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Development of Preserved Products Using Under Exploited Fruit, Wood Apple (*Limonia acidissima*)

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ABSTRACT

The aim of study is to make preserved products using wood apple. Wood apple is the cheaper, highly nutritious and easily perishable and seasonally available fruit and it was decided to preserve for human consumption throughout the year. This study was planned to utilize the preserved wood apple by preserving them as jam and fruit bar. Using wood apple preserved products like jam and fruit bar were developed, stored and quality parameters were assessed for a periods of 90 days. Organoleptic evaluation shows storage stability was good in both jam and fruit Bar with respect to flavour and consistency. Nutritive analysis shows reduction in Vitamin C, Calcium and Phosphorous in both jam and fruit bar during 90th day of storage. The acidic content of the preserved products decreased in both Jam (2.5%) and fruit bar (1.66%). No Significant change observed in TSS, pH, pectin and ash value for both jam and fruit bar during storage. Total sugar increased up to 0.68 and 0.89% and reducing sugar increased to 2.59 and 1.53% in both jam and fruit bar, respectively. The microbial load of both jam and fruit bar was under the limit at the end of 90 days. Hence, the prepared jam and fruit bar was safe and fit for consumption.

Key words: Fruit, jam, fruit bar, pectin

INTRODUCTION

The perishable fruits and vegetables are available as seasonal surpluses during certain parts of the year in different regions and are wasted in large quantities due to absence of facilities and know-how for proper handling, distribution, marketing and storage. Furthermore, massive amounts of the perishable fruits and vegetables produced during a particular season results in a glut in the market and become scarce during other seasons. Quality of fruits in pre and post harvest influences the consumer acceptance. The changes that occur in various physical and chemical characters determine the quality and in turn the economic returns to the producers and processors (Agarwal and Mangaraj, 2005). Fruits and vegetables needed simple technologies for processing, preservation and transport to various places of need, have suffered post-harvest losses, estimated to nearly 35%. Only 1% of the total fruits and vegetables produced are processed in the 3000 food industries in the country (Das, 1991). India accounts for 10.1% of the total world population of fruit crops and ranks second with the production of 45.47 million tones in 2002. In India, fruits and vegetables are wasted to the tune of rupees 30,000 million tons due to poor post harvest management.

Fruit processing is necessary where it ensures fair returns to the growers to improve their economic condition. It also helps to mitigate the problem of under-employment during off-seasons in the agricultural sectors. According to the estimates, nearly 30% of the fruits are lost due to spoilage, due to handling, transportation and lack of cold storage and processing techniques (Singh *et al*., 1994). Food preservation has an important role in the conservation and better utilization of fruits and vegetables in order to avoid the glut and utilize the surplus during the off-season. It is necessary to employ modern methods to extend storage life for better distribution and also processing techniques to preserve them for utilization in the off-season in both large scale and small scale. Fruit plays an important role in the preparation of preserves, in cooking and in fermented beverage production.

The Wood apple (*Limonia acidissima*) is the only species of its genus, in the family Rutaceae. Another related species, *Feronia limonia* popularly known as kathbel (elephant apple) is a highly demanding fruit. The wood apple is native and common in dry plains of India and Ceylon. Wood apple is used in the preparation of chutneys and for making jelly and jam (Morton, 1987). Wood apple has got high medicinal value. Every part of the fruit has got its medicinal property. The Fruit is much used in India as a liver and cardiac tonic and when unripe, as a means of halting diarrhoea and dysentery and for effective treatment for hiccough, sore throat and disease of the gums (Anonymous, 1996).

Juice of young leaves is given as a remedy for biliousness and intestinal troubles of children. Oil derived from the crushed leaves is applied on itch and the leaf decoction is given to children as an aid to digestion. Leaves, bark, roots and fruit pulp are all used against snakebite. Wood apple is rich in acid, minerals and pectin. Wood apple pulp contains about 74% of moisture and 7.45% of carbohydrates. As wood apple is a highly under-utilized fruit, it can be preserved by making it as a processed food to use it during off-season (Singh *et al*., 2008).

