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Studies on preparation and preservation of squash 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 squash from wood apple fruit. The prepared beverage from 25 percent wood apple pulp, 50 percent TSS, 1.00 percent titratable acidity was found to be best during organoleptic quality. The manufactured squash was bottled in sterilized glass bottles (750mL capacity) and stored at ambient temperature. During shelf-life study of squash 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 squash under the limit up to the end of shelf-life. Hence, the manufactured squash was safe and suitable for consumption up to 5 month.

Keywords: Wood apple, squash, organoleptic quality, microbial growth and shelf-life

1. Introduction

Wood apple (*Limonia acidissima* L.) fruit is one of the important, former and indigenous fruit plants. It is also known by different vernacular names such as kainth and elephant apple in different part of India. It is one of the very hardy fruit crops found all over the plains of Southern Maharashtra, West Bengal, Uttar Pradesh, Chhattisgarh and Madhya Pradesh. The wood apple is not under regular orcharding, however along the border of fields, roads, railway lines and as a roadside tree, near villages and banks of the river are the common places, where the plants are found as stray plant. The fruit tree can be grown even on saline, marginal lands, waste and neglected lands normally unsuitable for cultivation of other fruit trees. It is highly regarded as religious, cultural, nutritional and medicinal value fruit crop. The fruits are consuming as 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. 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. Geda and Bokadia (1980) [7] reported antimicrobial activity of essential oil extracted from wood apple fruits and noticed its effectiveness against 12 human pathogenic bacteria. Maiti and Mishra (2000) [14] also reported presence of antivenom activity in wood apple fruits. Fruits are very well known for their medicinal properties due to its high nutritive value. The nutritional and chemical properties of fresh wood apple fruits showed that it contains 9.45-21.70 percent TSS, 1.98- 3.80 percent titratable acidity, 4.77-5.71 TSS/acid ratio, 0.30-6.03 percent reducing sugars, 5.65-13.80 percent non-reducing sugar, 7.95-19.83 percent total sugars, 3.86-6.82 mg/100g ascorbic acid, 221.50- 80.10 mg/100g total phenol, 1.22-1.30 percent pectin (Kumar and Deen, 2017a) [10]. Thus, large variability in physico-chemical characteristics of wood apple fruits provides an opportunity to select desirable types for commercial exploitation and plantation in waste and neglected lands.

It is a climacteric fruit, ripening may also takes place after fruit harvest but do not consumed as fresh fruit due to high acidic and astringent taste. Fruits are very well known for their medicinal properties due to its nutritive value. After ripening fruits become soft in flesh and decreases the acidity and astringency in taste and increases the flavor. However, the present study would provide opportunity for commercial exploitation of the wood apple fruits and leads to the marketing and processing in to quality drinks.

2 Materials and Methods

The present study was carried out 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 ripening stage from Ratapur village of Milkipur Tehsil, District Faizabad.

2.1 Extraction of Pulp

The pulp extracted from ripe fruits of wood apple as per flow sheet depicted in Fig-1. The wood apple pulp extracted by adding 3 fold water. The obtained data from analyzed fruits regarding on chemical characteristics of wood apple pulp, which used for the preparation of wood apple squash was presented in Table- 1.0.

2.2 Preparation of Squash

For formulation of recipes total soluble solids and total titratable acidity present in extracted pulp were first determined by hand refractometer and titration, respectively. Then calculation was done for sugar and acid present in the pulp as well as for remaining amount of sugar, citric acid, potassium metabisulphite and water required to prepare the finished squash in different proportions according to desired recipes.

One liter squash of each recipe were prepared by mixing the calculated amount of pulp, sugar, citric acid and water in different proportions (recipes) then organoleptically evaluated by a panel of seven semi trained judges on a 9.0 Point Hedonic Rating Scale to find out the best one recipe of wood apple pulp, sugar and acidity content. Finally ten liter squash was prepared with best recipe viz. 25 percent wood apple pulp, 50 percent TSS, 1.00 percent titratable acidity and 350 ppm SO_2. The technique used for making squash is given in Fig 2.0. Prepared squash was filled in sterilized bottles (750 mL capacity) by leaving 2cm head space. Bottled squash was stored at ambient temperature for further study and biochemical constituents were analyzed till the acceptability of the beverage.

