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DEVELOPMENT AND STANDARDIZATION OF WOOD APPLE (*LIMONIA ACIDISSIMA*) INCORPORATED NOVEL FOOD PRODUCTS

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ABSTRACT: Aim: This study was planned to keep in view on the medicinal and nutritional importance of wood apple pulp, and to utilize them by value-added product as fresh pulp incorporated spread and its dry powder incorporated cookies. **Objectives of the study:** To develop food products by using wood apple pulp and its dry powder and to analysis the nutritional value antioxidant content and phytochemical properties in the developed food products. **Methods:** By using AOAC methods for nutrient composition the wood apple fruit incorporated food products were analyzed for the nutrients, namely moisture, protein, fat and ash, minerals like sodium, potassium, calcium, and iron. The carbohydrate content of the sample was computed by a different method. **Results and Discussion:** Based on the sensory evaluation both the products were highly acceptable (variation 3) for palatability. All major and minor nutrients were detected in the highly accepted (variation 3) food products. **Conclusion:** The wood apple pulp incorporated spread and wood apple dry powder incorporated cookies are low in cost but high in nutraceuticals. So, wood apple incorporated novel food products are good for health.

INTRODUCTION: The wood apple, swingle (*Limonia acidissima* L.) is the only species of its genus, in the family Rutaceae. Besides wood apple, it may be called as elephant apple, monkey fruit, kathbel, and other dialectal names in India¹. Other Indian names include Kotha, Vila, Vilanga, Kapith, Vela marum². The fruit is a hard-shelled, many-seeded berry with its pinkish-brown aromatic sour-sweet pulp being the edible portion, the seeds embedded in it.

It is an ideal tree to be exploited for growing in wasteland³. The fruit is used in India as a liver and cardiac tonic, when unripe, as an astringent (halting diarrhea and dysentery), effective treatment for hiccups, sore throat, and diseases of the gums¹⁵. Wood apple lowers the blood glucose level, blood pressure and reduces lipid levels in hyperlipidemia subjects⁴.

The fruit pulp has anti-inflammatory, antipyretic, and analgesic activity⁵. Nowadays, this fruit has a great potential for value addition especially the food industry and beverage industry, due to its excellent flavor and nutritive value. Many wood apple products are new to consumers, sincere efforts need to be made to introduce them in the market and to evaluate the consumer acceptance and economic viability of commercialization of

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such products ⁶. This not only will open new avenues as a means of augmenting the utilization of high yielding nutritious fruits to the best possible extent but will also give a fillip to the establishment of wood apple processing industry.

Since, the consumers have an ultimate say, in the selection of any food, study of acceptability and nutrients is of prime importance ⁷. Therefore, the present study was undertaken to exploit the excellent and delightful pulp characters having exceptional medicinal value of these fruits in novel food product industry, which would help to overcome market glut and thereby assure economic prices to the fruits with the following objectives.

Objectives of the Study:

1. To develop wood apple pulp and its powder.
2. To develop food products by using wood apple pulp and its dry powder.
3. To estimate the sensory evaluation of the developed food products.
4. To analysis the nutritional value, antioxidant activity and phytochemical properties in the developed food products (spread & cookies).

MATERIALS AND METHODS: Ripe wood apple (*Limonia acidissima*) with a hard shell, fairly large and globular shaped was purchased from the local market and stored at room temperature.

Preparation of Wood Apple Pulp: Fruits were first washed to remove the dirt. The hard shell was cracked open. The soft yellowish-brown pulp is scooped out. The pulp was mashed manually to get a homogenized mass.

Preparation of Wood Apple Pulp Powder: Two kg of wood apple were procured from the market, cleaned than hard shell was broken and pulp was removed from the shell. Pulp was dried in a hot air oven at a temperature of 600 °C for 8 h, made into powder, and used for the preparation of food products.

Development of Wood Apple Pulp Incorporated Spread: Three variations of wood apple pulp incorporated spread (20, 40, and 60 percent) were

developed and compared with control as indicated below.