Jam, jellies, fruit bar and preserves are manufactured as one of the important fruit by product in industries and based upon the high solids-high acid principle. Not only are such fruit concentrates an important method of preserving fruits, but it is an important utilization of fruits. In addition to the pleasing taste of such preserved fruits, they possess substantial nutritive value also. Jams are of two kinds one prepared from a single fruit and another is prepared from a combination of two or more fruits (Manay and Shadaksharaswamy, 2005).

Realizing the importance of fruit, as a cheaper, highly nutritious and because of perishable nature and seasonally available it was decided to make a preserved products for human consumption throughout the year. This study was planned keeping in view the nutritional importance of wood apple, to utilize them by preserving them as jam and fruit bar.

MATERIALS AND METHODS

Selection of the wood apple: Ripe wood apple *(Limonia acidissima)* with hard shell, fairly large and globular shaped with soft, fleshy, yellowish edible pulp was selected for the study (2008). They were purchased from the daily market as a bulk as they are highly seasonal and available only during the month of November. The procured wood apples were stored at room temperature in jute bag until they were used for the product development.

Selection of the method of preservation: Food preservation has an important role in the conservation and better utilization of fruits and vegetables. In order to avoid glut and utilize the

surplus during the season, it is necessary to employ methods to extend storage life, for better distribution, to preserve them for utilization in the off-season both in large scale and home scale.

Jam is more or less a concentrated fruit processing which has fairly thick consistency and body. It is also rich in flavour, because ripe fruits which have developed full flavour are used in its preparation. A great advantage in its preparation is that it can be prepared in a single operation.

Fruit bar is a nutritious product, has a chewy texture, similar to dried raisins and is a good source of dietary fibre and natural sugar. Hence it was decided to prepare the two products. For the preparation of good quality jam, jelly and fruit bar, the fruit should contain adequate amounts of pectin.

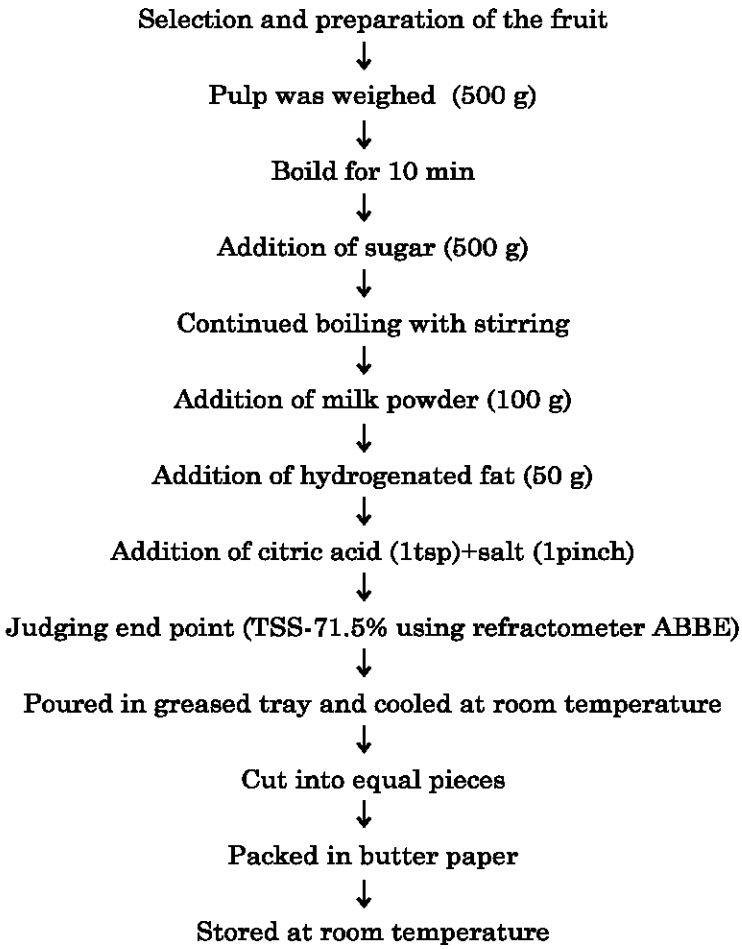
Pre-preparation of the selected wood apple: Sorting and grading is essential to get suitable quality of fruit which was done by hand. The fruits were first washed to remove the dirt. Grading of fruit was done based on soundness, firmness, cleanliness, size, maturity, weight, color, shape and freedom from foreign matters, insect damage and mechanical injury. From the graded wood apple the pulp was extracted manually. It was homogenized in a mixer to obtain fine pulp.

