

RESEARCH PAPER

**Physico-chemical characteristics and nutrient composition of wood apple  
(*Feronia limonia* Swingle) fruit with and without seeds**

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**Abstract:** Wood apple (*Feronia limonia* Swingle), a nutrient dense but underutilized fruit, has potential for value addition and commercialization. The physico-chemical characteristics of wood apple revealed high shell weight (55.67%) compared to pulp weight (43.77%). The fruit pulp comprised of 31.55 per cent of pulp and 12.22 per cent of seeds and fibers. Fruit pulp with seed had acidic pH (4.23), acidity (1.68 per cent) and TSS (16.9°Brix). The contents had high protein (11.71 g), fat (9.41 g), ash (6.39 g), crude fiber (11.32 g), energy (350 Kcal), calcium (138.14 mg), phosphorus (260.7 mg), magnesium (39.6 mg) and zinc (0.77 mg) than pulp without seed. Moisture (77.02 g), carbohydrate (80.01 g), total sugars (7.05%), reducing sugars (4.33%), iron (2.33 mg) and total dietary fiber (7.33 g) were found high in wood apple pulp without seed. Nutraceutical constituents such as soluble (2.17 g), insoluble dietary fiber (5.1 g) and ascorbic acid (5.03 mg) of wood apple fruit pulp with and without seed did not differ significantly ( $p > 0.05$ ). Wood apple can thus be consumed with seed to reap maximum nutrient benefits.

**Key words:** Nutraceutical, Nutrient, Physical parameters, Wood apple

**Introduction**

Wood apple is native and common in dry plains of India and Sri Lanka. Today, wood apple grows in Thailand, Malaysia, Cambodia and other parts of Southeast Asia. In India, the fruit ripens from early October through March. States growing the wood apple fruit include Maharashtra, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Madhya Pradesh and the western Himalayas. In the cooler northern regions, the fruit grows well up to 450 meters. It is also called as elephant apple, monkey fruit, curd fruit, *kathbel* and by other dialectal names in India. Sometimes a few trees are also planted in the orchards (<http://theindianvegan.blogspot.co.uk>). Wood apple is not cultivated as commercial crop in India. But it is often sold by local vendors during *Ganesh chaturthi* festival time (August - September) in south India as it has religious importance. They are said to be the favourite of Lord Ganesha, and are often served during the festival. The tree yields 200-250 fruits per year (Pareek and Sharma, 2009).

The wood apple fruits are round to oval, 2 to 5 inches (5 - 12.5 cm) wide with a hard, woody, greyish-white, scurfy rind of about ¼ inches (6 mm) thick. Each fruit weighs about 150 to 500 g. The pulp represents 36 per cent of the whole fruit. There are two types of wood apple viz., larger one with more sweet and smaller one with less sweet. The fruit pulp is brown colour, mealy, odorous, resinous, astringent, acid or sweetish with numerous small white seeds scattered through it. The seeds contain non-bitter oil and are high in unsaturated fatty acids (Singh *et al.*, 2009). The numerous tiny hard seeds require no spitting or removal and are edible. As wood apple ripen, greenish white shell develops into a tough, brown speckled wooden shell that looks and feels similar to tree bark. Ripe fruits also emit a sugary yet musky aroma. The

unripe wood apple pulp is pale gold color. Ideal, fully ripe wood apples are light brown to toffee brown color. Wood apple pulp has a remarkably long shelf life of two months if refrigerated (<http://theindianvegan.blogspot.co.uk>). The quality of fruits is laid on its physico-chemical characteristics and nutrient composition which decides its consumer acceptability and marketing strategy. Hence, the present study was conducted to assess physico-chemical characteristics of wood apple fruit with and without seeds.

**Material and methods**

The study was conducted in the Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad during the year 2016-17.

**Procurement of wood apple fruits**

The physiologically matured fruits were procured from the local market, Dharwad between the November to January, 2016 and fruits were kept for ripening in the sunlight for 3-5 days until fully ripened. The ripened fruits were subjected for analysis.

**Physico-chemical characteristics of wood apple**

Fruit girth, length and breadth were measured on 10 randomly selected fruits using Vernier caliper. Physiologically matured ripen 10 wood apple fruits were selected randomly. The fruit was washed using water and fruit weight was noted. Whole fruit was broken using hammer. The fruit pulp along with seeds and fiber was scooped out from shell. Weight of shell and pulp were noted. Seeds and fiber were sieved and

separated. The weights of seeds, fiber and pulp were taken. The average value was calculated and edible portion was determined. Fruit volume (ml) was determined by seed (*Amaranthus*) displacement method and density was calculated. Pulp pH and TSS were determined using digital pocket pH meter (pHep®) and refractometer PAL-1 (ATAGO), respectively. Titrate acidity was determined by titrating it against 0.1 N NaOH in presence of phenolphthalein indicator (Ranganna, 1994).