TABLE 1: DEVELOPMENT OF WOOD APPLE PULP INCORPORATED SPREAD

Name of the recipe	Ingredients	Quantity of the ingredients			
		Control	V-I (20%)	V-II (40%)	V-III (60%)
Spread	Gram flour	50 g	50 g	50 g	50 g
	Wood apple pulp	-	20 g	40 g	60 g
	Chocolate powder	20 g	-	-	-
	Jaggery	100	100	100	100
	syrup	ml	ml	ml	ml
	Ghee	1 tbsp.	1 tbsp.	1 tbsp.	1tbsp

Add ghee to a pan and after it melts add gram flour to ghee and mix properly. Slow up the flame and keep stirring continuously for 5 to 10 min until it completely changed its color to golden brown or leave the oil. Then add wood apple pulp and keep mixing very well for 5 min. Then add sugar syrup (Jaggery dissolved with water) to it and keep stirring continuously for 5 to 10 min until it gets thicken. Let it cool and replacing in the bottle.

Development of Wood Apple Dry powder Incorporated Cookies: Three variations of wood apple dry powder incorporated cookies (10, 20, and 30 percent) were prepared and compared with control as indicated below.

TABLE 2: DEVELOPMENT OF WOOD APPLE DRY POWDER INCORPORATED COOKIES

Name of the recipe	Ingredients	Variations			
		Control	V-I (10%)	V-II (20%)	V-III (30%)
Cookies	Refined wheat flour	100 g	90 g	80 g	70 g
	Powdered sugar	50 g	50 g	50 g	50 g
	Wood apple powder	-	10 g	20 g	30 g
	Butter	60 g	60 g	60 g	60 g
	Milk	13 ml	13 ml	13 ml	13 ml
	Baking powder	¼ tsp	¼ tsp	¼ tsp	¼ tsp

Baking powder and refined wheat flour were sieved twice. Butter and powdered sugar were creamed, blended with sieved flour. Then wood apple dried powder was added gradually. The smooth dough was made by using milk. The dough was rolled and cut using a biscuit cutter, transfer into a tray. Preheat the oven and put the tray into the oven, baked at 170 °C for 15 min.

Sensory Evaluation of the Developed Food Products: The sensory evaluation of the developed value-added products (spread & cookies) was carried out to select the most acceptable variation.

Physiochemical and Nutrient Analysis of the Developed Food Products:

Physical Characteristics: The physical characteristic of traditional product diameter, thickness, weight was assessed. Cooking quality parameters *viz.*, cooked diameter, cooked weight, the cooked thickness was assessed, and the Nutrients were also analyzed in the developed products.

Estimation of Moisture: The moisture content of the sample was estimated by the hot air oven method. Moisture was determined by taking about 10 g of sample in Petri dish and dried in an oven at 105 °C till the weight of the Petri dish with its content was constant. Each time before weighing, the Petri dish was cooled in desiccators. The moisture content of the sample was expressed in g/100g of the sample.

Moisture content (g/100 g) = (Initial weight (g) - Final weight (g)) / (Weight of the sample (g)) × 100

Estimation of Protein: The protein content of the dried samples were estimated as percent total nitrogen by the Micro-Kjeldahl method (AOAC, 2005) in kjel plus (pelican equipment, India) ⁸.

Estimation of Fat: Fat was estimated as crude ether extract using moisture free samples. Fat estimated by Soxhlet extraction (AOAC) in socs plus (Pelican equipment, India) ⁸.

The solvent was removed by evaporation and the residue of fat was weighed.

Fat content (g /100 g) = Weight of ether extract (g) / Weight of sample taken (g) × 100

Estimation of Fiber: Fiber content of the sample was estimated by using moisture and fat-free samples. The fiber was estimated by boiling in acid (sulphuric acid 0.255 N) and subsequent alkali (0.31 N NaOH) using the Gerhardt fiber bag system. Then it was filtered and washed with distilled water and dried at 80 °C - 100 °C. Sample in the crucible with residue (We). Ashing was done in a muffle furnace. The ash content was cooled in

desiccators and weighed (Wa). The difference represents the crude fiber content of the sample and was expressed as gram per 100 g or percent.

Crude fiber (g/100 g sample) = [100 - (moisture*+fat)] × (We-Wa) / Weight of sample taken (moisture and fat free)

Estimation of Ash: Total ash was estimated by taking about 5 g of the sample into a crucible (which was previously been heated to about 600 °C and cooled). The crucible was placed on a clay pipe triangle and heated first over a low flame till all the material was completely charred followed by heating in a muffle furnace for about 4 to 5 h at about 600 °C. It was then cooled and weighed. This was repeated till two consecutive weights were the same and the ash was almost white or grayish-white.

Ash content (g/100 g sample) = Weight of the ash (g) / Weight of the sample (g) × 100

Calculation of Carbohydrate: Carbohydrate content was calculated by the differential method.