Preparation of jam: Fruits are preserved in the form of jam, jelly, preserves and candies by relying upon the high solids-high acid principle. It is an important utilization avenue of fruits which have excellent qualities but do not have an appeal to eye. Such fruits do not enter usual fresh market channels and can be made attractive by preparing products with pleasing color and good taste. Wood apple does not have appeal to the eye.

Jam is prepared by boiling the fruit pulp with sufficient quality of sugar to a reasonably thick consistency, firm enough to hold fruit issues in position.

Selection and preparation of fruit
↓
Pulp was weighed (500 g)
↓
Addition of sugar (500 g)
↓
Cooking the pulp (slow cooking with occasional stirring for 15 min)
↓
Addition of citric acid (1 tsp)+salt (1 pinch)
↓
Judging the end point (TSS-68.5% using refractometer ABBE)
↓
Packing (filled the hot jam into clean, dry sterilized plastic container)
↓
Cooling
↓
Stored in refrigerator

Preparation of fruit bar: Fruit bar is a nutritional product, has a chewy texture similar to dried raisins and is a good source of dietary fiber and natural sugars.



Physico-chemical characteristics of jam and fruit bar: Knowledge of the physico-chemical properties of food is fundamental in analyzing the characteristics of food during its processing. The study of these food properties and their responses to process conditions are necessary because they influence the treatment received during the processing and also because they are good indicators of other properties and qualities of food (Rao and Das, 2003). In the present investigation certain physico-chemical properties of the developed wood apple jam and fruit bar were analysed, to ensure the quality of the products. The PFA specifies that jam is the product obtained by processing fresh fruits, canned, dried fruit pulp with water, sugar, dextrose, invert or liquid glucose either singly or in combination by boiling to a suitable consistency.

The analysis of jam and fruit bar for the various properties was done using an aqueous solution of the sample. This was prepared by weighing about 25 g of the sample and dissolving it in 200 mL of water. The aqueous solution was kept on a boiling water bath for 1 h. The solution was cooled and diluted to 250 mL with distilled water, filtered and used for analysis.

Titrable acidity and pH value: Acidity value is a measure of stability and shelf life of jam and fruit bar. It is due to the organic acids in fruits and those which are added while making the jam. The setting quality of jam is improved by adequate pH maintenance.

Ash value: The ash value is mainly due to potassium and phosphorous and the composition of it. It is the measure of fruits and fruit juice content. A low value indicates deficiency of fruit or excess of sugar.

Reducing sugar: During jam making, sucrose is added. During boiling, the sucrose partly gets converted into invert sugar which prevents crystallization.

Total solids and soluble solids: For jam total solids and soluble solids are calculated. The figure for soluble solids help in accessing the fruit content of jam and fruit bar and also helps to prevent the growth of mould and yeast.

Pectin: Pectic substances occur as structural constituents in fruits. They are important in setting the jam and jelly. The pectin- acid- sugar ratio has to be maintained for correct setting.

Nutrient analysis of the jam and fruit bar: Wood apple is rich in minerals, acid and pectin. Storage conditions and length of storage period may alter the nutritive value of fruit. Hence, the jam and fruit bar were subjected to analysis of the following nutrients at an interval of 30 days, for a period of 90 days.

Vitamin C: Fruits are important source of ascorbic acid. The ascorbic acid content decreased during storage due to oxidation of ascorbic acid to dehydro ascorbic acid.

