla shred stored under ambient condition. The reduction in tannin content may be attributed to the degradation and leaching out of the tannin from fruit into syrup as reported by Tripathi *et al.* (1988). The higher vitamin C and tannin content in the refrigerated tutifruiti could be attributed to the higher retention of this vitamin at low temperature as reported by Giri (1993), Ramasastry (1994) and Salunkhe *et al.* (1991). The increment in the sugar content was more in the ambient condition stored tutifruiti which may be due to the higher penetration of sugar from the syrup to the fruit tissue at higher temperature.

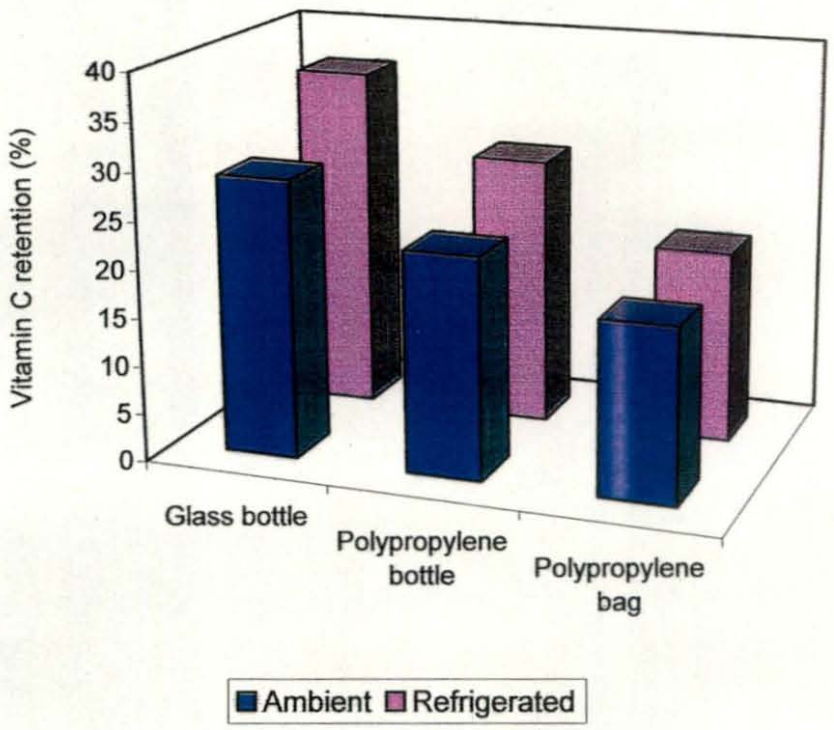
The different packaging systems were observed to have varying effects on the chemical constituents of stored tutifruiti under both ambient and refrigerated conditions (Table 22).

Under ambient condition the moisture content was observed to vary significantly with the packaging systems, the tutifruiti stored in polypropylene bag

having the highest moisture content (30.73%) followed by polypropylene bottle and the least in glass bottle. But under refrigerated storage the highest moisture content was observed in tufifruiti stored in glass bottle. The maximum sugar content was observed in tutifruiti stored in glass bottle under both storage conditions. Under ambient condition of storage significantly low levels of tannin was observed in tutifruiti in polypropylene bag but under refrigerated condition low levels of tannin was observed in glass bottle. The vitamin C content of the stored tutifruiti was found to vary significantly with the packaging systems. Tutifruiti stored in glass bottle retained the maximum vitamin C and tutifruiti stored in polypropylene bag exhibited the least vitamin C under both conditions (Fig.20). Regarding the fibre content the maximum fibre was observed in glass bottle under both storage conditions. Fibre content of the product stored in polypropylene bottle and bag did not vary significantly. No significant variation in the iron content was observed with the different packaging systems under both storage conditions.

Earlier studies conducted by Kumar and Manimegalai (2001) on the effect of packaging systems on vitamin C retention of strawberry sauce revealed that the sauce packed in glass bottle exhibited a higher retention of ascorbic acid content than the samples packed in polypropylene pouch. In the present study also maximum vitamin C retention was found in glass bottles. Ramasastry (1994) also reported that dried and powdered amla fruit stored in glass containers retained more ascorbic acid compared to other packages.

**Fig. 20. Vitamin C retention in tutifruiti stored (six months) under ambient and refrigerated conditions in different packaging systems**



d) Jelly

Changes in the chemical composition of jelly stored in glass bottle, polypropylene bottle and polypropylene bag was studied both under ambient and refrigerated condition for a period of six months.

Moisture content of jelly was found to decrease with the storage period under both storage conditions. Sugar content was found to increase significantly with the storage period. This is in accordance with the result obtained by Tripathi *et al.* (1988) in amla jam stored for a period of 135 days. This increase may be due to the increased inversion of sugar on account of higher fixed acidity. A reduction in the tannin content was observed which was also reported by Tripathi *et al.* (1988) in amla jam stored for 135 days. But George (2000) observed no change in tannin content of amla jelly stored for 6 months.

A reduction in vitamin C content of jelly was observed under both storage conditions. This is in accordance with the result obtained by George (2000) in her storage studies with amla jelly for a period of 6 months. In a similar product - amla jam Tripathi *et al.* (1988) also reported a gradual reduction in vitamin C during storage period. The higher vitamin C in the refrigerated product could be attributed to the higher retention of vitamin C at lower temperature as reported by Gopalan and Ram (1990), Salunkhe *et al.* (1991), Giri (1993) and Ramasastry (1994) who observed retention of vitamin C at low temperature in amla fruit as well as dried and powdered amla.

No fibre was observed in jelly since jelly was prepared from fruit extract. The iron in amla jelly was found to reduce with storage period under both storage conditions but George (2000) observed that in amla jelly stored for 6

months, the initial iron content was retained up to the 3rd month of storage which then reduced by the end of storage period.

