

## Formulation and Evaluation of Preserved Products Utilizing under Exploited Fruit, Wood Apple (*Limonia acidissima*)

<sup>1</sup>R. Vidhya and <sup>2</sup>Anandhi Narain

<sup>1</sup>PSG College of Arts and Science, Coimbatore, India

<sup>2</sup>HOD, PSG College of Arts and Science, Coimbatore, India

**Abstract:** Investigations made on “Formulation and Evaluation of Preserved products utilizing Under Exploited Fruit, Wood apple (*“Limonia acidissima”*)”. The jam and fruit bar was formulated, bottled and quality parameters were assessed during different periods of storage upto 90 days. The storage stability was good in both jam and fruit Bar with respect to flavour and consistency. The percent reduction in vitamin C content was significantly higher in both Jam (50%) and Fruit Bar (57.7%). The loss in Calcium content was significantly higher in Jam (15%) as compared to fruit bar (12.5%). The loss in phosphorus content was higher in Fruit Bar (10.7%) as compared to Jam (8.8%). As the period of storage increased the titrable acidity percentage 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. There was gain in total sugar content of both Jam and Fruit Bar to the extent 0.68% and 0.89% respectively. There was a gain in reducing sugar content of jam (2.59%) and fruit bar (1.53%). 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:** Wood apple • Jam • Jelly • Nutrients

### 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 [1]. 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 [2]. Fruits and vegetables are for want of simple technologies of 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 [3]. 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 [4]. In India, fruits and vegetables are

wasted to the tune of rupees 30,000 million tones 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 [5]. 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 [1]. Fruit plays an important role in the preparation of preserves, in cooking and in fermented beverage production [6].

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.



Fig. 1: Wood apple

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 [7]. 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 [8].

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.

Jam, jellies, fruit bar and preserves are manufactured as one of the important fruit by product in industries and is 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.

Realizing the importance of fruits as a significant contributor to human well being, as a cheaper and better source of protective foods, their perishable nature and seasonality in production calls for preservation of them to be supplied throughout the year for human consumption. 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. 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 [1].

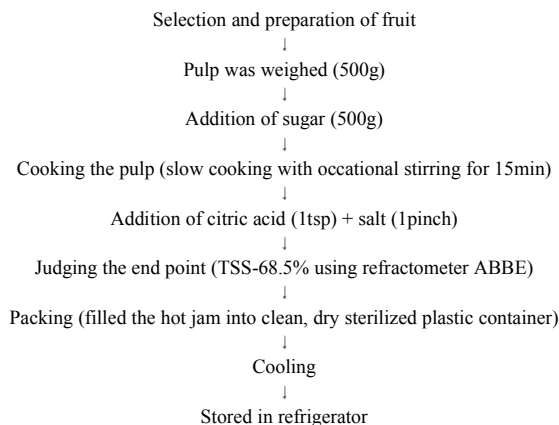
Jam is more or less a concentrated fruit processing which has fairly thick consistency and body. It is also rich in flavour, because ripe fruits which have developed full flavour are used in its preparation. A great advantage in its preparation is that it can be prepared in a single operation.

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.

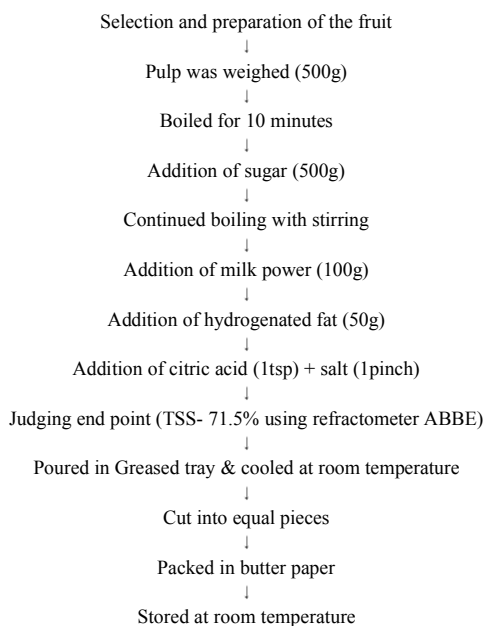
**Pre-Preparation of the Selected Wood Apple:** Sorting and grading is essential to get suitable quality of fruit which was done by hand. The fruits were first washed to remove the dirt. Grading of fruit was done based on soundness, firmness, cleanliness, size, maturity, weight, color, shape and freedom 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 colour 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.