Calcium and phosphorus: Wood apple is rich in minerals.

Organoleptic evaluation of jam and fruit bar: Sensory evaluation offers the opportunity to obtain a complete analysis of the various properties of food as perceived by human sense. Sensory evaluation is an important and best method for evaluating new products developed which provide quality measure and production control. The Sensory evaluation was done using a score card developed. A panel of 20 members evaluated the products at an interval of 30 days for a period of 90 days.

Determination of microbial load: Contamination of food by moulds and bacteria is common. Hence, their presence in the finished products is considered unfit for consumption (Ranganna, 1986). In order to find the presence of bacterial load, standard pour plate method in nutrient agar was carried out. The results were analysed and interpreted.

RESULTS AND DISCUSSION

Periodical Organoleptic Evaluation of the prepared Jam and Fruit Bar: The jam and fruit bar was prepared and bottled by standard techniques. The samples were evaluated organoleptically once in 30 days. The samples were graded by numerical scoring, on a five point scale. The results of organoleptic evaluation were shown in Table 1 and 2 for jam and Fruit bar, respectively. The organoleptic evaluation shows, gradual reduction in the mean score for over all acceptability after 90 days of storage. Consistency remains same and the taste declined. Flavour change was observed, which showed a correlation with the study result of Ashwah *et al.* (1982) in fruit juices. Otto (1984) has reported a reduction in appearance and taste of fruit products on storage. Hence, maximum

Table 1: Mean acceptability scores for the jam

Criteria	Initial	30th day	t-value initial vs. 30th day	60th day	t-value initial vs. 60th day	90th day	t-value initial vs. 90th day
Appearance	4.75±0.44	4.75±0.44	0Ns	4.75±0.55	0Ns	4.70±0.57	0.33Ns
Flavour	4.75±0.44	4.70±0.57	0Ns	4.70±0.65	0.58Ns	4.60±0.75	0.58Ns
Consistency	4.75±0.44	4.75±0.44	0.33Ns	4.75±0.55	0.33Ns	4.67±0.67	0.58Ns
Taste	4.8±0.41	4.75±0.57	0.33Ns	4.65±0.74	0.58Ns	4.55±0.82	0.83Ns
Overall acceptability	4.8±0.41	4.75±0.57	0 Ns	4.70±0.53	0.66Ns	4.65±0.58	0.58ns

Ns: Not significant. Values in initial, 30th, 60th and 90th day as Mean±SD

Table 2: Mean acceptability scores for the fruit bar

Criteria	Initial	30th day	t-value initial vs. 30th day	60th day	t-value initial vs. 60th day	90th day	t-value initial vs. 90th day
Appearance	4.8±0.41	4.80±0.41	0Ns	4.80±0.41	0Ns	4.75±0.55	0.33Ns
Flavour	4.8±0.41	4.80±0.41	0Ns	4.70±0.65	0.58Ns	4.70±0.65	0.58Ns
Consistency	4.8±0.41	4.75±0.55	0.33Ns	4.75±0.55	0.33Ns	4.70±0.65	0.58Ns
Taste	4.8±0.41	4.75±0.55	0.33Ns	4.70±0.65	0.58Ns	4.65±0.74	0.83Ns
Overall acceptability	4.8±0.41	4.80±0.45	0 Ns	4.75±0.55	0.66Ns	4.70±0.65	0.58Ns

Ns: Not significant. Values in initial, 30th, 60th and 90th day as Mean±SD

storage period of 60 days, at room temperature may give a better acceptability. Though there was reduction in the mean scores, statistical tests proved that there were no significant changes in any of the products, over the entire period. Sensory evaluation of fruit bar revealed higher deterioration in colour, appearance and texture on 60th and 90th days of storage at higher temperature (Arun *et al.*, 1998). A gradual decrease in the scores of sensory parameters was reported in amla Jam by Tripathi *et al.* (2004).

