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Studies on preparation and storage of jelly from wood apple (*Limonia acidissima* L.) fruits

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Abstract
The objective of this research work was to preparation and shelf-life study of jelly from wood apple fruit. The prepared jelly from 75 % water and 25 % mature fruit pulp was found to be best for better pectin extract recovery and the jelly prepared from the extract was found to be best during organoleptic quality. Extract containing moderate amount of pectin, and extract and sugar ratio of 25:75 was found as ideal recipe for excellent quality of jelly making from wood apple fruits. The prepared jelly was bottled in sterilized glass bottles (500mL capacity) and stored at ambient temperature. During storage study of jelly TSS, titratable acidity, reducing sugars, total sugars and browning were increased, whereas ascorbic acid, non-reducing sugar and organoleptic quality was decreased with increased storage period, while microbial growth was first increased thereafter decreased. The microbial growth in jelly under the limit up to the end of shelf-life. Hence, the prepared jelly was safe and suitable for consumption up to 6 month.

Keywords: wood apple, jelly, shelf-life, pectin, microbial growth

1. Introduction
Wood apple (*Limonia acidissima* L.) is one of the very hardy fruit crops found all over the plains of Southern Maharashtra, West Bengal, Uttar Pradesh, Chhattisgarh and Madhya Pradesh. It is also present in the Western Himalaya up to an elevation of about 500 metres from sea level. Wood apple is a small to moderate size, deciduous, glabrous tree with thorny branches reaching to a height of 10 metres with 0.6 metres to 1.6 meters girth. The tree also flourishes well in dry areas and is not affected by any serious pests or diseases due to its resistant nature to both biotic and abiotic stresses.

It is highly regarded as religious, cultural, nutritional and medicinal valued fruit crop. The fruits are consumed as a good source of juice during its harvesting season due to their low cost and thirst quenching ability. A homemade drink popularly known as "*Sarbat*" is prepared from the wood apple fruits. The RTS, squash, syrup, jelly and chutney are other possible value added products of wood apple. It is seldom used alone for preparation of jelly due to its harsh flavour (Hayes, 1960) [8], whereas, Bhat (1944) [3] was of openion that the jelly made of this fruit was having exceedingly agreeable flavour. He further mentions syrup and chutney as other possible products from wood apple.

The wood apple pulp is a rich source of Beta carotene, a precursor of vitamin-A which also contains significant amount of vitamins-B such as riboflavin and thiamine and it had small quantities of ascorbic acid content (Kumar and Deen, 2017) [13]. Fruits have high medicinal value and used in India as a liver and cardiac tonic while unripe fruits are used as an astringent means of treating diarrhea and dysentery in folk medicines. It is effective treatment for hiccough, sore throat and diseases of the gums. The powdered gum mixed with honey is given to overcome dysentery and diarrhea in children. Oil derived from the crushed leaves is applied on itch and leaf decoction is given to children as an aid to digestion. The flesh of the mature fruits blended with cardamom, honey and cumin seeds are efficacious for indigestion, diarrhea and piles. Fruits are very well known for their medicinal properties due to its high nutritive value. Every part of wood apple plant like leaves, bark, roots, and fruit pulp are used against snakebite. The average TSS ranges from 10.67 to 14.33 ^{0}Brix, acidity 1.04- 4.50 per cent and total sugars 4.08-4.47 per cent (Hiwale, 2006) [9]. The nutritional and chemical properties of fresh of wood apple fruits showed that it contains 9.45-21.70 per cent TSS, 1.98- 3.80 per cent titratable acidity, 4.77-5.71 TSS/acid ratio, 0.30-6.03 per cent reducing sugars, 5.65-13.80 per cent non-reducing sugar, 7.95-19.83 per cent total sugars, 3.86-6.82 mg/100g ascorbic acid, 221.50- 80.10 mg/100g total phenol, 1.22-1.30 per cent pectin (Kumar and Deen, 2017) [13]. Thus, large variability in physico-chemical characteristics of wood apple fruits provides an opportunity to select desirable types for commercial exploitation.