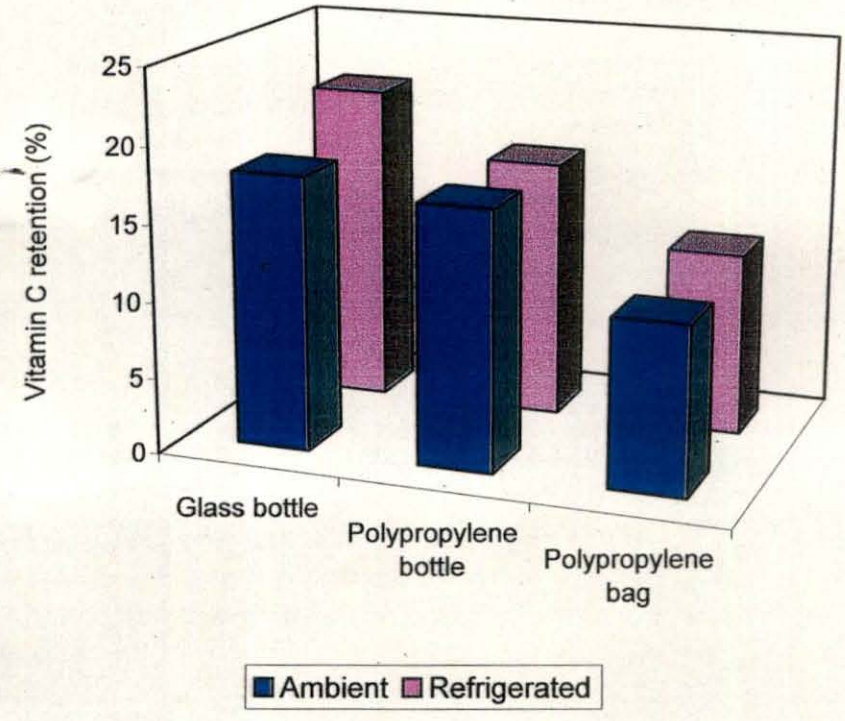
The effect of different packaging systems viz., glass bottle, polypropylene bottle and polypropylene bag on different chemical constituents of jelly stored under ambient and refrigerated conditions for a period of six months was studied. Moisture content was low in jelly stored in polypropylene bag under both storage conditions. Under ambient condition there was no variation in sugar content with respect to glass bottle and polypropylene bag and the least sugar was observed in polypropylene bottle but in refrigerated condition maximum sugar was in polypropylene bottle. No significant variation in tannin content was observed with packaging systems but with regard to vitamin C maximum retention was observed in glass bottle (Fig.21). Maximum iron was also retained in jelly stored in glass bottle.

5.1.2.2 Changes in the organoleptic qualities of six Indian gooseberry products stored in glass bottle, polypropylene bottle and polypropylene bag under ambient and refrigerated condition was evaluated for a period of six months

a) Candy

No variation was observed in the appearance of candy stored under both ambient and refrigerated conditions up to 4th month of storage. Colour of the product was well accepted till 3rd month of storage under ambient condition and under refrigerated condition till 5th month of storage the colour was found to be good. Regarding the flavour of the product no significant variation was observed in its acceptability under both storage conditions up to the 5th month. But the flavour of the product was found to decrease significantly by the 6th month of storage.

**Fig. 21. Vitamin C retention in jelly stored (six months) under ambient and refrigerated conditions in different packaging systems**



Acceptability of the texture of the candy under both storage conditions was found to have a significant increase up to the 3rd month of storage with maximum scores during the 5th month of storage but after 3rd month the increase was not significant. Regarding the taste of the candy, under ambient storage the taste of the product was found to increase significantly up to the 3rd month of storage which then reduced significantly. Under refrigerated condition the taste was found to be increasing but no significant variation was observed between 2nd and 5th months of storage but reduced significantly by the end of storage study.

With respect to all the criteria evaluated candy stored up to three months was well accepted.

The improvement in the mean score for texture and taste in the present study was in accordance with the results obtained by Tripathi *et al.* (1988) who reported a gradual increase in the mean scores for taste and texture up to the 4th month in stored candy. But the mean scores obtained by colour and flavour was found to reduce with the storage period. In the present study also significant reduction in the colour of the product was observed after three months in ambient storage and after four months in refrigerated storage. Incidence of colour change during advancement of storage period might be due to the oxidation and amino acid-sugar interaction leading to the formation of brown pigment. Texture of the stored candy was found to be increasing up to 3rd month in the present study which may be due to a decrease in the fibre content of stored candy. An increase in the taste of candy was also noted under both storage conditions which may be due to a decrease in the tannin content in the stored product which reduces the astringency

in the product. But Prasad *et al.* (1988) reported that the acceptability of candy improved all throughout the storage period up to six months. According to Nath (1999) amla candy can be stored for 11-12 months with acceptable organoleptic qualities.

The effect of different packaging systems on the organoleptic qualities of candy stored under ambient and refrigerated condition was evaluated for six months.

Appearance of candy was highly acceptable in glass bottle under ambient condition but under refrigerated condition no variation was observed in the appearance of the product with regard to packaging system. Colour and taste of the product was also found to have no variability with regard to storage in different packaging systems. Regarding flavour of the product, under ambient condition, the product stored in glass bottle was best accepted and the least accepted product was in the polypropylene bag. Under refrigerated condition also the least accepted product with regard to flavour was in polypropylene bag. But no variation in flavour was noted in products stored in glass bottle and polypropylene bottle. Under ambient condition texture of the product was found to have no variation between polypropylene bag and polypropylene bottle but product stored in glass bottle was found to be least accepted. Under refrigerated condition no such variation in texture of the product was observed with regard to packaging systems.

In the present study criteria like appearance, colour and taste of amla candy showed no variation with regard to packaging systems but flavour was found to be least in candy stored in polypropylene bags. This result is in contrast to

Vijayanand *et al.* (2001) who reported that pineapple, mango and papaya fruit chunks packed in 150 gauge polypropylene pouches showed acceptable sensory qualities up to a period of 30 days at 27°C and 60 days at 2°C. But Kumar and Manimegalai (2001) reported that strawberry sauce stored in glass bottle recorded higher organoleptic scores compared to that stored in polypropylene pouch.

b) Preserve

The highest mean score for the appearance, colour, texture and taste of the preserve under ambient and refrigerated storage was exhibited during the 6$^{th}$ month of storage. But no significant variation was observed between every month of storage.

In general the acceptability of the quality attributes did not show variation with the storage conditions. But due to storage periods, appearance was highly acceptable for the preserve stored for six months. Colour of the stored preserve was also highly acceptable in the products stored for six months. There observed no variation in the acceptability of flavour with storage periods but maximum texture and taste of preserve was also observed during the 6$^{th}$ month.

As in the present study an increment in the mean scores for colour, taste and flavour with the advance of the storage period was also observed by Tripathi *et al.* (1988). Their study showed that the percent of acceptability for taste, colour and flavour of stored preserve increased with the advance of the storage period up to the 45$^{th}$ day and did not change up to the 135$^{th}$ day. But the acceptability of texture was found to increase to a maximum by the 90$^{th}$ day which then reduced.

According to Singh *et al.* (1999) the preserve should preferably be stored at least for 60 days before consumption. Prasad *et al.* (1988) also observed that the acceptability of amla preserve improved all throughout the storage up to 6 months. Nath (1999) also reported that preserve stored for 11-12 months was found to have acceptable quality.