### Nutrient composition of wood apple

Moisture was determined by drying in hot air oven, protein by Kjeldahl method, fat by solvent extraction method, ash by dry ashing method, calcium and magnesium by titrimetric method, iron, zinc and phosphorus by Atomic Absorption Spectrophotometry method (Anon., 2005). Dietary fiber was estimated by enzymatic method (Asp *et al.*, 1983). Carbohydrate was computed by difference method. Total sugars, reducing and non-reducing sugars were estimated by Nelson-Somogyi's method (Anon., 2005). Vitamin C was determined by titrimetric method (Anon., 2005).

### Results and discussion

The ripened wood apple constituted outer shell (55.67%) and pulp (43.77%). Of the 43.77 per cent fruit pulp, seed and fiber comprised of 12.22 per cent (Fig. 1). The average fruit length (60.17 mm), breadth (56.4 mm) and weight (104.33 g) of wood apple fruit in the present study (Table 1) were lower than those reported by Namdev (2010), Vijayakumar *et al.* (2013) and Harsh *et al.* (2014). The differences in physical characteristics may be due to the diverged fruit collection where the fruits procured from which lacked uniform size, shape and soil type and location. The fruits analyzed in present study were procured from local market which varied in size and shape. The percentage of seed and fiber noted in the present study is on par with those mentioned by Harsh *et al.* (2014). The quantity of pulp with seed (43.77%) noted in the present study is similar to the findings of Hiwale *et al.* (2008) and Harsh *et al.* (2014). An average per kg of wood apple yielded nine fruits which is concurrent with the results of Vijayakumar *et al.* (2013).

The TSS (15.6 to 16.9 °Brix) content of wood apple fruit in the present study (Table 2) was similar to the observation of Hiwale *et al.* (2008). The pH of fruit pulp without seed (3.77) resembled the pH of wood apple analyzed by Patel (2013) and Harsh *et al.* (2014). The lower pH (3.77) with higher titratable acidity (1.82%) of fruit pulp without seed in the present study may be due to the fact that ripened fruits are less acidic than unripened fruits (Harsh *et al.*, 2014). The acidity percentage of fruit pulp varied from 7.6 per cent in unripe to 2.3 per cent in fully ripe ones.

The high protein (11.71 g), fat (9.41 g), ash (6.39 g), crude fiber (11.32 g), calcium (138.14 mg), phosphorus (260.7 mg), magnesium (39.6 mg) were evident in fruit with seed

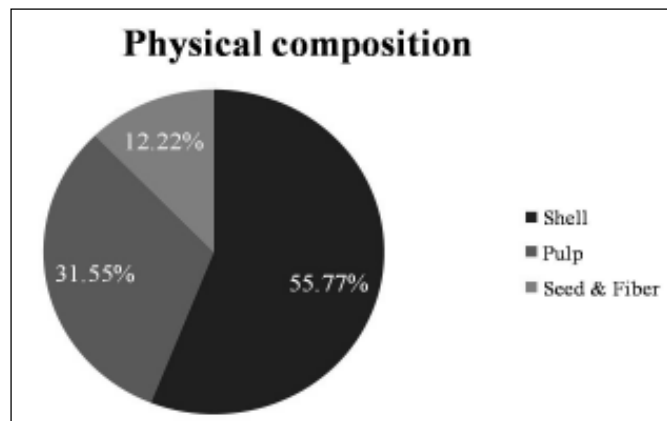


Fig. 1. Physical composition of wood apple fruit

Table 1. Physical parameters of wood apple

Parameters	Range	Mean $\pm$ SD
<b>Fruit</b>		
Girth (cm)	15.10 - 22.00	18.07 $\pm$ 2.22
Length (mm)	46.32 - 73.49	60.17 $\pm$ 10.21
Breadth (mm)	47.57 - 65.89	56.40 $\pm$ 6.74
Fruit wt. (g)	61.00 - 148.00	104.33 $\pm$ 36.84
Fruit volume (ml)	88.00 - 193.00	135.25 $\pm$ 40.85
Shell wt. (g)	35.00 - 81.00	58.08 $\pm$ 18.37
Density (g/ml)	0.65 - 0.85	0.76 $\pm$ 0.07
<b>Fruit pulp (g)</b>		
Fruit pulp wt. (with seed)	25.00 - 69.00	45.67 $\pm$ 19.07
Fruit pulp wt. (without seed)	16.00 - 51.00	32.92 $\pm$ 13.71
Seed and fiber wt. (g)	6.00 - 25.00	12.75 $\pm$ 6.05