In most of tribal part of central India, wood apple is available in ample quantity as raw material that can be processed in to different processed products very easily.

The wood apple fruits are not consumed as fresh fruit due to acidic and astringent taste. Although, the medicinal and nutritive value are very high, yet unfortunately, there is not much demand of wood apple fruit either for fresh market or for processing which may be due to poor awareness of consumers about its nutritive and medicinal importance of this underutilized fruits. It indicates that processing potential of wood apple fruits needs to be explored for commercialization of fruit. This study was planned keeping in view on medicinal and nutritional importance of wood apple, to utilize them by processing product as jelly including other value added product would provide opportunity for commercial exploitation of this fruits.

2. Materials and Methods

The present experiment was conducted during the year 2012-2013 at post graduate laboratory of Department of Horticulture, College of Horticulture and Forestry, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad U.P. The fruits of wood apple were collected at maturity stage from Ratapur village of Milkipur Tehsil.

2.1. Technique of extraction for processing

The technique used for extraction of wood apple pulp is shown in Fig-1. Known amount of fruit pieces were taken and water was added according to recipes (Table-1), and heated up to boiling of water for 10 minuts. Extract was obtained by straining the heated material through muslin cloth without pressing or squeezing.

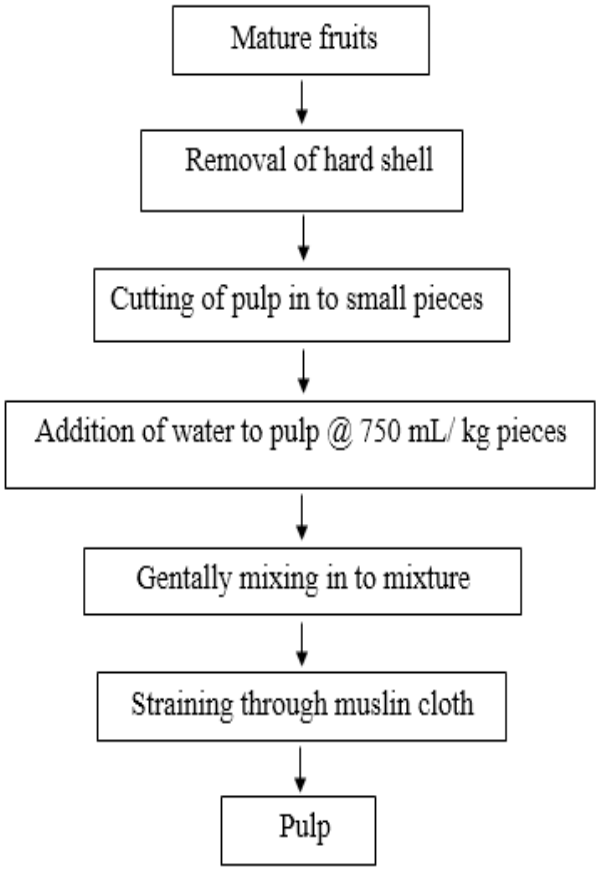

Fig 1: Flow sheet for extraction of pulp from wood apple fruits

Table 1: Organoleptic quality of jelly prepared from different pectin extract of wood apple fruits.

Treatments (Recipes No.)	Water/ Pulp ratio	Extract recovery (%)	Alcoholic test for pectin	Sugar (g)	Organoleptic Quality	
					Score	Rating
1	25 % water + 75 % pulp	0.00 (0.71)	-	-	-	-
2	50 % water + 50 % pulp	28.00 (5.33)	Rich pectin	280.00	7.20	Like Moderately
3	75 % water + 25 % pulp	60.00 (7.77)	Moderate pectin	450.00	7.85	Like Very Much
SEm ±		0.24		0.66	0.11	
CD at 5%		0.83		2.28	0.37	

In parenthesis angular transformed data ($Y = \sqrt{x + \frac{1}{2}}$)

2.2. Extract Recovery (%)

Total extract was collected in glass jar and measured by measuring cylinder. The per cent recovery was calculated against total materials used and expressed.