The improved acceptability of the preserve with the advance of the storage period may be attributed to the increased penetration of sugar into the fruit tissue from the syrup and the improvement of texture. Alzamora *et al.* (1993) reported that the lower pH and penetration of sugar into the fruit chunks improved their sensory quality by establishing sugar-acid ratio with the storage.

The effect of different packaging systems on the organoleptic qualities of preserve stored under ambient and refrigerated condition was evaluated for a period of six months.

Quality parameters like appearance, colour and flavour of preserve stored in different packaging systems did not show variation with respect to storage conditions as well as packaging systems. But texture of the preserve stored under ambient condition was highly acceptable in polypropylene bag whereas in refrigerated condition the least acceptable product for texture was in polypropylene bag. Taste of preserve was also highly acceptable in glass bottle stored under ambient condition.

Rani and Bhatia (1986) reported that Bagugosha preserve packed in glass jars and intermediate moisture product in polypropylene bags showed satisfactory quality for about 40 weeks under ambient condition with the glass

bottle retaining better quality. Ramasastry (1994) also reported that glass containers retained more organoleptic quality at room temperature. Studies carried out by Mahadeviah *et al.* (1994) also reported that pineapple slices stored in glass jars were more acceptable compared to the flexible pouches. In the present study the texture of the preserve obtained the highest mean score when stored in polypropylene bag under both storage conditions. This was in accordance with the results of the investigation done by Irwandi (1998) on the effects of type of packaging material and length of storage quality of durian fruit leather. She observed that polypropylene film satisfactorily maintained the quality of products stored up to 12 weeks at room temperature. This finding was also supported by Premlatha *et al.* (1999) who found polypropylene pouches to be suitable for long term storage of papaya and jackfruit based products. Krishnaveni *et al.* (1999) also reported that the jack fruit bar stored in polypropylene bags obtained high scores in organoleptic evaluation especially texture of the product.

c) Tutifruiti

The mean scores for appearance and texture of tutifruiti was found to improve significantly with the advance of the storage period and exhibited the maximum mean score by the $6^{th}$ month under both ambient and refrigerated storage.

In the present study storage conditions were found to have no effect on the organoleptic qualities of tutifruiti stored for six months. But with storage period, maximum acceptability with regard to appearance, colour, flavour, texture and taste was observed in tutifruiti stored for six months.

The increase in the mean score of colour, flavour and texture of the tutifruiti in the present study was in accordance with the results obtained by Tripathi *et al.* (1988) in a similar product which was stored in syrup for a period of 135 days. But Aruna *et al.* (1999) observed a significant reduction in the organoleptic scores of papaya fruit bars under both ambient and refrigerated storage.

The effect of different packaging systems viz., glass bottle, polypropylene bottle and polypropylene bag on the organoleptic qualities of tutifruiti under ambient and refrigerated storage was evaluated for a period of six months.

Variation in the organoleptic qualities of tutifruiti was observed with packaging systems and also storage conditions. Under ambient condition tutifruiti stored in polypropylene bag was least acceptable with regard to appearance. The same was also observed in refrigerated condition, but the difference was not statistically significant. Under ambient condition, tutifruiti stored in glass bottle was found to be ideal with regard to colour when compared to polypropylene bag but under refrigerated condition no such variation in colour was observed. No variation in the flavour of tutifruiti was also observed under both storage conditions. Texture was also more acceptable in glass bottle and polypropylene bottle than polypropylene bag under ambient condition. No variation in texture was observed under refrigerated condition with regard to packaging system. Taste under ambient condition was highly acceptable in tutifruiti stored in glass bottle but no variation in taste was observed with packaging systems under refrigerated

condition. Thus in the present study maximum mean score for all the quality attributes under both ambient and refrigerated storage was obtained for tutifruiti stored in the glass bottle. This was in accordance with the results of the storage studies carried out by Tandon and Kalra (1984) on guava pulp, Rani and Bhatia (1986) on Bagugosha preserve, Ramasastry (1994) on dried and powdered amla fruit and Mahadeviah *et al.* (1994) on pineapple slices. Kumar and Manimegalai (2001) reported that the glass bottle stored strawberry sauce was found to retain better organoleptic qualities compared to polypropylene pouch stored sauce up to a period of six months.

d) Jelly

Appearance of jelly was found to be gradually decreasing with storage period under ambient condition, but this gradual reduction in the appearance was not significant. But under refrigerated condition no significant variation was observed in appearance of the product up to fourth month of storage. Later a significant reduction was observed. Regarding colour of the product under ambient condition there was gradual reduction in the colour but significant reduction was from the $4^{th}$ month of storage. But under refrigerated condition, no change in colour was noted up to the $3^{rd}$ month, then it reduced significantly. Flavour showed significant which reduction from $4^{th}$ month onwards. Under ambient condition no variation in texture was observed up to $5^{th}$ month and under refrigerated condition maximum acceptability for texture was during the $4^{th}$ month of storage. Under both storage conditions taste was found to be highly acceptable during the $3^{rd}$ month of storage which then reduced with storage period.

In the present study the maximum mean scores for most of the quality criterias was found to be exhibited during the 3rd month of storage under refrigerated condition. This was similar to the result obtained by Sehgal and Singh (1999) in a similar product - amla-honey spread which was best acceptable by 90 days of storage. According to Tripathi *et al.* (1988) the maximum acceptability of amla jam was observed after 45 days of storage which did not change up to 135 days. Che Man and Taufik (1995) observed a decrease in colour and texture values of jackfruit leather during storage under ambient and refrigerated condition. The reduction in the mean score of appearance and colour of the jelly with the advance of storage under ambient condition from the 2nd month onwards may be due to the increased deposition of tannin which lead to the development of undesirable colour and opacity of the product. The reduction in the mean score of taste could also be attributed to the deposition of tannin contributing more astringent taste. The improved acceptability under refrigerated storage was in agreement with the result obtained by Sagar *et al.* (2000) who reported that the organoleptic quality obtained higher score in low temperature stored mango powder compared to the room temperature stored product.

Joshi and Attri (1990) found that Karonda jelly was organoleptically acceptable up to a period of one year. Gothwal *et al.* (1998) reported that plum jam could be stored for 09 months at room temperature with acceptable quality whereas Nath (1999) reported that it remains acceptable for 08 months.

The effect of different packaging systems viz., glass bottle, polypropylene bottle and polypropylene bag on the organoleptic qualities of jelly stored under ambient and refrigerated conditions was evaluated for a period of six months.