**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 [9]. 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. 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 25gm of the sample and dissolving it in 200ml of water. The aqueous solution was kept on a boiling water bath for 1 hour. The solution was cooled and diluted to 250ml with distilled water, filtered and used for analysis.

**Titration 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 [10]. 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 [11]. 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 mean scores are reported in Table 1 for Jam and Table 2 for Fruit bar. 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 [12] in fruit juices [13] has reported a reduction in appearance and taste of fruit products on storage. Hence maximum 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 60<sup>th</sup> and 90<sup>th</sup> days of storage at higher temperature [14]. A gradual decrease in the scores of sensory parameters was reported in amla Jam by [15].

**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 [16] and during storage [17].

In Jam, acid content decreased to 0.51% at 30days 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. Similar observations was seen by [18] 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 [19].

**Brix Value:** There is no significant change observed in TSS during the storage period. Similar observation was seen by [20] during storage of pomegranate fruits. There was an increase in TSS of amla jam during storage [15]. TSS of the products was the index of sweetness. It is correlated in most of the fruits with maturity and ripeness [21].

**pH Value:** Fruit products are being effectively preserved at low pH [18]. 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. Similar observation was seen by [18] in the tomato juice on storage of 90 day. Significant pH changes were noticed during storage of papaya fruit bar by [22]. No appreciable changes in pH and titrable acidity occurred in mango juice stored at room temperature as observed by [23,24].

**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 [25]. Similar observation was focused by [26] during the storage of pear juice concentrates. [27] found that there was no remarkable change in ash content during storage where as the mineral compounds decreased during storage. Similar observation was found by [28] 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 flavor and intensity of flavour and taste, whereas low methoxylated pectin induced few alterations [29]. Pectin content was expressed as percent on the basis of fresh weight of fruits [30].

Table 1: Mean acceptability Scores for the Jam

Criteria	Mean±Sd						
	Initial	30 <sup>th</sup> DAY	T Value Initial Vs 30 <sup>th</sup> Day	60 <sup>th</sup> DAY	T Value Initial Vs 60 <sup>th</sup> Day	90 <sup>th</sup> day	T Value Initial Vs 90 <sup>th</sup> Day
Appearance	4.75 ± 0.44	4.75 ± 0.44	0 Ns	4.75 ± 0.55	0 Ns	4.7 ± 0.570	0.33Ns
Flavour	4.75 ± 0.44	4.7 ± 0.570	0 Ns	4.7 ± 0.650	0.58Ns	4.6 ± 0.750	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 ± 0.410	4.75 ± 0.57	0.33Ns	4.65 ± 0.74	0.58Ns	4.55 ± 0.82	0.83Ns
Overall acceptability	4.8 ± 0.410	4.75 ± 0.57	0 Ns	4.7 ± 0.530	0.66Ns	4.65 ± 0.58	0.58ns