Carbohydrate (g/100 g) = 100 - [Protein (g) + Fat (g) + Fibre (g) + Ash (g) + Moisture (g)]

Estimation of Magnesium: Determination of magnesium was carried out in the di-acid digest of wood pulp tissues using Atomic Absorption Spectrophotometer by using orthophenanthroline method.

Estimation of Iron: The iron content of the sample was estimated by using an atomic absorption spectrophotometer and the results were expressed in mg per 100 g of the sample.

Estimation of Sodium / Potassium: Sodium/potassium in solution is atomized into oxyhydrogen or oxyacetylene flame. The flame excites atoms of sodium/potassium causing them to emit radiations at specific wavelengths, the amount of radiation emitted is measured on a spectrophotometer. Under standard conditions, it is proportional to the concentration of sodium/potassium in solution.

Estimation of Sodium: Sodium was estimated by using a flame photometer.

Estimation of Potassium: Potassium was estimated using a flame photometer.

Estimation of Antioxidant Activity: DPPH scavenging activity was determined by the method of Blois 2000 with slight modification. The absorbance was measured at 517 nm.

Methanol was used as a reference and all reagents (2 ml methanol + 1 ml DPPH) used as blank.

Polyphenol: Folin Ciocalteu's reagent method was used to determine total phenols. Absorbance was measured at 765 nm using a spectrophotometer.

Evaluation of Phytonutrients in Wood Apple Pulp Incorporated Food Products: The phytochemical content of developed wood apple incorporated spread and cookies were assessed. The phytonutrients and antioxidants assessed include tannins, saponins, flavonoids, steroids, terpenoids, alkaloids, polyphenols triterpenoids, and cardiac glycoside.

Tannins: Tannin content was determined by the Foliés-Denis colorimetric method described by Kirk. The absorbance was measured in a spectrophotometer at 260 nm using the reagent blank to calibrate the instrument at zero.

Gallic Acid and Catechins: Gallic acid and catechins were quantitatively estimated using a waters HPLC system with luna 5 μ phenyl hexyl phenomena column (4.5 mm \times 250 mm) and UV-vis detector set at 278 nm.

Cost Calculation of the Developed Products: The cost involved in the processing of the wood apple value-added products *viz.*, wood apple pulp incorporated spread, and wood apple dry powder incorporated cookies were calculated by taking into account the fixed and variable cost during processing.

The statistical analysis was done by the SPSS method.

RESULTS AND DISCUSSION:

Physical Characteristics of Wood Apple Dry Powder Incorporated Cookies: Physical characteristics of the wood apple dry powder incorporated cookies include height, weight, and bulk density of the product. The initial value of the product means measuring the physical characteristics of the product before the cookies were baked; final value means measuring the physical characteristics of the product after the cookies were baked. The initial value of the wood apple pulp powder incorporated cookies V1, V2 & V3 height was respectively 1.13 cm, 1.10 cm & 1.12 cm, the final value of the wood apple pulp powder incorporated cookies V1, V2 & V3 height was respectively 1.16 cm, 1.13 cm & 1.15 cm.

The initial value of the wood apple pulp powder incorporated cookies V1, V2 & V3 weight was respectively 10.02 g, 10.0 g & 10.01, the final value of the wood apple dry powder incorporated cookies V1, V2 & V3 weight was respectively 10.54 g, 10.52 g & 10.53 g. The initial value of the wood apple pulp powder incorporated cookies V1, V2 & V3 bulk density was respectively 0.57 g, 0.56 g & 0.57 g, the final value of the wood apple dry powder incorporated cookies V1, V2 & V3 bulk density was respectively 0.58 g, 0.57 g & 0.58 g. So, it was concluded that there is a difference between the initial value and final value; the final value is greater than the initial value. The weight and color of the spread values taken after the food product was done. The weight of the spread V1, V2 & V3 was respectively 100.50 g, 125 g & 151.10 g. The color of the spread V1, V2 & V3 was respectively light brown, brown and dark brown. So, it was concluded that there are the weight and color concentration of the spread V1, V2 & V3 was positively correlated with the increased wood apple pulp concentration respectively 20%, 40% and 60%.