With packaging systems under ambient condition appearance was significantly low in jelly stored in polypropylene bag but under refrigerated condition no variation in appearance was observed with packaging systems. There was no variation in the colour, texture and taste of jelly stored under both conditions with regard to packaging systems. But flavour of jelly under ambient condition was significantly low in polypropylene bag. The jelly stored in glass bottle was found to exhibit the highest mean scores in most of the quality parameters. This was in accordance with the result obtained by Kumar and Manimegalai (2001) who observed that the sauce stored in glass bottle obtained higher organoleptic scores compared to that stored in polypropylene pouches. Appearance and flavour of the jelly stored in polypropylene bag was found to be the least acceptable with regard to packaging systems.

Nadanasabapathi *et al.* (1993) also reported that of mango bars packed in flexible packaging materials was not acceptable after five months of storage, due to the development of undesirable colour. In the present study also the reduced acceptability of the jelly with storage could be attributed to the development of undesirable colour. Mahadeviah *et al.* (1994) also found that mango and banana pulp stored in flexible pouches exhibited reduced acceptability due to the browning of the products.

5.1.2.3 Microbial study

Microbial load of all the selected products viz., candy, preserve, jelly and tutifruiti stored in glass bottle, polypropylene bottle and polypropylene bag under both ambient and refrigerated storage was evaluated at monthly intervals for a period of six months and were found to be free from any microorganisms viz., fungi and bacteria. The absence of microbes may be attributed to the higher sugar content, acidity and presence of the preservative viz. Potassium metabisulphate.

Nath (1999) also reported that aonla preserve and candy could be stored for 11 to 12 months and amla jam for 08 months without any spoilage. The absence of microorganisms in the stored product was also observed by Jayaraman *et al.* (1997) in papaya, jackfruit and banana preserve, Kumar and Manimegalai (2001) in straw berry sauce, Alzamora *et al.* (1993) in papaya, mango and chicosapote preserve stored at ambient temperature for three months. Joshi and Attri (1990) observed that Karonda jam and jelly could be successfully stored under ambient condition without any spoilage up to one year.

## 5.2 Yield and cost ratio

Among the selected six Indian gooseberry products five products viz., candy, salad, preserve, samosa and jelly were found to obtain yield and cost ratio above one and could be recommended for commercial popularization. But the product tutifruiti was found to obtain an yield and cost ratio (0.62) below one which means the cost of production of the product is more compared to the final product yield. The candy with the highest yield and cost ratio (7.06) could be recommended as the most beneficial product followed by salad (5.95), preserve (4.47), samosa (2.65) and jelly (1.58).

The least yield and cost ratio obtained by tutifruiti could be attributed to the use of destoned fruit and dehydration of the sliced fruit. In products like samosa and salad also the fruits were destoned before preparing the product but the presence of other ingredients might have contributed to its higher yield and cost ratio. Gooseberry being the main ingredient in tutifruiti might be the reason behind the significant reduction in its ratio.

# *Summary*

# 6. SUMMARY

The study on "Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products" was undertaken to evaluate the different Indian gooseberry products for their acceptability, chemical composition and storage stability.

Six Indian gooseberry products were selected from a total of eighteen products viz., candy, preserve, tutifruiti, jam, jelly, salad, pakoda, samosa, pickle, mixed uppuma, biscuit, custard jelly, pachadi, Indian gooseberry-Guava jelly, dehydrated product, squash, nectar and beverage through preliminary acceptability study. The study was conducted using score cards in 120 individuals - 40 high school students, 40 college students and 40 college staff with equal distribution of male and female from elite, rural and urban communities. The study revealed that the product tutifruiti was best accepted (mean score 21.98) and dehydrated product the least (15.33).

The six products viz., tutifruiti, preserve, jelly, salad, samosa and candy which obtained the maximum mean score were selected for the detailed storage study. Among the selected products samosa and salad were perishable by the second day itself and were deleted from the detailed storage study.

The chemical constituents such as moisture, sugar, vitamin C, tannin, fibre and iron were analysed in the fresh, sugar treated and salt treated Indian gooseberry and selected products. The sugar treated gooseberry was found to retain all the chemical constituents better than the salt treated gooseberry. The product

salad obtained the highest moisture, vitamin C and fibre content while jelly obtained the highest sugar content. The maximum tannin and iron content was observed in candy and preserve respectively. The lowest sugar, tannin, vitamin C and iron content were observed in samosa while the least moisture and fibre content was observed in jelly.

The yield and cost ratio of the selected six products was computed. Candy was found to be the most economical product for commercial popularization followed by salad, preserve, samosa and jelly. But the production of tutifruiti was not found to be profitable.

The selected products viz., candy, preserve, tutifruiti and jelly were stored under ambient and refrigerated conditions in glass bottle, polypropylene bottle and polypropylene bag for a period of six months and their chemical constituents, organoleptic qualities and microbial load were analysed at monthly intervals. The stored products were analysed for the moisture, sugar, vitamin C, tannin, fibre and iron contents at monthly intervals.

The moisture, vitamin C, tannin, fibre and iron contents of all the products under storage were found to reduce and sugar content increased with the advance of the storage period under both ambient and refrigerated conditions. Low moisture was observed in candy and preserve stored in refrigerated condition but in tutifruiti and jelly the low moisture levels were observed when stored under ambient condition. In all the stored products the retention of vitamin C was more when stored under refrigerated condition compared to ambient condition. For tannin content also the retention was more when stored under refrigerated

condition. Regarding the fibre the low value was observed in refrigerated storage except for tutifruiti during the 1st two months of storage. No fibre content was observed in jelly. The retention of iron in the products did not vary significantly with storage conditions.

The different packaging systems were found to have significant effect on the vitamin C content of all the stored products under both storage conditions. The product in glass bottle was found to retain the maximum vitamin C while in the polypropylene bag the stored product retained the least vitamin C.

In candy almost all the chemical constituents were higher in glass bottle and the least in polypropylene bottle.

In preserve under both storage conditions fibre and iron was significantly high when stored in glass bottle while the sugar content was maximum in product stored in polypropylene bag under the ambient condition. Tannin content of the product was also significantly affected by the packaging systems.

Chemical constituents such as sugar, vitamin C, fibre and iron were high in tutifruiti kept in glass bottle under both storage conditions. But high moisture and tannin content was observed in tutifruiti in polypropylene bag under ambient and refrigerated conditions respectively.

The jelly stored in glass bottle showed the highest mean value for all the chemical constituents under both storage conditions. With regard to packaging systems under refrigerated storage no significant variation in moisture was obtained but the moisture retention was more when compared to product stored in

ambient condition. The sugar and iron content of the jelly stored under both conditions were found to vary significantly between the glass bottle and polypropylene bottle the maximum retention being in glass bottle. The tannin content was observed to exhibit no significant variation with regard to packaging systems. But refrigerated products retained more tannin when compared to products in ambient condition storage.

