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Development and Standardization of Wood Apple (*Limonia acidissima* Linn) Sauce

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Development and standardization of Wood apple (*Limonia acidissima* Linn) Sauce, its acceptability and storage stability were studied in this study. To analyze the physic- chemical properties of developed product four variations of wood apple sauce of containing different levels of pulp (70, 80, 90 and 95per cent) were prepared and compared with control tomato sauce. Organoleptic evaluation for control sample was 8.40, 8.59, 8.79, 8.56, 8.26 and 8.60 for appearance, texture, colour, flavour, taste and overall acceptability respectively. It is followed by WA (wood apple 70%) which scored 7.80 for appearance, 7.90 for texture, 8.00 for colour, 8.15 for aroma, 7.50 for taste and 8.35 for overall acceptability. Phosphorous (90mg/100g), zinc (0.501mg/100g), copper

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(0.245mg/100g) and manganese (0.286mg/100g) content were observed in sauce prepared with 70% wood apple. Best accepted sauce powder WA-1 was stored at room temperature and refrigerated temperature in polythene pouches of 8 gauges for storage period of 3 months. There was a non significant difference with respect to pH of sauce stored for a period of three months under ambient conditions. Significant decrease in titrable acidity of sauce was observed from initial (6.07%) to final (6.02%) stored for a period of three months. Organoleptic evaluation of sauce stored under both ambient and refrigerated conditions were decreased as the duration increases. Moulds population of sauce at initial day was found to be 1.33 X 10^4 CFU, 3.67 X 10^4 CFU on 30th day, 6.67 X 10^4 CFU on 60th day and 8. 33 X 10^4 CFU on 90th day of storage.

Keywords: Wood apple; sensory evaluation; chemical evaluation; storage studies sauce.

1. INTRODUCTION

"Many underutilized fruits and vegetables are rich in micronutrients and could significantly contribute to nutritional security if eaten as a part of daily diet. Common name for Woodapple (*Limonia acidissima* Linn) is Bael. India is the native place for wood apple and is also cultivated in Bangladesh, Pakistan and SriLanka" [1]. "Fruit is, 5to 12.5 cm wide, shape is oval to round, woody, amazingly hard rind which is difficult to crack, greyish-white, scurfy rind about six mm thick, pulp brown, mealy, odorous, resinous, astringent, acid or sweetish, with numerous small, white seeds scattered through it. Two types of wood apples are available, one with small, acidic fruits and the other with large, sweet fruits" [2].

Fig 1. Woodapple fruit

"All parts of the plants are prescribed in indigenous system of medicine for the treatment of various ailments. Leaves, barks, roots and fruit pulp are all used against snake bite" [3]. "In India, fruit is used as a liver and cardiac tonic, in diarrhea and dysentery, an effective treatment for hiccup, sore throat and gum diseases. The pulp is poultice onto bites and stings of venomous insects" [4]. In English they call it as Curd fruit, Elephant apple, Monkeyfruit, and Wood apple.

"Fruits of wood apple are refrigerant, stimulant, astringent, diuretic, cardiotonic, tonic to liver and lungs, cures cough, hiccup and good for asthma, constipation, tumours, opthalmia and leucorrhoea" [5].

Wood apple is seasonal fruit and want to store in offseason and reduce post harvest losses, so develop the product which can store for long duration and it should be good in sensory qualities. To meet all these requirements selected wood apple fruit with the following objectives.

1. Development and standardization of Sauce, its acceptability and storage stability.
2. To analyze the physico-chemical properties of developed product.

2. MATERIALS AND METHODS

From the local market wood apples were collected during the season and they were stored in deep freezer for the further study. For the preparation of products ingredients were procured from local market.

Fig 2. Wood apple sauce

Wood apple sauce (WA): Four variations of wood apple sauce of containing different levels of pulp (70, 80, 90 and 95per cent) were prepared and compared with control tomato sauce as indicated in Table 1 and method used in the preparation of sauce is given in Fig 3.