2.3. Alcoholic Test

Alcoholic test is important for jelly preparation. For determination of pectin content of the strained extract, 5 mL of strained extract were taken in a 50 mL beaker and cooled and 15 mL of ethanol absolute are poured gently down the side of the beaker which was rotated for mixing and allowed to stand for a few minutes. After few minutes extract is rich in pectin then the single transparant clot will form. Thus, the equal amount of sugar was to be added to the extract for preparing the quality jelly.

2.4. Methods used for preparation of jelly

The obtained extract was strained through muslin cloth without squeezing to get the clear extract. Then alcohol test was done to determine sugar amount that had to be added with extract. The mixture of extract and sugar was boiled to the end point to make jelly of desired consistency. The prepared jelly was filled in sterilized wide mouth jelly bottles (500 g capacity), and sealed air tightly then bottles were covered with lid. The jellies prepared from different recipes (Table-2), were subjected to sensory evaluation on next day for their organoleptic quality such as firmness, cut-edges, transparency, colour, odour and taste by a panel of seven semi trained judges and the samples were scored on a 9.0 Point Hedonic Rating Scale to find out the best recipe of jelly. Six kilogram jelly were prepared with best recipe following similar process (Fig.2), for storage life studies and jelly bottles were kept at ambient temperature for shelf-life studies.

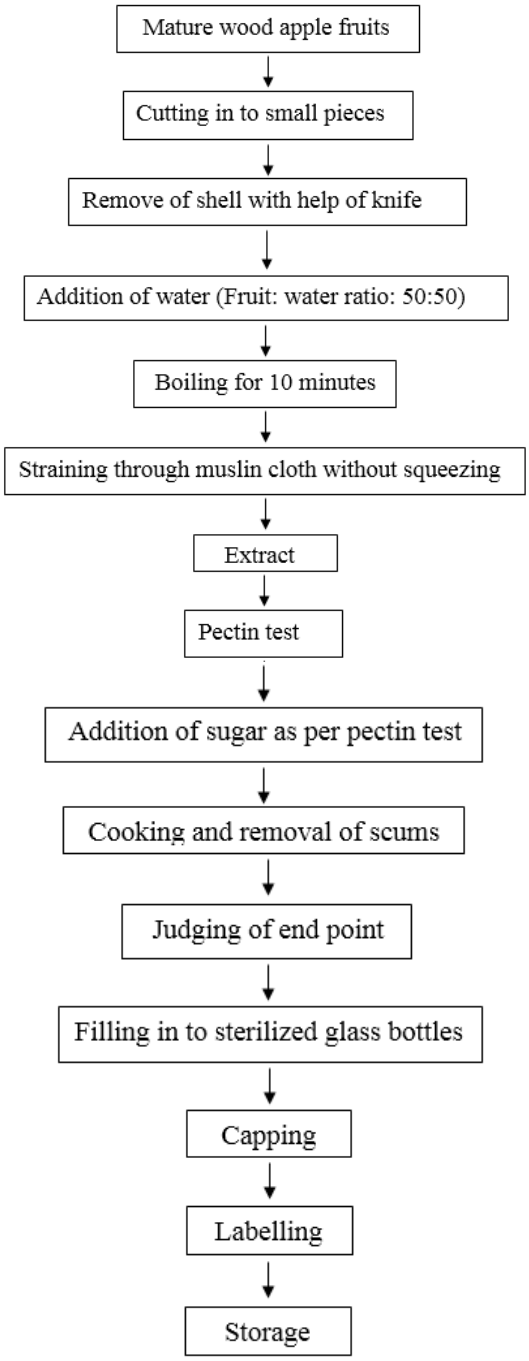

Fig 2: Flow sheet for preparation of wood apple jelly.