Quality parameters of the prepared jam and fruit bar

Acidity: Acidity is the measure of shelf-life of the product. Titrable acidity studied to ensure physico-chemical changes during preparation (Sandhu *et al.*, 1985) and during storage (Kalra and Tandon, 1985). In Jam, acid content decreased to 0.51% at 30 days and 1.55 and 2.5% at 60 and 90 days of storage, respectively. In fruit bar, the value decreased upto 0.55, 1.11 and 1.66% after 30, 60 and 90 days of storage (Table 3). Similar observations was seen by Sidhu *et al.* (1984) where there was a negligible change in titrable acidity and the acidity was maintained, during storage of tomato juice for a period of 60 days. Acidity of guava fruit bar increased while pH decreased during storage as per the study result of Gowda *et al.* (2005).

^{0}Brix value: There is no significant change observed in TSS during the storage period (Table 3). Similar observation was seen by Pota *et al.* (1987) during storage of pomegranate fruits. There was an increase in TSS of amla jam during storage (Tripathi *et al.*, 2004). The TSS of the products was the index of sweetness.

pH value: Fruit products are being effectively preserved at low pH (Sidhu *et al.*, 1984). The pH estimation was done in order to find out whether a low pH was maintained throughout the study which could be an effective preservation. There was no change in the pH during the entire storage (Table 3). Similar observation was seen by Sidhu *et al.* (1984) in the tomato juice on storage of

Table 3: Nutrient content of wood apple jam and fruit bar

Products	No. of days stored	Titrable acidity (%)	TSS (°brix)	Ash (%)	Pectin (%)	Total sugar (mg/100 g)	Reducing sugar (mg/100 g)	Vitamin C (mg/100 g)	Calcium (mg/100 g)	Phosphorus (mg/100 g)
Jam	30th day	1.92	68.5	4.6	1.31	46.50	30.63	1.6	15.2	34.1
	60th day	1.90	68.5	4.6	1.31	46.62	30.66	1.4	14.1	33.4
	90th day	1.88	68.5	4.6	1.31	46.81	30.80	0.9	13.6	32.1
Fruit bar	30th day	1.79	71.5	4.8	1.36	45.51	8.38	1.7	18.1	31.6
	60th day	1.78	71.5	4.8	1.36	45.54	8.42	1.3	17.1	30.8
	90th day	1.77	71.5	4.8	1.36	45.91	8.48	0.8	16.8	29.2

90 day. Significant pH changes were noticed during storage of papaya fruit bar by Arun *et al.* (1998). No appreciable changes in pH and titrable acidity occurred in mango juice stored at room temperature as observed by Sandhu *et al.* (1988).

Ash value: The ash value is a measure of the amount of added minerals. Natural ash content is due to the minerals like calcium, phosphorus and iron. Ash content of a foodstuff represents inorganic residue remaining after destruction of organic matter (Ranganna, 1986). Similar observation was focussed by Saini and Jain (1995) during the storage of pear juice concentrates. Similar observation was found by Narayana and Maini (1989) who found no change in ash content during the storage of turnip pickle.

Pectin: Addition of correct amount of pectin helps to attain correct consistency of jams and jellies and it also improve the shelf life of the product. At usual concentrations, high methoxylated pectin induced an undesirable modification of typical flavour and intensity of flavour and taste, whereas, low methoxylated pectin induced few alterations. Pectin content was expressed as percent on the basis of fresh weight of fruits (Jashkaran *et al.*, 2005). The pectin content remain constant in both jam and fruit bar (Table 3).

Total sugars: The increase in TSS and sugars would be attributed to the conversion of starch and other insoluble carbohydrates into sugars. In Jam, there was gradual increase (0.02, 0.27 and 0.68%) on 30th, 60th and 90th day. In fruit bar, there was an increase of about 0.02, 0.08 and 0.89% on 30th day, 60th day and 90th day, respectively (Table 3). The increase in sugar was also observed by (Pota *et al.*, 1987) where the increase would be attributed to the conversion of starch and other insoluble carbohydrates into sugars. Significant changes were observed in total sugars by Arun *et al.* (1998) during storage of cereal based papaya powder.