The organoleptic evaluation of the stored products revealed that with respect to all the criteria evaluated the candy stored under both ambient and refrigerated conditions was well accepted during the 3rd month. The appearance of the candy was best accepted during the 3rd and 4th months of storage under ambient and refrigerated conditions respectively. Under both storage conditions the acceptability of colour was best during the 3rd month but the best acceptability for flavour and texture was exhibited during the 4th and 5th months respectively. The ambient temperature stored candy was found to be more acceptable compared to refrigerated candy. So a well acceptable amla candy with regard to all the sensory qualities can be obtained by the 3rd month of storage under ambient conditions.

In preserve maximum acceptability for all the sensory qualities were during the 6th month of storage under both storage conditions. The least acceptable product with regard to sensory qualities was in the products stored for one month. The storage conditions were found to have no significant effect on the acceptability of the product.

In tutifruiti also the storage conditions were found to have no significant effect on the organoleptic qualities. But with regard to storage period the maximum

acceptability for all the quality attributes was observed during the 6th month and the least during the first month. Thus storage for six months was found to be ideal for the best acceptability of tutifruiti.

With regard to all the quality attributes the maximum acceptability for jelly was observed during the 3rd month of storage. Under ambient storage the maximum acceptability for appearance and colour was observed during the 1st month while the flavour and taste obtained the maximum acceptability during the 2nd and 3rd months respectively. The texture of the product was best accepted during the 4th month under both storage conditions. The appearance, colour, texture and taste of the jelly was best accepted during the 3rd month under refrigerated storage.

With regard to packaging systems the highest acceptability for candy was observed in products kept in glass bottle. The least acceptable product was in the polypropylene bag, except for texture which was highly acceptable in candy stored in polypropylene bag.

Quality parameters like appearance, colour and flavour of the stored preserve did not show variation with respect packaging systems. A slight variation was observed only with the texture of the product. The texture was best accepted when stored in polypropylene bag under ambient condition and in glass bottle under refrigerated condition. Taste was more acceptable for preserve stored in glass bottle under ambient condition.

The appearance, colour, texture and taste of the tutifruiti stored in the glass bottle was found to have better acceptability compared to the product in

polypropylene bag under ambient storage. The flavour of the product did not vary with the storage condition as well as packaging system. The different packaging systems were found to have no significant effect on the quality attributes of tutifruiti stored in refrigerated condition.

The colour, flavour, texture and taste of the jelly was found to have no significant variation with regard to packaging systems as well as storage condition. But the appearance of the jelly stored under ambient condition was observed to exhibit a significantly higher acceptability in glass bottle compared to polypropylene bag. The glass bottle stored jelly exhibited comparatively higher acceptability in all the quality attributes under both storage conditions.

Thus the present study identified glass bottle as the best packaging system for storage of Indian gooseberry products compared to polypropylene bottle and polypropylene bag. Ambient condition storage was found to be ideal for the lower retention of tannin while refrigerated storage was ideal for the maximum retention of vitamin C in the different Indian gooseberry products. Ambient storage could be recommended for the lower retention of moisture content in tutifruiti jelly and refrigerated storage in candy and preserve. The acceptability of candy and tutifruiti was better when stored under ambient condition while the acceptability of preserve was better when stored under refrigerated condition. The ideal storage period for candy was found to be for three months whereas for preserve and tutifruiti it was six months under both storage conditions. For jelly stored under refrigerated condition the ideal storage period was three months.

All the products stored under both ambient and refrigerated conditions in different packaging systems were found to be free from microbes throughout the storage period up to six months.

From the results of the above study the Indian gooseberry salad with very high vitamin C content could be recommended as a delicious dessert. Usually the retention of vitamin C in processed fruit products is very low whereas in amla products the retention of the vitamin C was found to be fairly high even after processing and storage. In the present study the maximum vitamin C retention (38%) was observed in candy stored under refrigerated condition in glass bottle. Thus the candy which was a highly acceptable product could be recommended as a nutritious preserved fruit product even during the off season. Thus the study highlighted the significance of processed Indian gooseberry products as a solution for the increased consumer demand for nutritious, delicately flavoured and economical fruit products all throughout the year.

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* Originals not seen

# *Appendices*

## APPENDIX-I

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Candy/Preserve/Tutifruiti

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Colour | Very acceptable | 5 | |
| | Acceptable | 4 | |
| | Slightly acceptable | 3 | |
| | Neither acceptable nor unacceptable | 2 | |
| | Unacceptable | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Texture | Moderately hard | 5 | |
| | Hard | 4 | |
| | Very hard | 3 | |
| | Hard and shrunken | 2 | |
| | Stony | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Jam/Jelly/Indian Gooseberry - Guava Jelly/Custard Jelly

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Colour | Very acceptable | 5 | |
| | Acceptable | 4 | |
| | Slightly acceptable | 3 | |
| | Neither acceptable nor unacceptable | 2 | |
| | Unacceptable | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Texture | Smooth and spreading | 5 | |
| | Smooth | 4 | |
| | Grainy not spreading | 3 | |
| | Watery | 2 | |
| | Hard | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Mixed uppuma, Pachadi, Pickle, Dehydrated product, Salad

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Colour | Very acceptable | 5 | |
| | Acceptable | 4 | |
| | Slightly acceptable | 3 | |
| | Neither acceptable nor unacceptable | 2 | |
| | Unacceptable | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Texture | Very acceptable | 5 | |
| | Acceptable | 4 | |
| | Slightly acceptable | 3 | |
| | Neither acceptable nor unacceptable | 2 | |
| | Unacceptable | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Pakoda/Biscuit

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Colour | Light brown | 5 | |
| | Brown | 4 | |
| | Dark brown | 3 | |
| | Blackish brown | 2 | |
| | Black | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Texture | Very crisp | 5 | |
| | Crisp | 4 | |
| | Soggy | 3 | |
| | Leathery | 2 | |
| | Hard | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Nectar/Squash

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Consistency | Correct | 5 | |
| | Thin | 4 | |
| | Thick | 3 | |
| | Too thin | 2 | |
| | Too thick | 1 | |
| Colour | Very acceptable | 5 | |
| | Acceptable | 4 | |
| | Slightly acceptable | 3 | |
| | Neither acceptable nor unacceptable | 2 | |
| | Unacceptable | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Beverage