TABLE 3: PHYSICAL CHARACTERISTICS OF WOOD APPLE DRY POWDER INCORPORATED COOKIES

Parameters	Variation-1		Variation-2		Variation-3	
	Initial value	Final value	Initial value	Final value	Initial value	Final value
Height (cm)	1.13	1.16	1.10	1.13	1.12	1.15
Weight (g)	10.02	10.54	10.0	10.52	10.01	10.53
Bulk density (g)	0.57	0.58	0.56	0.57	0.57	0.58

Sensory Evaluation of the Developed Food Products: The sensory evaluation of the developed

value-added products was carried out to select the most acceptable variation. The wood apple

incorporated products such as spread and cookies were subjected to assess the maximum acceptability of the products. The quality attributes in terms of color and appearance, texture, flavor, mouthfeel, taste, and overall acceptability were evaluated by a group of 20-panel members of semi-trained judges (n=20) using 9 points hedonic scale 'like extremely' to 'dislike extremely'.

TABLE 4: SENSORY EVALUATION OF WOOD APPLE PULP INCORPORATED SPREAD

S. no.	Criteria	Mean ± S.D	"F" value	P value
1	Colour	7.60 ± 1.05		
2	Texture	7.95 ± 0.69		
3	Flavor	7.75 ± 0.85	20.040	1.000
4	Mouthfeel	7.70 ± 0.80		
5	Taste	7.85 ± 0.87		
6	Overall acceptability	8.35 ± 0.75		

TABLE 5: SENSORY EVALUATION OF WOOD APPLE DRY POWDER INCORPORATED COOKIES

S. no.	Criteria	Mean ± S.D	"F" value	P value
1	Colour	8.15 ± 0.81		
2	Texture	8.10 ± 0.78		
3	Flavor	7.85 ± 0.93	13.904	1.000
4	Mouthfeel	7.90 ± 0.96		
5	Taste	8.25 ± 1.01		
6	Overall acceptability	8.45 ± 0.75		

The sensory criteria of wood apple pulp incorporated spread variation-3 (wood apple pulp 60 g) has the mean and SD value was obtained to the color - 7.60 ± 1.05, texture - 7.95 ± 0.69, flavour-7.75 ± 0.85, mouth feel - 7.70 ± 0.80, taste

- 7.85 ± 0.87 and overall acceptability - 8.35 ± 0.75. The mean of wood apple pulp incorporated spread variations is significantly different from the group.

Also, the p-value is 1.000 which is greater than 0.05 this it can be said that there was no significant difference in sensory characteristics of three variations in the wood apple pulp incorporated spread. The sensory criteria of wood apple dry powder incorporated cookies (wood apple pulp powder 30 g) variation-3 have the Mean and SD value obtained to the color - 8.15 ± 0.81, texture- 8.10 ± 0.78, flavor - 7.85 ± 0.93, mouth feel - 7.9 ± 0.96, taste - 8.25 ± 1.01 and overall acceptability - 8.45 ± 0.75.

The mean variation is significantly different from the group. Also, the p-value is 1.000, which is greater than 0.05 so accept the null hypothesis this it can be said that there was no significant difference in sensory characteristics of three variations in wood apple dry powder incorporated cookies.

Nutrient Contents of the Developed Food Products: Based on the sensory evaluation, analysis done by variation 3 (60%) wood apple pulp incorporated spread and wood apple dry powder incorporated Cookies (30%) were selected and assessed for moisture, protein, fat, dietary fiber, crude fiber, carbohydrate, iron, calcium, vitamin C were evaluated.

TABLE 6: NUTRIENT CONTENTS OF THE WOOD APPLE PULP INCORPORATED SPREAD (VARIATION 3) AND WOOD APPLE DRY POWDER INCORPORATED COOKIES (VARIATION 3)

S. no.	Parameters	Wood apple pulp incorporated spread (Variation 3 - 60%)	Wood apple dry powder incorporated Cookies (Variation 3 - 30%)
1	Moisture (g/100g)	47.16	5.18
2	Total Ash (g/100g)	1.57	1.44
3	Protein (g/100g)	3.20	5.54
4	Fat (g/100g)	4.94	17.45
5	Crude Fiber (g/100g)	0.10	1.61
6	Carbohydrates (g/100g)	43.13	68.15
7	Energy (kcal/100g)	229.82	451.81
8	Sodium (mg/100g)	81.60	201.32
9	Potassium (mg/100g)	97.17	378.45
10	Calcium (mg/100g)	75.47	96.79
11	Magnesium (mg/100g)	65.09	127.76
12	Phosphorus (mg/100g)	39.2	4.72
13	Vitamin C (mg/100ml)	0.90	1.46
14	Iron (mg/100ml)	4.72	0.01
15	Dietary Fiber (%)	1.56	4.42