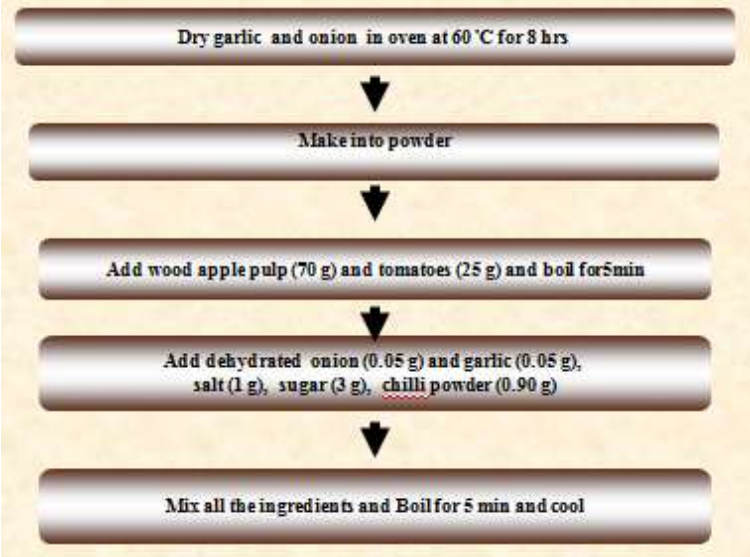

Fig. 3. Flow chart for the preparation of Sauce

Table 1. Standardization of value added wood apple sauce

Sl.No.	Ingredients	Control	WA-1	WA-2	WA-3	WA -4
1.	Wood apple (g)	-	70	80	90	95
2.	Tomato (g)	95	25	15	5	-
3.	Chilli powder (g)	0.90	0.90	0.90	0.90	0.90
4.	Sugar (g)	3.00	3.00	3.00	3.00	3.00
5.	Salt (g)	1.00	1.00	1.00	1.00	1.00
6.	Onion (g)	0.05	0.05	0.05	0.05	0.05
7.	Garlic (g)	0.05	0.05	0.05	0.05	0.05
	Total	100	100	100	100	100

WA-Wood apple sauce g = grams
WA-1=Wood apple Sauce with addition of 70 g of wood apple.
WA-2=Wood apple Sauce with addition of 80 g of wood apple.
WA-3=Wood apple Sauce with addition of 90 g of wood apple.
WA-4=Wood apple Sauce with addition of 95 g of wood apple.

Nutrients analysis of the sauce [6]: Nutrients namely moisture, protein,fat, ash, crude fibre, calcium, phosphorus, ironand zinc were analysed using standard AOAO method 2010. Carbohydrate content of sauce was computed by difference method. Using analytical grade chemicals nutrients were analysed in triplicate. Results were expressed on dry weight basis.

3. RESULTS AND DISCUSSION

3.1 Organoleptic evaluation of Sauce

Table 2 and Fig 4 show the organoleptic evaluation of wood apple Sauce. Sensory scores of control sample were 8.40, 8.59, 8.79, 8.56, 8.26 and 8.60 for appearance, texture, colour, flavour, taste and overall acceptability respectively. It was followed by WA-1 (wood apple70%) which scored 7.80 for appearance, 7.90 for texture, 8.00 for colour, 8.15 for aroma, 7.50 for taste and 8.35 for overall acceptability. The lowest score for appearance (7.00), texture (7.03), colour (7.04), flavour (7.56), taste (7.36) and overall acceptability (7.29) wasobserved by WA-4 (wood apple 100%). There was significant difference for appearance, flavour, taste and overall acceptability was observed. Similar results were observed by Jayashree et al. [7], organoleptic analysis showed that ginger sauce had the best flavor and taste, with overall acceptability score of 8.0; the next was ginger-pepper sauce with acceptability score of 7.1, followed by ginger-nutmeg sauce with a score of 6.4. *Ginger-kokum* and ginger-nutmeg-kokum sauces had a near-similar acceptability score of 5.3.