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Clarity | Sparkling clear | 5 | |
| | Clear | 4 | |
| | Slightly clear | 3 | |
| | Slightly cloudy | 2 | |
| | Very cloudy | 1 | |
| Colour | Very acceptable | 5 | |
| | Acceptable | 4 | |
| | Slightly acceptable | 3 | |
| | Neither acceptable nor unacceptable | 2 | |
| | Unacceptable | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

Score card for evaluating the acceptability of the different Indian gooseberry products

Tested by

Products: Samosa

Signature :

Name :

Date :

Age :

Designation :

| Quality attribute | Word description | Score | Assigned score |
|---|---|---|---|
| Appearance | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |
| Colour | Golden brown | 5 | |
| | Light brown | 4 | |
| | Brown | 3 | |
| | Dark brown | 2 | |
| | Blackish brown | 1 | |
| Flavour | Very pleasant | 5 | |
| | Pleasant | 4 | |
| | Neither pleasant nor unpleasant | 3 | |
| | Unpleasant | 2 | |
| | Not at all pleasant | 1 | |
| Texture | Crisp | 5 | |
| | Hard | 4 | |
| | Soggy | 3 | |
| | Elastic | 2 | |
| | Chewy | 1 | |
| Taste | Excellent | 5 | |
| | Good | 4 | |
| | Satisfactory | 3 | |
| | Mediocre | 2 | |
| | Poor | 1 | |

## APPENDIX-II

## Standard Recipes

### BEVERAGE

Ingredients

| | | |
|---|---|---|
| Indian gooseberry juice (treated) | - | ½ cup |
| Lemon juice | - | 1 tb sp |
| Pineapple juice | - | ¼ cup |
| Sugar | - | as required |
| Citric acid | - | 1 tsp |
| KMS | - | 1 pinch |
| Water for dilution | - | 8-10 ounces |

Procedure

1. Mixed the fruit juices, sugar, citric acid and potassium metabisulphite (KMS)
2. Poured water to fill the glass

Andrew (1991)

### NECTAR

Ingredients

| | | |
|---|---|---|
| Indian gooseberry | - | 100 g |
| Pineapple | - | 100 g |
| Sugar | - | 150-200 g |
| Water | - | 650 g |
| Citric acid | - | 2 ½ g |
| KMS | - | 1 pinch |

Procedure

1. Treated the Indian gooseberry and pulped them in a liquid
2. Extracted pineapple juice and strained
3. Prepared the syrup with water, sugar and citric acid and filtered
4. Mixed the pineapple juice and Indian gooseberry pulp with KMS
5. Heated the mixture to 90°C and bottled

Andrew (1991)

## MIXED UPPUMA

Ingredients

| | | |
|---|---|---|
| Rava | - | 20 g |
| Red gram dhal | - | 10 g |
| Carrot | - | 15 g |
| Peas | - | 10 g |
| Indian gooseberry (treated) | - | 15 g |
| Onion | - | 15 g |
| Green chilli | - | ½ |
| Coconut scrapings | - | ½ tbsp |
| Ginger | - | ¼" piece |
| Dalda | - | 1 tbsp + 1 tsp |
| Mustard | - | 1/8 tsp |
| Black gram dhal | - | ½ tsp |
| Corriander leaves | - | for garnishing |
| Salt | - | to taste |
| Sodium benzoate | - | 1 pinch |

Procedure

1. Roasted the rava until the smell of the broiled rava came out
2. Finely chopped Indian gooseberry, carrot, onion, ginger and green chilli
3. Cooked the dhal, Indian gooseberry, carrot, green peas separately. When cooked, added salt.
4. Heated 1 tbsp dalda in a deep frying pan. Seasoned it with mustard and black gram dhal. Put the chopped onions, ginger and green chilli and fried for 2-3 mins.
5. Added water and salt (water 1/8 cup)
6. When the water started boiling rava was added and stirred with fork until it was cooked.
7. Saute the cooked dhal and vegetable in 1 tsp of dalda.
8. Added this to the uppuma and mixed well.
9. Served garnished with coconut scrapings.

Pritam and Nimmi (1991)

## PACHADI

Ingredients

| | | |
|---|---|---|
| Indian gooseberry (treated) | - | 25 g |
| Coconut scrapings | - | 1 tbsp |
| Ginger | - | 1/8" pieces |
| Green chilli | - | ½ |
| Small onion | - | 2 |
| Garlic | - | 1 small pod |
| Mustard seed | - | 1/8 tsp |
| Minced onion (small) | - | 1 tsp |
| Curry leaves | - | 3 |
| Curd | - | 2 ounces |
| Oil/dalda | - | 1 tsp |
| Salt | - | to taste |

Procedure

1. Chopped Indian goose berry
2. Items 2 to 6 were ground coarsely
3. Heated the oil, added mustard seeds, when they crackled added minced onions and curry leaves.
4. When onion turned brown, added the ground masala, mixed well and added 1 tbsp of water and salt to taste.
5. The chopped Indian gooseberry was added, mixed well, covered and cooked until the Indian gooseberry became tender.
6. Removed from fire. Added beaten curd and mixed well.

Pritam and Nimmi (1991)

## SAMOSA

Ingredients

| | | |
|---|---|---|
| Indian gooseberry | - | 50 g |
| Turmeric | - | ¼ tsp |
| Onion | - | 50 g |
| Green chillies | - | 3 |
| Ginger | - | 1 piece |
| Curry leaves | - | a little |
| Mustard | - | 1 tsp |
| Oil | - | 2 tbsp |
| Maida | - | 150 g |
| Salt | - | to taste |

Oil for frying

Procedure

1. Boiled the oil and crackled the mustard, curry leaves, add green chilli, onion, ginger, turmeric powder. Fried it and added Indian goose berry and cook it.
2. Made dough with maida, salt and water. Rolled it and cut it at one end.
3. Kept the cooked Indian goose berry (2 tsp)
4. Rolled in the samosa and fried in hot oil.

Pritam and Nimmi (1991)

## PAKODA

Ingredients

| | | |
|---|---|---|
| Indian gooseberry (treated) | - | 40 g |
| Bengal gram flour | - | 72 g |
| Maida | - | 5 g |
| Broken cashewnut | - | 10 g |
| Small onion | - | 50 g |
| Green chillies | - | 2 |
| Ginger chopped | - | 1 tsp |
| Curry leaves | - | 7 |
| Coriander leaves | - | 5 g |
| Fennel seeds | - | 5 g |
| Salt | - | ¾ tsp |
| Dalda | - | ½ tbsp |
| Oil for frying | - | ½ cup |

Procedure

1. Sift bengal gram flour, maida and salt
2. Chopped onions, green chillies, coriander leaves and curry leaves and ground them coarsely.
3. Melted dalda and added it to the flour mixture, Indian gooseberry (treated), broken cashewnuts and fennels and coarsely ground ingredients and mixed well.
4. The mixture was made into stiff dough, with a little water (2 tbsp). Heated oil in a deep frying pan, took small bits of dough (about 10 g) and deep fried on a medium fire. When pakoda turned evenly brown, removed it from fire.

