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Nutra-Chemical and Organoleptic Quality Evaluation of Wood Apple (*Limonia acidissima* L.) Pickle

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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

Wood apple is a nutritious minor fruit crop indigenous to India but it is not much popular for the purpose of consumption. The value addition can increase the production and utilization of this valuable fruit crop. Among various value-added products, pickle is popular and traditionally acceptable in India. The present investigation conducted at Department of Horticulture, College of Agriculture, RVSKVV, Gwalior, MP between 2019-20 and 2020-21, to study the nutrients, chemicals and sensory qualities of wood apple (*Limonia acidissima* L.) pickle and Nutra-chemical changes in pickle during storage period. The wood apple pickle was prepared as per standard procedure and analyzed for its nutrients and chemical status as well as during storage period to access its self-life and suitability. Fresh wood apple has nutritive property and its pickle was found more nutritious with 3.20 g and 3.43 g crude protein, 1.43 g and 1.53 g crude fibre, 7.03 g and 7.37 g crude fats, 20.33 g and 19.00 g carbohydrates, 1.90 and 1.97 total minerals, 253 mg and 256 mg calcium and 107 mg and 103 mg phosphorous per 100 g of pickle for first and second year respectively. Sensory evaluation revealed color, taste, flavor changed after 90 days of storage remarkably as shelf life is better retained up to 90 days of storage. Moisture, pH and ascorbic acid decreased while titratable acidity and total sugars increased with 0, 30, 60 and 90 days of storage.

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Wood apple pickle is nutritious, good in taste and a better source for protein, fibre, calcium and phosphorus among different fruits and it was found suitable for consumption up to 90 days of storage without major organoleptic and Nutra-chemical changes.

Keywords: Chemicals; nutrients; pickle; storage; wood apple.

1. INTRODUCTION

Wood apple is botanically known as *Limonia acidissima* L. and belongs to the family Rutaceae. Wood apple is one of the most important underutilized indigenous fruit of India and a hardy fruit crop found all over the plains of Southern Maharashtra, West Bengal, Uttar Pradesh, Chhattisgarh and Madhya Pradesh. Wood apple is a nutritious fruit which contains high amount of protein and low amount of carbohydrates (sugar), compared to other underutilized fruit crops.

The fruits obtained from the trees are edible and the pulp of fruit is sour-sweet with coarse texture, seediness and fibrous. Edible full ripe pulp contains, on an average, 69.5 % moisture, 7.3 % proteins, 0.6 % fats and 1.9 % mineral matter. Total soluble solids content of the pulp varies around 7.0 °Brix; total acidity ranges between 3.0 % to 2.3 % and pectin content between 3 % to 5 %. Fruit pulp is considered tonic, refreshing and astringent and it is used to treat diarrhoaes and dysentery when unripe. Pulp extracted from the ripe fruits which has pleasant smell is used to treat gum and throat infections [1].

Wood apple pulp in the form of chutneys or sharbat is useful in treating hiccups [2]. Pal *et al.* [1] evaluated physico-chemical properties of wood apple pickle and revealed that Wood apple pulp with Sugar was superior for Wood apple pickle preparation in term of TSS (43.977 °Brix), pH (4.526), Acidity (0.4375 %), Moisture (16.426 %), color and appearance (8.625), texture (8.79), flavor and taste (8.575), and over all acceptability (8.225).

Different processed foods like pickles sour and sweet, refreshing drinks, chutney, paste etc. could be prepared from the pulp [1]. Being a nutritious fruit, the wood apple can be processed and preserved in the form of a tasty pickle. As pickles are traditionally important in India and consumed regularly in meals. In order to increase the production and utilization of wood apple, pickle may be a better product. Therefore, this study was carried out to access the Nutra-Chemical and storage life of wood apple pickle.