Table 2: Organoleptic quality of jelly prepared from wood apple fruits of different maturity

Treatments (Recipes No.)	Particulars	Organoleptic Quality	
		Score	Rating
1	Pectin extract from mature fruits	8.42	Like Very Much
2	Pectin extract from ripe fruits	7.30	Like Moderately
3	Pectin extract from mature and ripe fruits (1:1)	7.71	Like Very Much
SEm ±		0.12	
CD at 5%		0.42	

2.5 Determine the biochemical composition

Total soluble solids were determined by hand refractometer (ERMA made) of 58-92 %, range at room temperature (Ranganna, 2010) [20] and the mean value were expressed as per cent. For determination of titratable acidity present in fruit sample was titrated against 0.1 N Sodium hydroxide solution using phenolphthalein drops as an indicator (Ranganna, 2010) [20]. The determination of ascorbic acid content in sample with the help of 3% HPO_3 (metaphasphoric acid) solution and sample was titrated against 2, 6-dichlorophenol-indophenol dye solution as described by (AOAC, 2012) [2]. The Fehling's 'A' and 'B' solutions (Lane and Eynon, 1923) [15] were used to estimate the sugars content in sample and the procedure as suggested by Ranganna, 2010 [20].

2.6. Microbial Growth
The microbial contamination and growth were determined by standard plate count method using malt extract medium. The sterile distilled water was used in control and the counting was done after incubating the plate at 38º C for 48 hours (Ranganna, 2010) [20].

2.7. Browning (Non-enzymatic)
The non-enzymatic browning was recorded according to the procedure outlined by Ranganna (2010) [20]. The colour of jelly aliquot sample was measured at 440 nm by UV-spectrophotometer using 60 per cent aqueous alcohol as blank solution. The absorbance was expressed as browning in term of O.D.

2.8. Organoleptic Quality
Sensory evaluation offers the opportunity to obtain a complete analysis of the various properties of jelly as perceived by human sense. The organoleptic evaluation for assessing the sensory attributes like- colour, appearance, flavour, aroma, taste and texture of jelly was conducted by a panel of seven semi trained judges on 9.0 point Hedonic Rating scale (Amerine *et al.*, 1965) [1].

2.9. Statistical Analysis
During shelf-life study of jelly data were recorded at monthly interval on different parameters were subjected to statistical analysis using completely randomized design of analysis of variance (Panse and Sukhatme, 1985) [18].

3. Results and Discussion
3.1. Standardization of technique to extract pectin for jelly preparation
Data regarding observations on organoleptic quality of jelly prepared from different extract are presented in Table-1. It is apparent from table that organoleptic quality of jelly prepared from the pectin extract extracted by adding the 75 per cent water to pulp secured highest 7.85 organoleptic score on 9-point Hedonic scale. The organoleptic quality of jelly prepared from this extract was significantly superior with the jelly prepared from the extract obtained by adding equal water to pulp. There was no recovery of pectin extract from treatment no. 1 where only 25 per cent water was added to pulp for extraction pectin. It is obvious to increase in extract of pectin by adding more water in the process of extraction that subsequently dilutes the concentration of TSS, acidity, ascorbic acid, reducing sugars, non-reducing sugar and total sugars and water soluble pectin in the extract. The extract obtained from treatment no.2 was rich in pectin than the extract of treatment no.3 because of this reason equal sugar (280 g to 280 ml extract) in case of treatment no.2 and 3/4th sugar (450 g to 600 ml extract) was added in treatment no.3. The organoleptic quality of jelly prepared from the pectin extract of treatment no. 3 was found to be significantly superior over the jelly prepared from the extract of treatment no.2.