Pritam and Nimmi (1991)

## INDIAN GOOSEBERRY - CUSTARD JELLY

Ingredients

| | | |
|---|---|---|
| Indian gooseberry (treated) | - | 50 g |
| Soft custard | - | ¼ cup |
| Gelatin | - | 5 g |
| Sugar | - | 20-30 g |

Procedure

1. Soaked the gelatin in 1 to 2 tbsp of cold water.
2. Prepared the soft custard and added the soaked gelatin while the custard was hot. Stirred and dissolved gelatin and cooled the mixture.
3. In the mean time sugar was added to the Indian gooseberry and kept aside.
4. When the custard mixture was cooled and when it reached the consistency of thick egg white (i.e., when it just begin to set) added the Indian gooseberry and mixed well. Frozen until it was set. This was served cold.

Ram (1983)

## PICKLE

Ingredients

| | | |
|---|---|---|
| Indian gooseberry (treated) | - | ¼ kg |
| Garlic | - | 6 flakes |
| Ginger | - | 1" piece |
| Green chilli | - | 2 |
| Chilli powder | - | 1 tbsp |
| Vinegar | - | 2 or 3 ounces |
| Cumin seeds | - | ¼ tsp |
| Oil | - | 1 ounce |
| Salt | - | 1 tbsp |
| Turmeric powder | - | ¼ tsp |
| Mustard seeds | - | ¼ tsp |
| Red colour | - | 4 drops |

Procedure

1. Washed and cut the Indian gooseberry into thin slices
2. Added salt and kept it aside for an hour
3. Sliced green chillies, garlic and ginger
4. Ground chilli powder, turmeric powder, cumin seeds.
5. Heated oil in a deep frying pan, added mustard, when it burst, added green chillies, garlic and ginger. Continued heating for 3 minutes.
6. Added the ground paste and mixed well.
7. When it became brown added the water from Indian gooseberry.
8. When it thickened added Indian gooseberry.
9. When it boiled added vinegar.
10. Added salt and bottled when cooled.

Morton (1985)

## SALAD

Ingredients

| | | |
|---|---|---|
| Indian gooseberry (treated) | - | 1kg |
| Grapes | - | 1 ½ kg |
| Angour | - | 1 ¼ kg |
| Orange | - | 2 |
| Sweet lime | - | 1 |
| Guava | - | 3 small |
| Plantain | - | 3 |
| Banana | - | 1 |
| Apple | - | 2 |
| Pineapple | - | ½ |
| Pears | - | 1 |
| Lettuce leaves | - | 3 bunches |
| Cheese | - | 350 g |
| Sugar | - | 150 g |
| Water | - | 1 ½ cup |
| Cherries | - | 50 g |
| Dates | - | 25 g |

Procedure

1. Added the sugar to water and heated until the sugar dissolved.
2. Removed the skin of orange, sweet lime, guava, plantain, banana, pineapple and pears. Cut Indian gooseberry and all above fruits into small piece (1 cm cubes except for banana which was sliced into round shape) and put them into the sugar syrup.
3. Arranged the lettuce leaves around inside of a round fruit bowl. Put some cheese in the centre, covered it with the fruits and chilled.
4. Put more cheese on the top and garnished with dates and cherries. Served cold.

Bachman (1985)

## JAM

Ingredients

| | | |
|---|---|---|
| Indian gooseberry | - | 1 kg |
| Sugar | - | 1 kg |
| Citric acid | - | 4-5 g |

Procedure

Fruits were kept in 8% salt solution for 2 days to remove astringency, then washed thoroughly and boiled for 10 minutes. The fruits were then cut into pieces cooled and subsequently blended. Then one kg sugar and 4 g citric acid was added to the blend and cooked.

As the product attained desired consistency or the sugar percentage reached 68%, the hot jam was filled into wide mouthed sterilized bottles up to the brim. On cooling jam set. A thin layer of hot paraffin wax was kept on the surface of the product in the bottle and capped. The jam bottles were stored in cool and dry place.

Bachman (1985)

## JELLY

Ingredients

| | | |
|---|---|---|
| Indian gooseberry extract | - | 1 cup |
| Sugar | - | ¾ cup |

Procedure

Boiled the Indian gooseberry extract and sugar together until it reached the correct consistency, bottled hot and capped when set.

Bachman (1985)

## INDIAN GOOSEBERRY - GUAVA JELLY

Ingredients

| | | |
|---|---|---|
| Indian gooseberry extract | - | 1 cup |
| Guava extract | - | 1 cup |
| Sugar | - | 1 ½ cup |

Procedure

Boiled the extracts and sugar together until it reached the correct consistency, bottled hot and capped when set.

Throne (1995)

## CANDY

Ingredients

| | | |
|---|---|---|
| Indian gooseberry | - | 1 kg |
| Sugar | - | 1½ kg |
| KMS | - | 2 g |

Large size Indian gooseberry were selected and put in tap water for 2 days and then pricked thoroughly with stainless steel fork. The fruits were kept in 2% alum and 0.5% sodium sulphate solution for 5 mins. The fruits and sugar were kept in alternative layers and then left for 24 hrs. In the following day the sugar dissolved. The fruits were taken out from syrup and boiled. Added KMS. Then the syrup was strained with muslin cloth and the fruits were kept in hot syrup for 24 hours. On the 3$^{rd}$ day again the fruits were taken out from the syrup and boiled till the sugar percentage reaches 70-72 per cent. Then the fruits were kept in hot syrup. Kept the preserve for 5 mins. Took out the fruits from the syrup. Ground sugar was then sprinkled on the fruits and the fruits were allowed to dry at room temperature. Candy was ready for use.

Ram (1983)

## PRESERVE

Ingredients

| | | |
|---|---|---|
| Indian gooseberry | - | 1 kg |
| Sugar | - | 1 ½ kg |
| Citric acid | - | 2 g |

Procedure

Large size Indian gooseberry were selected and put in tap water for 2 days and then pricked thoroughly with stainless steel fork. The fruits were kept in 2% alum and 0.5% sodium sulphate solution for 5 mins. The fruits and sugar were kept in alternate layers and then left for 24 hours. In the following day the sugar dissolved. The fruits were taken out from syrup, boiled and citric acid was added at boiling point. The syrup was strained through muslin cloth and the fruits were kept in hot syrup for 24 hours. On 3rd day again the fruits were taken out from the syrup and boiled till the sugar percentage reached 70-72%. Then fruits were kept in hot syrup. Preserve was ready for use with 15-20 days.