2. MATERIALS AND METHODS

In the study fresh and uniform size of wood apple fruits were purchased from a local market in Gwalior (M.P.). Fruits were selected by taking into consideration various factors such as soundness, firmness, cleanliness, size, maturity, weight, shape and freedom from foreign matters. unripe and ripe fruits of wood apple were classified and used for preparation of various value-added products. The fruits of wood apple were graded to select fruits according to treatment having uniform maturity. Fruits were first washed to remove the dirt. The fruits of wood apple were broken into small pieces with a hammer, and the resulting pulp is scooped with a spoon, cooked with water until it is soft and then grind.

2.1 Wood Apple Pickle Preparation

Wood apple pickle was prepared based on the principle of binding moisture with salt and spices. Three different levels of formulations had been conducted in a small scale before actually developing the product in this report. The pickle is prepared by standard techniques of mixing fruit pulp with salt and spices. The nutritive value of wood apple fresh pulp as per 100 g is given in Table 1. Ripe wood apple was collected for preparing pickle, the pulp was checked for pH initially so as to assess the proportion of spice mixtures to be added for product development.

For 1 kg of pulp, 200 g chilli powder, 120 g fenugreek seed powder, 20 g turmeric powder, 180 g of common salt and 250 ml of mustard oil were used. Asafoetida, mustard seeds and red chillies were used for seasoning.

2.2 Nutra-chemical Estimation

2.2.1 Crude protein (g)

Determined as per AOAC (2000) method [3]. 1.0 g of sample placed in digestion flask. 5 g of Kjedahl catalyst and 200 ml of conc. H_2SO_4 taken in a tube except sample as blank. Flasks was placed in inclined position and heated gently unit frothing ceases. Boiled briskly until solution

clears. Allowed cool and 60 ml of distilled water added. Immediately flask was connected to digestion bulb on condenser and with tip of condenser immersed in standard acid and 5-7 drops of mix indicator in receiver. Flask was rotated to mix content thoroughly; then heated until all NH_3 is distilled. Removed receiver, washed tip of condenser and titrated excess standard acid distilled with standard NaOH solution.

Calculation

$$\text{Protein (\%)} = \frac{(A-B) \times N \times 1.4007 \times 6.25}{W}$$

Where
A = volume (ml) of 0.2 N HCl used sample titration
B = volume (ml) of 0.2 N HCl used in blank titration
N = Normality of HCl
W = weight (g) of sample
14.007 = atomic weight of nitrogen
6.25 the protein-nitrogen conversation factor for fish and its by-products

2.2.2 Crude fibre (g)

Determination as per AOAC (1984) method [4]. 2 g extract of ground material with ether or petroleum ether to remove fat (Initial boiling temperature 35°C to 38°C and final temperature 52°C). After extraction with ether boil 2 g of dried material with 200 mL of sulphuric acid for 30 minutes with bumping chips. Filter through muslin and wash with boiling water until washing are no longer acidic. Boil with 200 mL of sodium hydroxide solution for 30 minutes. Filter through muslin cloth again and wash with 25 mL of boiling 1.25% H_2SO_4, three 50 mL portions of water and 25 mL alcohol. Remove the residue and transfer to ashing dish (pre weighed dish W_1). Dry the residue for 2 hours at 130 ± 2°C. Cool the dish in a desiccator and weigh (W_2). Ignite for 30 min at 600 ± 15 °C. Cool in a desiccator and reweigh (W_3).

$$\text{\% crude fiber in ground sample} = \div \frac{\text{Loss in weight on ignition } (W2 - W1) - (W3 - W1)}{\text{Weight of the sample}} \text{ X } 100$$

2.2.3 Crude fat (g)

By Chloroform-Methanol Method of AOAC (1984) [4]. Accurately weighing 5 g of well minced sample (3 g if more than 10% fat) into a 50 ml digestion tube, adding 30 ml of enzyme solution and mix. Placing tube and contents in a water bath at 50°C with occasional mixing for one hour. Quantitatively transferring this mixture to a semi micro blending assembly with 80 ml of methanol followed by 40 ml of chloroform. Covering and blending for two minutes. Cover removed, adding 40 ml chloroform. Covering and blending for an additional 30 seconds. Then extract was transferred to a centrifuge bottle and centrifuge at 5000 rpm for 10 minutes to clarify the bottom chloroform layer. Transfer ring ca 20 ml aliquot of the clear chloroform layer to a tared 100 ml beaker. Evaporated to dryness on a bath in a fume hood. Residue dried in beaker for 30 minutes at 101°C and cooled on bench top. Determined residue weight and calculated percentage of total fat.

