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Development and storage studies of wood apple (*Limonia acidissima*) chutney

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Abstract
Wood apple chutney was nutritious and health beneficial product with biochemical properties such as phenolic compounds that act as antioxidant properties. The present investigation was to develop and storage study of wood apple chutney. The best quality of chutney was selected on the basis of organoleptic quality for storage study. During the storage period of chutney moisture content, pH, total soluble solid, titratable acidity, ascorbic acid and biochemical properties (total phenolic content and antioxidant activity) were analyzed. Wood apple chutney was recorded on second month that ascorbic acid, total phenolic content and antioxidant activity had 2.2 mg/100g, 143.7 mg/g and 65.4% respectively. Hence result signified that chutney prepared from wood apple fruit was contained nutritional properties that beat suitable for consumption up to 2 month after that biochemical properties start to degraded.

Keywords: Wood apple fruit, chutney, total phenolic content, antioxidant activity

Introduction
Wood apple (*Limonia acidissima)* fruit is an underutilized fruit, which commonly belongs to family Rutaceae. It is also known by various names in different parts of India like elephant apple, monkey apple, Kotha, kainth etc. and generally found all over the plain areas such as Maharashtra, West Bengal, Chhattisgarh, Uttar Pradesh, Madhya Pradesh and also present in western part of Himalayas [1, 2, 3]. The outer shell of the fruit is very hard, brown in color, while the pulp of fruit is sour in taste with seeds embedded in it. Wood apple contain adequate amount of flavanoids, glycosides, saponins, tannins [4, 5], also good source of ascorbic acid, riboflavin, vitamin B complex, beta carotene, abundant in minerals and seed contain high amount of oil content [6]. The fresh wood apple per 100g contains 7.1g protein, 18.1g carbohydrate, 10.45-21.70 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, 9.88-8.50 percent pectin [7,8,9].
At present, this fruit is underutilized inspite of its good nutritional and therapeutic properties along with its delicate flavor. Wood apple used as folk medicine in treating dysentery, different infections [10], fruit consist phytochemicals which possess anti-oxidative, antifungal, hypoglycemic, hypolipidaemic and hepatoprotective properties [11, 12]. Different parts of wood apple plant have been reported to exhilarated liver tissue, cut injuries, skin malignant growth, bosom disease and cell reinforcement exercises [13].
Wood apple fruit becomes soft during ripening is utilized for preparation of fruit bars, beverages, desserts and fruit crush used for preparing of jam and ready-to-serve drinks [14]. The pulp of fruit can be used in preparation of blended beverages with coconut milk and palm-sugar syrup. Despite of its numerous nutritional and health benefits this fruit is still underutilized, not in demand or market value. Therefore, an attempt was made to utilize wood apple fruit as a value-added product and study different physicochemical properties of the prepared product.

Materials and Methods
The present study was carried out in department of Food Technology, Guru Jambheshwar

University of Science and Technology, Hisar, India. The ripen wood fruit were purchased from Surat, Gujarat and the other ingredients which are added to preparing chutney such as salt, sugar, garlic, ginger, fresh green chili, green mint, coriander were purchased from local market of Hisar.

Preparation of wood apple chutney

Chutney was prepared with wood apple pulp along with seeds, which is major ingredient of chutney along with green chilies, garlic, ginger, coriander and sodium benzoate (150 ppm) was used. Garlic and ginger are common ingredients used for formulation of chutney which enhance all over flavor of product [15].The wood apple chutney prepared using the hit and trial method and four different formulation as per giving in Table 1 and processing steps used for making chutney is given in Fig. 1.

Table 1: Different formulation of Chutney

Ratio (wood apple: other ingredients)	Wood Apple Pulp (g)	Garlic (g)	Ginger (g)	Coriander (g)	Green Chili (g)
R1 (80:20)	80	5	5	5	5
R2 (70:30)	70	8	8	8	6
R3 (60:40)	60	10	10	10	10
R4 (50:50)	50	15	12	12	11

Sensory evaluation

Prepared wood apple chutney was evaluated on 9-point Hedonic Scale by panel of 20 semi trained panelist and scoring was done on quality attributes like appearance, color, consistency, taste, texture and flavor of freshly prepared chutney. On the basis of sensory score, best wood apple chutney ratio formulation was chosen for further analysis.