According to El-sherif [8] significant differences were obtained among the taste samples. Analysis of variance showed that tomato ketchup (T1) had the highest score for color, taste, odor, texture and overall acceptability compared to those of the other investigated samples. No significant difference was observed in the means of taste for T2 and T3compared to T4 which had the lowest mean of taste compared to the others. The color scores of tamarind ketchup (T5) were lower than the other ketchup products. It could be stated that tomato ketchup (T1) and tomato ketchup supplemented with red Roselle extract had the highest palatability compared to all other ketchup treatments while the mean score of T3, T4 andT5 was lower than T1 andT2 for the overall acceptability.

Table 2. Organoleptic evaluation of Sauce (n=20)

Treatments	Appearance	Texture	Colour	Aroma	Taste	Overall acceptability
Control	8.40	8.59	8.79	8.56	8.26	8.60
WA-1 (70%)	7.80	7.90	8.00	8.15	7.50	8.35
WA-2 (80%)	7.44	7.59	7.52	7.97	7.96	8.10
WA-3 (90%)	7.18	7.36	7.28	8.01	7.15	7.65
WA-4 (100%)	7.00	7.03	7.04	7.56	7.36	7.29
F value	*	*	*	*	*	*
SEm±	0.15	0.18	0.24	0.22	0.19	0.17
CD at 5%	0.43	0.50	0.66	0.62	0.53	0.48

**Significant at 5 percent*
WA-1=Wood apple Sauce with addition of 70 g of wood apple.
WA-2=Wood apple Sauce with addition of 80 g of wood apple.
WA-3=Wood apple Sauce with addition of 90 g of wood apple.
WA-4=Wood apple Sauce with addition of 95 g of wood apple.

Fig. 4. Organoleptic evaluation of wood apple Sauce

3.1.1 Macronutrient composition of Sauce

Table 3. Macronutrient composition of developed products (per100g)

Products	Moisture(g)	Protein(g)	Fat(g)	TotalAsh (g)	CrudeFibre (g)	Carbohydrates(g)	Energy(g)
WA-1 Sauce (70%)	69.2	5.085	1.08	1.75	3.97	18.90	106

Note: For sauce, fresh wood apple is added
WA-1=Wood apple Sauce with addition of 70 g of wood apple.

3.1.2 Micronutrient composition of Sauce

Table 4. Micronutrient composition of developed products (mg per100g)

Products	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Zinc (mg)	Copper(mg)	Manganese (mg)
WA-1 Sauce (70%)	217.00	90.00	0.46	0.50	0.25	0.29

Phosphorous (90mg/100g), zinc (0.501mg/100g), copper (0.245mg/100g) and manganese (0.286mg/100g) content were observed in sauce prepared with 70% wood apple (Table 4).

Nutrient composition varies depending upon plant variety, agronomic practices, and stage of collection of fruits and climate and geological conditions of area from where seeds are collected [9].

Calcium content was highest in treatment T2 (54.74mg) followed by T1 (53.59mg) and T3 (53.38mg). Iron content was highest in treatment T2 (0.67mg) followed by T1 (0.66mg) andT3 (0.63mg). Phosphrous content was highest in treatment T2 (37.86mg) followed by T1 (36.82mg) and T3 (36.20mg) [10].

3.1.3 Shelf life study of the developed products

Wood apple sauce mix was aseptically packed in HDPE polythene covers and sealed. The samples were kept at ambient and refrigerated conditions. Sauce stored product mix, was evaluated for sensory attributes, pH, and acidity percentage and microbial load for a period of three months.