Reducing sugars: Sugars with reducing property are called reducing sugars. Estimation of reducing sugar is done to find out the starch material content. Gradual increase of about 2.05, 2.15 and 2.59% during 30th, 60th and 90th day of storage in Jam was observed. In fruit bar, there was a gain of about 0.35% at 30th day, 0.83% at 60th day and 1.53% at 90th day (Table 3). Similar observation was found by Arun *at al.* (1998) where there was an increase in reducing sugar content during storage of cereal based papaya powder. Changes in the values of reducing sugars were more due to the ambient temperature.

Nutrient content of the prepared jam and fruit bar

Vitamin C: Fruits and vegetables are important sources of ascorbic acid. The ascorbic acid content decreased during storage due to oxidation of ascorbic acid to dehyroascorbic acid. Hence, vitamin C estimation was carried out during the storage period. This is due to oxidation or exposure to atmosphere oxygen while preparing the jam and Fruit bar (Fennema, 1977). The Vitamin C loss was to the extent of 11.1, 22.2 and 50% after 30th day, 60th day and 90th day, respectively for jam. In Fruit bar, there was a loss of 10.5 and 31.5% after 30th day and 60th day. There is loss of 57.8% after 90th day (Table 3). Temperature has a major effect on the rate of loss of ascorbic acid. Losses of ascorbic acid were increased with the increase in temperature (Johnson and Hessel, 1982). The ascorbic acid content decreased during storage. This may be due to oxidation of ascorbic acid to dehydroascorbic acid. This was observed by Gupta (2000) in the storage of sweet papaya chutney. The loss of vitamin C in the initial stages of preservation is because of the presence of oxygen in the headspace (Reimer and Karel, 1978).

Calcium: Calcium estimation was done as there is a significant amount of calcium present in wood apple. In both Jam and fruit bar, calcium content decreased to 2% at the end of the storage period (Table 3).

Phosphorus: Wood Apples have significant amount of phosphorus. A loss to the extent of 3.12%, 5.11 and 8.80% on 30, 60 and 90 days was observed. For Fruit bar there was loss of 3.36, 5.81 and 10.7% during the month of first, second and third respectively (Table 3).

Microbial load of the prepared jam and fruit bar: By following serial dilution method the microbial content in the prepared products was observed. There was acceptable amount of microbes has observed at the end of the storage period. Gargi *et al.* (1995) showed that after one month storage no microbial growth was observed in properly sealed jars.

CONCLUSION

Organoleptic evaluation, nutrient analysis and microbial analysis were noted both in jam and fruit bar during 30th, 60th and 90th day of storage. In organoleptic evaluation, the overall acceptability of jam and fruit bar decreased upto 1 to 2% and 2 to 3% on 90th day, respectively. The analyzed nutrient content showed that the percent reduction in vitamin C content was significant (11.1 to 50.0% and 10.5 to 57.8%, respectively). During the storage of Jam and Fruit Bar upto 90th day the percent loss in Calcium was 15 and 12.5%, respectively. The reduction in phosphorus content of both jam and fruit bar was observed upto 90 days. The reduction in phosphorus content of jam was 5.11% during 60th day and 8.80% during 90th day and in fruit bar 5.81% during 60th day and 10.7% during 90th day of storage. As the period of storage increased the percentage loss of titrable acidity was also increased in both jam and fruit bar. No changes in TSS, pH, pectin and ash value was observed in the prepared product during storage when compared to the initial observations. The percentage gain in total sugar contents (mg/100 g of sample) was higher in jam followed by fruit bar recording 0.68 and 0.89%, respectively. The reducing sugar content (mg/100 g of sample) was higher in jam followed by fruit bar recording 2.59 and 1.53, respectively. With regards to microbial load content of jam and fruit bar, only acceptable amount was observed during 90 day of storage. Hence, the prepared wood apple Jam and fruit bar was safe and fit for consumption.

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