$$\text{Percent total fat} = \frac{\text{residue weight X 4}}{\text{sample weight}} \text{X } 100$$

2.2.4 Total mineral (Ash) content (g)

Ash represents the inorganic residue as total minerals. Determined as per AOAC (2000) [3]. Placing the crucible and lid in the furnace at 550°C overnight to ensure that impurities on the surface of crucible are burned off. Then the crucible allowed to cool in the desiccator (30 min). Weighed the crucible and lid to 3 decimal places. About 5 g sample weighed into the crucible. Heated over low Bunsen flame with lid half covered. When fumes are no longer produced, crucible and lid was placed in furnace. Heated at 550°C overnight and lid was not covered. Placed the lid after complete heating to prevent loss of fluffy ash and allowed to cool down in the desiccator. Weighed the ash with crucible and lid when the sample turns to gray. If not, return the crucible and lid to the furnace for the further ashing.

$$\text{Total mineral content (Ash) (\%)} = \frac{\text{Weight of ash} \times 100}{\text{Weight of sample}}$$

2.2.5 Carbohydrate (g)

Carbohydrate estimated by the phenol sulphuric acid method [4]. Weighing 100 mg of the sample into a boiling tube. Then Hydrolysed by keeping it in boiling water bath for 3 hours with 5 mL of 2.5 N HCl and cool to room temperature. It was neutralised with solid sodium carbonate until the effervescence ceases. Volume made up to 100 mL and centrifuged. Pipette out 0.2, 0.4, 0.6, 0.8 and 1 mL of the working standard into a series of test tube. Pipette out 0.1 and 0.2 mL of the

sample solution in two separate test tubes. Volume made up to in each tube to 1 mL with water. Blank was set with 1 mL of water. Added 1 mL of phenol solution to each tube. Added 5 mL of 96% sulphuric acid to each tube and shake well. After 10 minutes shaking the content in the tubes and place in a water bath at 25-30°C for 20 minutes. Read the colour at 490 nm. Calculated the amount of total carbohydrate present in the sample solution using the standard graph.

Calculation
Absorbance corresponds to 0.1 mL of the test = 'x' mg of glucose

100 mL of the sample solution contains = ('x' ÷ 0.1) × 100 mg of glucose = % of total carbohydrate present.

2.2.6 Calcium (mg/100g)

Calcium was estimated by the method of Sadasivam and Manickam [5]. Fill the burette with 0.02 N EDTA solution up to zero mark. Take 10 ml of ash solution of simple in conical flask. Add 2 ml of 0.01 N NaOH as buffer solution and 4 to 5 drops of Eriochrome Black-T indicator. Titrate it against 0.02 N EDTA solution, the color change will be wine red to blue. Note the burette reading and repeat it twice or thrice till concordant values were obtained.

2.2.7 Phosphorous (mg/100g)

500 mg of oven dried and ground samples were digested with 10 ml of tri-acid mixture in the ratio of 10:1:4 v/v. After digestion, about 30 ml of distilled water was added, the mixture was shaken thoroughly and allowed to stand overnight. The mixture was then filtered in 50 mL volumetric flask with Whatman no. 42 filter paper and the volume was made up to 50 mL by repeated washing the conical flask with distilled water. The filtrate was kept for phosphorus estimation. The phosphorus was estimated Colorimetrically by using vanadomolybdate as indicator [6].

2.2.8 Titratable Acidity (%)

The titratable acidity was determined by titrating 10 ml aliquot against 0.1 N sodium hydroxide solution using phenolphthalein as indicator by method suggested by AOAC (1980) [7] and expressed in percent.