Ns: Not significant

Table 2: Mean acceptability scores for the Fruit Bar

Criteria	Mean±sd						
	Initial	30 <sup>th</sup> DAY	T value Initial Vs 30 <sup>th</sup> day	60 <sup>th</sup> DAY	T value Initial Vs 60 <sup>th</sup> day	90 <sup>th</sup> DAY	Tvalue Initial Vs 90 <sup>th</sup> day
Appearance	4.8 ± 0.41	4.8 ± 0.41	0 Ns	4.8 ± 0.41	0 Ns	4.75 ± 0.55	0.33Ns
Flavour	4.8 ± 0.41	4.8 ± 0.41	0 Ns	4.7 ± 0.65	0.58Ns	4.7 ± 0.65	0.58Ns
Consistency	4.8 ± 0.41	4.75 ± 0.55	0.33Ns	4.75 ± 0.55	0.33Ns	4.7 ± 0.65	0.58Ns
Taste	4.8 ± 0.41	4.75 ± 0.55	0.33Ns	4.7 ± 0.65	0.58Ns	4.65 ± 0.74	0.83Ns
Overall acceptability	4.8 ± 0.41	4.8 ± 0.45	0 Ns	4.75 ± 0.55	0.66Ns	4.7 ± 0.65	0.58Ns

Ns:- Not significant

Table 3: Nutrient content of Wood apple jam and Fruit bar

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

The pectin content of papaya fruit Bar decreased in a non-significant manner as the period of storage increased [31]. The pectin content remain constant in both jam and fruit bar.

**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% & 0.68%) on 30<sup>th</sup>, 60<sup>th</sup> and 90<sup>th</sup> day. In fruit bar, there was an increase of about 0.02%, 0.08% and 0.89% on 30<sup>th</sup> day, 60<sup>th</sup> day and 90<sup>th</sup> day respectively. The increase in sugar was also observed by [20] 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 [32] during storage of cereal based papaya powder. The total sugars increased as the storage time increased which was observed by [33] during storage.

**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 30<sup>th</sup>, 60<sup>th</sup> and 90<sup>th</sup> day of storage in Jam was observed. In fruit bar, there was a gain of about 0.35% at 30<sup>th</sup> day, 0.83% at 60<sup>th</sup> day and 1.53% at 90<sup>th</sup> day. Similar observation was found by [32] where there was an increase in reducing sugar content during storage of cereal based papaya powder. The increase in reducing sugar content was observed during storage as observed by [34] of processed products. Changes in the values of reducing sugars were more due to the ambient temperature. This was mainly due to the hydrolysis of non-reducing sugars, resulting into their increase [35].

#### 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 dehydroascorbic 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 [36]. The Vitamin C loss was to the extent of 11.1%, 22.2% and 50% after 30<sup>th</sup> day,

60<sup>th</sup> day and 90<sup>th</sup> day respectively for Jam. In Fruit bar, there was a loss of 10.5% and 31.5% after 30<sup>th</sup> day and 60<sup>th</sup> day. There is loss of 57.8% after 90<sup>th</sup> day. Temperature has a major effect on the rate of loss of ascorbic acid. Losses of ascorbic acid were increased with the increase in temperature [37]. The ascorbic acid content decreased during storage. This may be due to oxidation of ascorbic acid to dehydroascorbic acid. This was observed by [38] 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 [39].

**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 per cent at the end of the storage period.

**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.

**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 [40] 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 30<sup>th</sup>, 60<sup>th</sup> and 90<sup>th</sup> day of storage. In Organoleptic evaluation, the overall acceptability of jam and fruit bar decreased up to 1 to 2 percent and 2 to 3 percent on 90<sup>th</sup> day respectively. The analyzed nutrient content showed that the percent reduction in vitamin C content was significant (11.1 to 50.0 percent and 10.5 to 57.8 percent respectively). During the storage of Jam and Fruit Bar up to 90<sup>th</sup> day the percent loss in Calcium was 15 percent and 12.5 percent respectively. The reduction in phosphorus content of both jam and fruit bar was observed up to 90 days. The reduction in phosphorus content of jam was 5.11 percent during 60<sup>th</sup> day and 8.80% during 90<sup>th</sup> day and in fruit bar 5.81 percent during 60<sup>th</sup> day and 10.7 percent during 90<sup>th</sup> day of storage. As the period of storage increased the percentage loss of terrible 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/100g of sample) was higher in jam followed by fruit bar recording 0.68 and 0.89% respectively. The reducing sugar content (mg/100g 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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