2.3 Determine the Proximate Biochemical Composition

Total soluble solids (TSS) were determined by hand refractometer (ERMA made) and reading was corrected at 20°C (Ranganna, 2010) [17]. Total titratable acidity content was analyzed, microbial growth were determined and browning was recorded as per Ranganna (2010) [17], while ascorbic acid content in the pulp and product according to the method of AOAC (2012) [3] and the determination procedure was followed as described by (Ranganna, 2010) [17]. The Fehling's 'A' and 'B' solutions (Lane and Eynon, 1923) [12] were used to estimate the sugars content adopting the procedure as suggested by (Ranganna, 2010) [17].

2.4 Sensory Evaluation

Sensory evaluation offers the opportunity to obtain a complete analysis of the various properties of squash as perceived by human sense. The organoleptic evaluation for assessing the sensory attributes like- colour, appearance, flavour, aroma, taste and texture of squash was conducted by a panel of seven semi trained judges on 9.0 point Hedonic Rating scale (Amerine *et al.*, 1965) [2].

2.5 Statistical Analysis

During shelf-life study of squash 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) [15].

3. Results and Discussion

3.1 Chemical Characteristics of Wood Apple Pulp

The data recorded on the chemical characteristics of wood apple pulp are showed in Table-1. The wood apple pulp extracted by adding 3 fold water was contained 6.00 percent total soluble solids, 1.28 percent titratable acidity, 1.80 mL/ 100g ascorbic acid, 1.40 percent reducing sugars, 2.45 percent non-reducing sugar and 3.85 percent total sugars, which affected the palatability and quality of processed squash.

3.2 Preparation of Squash

The squash manufactured from different amount of wood apple pulp and sugars are furnished in Table-2. It is clear from the data that the recipe no.2 consisting 25 percent pulp, 50 percent TSS and 1.00 percent titratable acidity was significantly best over the rest treatments. Therefore, 25 percent wood apple pulp, 50 percent TSS, 1.00 percent titratable acidity and 350 ppm SO_2 was used in squash making for storage studies.

3.3 Total Soluble Solids

Data as embodied in table-3 clearly reflected that the total soluble solids of wood apple squash gradually increased with storage period. An increase in total soluble solids content in squash 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 Kumar (2014) [5] in mango-ginger RTS, Hamid *et al.* (2017) [9] in mulberry RTS and Sherzad *et al.* (2017) [18] in strawberry nectar.

3.4 Titratable Acidity

The data portrayad in table-3 apparently indicated that percent titratable acidity of squash was increased gradually during storage period. The 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 drink. Conn and Stumf, 1976 [4] have been reported to increase the acidity in fruit products, hence degradation of pectin substances of pulp in to soluble solids might have contributed towards an increase in titratable acidity of squash. This is in consonance with the findings of Priyanka *et al.* (2015) [16] in jamun blended squash and Kumar and Deen (2017b) [11] in wood apple RTS.

3.5 Ascorbic acid

As per observation of the present study, the ascorbic acid content of squash was presented in table-3 indicated that the ascorbic acid content of squash showed that it was decreased continuously during storage period. Reduction in ascorbic acid content of the drink 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. The findings of present investigation matches with those as reported by Priyanka *et al.* (2015) [16] in jamun blended squash, Hamid *et al.* (2017) [9] in mulberry RTS and Sherzad *et al.* (2017) [18] in strawberry nectar.