2.2.9 Ascorbic acid (mg/100g)

Estimated by using 2, 6- Dichlorophenol-indophenol visual titration [8]. Ascorbic acid in terms of mg per 100 g pulp weight was calculated by using following formula-

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Dye factor X titre reading X dilution X 100}}{\text{Weight X Volume of sample}}$$

2.2.10 Total sugar (%)

Estimated by the standard method of AOAC (1980) [7], extract was hydrolyzed with concentrated hydrochloric acid and titrated against 10 ml of mixed Fehling solutions (5 ml Fehling A + 5 ml Fehling B) using methylene blue as indicator. Results expressed as percent total sugar.

2.2.11 pH

pH of each sample was agitated (using a magnetic stirrer) for 1 minute until a stable reading was obtained.

2.3 Sensory Evaluation

The quality of wood apple products was judged by offering the sample to the panel of 5 judges in each trial separately. Score card method for sensory evaluation of products as suggested by Pal and Gupta [9] was adopted. Overall acceptability was determined by a trained sensory panel (minimum of 5 members) on a 9-point hedonic scale as prescribed by Nelson and Trout [10].

3. RESULTS AND DISCUSSION

Nutritional analysis of fresh wood apple revealed that it contains 6.53 g & 6.90 g crude protein, 0.80 g & 0.90 g crude fibre, 3.73 g & 4.03 g crude fats, 18.33 g & 18.00 g carbohydrates, 1.60 g & 1.97 g total minerals, 234 mg & 239 mg calcium and 69 mg & 63 mg phosphorous per 100 g of pulp for first & second year respectively. Similarly, these levels of nutritional composition of wood apple pulp was also reported and reviewed by Hemalatha and Parameshwari [11] & Mani and Mitra [12]. When compared with fresh wood apple pulp, pickle found to be more nutritious containing 3.20 g & 3.43 g crude protein, 1.43 g & 1.53 g crude fibre, 7.03 g & 7.37 g crude fats, 20.33 g & 19.00 g carbohydrates, 1.90 g & 1.97 g total minerals, 253 mg & 256 mg calcium and 107 mg & 103 mg phosphorous per 100 g of pickle for first & second year respectively (Table 1). The nutritional level of pickle is increased due to the addition of other ingredients *viz.,* chilli powder,

fenugreek seed powder, turmeric powder, mustard oil etc.

pH value 4.30, 4.20, 4.03 and 3.90 for first year and 4.33, 4.27, 4.13 and 4.07 for second year decreased at 0, 30, 60 and 90 days of storage respectively. Decrease in pH can be attributed to increase in acidity 0.83%, 0.87%, 1.00% and 1.07% in first year and 0.80%, 1.00%, 1.10% and 1.17% in second year at 0, 30, 60 and 90 days of storage respectively (Table 2). Remarkable increase in percent acidity was observed during 90 days of storage period, irrespective of recipe used. Maximum acidity was reported in pickle at 90 days of storage. The increased acidity is due the fermentation of sugars to acids with course of time, which also prevents the growth of harmful bacteria and moulds increasing the self-life of pickle. Similar results were obtained by Muhammad [13].

Ascorbic acid per 100 g of pickle decreased with increasing storage period from 3.10 mg, 2.93 mg, 2.80 mg and 2.60 mg in first year and 3.13 mg, 3.07 mg, 2.97 mg and 2.87 mg in second year respectively at 0, 30, 60 and 90 days of storage (Table 2). This loss of ascorbic acid content might be due to the leaching loss by the osmotic action of added salt & sugar and also its conversions into Dehydroascorbic acid by oxidation, as saline solution enhances rate of oxidation of ascorbic acid. Results are in accordance with Premi et al. [14]. Total sugar content in pickle gradually increased as 6.00%, 6.37%, 6.77% and 7.17% for first year and 7.00%, 7.23%, 7.50% and 7.77% for second year at 0, 30, 60 and 90 days of storage respectively (Table 2). The increase in sugar would be attributed to conversion of starch and other insoluble carbohydrate into sugars. Also observed by Pota et al. [15].