Shakir Moazzem et al. [11]., **"**The total soluble solids (◦Brix), pH, titrable acidity, ascorbic acid content, microbial growth and sensory attributes of the prepared juice samples were evaluated at an interval of 10 days over a storage period of 50 days. TSS was found to increase (16.30–18.25◦Brix) with storage period, while pH (5.43–4.10), titratable acidity (0.67–0.08%), and ascorbic acid content (4.65–1.01 mg/100 mL) decreased with time".

3.1.4 Effect of storage on organoleptic evaluation of the developed products

Best accepted product was selected for shelf life study. Environmental conditions may vary the sensory quality profile of products. In the present study, the effect of factors such as temperature and duration on wood apple sauce was studied for a period of 3months.

Table 5. Effect of storage condition on sensory characteristics of sauce

Temperature	Duration(days)	Appearance	Texture	Colour	Aroma	Taste	Overall acceptability
Ambient	Initial	7.80	7.90	8.00	8.15	7.50	8.35
	30days	7.05	7.20	7.50	7.60	6.85	7.65
	60days	6.25	6.35	6.55	6.65	6.20	6.90
	90days	6.00	6.10	6.45	6.25	5.75	6.45
Refrigerated	Initial	7.80	7.90	8.00	8.15	7.50	8.35
	30days	7.75	7.55	7.95	8.00	7.10	8.10
	60days	7.35	7.05	7.45	7.70	7.10	7.85
	90days	6.80	6.55	7.10	7.00	6.90	7.45
Temperature	**Fvalue**	**	**	**	**	**	**
	SEm±	0.08	0.08	0.10	0.09	0.11	0.09
	CD @5%	0.22	0.22	0.29	0.24	0.30	0.26
Duration	**Fvalue**	**	**	**	**	**	**
	SEM±	0.11	0.11	0.15	0.12	0.15	0.13
	CD @5%	0.31	0.31	0.41	0.33	0.43	0.36
Interaction	**Fvalue**	**	NS	NS	*	*	*
	SEM±	0.16	0.16	0.21	0.17	0.22	0.18
	CD @5%	0.44	0.43	0.57	0.47	0.60	0.51

**Significant at 5 percent level **Significant 1 percent level*
Ns= Non -significant

3.1.5 Mean sensory scores of sauce

Effect of storage on sensory scores of sauce is presented in Table 5. Best accepted sauce powder WA-1 was stored at room temperature and refrigerated temperature in polythenepouchesof8gaugesforstorageperiodof3 months.

All the sensory attributes of sauce stored under both ambient and refrigerated conditions were decreased as the duration increases. Mean sensory scores for ambient condition sample decreased from 7.8 to 6, 7.9 to 6.1, 8 to 6.45, 8.15 to 6.25, 7.5 to 5.75and 8.35 to 6.45 for appearance, texture, flavour, taste and overall acceptability, respectively. Similarly in WA-1samples, mean sensory scores decreased from7.8to6.8 (appearance), 7.9 to 6.55 (texture), 8 to 7.1 (colour), 8.15 to 7 (aroma), 7.5 to 6.9 (taste) and 8.35 to 7.45 (overall acceptability). There was a significant difference for all sensory attributes at five percent for texture and colour.

Present results were inconformity with the study conducted by Gokoglu et al. [12], to assess the organoleptic scores of both samples significantly decreased ($p< 0.05$) throughout the storage. Pomegranate sauce scores were significantly lowers ($p< 0.05$) for appearance than those found in sunflower oil. In marinated anchovy the pomegranate sauce also produced desirable taste and flavour.

All plastic materials showed an overall migration lower than the limit of EU and Mercosur Regulations. PVC better preserved polyphenols, antioxidant activity, and carotenoids until 50, 10, and 30 days, respectively, and lower development of brown pigments was observed. Higher storage temperatures favored undesirable changes in sensory attributes before 50 days of storage. PVC can be used to achieve greater conservation of the sensory attributes of sauce, regardless of the storage temperature. It could be considered the best material to preserve the bioactive properties and sensory attributes of the sauce until 30 days.