Storage of chutney

Best formulated chutney was stored in sterilized glass bottles for two months storage and in a week, sample was taken from stored bottle for analysis. Various physicochemical parameters were evaluated during storage period such as moisture content, total soluble solids, pH, and titratable acidity [16]. Ascorbic acid of chutney was determined according to AOAC (2012) method.

Total phenolic content

The total phenolic content of chutney was determined using folin-ciocalteu reagent [17]. Briefly, in 1 ml of sample extract 0.5 ml of FC reagent was added then incubation was done at room temperature for 5 min and 5 ml of 20% anhydrous sodium carbonate was added. Solution was kept undisturbed for 30 min and absorbance was recorded at 750 nm in UV-VIS Spectrophotometer (Thermo Scientific). The results were expressed in gallic acid equivalent (GAE)/g of fruit on the dry weight basis.

DPPH radical scavenging activity

The radical scavenging activity of sample was determined with standard methods with minor modification [18]. One ml of sample extract was mixed with 4 ml of 0.1 mM DPPH (2, 2 diphenyl-1-picrylhydrazyl) solution. The mixture was kept in dark for 45 min at room temperature for reaction. The absorbance of mixture was recorded at 517 nm and scavenging activity against DPPH radical.

Statistical analysis

All the values of data are interpreted at the significant difference of 5 percent among the data obtained and one way ANOVA by using SPSS software version 23. Variance and mean values were compared by Duncan multiple range test.

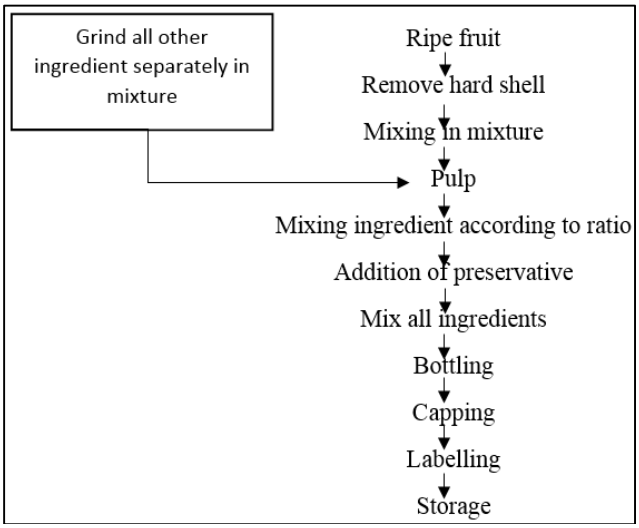

Fig 1: Flow chart of chutney processing

Results and Discussions

Selection of chutney

The wood apple chutney was prepared in different ratio as shown in table 1.The samples R1, R2, R3 and R4 were significantly different in sensory attributes due to variation in preparation material, especially wood apple fruit concentration variation. The best ratio was selected on the basis of organoleptic evaluation by panel members. The sample R3 made with 60% of wood apple fruit had highest acceptance with respect to taste, texture, color, flavor and consistency among the all ratios and high pungency was observed in R4 sample whereas R1 and R2 samples have

higher sourness and textural defects with inappropriate consistency.

Effect on physicochemical properties

The data pertaining to different storage period of chutney is presented in table 2. It was observed that moisture content in chutney found significant reduced from the initial week of storage to final week. Titratable acidity during storage period has increased gradually indicates significant different during storage period. In fourth week of storage, titratable acidity recorded as 2.30 percent and last week it was 3.98 percent that significantly higher from zeroth week. This could be possibly due to degradation of pectin compounds into soluble pectic acid that soluble substance responsible for elevation of acidity of product during storage [19].

Total soluble solid in stored chutney increased slightly due to reduction in moisture that prominently increased solid content that might be responsible for increase the total soluble solid content in chutney [15]. The data embodied in table shows that initially TSS of wood apple chutney was recorded 54.6 ºBrix, it slightly increased during the storage period. The result of finding by Deen and co-workers [19] during storage period of wood apple product that complex sugar convert into simple sugar cause elevation in total solid soluble content of product.