Ram (1983)

## TUTIFRUITI

Ingredients

| | | |
|---|---|---|
| Indian gooseberry | - | 1 kg |
| Sugar | - | 1 ½ kg |
| Citric acid | - | 2 g |

Procedure

Large size Indian gooseberry were selected and put in tap water for 2 days and then pricked thoroughly with stainless steel fork. The fruits were kept in 2% alum and 0.5% sodium sulphate solution for 5 mins. The fruits were cut into small slices, added green colour and kept in alternate layers with sugar and left for 24 hours. In the following day the sugar dissolved. The fruit slices were taken out from syrup, boiled and citric acid was added at boiling point. The syrup was strained through muslin cloth and the fruit slices were kept in hot syrup for 24 hours. On 3rd day again the fruit slices were taken out from the syrup and boiled till the sugar percentage reached 70-72%. Then fruits were kept in hot syrup. After 10-15 days the fruits slices were taken out from the syrup and dried in dehydrator.

Ram (1983)

## SQUASH

Ingredients

| | | |
|---|---|---|
| Indian gooseberry pulp (salt treated) | - | 1 cup |
| Water | - | 1 cup |
| Sugar | - | 1 ½ cup |
| Citric acid | - | 1 tsp |
| Sodium benzoate | - | 1 pinch |

Procedure

1. Prepared the sugar syrup.
2. Added cooled syrup to the pulp.
3. Added citric acid and sodium benzoate.
4. Bottled it in sterilized bottles.

Ram (1983)

## DEHYDRATED PRODUCT

Treated the Indian gooseberry in salt solution. Dehydrated in dehydrator.

Throne (1995)

## INDIAN GOOSEBERRY BISCUIT

Ingredients

| | | |
|---|---|---|
| Indian gooseberry paste (sugar treated) | - | 50 g |
| Maida | - | 250 g |
| Sugar | - | 250 g |
| Dalda | - | 50 g |
| Egg | - | 1 No. |
| Baking powder | - | 1 tsp |
| Yellow colour | - | 1 pinch |
| Egg | - | 1 |
| Vanilla essence | - | 1 tsp |
| Ice cream essence | - | 1 tsp |

Procedure

1. Powderd the sugar
2. Powdered sugar, dalda, essence and baking powder were mixed well and rubbed it well for ½ an hour.
3. Added 1 egg and rubbed it, till it became fluffy.
4. Added Indian gooseberry paste and mixed well.
5. Added maida little by little and made the dough, rolled it and cut it with biscuit cutters.
6. Greased the tray and kept the biscuits.
7. Mixed another egg and yellow colour. Beated it well and brushed it on the biscuit top.
8. Baked it for 10-15 minutes.

Bachman (1985)

# QUALITY EVALUATION OF INDIAN GOOSEBERRY (*Emblica officinalis* Gaertn.) PRODUCTS

By

SAIMA, N.S.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
requirement for the degree of

MASTER OF SCIENCE IN HOME SCIENCE
(FOOD SCIENCE & NUTRITION)

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# ABSTRACT

The study on "Quality evaluation of Indian gooseberry (*Emblica officinalis* Gaertn.) products" was undertaken to evaluate the different Indian gooseberry products for their acceptability, chemical composition and storage stability.

Six best accepted Indian gooseberry products viz., tutifruiti, preserve, salad, samosa, jelly and candy were selected from a total of eighteen Indian gooseberry products by conducting a preliminary acceptability study using score card in 120 individuals.

The fresh, sugar treated and salt treated Indian gooseberry and the selected products were analysed for chemical constituents like moisture, vitamin C, tannin, sugar, fibre and iron and found that the salt treated gooseberry had a lower vitamin C, retention when compared to the sugar treated gooseberry. Among the products, the maximum vitamin C was observed in salad and the least in samosa. The maximum moisture and fibre content was observed in salad, sugar content in jelly, tannin content in candy and iron content in preserve.

The yield and cost ratio of the selected products was computed. Based on the ratio candy was found to be the most economical product.

Among the six Indian gooseberry products selected for the storage study, two products viz., samosa and salad were found to be highly perishable and were deleted from the detailed storage study. The remaining four products viz., candy, preserve, tutifruiti and jelly were stored under ambient and refrigerated

conditions in glass bottle, polypropylene bottle and polypropylene bag for a period of six months and their chemical constituents, organoleptic qualities and microbial load were analysed at monthly intervals. The chemical constituents viz., moisture, vitamin C, tannin, sugar, fibre and iron were analysed. All the chemical constituents were found to reduce with the storage period except sugar which showed an increase with the storage period. All the products were found to retain better vitamin C when stored under refrigerated condition. Compared to the products stored in ambient condition the refrigerated products were found to contain higher tannin and lower fibre content. No significant variation in iron retention was observed with storage condition. Refrigerated storage condition was found to be ideal for better retention of nutrients.

With regard to packaging systems all the products exhibited higher vitamin C retention when stored in glass bottle and the least when stored in polypropylene bag. Sugar, fibre and iron content of the products were also found to be more when stored in glass bottle when compared to the products stored in polypropylene bag. Thus glass bottle was found to be the ideal packaging system compared to polypropylene bottle and polypropylene bag with regard to chemical constituents.

The organoleptic quality attributes viz., appearance, colour, flavour, texture and taste were evaluated in all the products stored under ambient and refrigerated condition in glass bottle, polypropylene bottle and polypropylene bag at monthly intervals for a period of six months. The evaluation revealed that with regard to all the quality criteria analysed the preserve and tutifruiti were best

accepted by the 6th month under both storage condition. The ideal storage period for candy and jelly under both ambient and refrigerated condition was for three months.

With regard to the quality parameters like the appearance, colour, flavour and taste all the products exhibited the maximum acceptability when stored in glass bottle and the least acceptability was for the products in polypropylene bag except for texture. Thus the glass bottle was found to be the ideal packaging system for Indian gooseberry products in terms of organoleptic qualities also.

The results of the above study revealed that compared to other processed fruit products Indian gooseberry products have better nutritive value. The products were found to retain a significant amount of vitamin C even after storage. The maximum retention of vitamin C was found in candy (38%) stored in glass bottle under refrigerated condition. The glass bottle storage was found to be ideal for higher retention of chemical constituents and for best acceptability.

The study highlighted the significance of processed amla products as a solution for the increased consumer demand for nutritious, delicately flavoured and economical fruit products all throughout the year.