3.2. Standardization of recipe for jelly preparation
Data recording on organoleptic quality of jelly prepared from wood apple fruits of different maturity stage are presented in Table-2 reveals that jelly prepared from pectin extract of mature fruits (treatment no.1) awarded highest score for its organoleptic quality followed by treatment no. 3 (Pectin extract of mature and ripe fruits mixed in equal ratio). The score awarded to treatment no.1 was significantly higher than treatment no.2 and 3.

Certain amount of water is required for easy and proper recovery of juice/ pulp from certain fruits. In present finding, water and pulp ratio of 75:25 was found best for easy extraction and better recovery of wood apple fruit pulp/juice with moderate total soluble solids, acidity, ascorbic acid and colour of the juice. Addition of water for proper extraction of pulp/ juice ratio was also recommended in jamun (Khurdiya and Roy, 1985) [11] and in karonda (Deen and Singh, 2013) [6] which are in support of present finding. Mature fruit pulp of wood apple was used for jelly preparation and it was found best on the basis of organoleptic quality. Mature fruits are best for jelly making because it produces original flavour of the fruits and contained maximum water soluble pectin which induces the colour, flavour, texture and overall acceptability of the jelly. Similarly, Kuchi *et al.* (2014) [12] reported that mature firm fresh fruits of guava was used for preparation of jelly bar and prepared product from mature firm fresh fruits were obtained maximum scores during organoleptic quality taste.

3.4. Biochemical changes during storage of jelly
3.4.1. Total soluble solids
In present finding total soluble solids of wood apple jelly gradually increased with storage period. An increase in total soluble solids content in jelly during storage period probably was due to the conversion of polysaccharides into sugars in the presence of organic acids. The results of present study are in close conformity to the findings of Deen and Singh (2013) [6] in karonda jelly, Kuchi *et al.* (2014) [12] in guava jelly bar.

3.4.2. Titratable Acidity
Data on changes in titratable acidity during storage of jelly revealed that the titratable acidity of jelly was increase gradually during storage period (Table-3). Total pectic substances have been reported to increase the acidity in fruit products (Conn and Stumf, 1976) [5], hence degradation of pectin substances of pulp into soluble solids might have contributed towards an increase in acidity of products. The another reason for slight increase in titratable acidity might be due to formation of organic acids by the degradation of the ascorbic acid as it decreased with storage period of the jelly. This is in consonance with the findings of Deen and Singh (2013) [3] in karonda jelly and Kuchi *et al.* (2014) [12] in guava jelly bar.

Table 3: biochemical changes during storage of wood apple jelly.

Storage period (months)	TSS (%)	Titratable Acidity (%)	Ascorbic acid (mg/100mL)	Reducing sugars (%)	Non-reducing sugar (%)	Total sugars (%)	Microbial growth (X 10^3 cfu/ml)	Browning	organoleptic quality	
									Score	Rating
0	65.00	0.57	0.40	3.65	59.25	62.90	0.270	0.42	8.45	LVM
1	65.15	0.58	0.39	4.83	58.37	63.20	0.298	0.43	8.38	LVM
2	65.30	0.61	0.38	5.95	57.45	63.40	0.365	0.45	8.20	LVM
3	65.65	0.66	0.35	7.25	56.60	63.85	0.283	0.48	7.95	LVM
4	65.98	0.71	0.32	8.58	55.70	64.28	0.236	0.52	7.50	LVM

5	66.30	0.74	0.30	9.94	54.77	64.71	0.179	0.57	7.40	LM
6	66.60	0.77	0.28	10.90	54.20	65.10	0.162	0.62	7.10	LM
SEm ±	0.99	0.01	0.01	0.11	0.54	0.45	0.08	0.11	0.12	
CD at 5 %	NS	0.03	0.02	0.35	1.65	1.35	NS	0.29	0.38	

3.4.3. Ascorbic Acid

In present findings the ascorbic acid content of wood apple jelly showed a decreasing trend (Table-3) with growth and development. The reduction in ascorbic acid content of the jelly could be due to oxidation by trapped oxygen in glass bottles which results a formation of highly volatile and unstable dehydro ascorbic acid followed by further degradation to 2, 3- diketogulonic acid and finally to furfural compounds. Mapson, *et al.* (1970) [17] observed that oxidation due to temperature and greater catalytic activity of fructose in the catabolization of vitamin-C could be the reason for its decrease. The finding of present investigation matches with those as reported by Chaudhary *et al.* (2007) [4] in karonda jelly and Deen and Singh (2013) [6] in karonda jelly.