The data revels that pH of chutney was significantly decreased throughout the storage period due to enhancement in acidity of wood apple chutney while storage. The result reported by Husaini *et al*. [20] in mango chutney that degree of acidity indicates pH decline due to increases in acidic substance during long storage.

Ascorbic acid recorded on zeroth week as 4.2 mg/ 100g and 2.2 mg/100g on final week of storage period. It was persistently decreased during the storage time due to trapped oxygen present in glass bottle react with ascorbic acid that form highly volatile and unstable dehydro ascorbic acid that further degraded to ketogulconic acid or furfurnal compounds resultant ascorbic acid reduce during storage process [21,22,23]. Kumar and Deen [24] have been reported that steadily reduction of ascorbic acid in squash prepared from wood apple fruit, initial day 0.44 mg/100g of ascorbic acid was recorded and on the final day of storage it remains to 0.37 mg/100g in stored wood apple squash.

Table 2: Effect of storage period on moisture content of wood apple chutney

Storage period (week)/ parameters	0	1st	2nd	3rd	4th	5th	6th	7th	8th
Moisture (%)	89.3^{g}	88.9^{f}	88.7^{e}	88.4^{d}	88.1^{d}	87.8^{c}	87.6^{b}	87.4^{b}	87.2^{a}
Titratable Acidity (%)	1.43^{a}	1.69^{b}	1.81^{c}	2.09^{d}	2.30^{e}	2.98^{f}	3.39^{g}	3.72^{h}	3.98^{i}
TSS (ºBrix)	54.6^{a}	55^{b}	55.3^{c}	55.5^{d}	55.8^{e}	56.1^{f}	56.4^{g}	56.7^{h}	56.9^{i}
pH	3.4^{a}	3.1^{b}	2.9^{c}	2.7^{d}	2.6^{e}	2.4^{f}	2.2^{g}	2.2^{h}	2.1^{i}
Ascorbic Acid (mg/100g)	4.3^{a}	3.9^{b}	3.7^{c}	3.4^{d}	3.1^{e}	2.9^{f}	2.7^{g}	2.4^{h}	2.2^{i}
Total Phenols Content (mg GAE/ g)	190.2^{a}	187.8^{b}	181.2^{c}	175.3^{d}	169.3^{e}	162.1^{f}	158.3^{g}	149.5^{h}	143.7^{i}
Free radical scavenging activity (%)	86.4^{a}	84.3^{b}	82.6^{c}	81.7^{d}	78.5^{e}	76.2^{f}	71.4^{g}	69.8^{h}	65.4^{i}

Effect on total phenolic content

The data presented in Table 2, total phenolic content in wood apple chutney was significantly decreased during the storage period, on first day value of total phenolic content recorded as 190.2 mg GAE/g and on the final day of storage it reduced to 143.7mg GAE/g. According to Deng *et al*. [25] in the storage duration of litchi pericarp phenolic content slowly decreases initially then rapid reduction was noticed due to higher enzyme activity in litchi pericarp which accelerated the oxidation process. Similarly, Joshi *et al*. [26] also reported significant reduction in the total phenolic content in guava-jamun chutney during the long term storage.

Effect on antioxidant activity

As given in Table 2, there is significant reduction in the antioxidant activity during the storage period, on the initial day of storage 86.4% of free radical scavenging activity was recorded and it gradually decreased during storage, at final day of storage antioxidant activity was 65.4%. Wood apple contain abandoned amount of antioxidant activity, DPPH method evaluates the scavenging free radical and hydrogen donating antioxidant activity of product. Naseem *et al*. [27] observed that antioxidant activity of strawberry decreased during the storage period and similar trend was also noticed in litchi pericarp that might be due to presence of molecular oxygen that degraded the quality of product [25].

Conclusion

The present study was found that wood apple chutney is superior in terms of bioactive compound such as phenolic content and its antioxidant properties which enhance the product quality and development of significant potential for marketing of product from the underutilized fruit. Further the study was designed to determine the effects on physicochemical properties, total phenolic and antioxidant activity of wood apple chutney during the storage period and outcomes of the present study propound that acceptance of best quality chutney was determined on the basis of sensory parameters and during the storage period physicochemical properties were declined. The value of total phenolic content and antioxidant activity was observed gradually decreased during storage period. Further study on modified atmospheric packaging that enhance or preserve the functional properties during the storage.

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