3.6 Reducing Sugars and Total Sugars
The data incorporated in table-3 indicated clearly the reducing sugars and total sugars of the squash were increased continuously throughout the entire period of study. The increase in reducing sugars and total sugars content of squash 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 Kumar (2014) [5] in mango-ginger RTS, Hamid *et al.* (2017) [9] in mulberry RTS and Kumar and Deen (2017b) [11] in wood apple RTS.

3.7 Non-reducing Sugar
The non-reducing sugar content in squash was decreased with storage period presented in table-3 that it was contrary to reducing and non-reducing sugar, the non-reducing sugar of squash, decreased continuously throughout the entire period of storage which might be because of inversion. Similar observations were reported by Yadav *et al.* (2013) [19] in banana RTS, Deen and Kumar (2014) [5] in mango-ginger RTS and Kumar and Deen (2017b) [11] in wood apple RTS.

3.8 Browning
Data regarding on browning are presented in table-3 showed that progressive increase in browning of squash was observed with the storage period. This could be mainly due to the non-enzymatic reaction such as reaction of organic acids with sugars or oxidation of phenol which leads to the formation of brown pigments. The present investigation also support the contention that reduction in ascorbic acid content during storage of squash corresponding an increase in browning. The browning was also reported in karonda squash (Deen and Singh, 2012) [6] and in mango-ginger RTS (Deen and Kumar, 2014) [5]. These referred findings are in supports of present results.

3.9 Organoleptic Score
In present investigation, organoleptic scores were decreased gradually with storage period but remained well within the acceptance illustrated in table-3. Loss in organoleptic quality of squash after certain period is obvious because of undesirable changes in the product. Temperature plays an important role in inducing certain undesirable biochemical changes in the beverage which leads to development of off flavour as well as discoloration (browning) and there by masking the original colour and flavour of the beverage. Similarly, reduction in organoleptic quality has also been reported in mango-ginger RTS (Deen and Kumar, 2014) [5], in pomegranate drink (Akhtar *et al.*, 2013) [1] and in mulberry RTS (Hamid *et al.*, 2017) [9]; these reported observations support the present findings.

3.10 Microbial Growth
Data with respect to microbial growth in squash as depicted in table-3 clearly reflected that microbial growth of squash was increased up to two month of storage at ambient temperature and thereafter, it showed continuously decreasing trend with storage period in squash. 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 acidity in squash because sugar and higher acid possess preservative properties to reduce the microbial growth. The results reported by Li *et al.*, 1989 [13] in orange juice, Goyal and Ojha, 1998 [8] in orange juice and Kumar and Deen (2017b) [11] in wood apple RTS are confirm the present findings. As reported by Ranganna (2010) [17] the microbial count should not exceed to 10^3 per mL of squash. In present findings the microbial count had not exceeded this limit up till the squash remained acceptable organoleptically.

4. Conclusion
It can be concluded from the present experiment that we can utilize the wood apple pulp for the preparation of drink. The preparation of wood apple squash with the recipe no.2 consisting 25 percent pulp, 50 percent TSS and 1.00 percent titratable acidity was significantly best over the rest treatments and can be stored successfully for 5 month at ambient conditions.

Table 1: Chemical characteristics of wood apple pulp extracted with (1:3) water

S. No.	Parameters	Observations (mean value)
1	Total soluble solids (%)	6.00
2	Titratable acidity (%)	1.28
3	Ascorbic acid (mL/100g)	1.80
4	Reducing sugars (%)	1.40
5	Non-reducing sugar (%)	2.45
6	Total sugars (%)	3.85

Table 2: Organoleptic quality of squash prepared with different recipes

Treatments (Recipes No.)	Wood apple pulp (%)	TSS (%)	Acidity (%)	Organoleptic Quality	
				Score	Rating
1	25	45	1.00	7.71	Like Very Much
2	25	50	1.00	8.57	Like Extremely
3	25	45	1.20	7.40	Like Moderately
4	25	50	1.20	7.15	Like Moderately
SEm ±				0.12	
CD at 5%				0.40	