3.4.4. Reducing and total sugars

The reducing and total sugars of the jelly were increased (Table-3), continuously throughout the entire period of storage in present investigation. The increase in reducing and total sugars content of jelly could be due to inversion of non-reducing sugar into reducing sugars as decreases in non-reducing sugar corresponded to increase in reducing sugars content. Hydrolysis of polysaccharides like pectin and starch could also be one of the reasons for increase in the sugars content. Similar observations were also observed by the several workers like Deen and Singh (2013) [6] in karonda jelly.

3.4.5. Non-reducing sugar

Contrary to reducing and non-reducing sugar (Table-3), the non-reducing sugar of jelly decreased continuously throughout the entire period of storage which might be because of inversion. Similar observations were reported by Kumari and Sandal (2011) [14] in mango jam and Deen and Singh (2013) [6] in karonda jelly.

3.4.6. Browning

Progressive increases in browning of jelly were observed in term of O.D. with the storage period in present findings (Table-3). This could be mainly due to the non-enzymatic reaction (Millard reaction) such as reaction of organic acids with sugars or oxidation of phenol which leads to the formation of brown pigments. Stadman (1948) [22] reported that reduction in ascorbic acid content of the fruit product may be one of the possible reasons for browning of the products. The present investigation also support the contention that reduction in ascorbic acid content during storage of processed products corresponding an increase in browning. The browning was also reported in guava jelly (Karla *et al.*, 1983) [10] in karonda jelly (Chaudhary *et al.*, 2007 and Deen and Singh, 2013) [4&6]. These referred findings are in supports of present results.

3.4.7. Organoleptic Quality

Organoleptic quality determines the shelf-life life of the jelly (Table-3). In present investigation, organoleptic score of jelly were decreased gradually with storage period at ambient temperature. The acceptability of jelly was maintained up to 6th month of storage. Losses in organoleptic quality of jelly after certain period are obvious because of undesirable changes in the product. Temperature plays an important role in inducing certain undesirable biochemical changes in the jelly which leads to development of off flavour as well as discoloration (browning) and there by masking the original colour and flavour of the product. Similarly, reduction in organoleptic quality has also been reported in guava jelly (Paul *et al.*, 2007) [19] and in karonda jelly (Chaudhary *et al.*, 2007 and Deen and Singh 2013) [4&6]; these reported observations support the present findings.

3.4.8. Microbial Growth

In present studies, microbial growth of jelly were increased up to two month of storage at ambient temperature (Table-3), and thereafter it showed continuously decreasing trend with storage period. The increase in microbial growth at first and second month may be due to some microbes present and contamination might occur during processing. The decrease in microbial growth at later stage of storage might be due to increase in the content of sugar and titratable acidity of products because sugar and higher acid possess preservative properties to reduce the microbial growth. The results reported by Li *et al.* (1989) [16] and Goyal and Ojha (1998) [7] in orange juice and Singh *et al.* (2013) [21] in custard apple RTS beverage are confirm the present findings. As reported by Ranganna (2010) [20] the microbial count should not exceed to 10^3 per ml or g of jelly. In present findings, the microbial count had not exceeded this limit up till the jelly remained acceptable organoleptically.

4. Conclusion

It can be concluded from the present findings we can use the wood apple extract for the development of jelly. The development of jelly with75 % water and 25 % mature fruit pulp was found to be best for better pectin extract recovery and the jelly prepared from the extract was found to be best during organoleptic quality. The manufatured jelly was safe and suitable for consumption up to 6 month.

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