Effect of storage on pH and titrable acidity of wood apple products is dipted in the Table 6. There was a nonsignificant difference with respect to pH of sauce stored for a period of three months under ambient conditions. Significant decrease in titrable acidity of sauce was observed from initial (6.07%) to final (6.02%) stored for a period of three months.

Nutrient content of wood apple jam and fruit bar stored under ambient condition for a period of 3months. Vitamin C content was significant reduced for stored products (11.1to50.0 percent and 10.5 to 57.8 percent respectively).

Loss in Calcium was 15 percent and 12.5 percent Jam and Fruit Bar, respectively during the storage of upto 90th day. Phosphorus content also reduced for storage of both jam and fruit bar was observed upto 90 days. “The reduction in phosphorus content of jam was 5.11 percent during 60th day and 8. 80% during 90 th day and in fruitbar 5.81 percentduring 60th day and 10.7 percent during 90th day of storage. Loss of titrable acidity was also increased in both jamand fruit bar as the period of storage increased. No changes in TSS, 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 90day of storage” (Vidhya and Narain., 2010).

Table 6. Effect of storing wood apple sauce on pH content and titrable acidity

	pH	**Titrable acidity**
Duration	**Sauce**	**Sauce**
Initial	3.45	6.07
Final (30thday)	3.47	6.02
Mean	3.46	6.04
F-value	NS	*
SEM±	0.060	0.012
CD at5%	0.245	0.045

**Significantat 5 percent level NS-non significant*

Table 7. Effect of storage on microbial load of sauce

Duration	Moulds (×10^4CFU)	Yeast (× 10^4CFU)
Initial	1.33	0.33
30thday	3.67	2.33
60thday	6.67	6.33
90thday	8.33	9.33
F-value	*	*
SEm±	0.83	0.73
CD at5%	2.34	3.96

3.1.6 Microbial load of Sauce

Table-7 indicates the microbial load of sauce. Best accepted sauce powder WA-1(24g of wood apple powder) in corporation was stored at room temperature in polythene pouches of 8 gauges for storage period of 3 months. Microbial count was observed at initial day and at the interval of 30days.

Moulds population of sauce at initial day was found to be 1.33 X 10^4 CFU, 3.67 X 10^4 CFUon30th day, 6.67X10^4CFU on 60th dayand8.33X10^4CFUon90th day of storage.

Similar findings were reported by Priyanka, [13] Bacterial population of sauce at initial day was found to be 73.33X10^3CFU/10 g and 105.33 X10^3 CFU, on 30th day was found and moulds was found to be 3.66X10^3CFU/10g at initial and7.00X10^3CFUon30th day.

"The different extracts of *F. limonia* against various fungal and bacterial strains indicate that this plant is having potent antifungal effects and antibacterial effect. The anti microbial activity of *F.limonia* would be due to the presence of alkaloids, flavonoids and these compounds are most probably soluble in organic polar solvent Jayashree and Londonkar, [14].

Natural products with dual efficiency as antimicrobial properties and preventing lipid oxidation have incredible potential for extending the shelf life of food products. Essential oil from the fruit pulp of *F. limonia* can be considered as a new and potential source of natural antimicrobial agent and antioxidant [15-18].

4. CONCLUSION

Excess production of wood apple in season leads to form glut in the market. To avoid scarcity in the off season and to reduce perish ability of wood apple, value added product sauce was developed. Sensory scores of control sample were highest wood apple 70%. Phosphorous, zinc, copper and manganese content were observed in sauce prepared with 70% wood apple. Best accepted sauce powder WA-1was stored at room temperature and refrigerated temperature in polythene pouches of 8 gauges for storage period of 3 months. There was a non significant difference with respect to pH of sauce stored for a period of three months under ambient conditions. All the sensory attributes of sauce stored under both ambient and refrigerated conditions were decrease as the duration increases. Using wood apple further products can be prepared and can do commercialize the products.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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