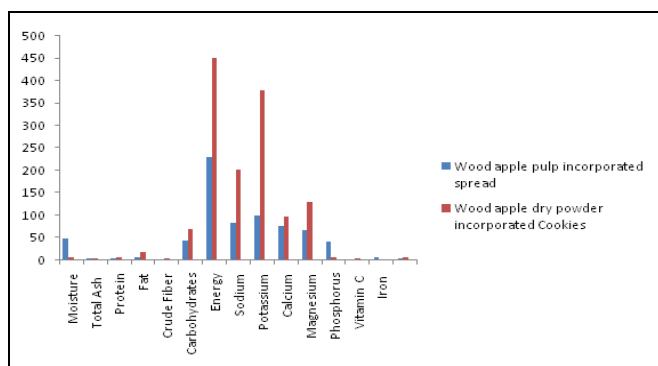


FIG. 1: NUTRIENT CONTENTS OF THE WOOD APPLE PULP INCORPORATED SPREAD (VARIATION 3) AND WOOD APPLE DRY POWDER INCORPORATED COOKIES (VARIATION 3)

The 60 g of the wood apple pulp incorporate spread (variation 3) contains 47.16 g of moisture, 1.57 g total ash, 3.20 g of protein, 4.94 g of fat, 0.1 g of crude fiber, 43.13 g of carbohydrates, 229.82 kcal of energy, 81.60 mg of sodium, 97.17 mg of potassium, 75.47 mg of calcium, 65.09 mg of magnesium, 39.2 mg of phosphorus, 4.72 mg of iron, 0.9 mg of vitamin C and 1.56% of dietary fiber. The 30 g of the wood apple dry powder cookies (variation 3) contains 5.18 g of moisture, 1.44 g total ash, 5.54 g of protein, 17.45 g of fat,

1.61 g of crude fiber, 68.15 g of carbohydrates, 451.81 kcal of energy, 201.32 mg of sodium, 378.45 mg of calcium, 127.76 mg of magnesium, 4.72 mg of phosphorus, 1.46 mg of vitamin C and 4.42% of dietary fiber.

Antioxidant and Phytochemical Content of the Developed Food Products: The antioxidant and phytochemicals of wood apple pulp incorporated spread (variation-3) and wood apple dry powder incorporated cookies (variation-3) were assessed. DPPH Scavenging activity, gallic acid, tannins, and phenols are present, and catechins, procyanidine, sterols, epicatechin, and proanthocyanidin are absent. Antioxidant and phytochemicals of wood apple pulp incorporated spread contain phytochemicals 25.6% of DPPH scavenging activity, 18 µg of gallic acid, 16 µg of tannins and 32 µg of phenols. The antioxidant and phytochemicals of wood apple dry powder incorporated cookies contain phytochemicals 35.8% of DPPH scavenging activity, 254 µg of gallic acid, 420 µg of tannins and 304 µg of phenols.

TABLE 7: ANTIOXIDANT AND PHYTOCHEMICAL CONTENT OF THE DEVELOPED FOOD PRODUCTS

S. no.	Test parameters	Wood apple pulp incorporated spread (Variation 3-60%)	Wood apple dry powder incorporated Cookies (variation 3-30%)
1	DPPH Scavenging activity (%)	25.6	35.8
2	Gallic acid (µg/g)	18	254
3	Tannins (µg/g)	16	420
4	Phenols (µg/g)	32	304

Cost Calculation of the Developed Food Products: The cost calculation of wood apple pulp incorporated spread - variation 3 (60%) indicated 21 rupees for a hundred grams pocket and wood apple pulp dry powder incorporated cookies-variation 3 (30%) indicated 42.92 rupees for hundred grams pocket. A hundred grams of cookies has 10 pieces.

SUMMARY AND CONCLUSION: Wood apple pulp incorporated spread at a 60% level (variation 3) and wood apple dry powder incorporated cookies at a 30% level (variation 3) were accepted by sensory evaluation. Wood apple pulp incorporated spread and wood apple dry powder incorporated cookies are on cost calculation; it is very low in cost but with high in nutraceuticals. So, wood apple incorporated novel food products are good for health.

Wood apple pulp incorporated spread and wood apple dry powder incorporated cookies can be suitable for supplementation to the school going children and early adulthood, considering the availability of almost all nutrients in the desired levels and also by the presence of antioxidants at appreciable levels and its low cost.

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