Slight chemical change in during storage like moisture content decreased with increasing storage period from 17.33%, 17.23%, 16.17% and 15.67% for first year and 17.67%, 16.60%, 16.27% and 15.00% for second year at 0, 30, 60 and 90 days of storage respectively (Table 2). The decrease in moisture content is due to the dehydration phenomenon. The organoleptic evaluation shows, gradual reduction in mean score for overall acceptability after 90 days of storage. Consistency remains same and the taste declined, flavor change was observed, reduction in appearance and taste of pickle in storage occurred after 90 days of storage. Hence, maximum storage at 90 days at room temperature may give better acceptability. Over the storage month sensory evaluation of pickle revealed fewer amounts of change in colour, flavor, texture, test, and overall acceptability (Table 3). Browning of pickle with time is the possible cause of slight colour and flavor change. Significant increased sourness of pickle with storage time might be one of the possible reasons for flavor changes and reduction in overall acceptability. Similar result found by Premi et al. [14]. Freshly made wood apple pickle showed high overall acceptability which reduced with time of storage.

Select ripe wood apple
↓
Break and collect inner pulp
↓
Check acidity
↓
Roast Fenugreek seeds and grind into powder
↓
Add chilli powder, Fenugreek seed powder, salt, turmeric
↓
Mix well and allow to ferment for three days
↓
Season well with spices,
(Add Red chillies, mustard seeds and Asafoetida).
↓
Packing (filled into clean, dry sterilized plastic container)
↓
Cooling
↓
Stored at ambient temperature

Flow chart for preparation of wood apple pickle

Table 1. Nutrients characters of wood apple fresh pulp and pickle

Nutrients	Fresh Pulp		Pickle	
	1St Year	2nd Year	1st Year	2nd Year
Crude Protein (g/100g)	6.53	6.90	3.20	3.43
Crude fibre (g/100g)	0.80	0.90	1.43	1.53
Crude fat (g/100g)	3.73	4.03	7.03	7.37
Carbohydrates (g/100g)	18.33	18.00	20.33	19.00
Total minerals (g/100g)	1.60	1.97	1.90	1.97
Calcium (mg/100g)	234	239	253	256
Phosphorous (mg/100g)	69	63	107	103

Table 2. Chemical characters change in pickle during storage

Chemical	Pickle							
	1St Year				2nd Year			
	0 DAS	30 DAS	60 DAS	90 DAS	0 DAS	30 DAS	60 DAS	90 DAS
Moisture (%)	17.33	17.23	16.17	15.67	17.67	16.60	16.27	15.00
pH	4.30	4.20	4.03	3.90	4.33	4.27	4.13	4.07
Titratable Acidity (%)	0.83	0.87	1.00	1.07	0.80	1.00	1.10	1.17
Ascorbic Acid (mg/100g)	3.10	2.93	2.80	2.60	3.13	3.07	2.97	2.87
Total Sugar (%)	6.00	6.37	6.77	7.17	7.00	7.23	7.50	7.77

DAS- Days after storage

Table 3. Sensory evaluation of wood apple pickle

Sensory	Pickle							
	1St Year				2nd Year			
	0 DAS	30 DAS	60 DAS	90 DAS	0 DAS	30 DAS	60 DAS	90 DAS
Colour	7.5	7.5	7.2	7.0	7.8	7.5	7.2	7.0
Flavour	7.0	7.0	6.8	6.6	7.5	7.2	7.1	7.0
Taste	8.0	7.8	7.3	7.2	7.6	7.4	7.2	7.0
Texture	8.0	7.6	7.2	7.2	7.8	7.6	7.3	6.9
Overall acceptability	7.6	7.3	7.0	7.0	7.5	7.2	7.0	7.0

DAS- Days after storage

4. CONCLUSION

A wood apple fruit has high nutritive property. Wood apple pickle is a nutrient rich and tasty product and their organoleptic evaluation revealed that wood apple pickle can be consumed up to 90 days of storage without major organoleptic and Nutra- chemical changes and is a good source of protein, fiber, calcium and phosphorous among other fruits. Overall acceptability of wood apple pickle was very good and its consumption is safe for human health.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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