Table 3: Changes in biochemical characteristics during storage of squash

Storage period (months)	TSS (%)	Titratable Acidity (%)	Ascorbic acid (mL/100g)	Reducing sugars (%)	Non-reducing sugar (%)	Total sugars (%)	Microbial growth (X 10^3 cfu/ml)	Browning	organoleptic quality	
									Score	Rating
0	50.00	1.00	0.44	0.33	47.79	48.12	0.298	0.29	8.60	LE
1	50.20	1.03	0.43	1.10	47.15	48.25	0.319	0.30	8.40	LVM
2	50.30	1.06	0.41	2.03	46.75	48.78	0.446	0.32	8.00	LVM
3	50.60	1.10	0.40	3.60	45.83	49.43	0.301	0.34	7.65	LVM
4	50.90	1.14	0.38	4.65	45.20	49.85	0.243	0.37	7.45	LM
5	51.25	1.17	0.37	5.47	44.85	50.32	0.183	0.41	7.15	LM
SEm ±	0.72	0.02	0.01	0.05	0.66	0.78	0.07	0.08	0.11	
CD at 5%	NS	0.05	0.02	0.16	NS	NS	0.18	0.21	0.34	

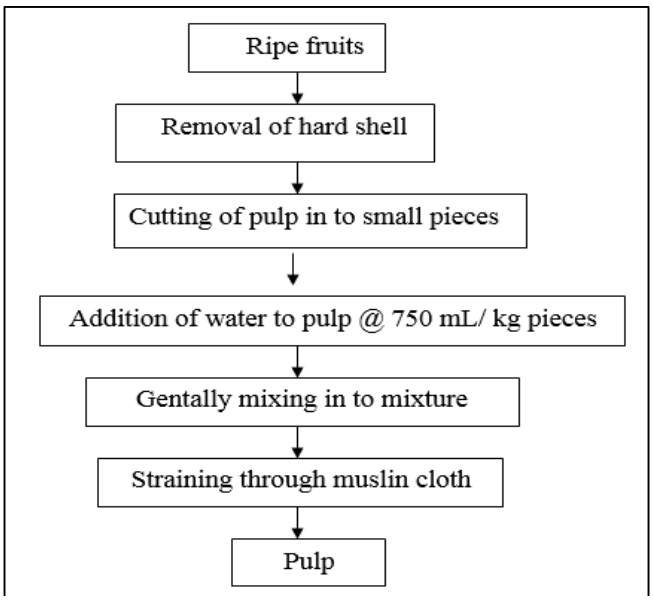

Fig 1: Flow sheet for extraction of pulp from wood apple fruits

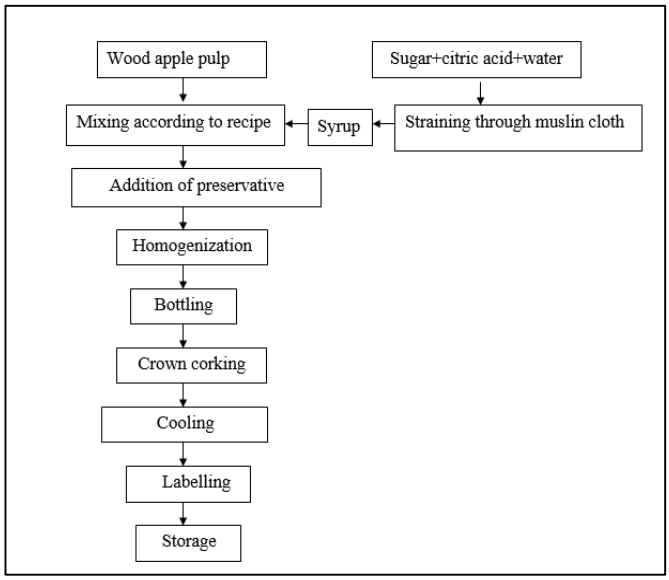

Fig 2: Flow sheet for preparation of wood apple squash

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