Note: Mean  $\pm$  SD - Average of 10 fruits

Table 2. Physico-chemical characteristics of wood apple fruit

Parameters	pH	TSS (°Brix)	Titratable acidity (%)
Pulp with seed	4.23 $\pm$ 0.06	16.90 $\pm$ 0.10	1.68 $\pm$ 0.01
Pulp without seed	3.77 $\pm$ 0.12	15.60 $\pm$ 0.26	1.82 $\pm$ 0.00
F value	39.20	63.37	588.00
S.E.m. $\pm$	0.06	0.12	0.00
C. D. @ 5 %	0.23*	0.45*	0.01*

Note: Mean  $\pm$  SD; C. D. - Critical difference;

S.E.m  $\pm$  - Standard error of mean; \*- Significant at 5 % level

(Table 3 and 4) which might be due to the presence of seeds and fiber (Rao *et al.*, 2011). The high fat present in fruit with seed might be due to the presence of seeds that contain non-bitter oil high in unsaturated fatty acids (Singh *et al.*, 2009).

The total sugars, reducing sugars and non-reducing sugars of wood apple with (6.33, 3.67, 2.67%) and without seed (7.05, 4.33, 2.72%) estimated in present study are similar to those reported by Hiwale *et al.* (2008) and Namdev (2010). Nutraceutical constituents (Table 4) such as soluble, insoluble dietary fiber and ascorbic acid of wood apple fruit pulp with (2.17 g, 5.1 g, and 5.03 mg) and without seed (1.98 g, 5.35 g, and 5.42 mg) did not differ significantly ( $\leq 0.05$ ). Dietary fiber

Table 3. Nutrient composition of wood apple fruit

Nutrients per 100 g	Pulp with seed	Pulp without seed	F value	S.Em. $\pm$	C. D. @ 5 %
<u>Proximate composition (g)</u>					
Moisture	71.62 $\pm$ 0.65	77.02 $\pm$ 0.13	200.99	0.27	1.06*
Protein	11.71 $\pm$ 0.13	3.27 $\pm$ 0.01	1260.00	0.05	0.20*
Fat	9.41 $\pm$ 0.77	0.22 $\pm$ 0.02	427.48	0.31	1.24*
Ash	6.39 $\pm$ 0.03	6.27 $\pm$ 0.07	8.88	0.03	0.10*
Crude fiber	11.32 $\pm$ 0.48	4.53 $\pm$ 0.15	551.36	0.20	0.80*
CHO	54.56 $\pm$ 1.40	80.01 $\pm$ 0.34	940.93	0.59	2.30*
Energy (Kcal)	350 $\pm$ 2.35	335 $\pm$ 1.46	84.67	1.13	4.44*
<u>Sugars (%)</u>					
Total sugars	6.33 $\pm$ 0.14	7.05 $\pm$ 0.26	16.96	0.13	0.51*
Reducing sugars	3.67 $\pm$ 0.14	4.33 $\pm$ 0.29	12.80	0.13	0.51*
Non-reducing sugars	2.67 $\pm$ 0.29	2.72 $\pm$ 0.06	0.087	0.12	NS
<u>Minerals (mg)</u>					
Calcium	138.14 $\pm$ 8.00	66.49 $\pm$ 4.04	192.67	3.65	14.33*
Iron	0.30 $\pm$ 0.02	2.33 $\pm$ 0.02	2715.00	0.00	0.00*
Phosphorus	260.70 $\pm$ 0.02	187.20 $\pm$ 0.02	3602.00	0.00	0.00*

Note: Mean  $\pm$  SD; C. D. – Critical difference; S.Em.  $\pm$  - Standard error of mean; \*- Significant at 5 % level; NS-Non-Significant

Table 4. Nutraceutical content of wood apple fruit

Nutrients per 100 g	Pulp with seed	Pulp without seed	F value	S.Em. $\pm$	C. D. @ 5 %
<u>Dietary fiber (g)</u>					
Total Dietary fiber	7.33 $\pm$ 0.25	7.27 $\pm$ 0.12	0.15	0.11	0.45*
Soluble dietary fiber	1.98 $\pm$ 0.61	2.17 $\pm$ 0.23	0.25	0.27	NS
Insoluble dietary fiber	5.35 $\pm$ 0.41	5.10 $\pm$ 0.11	1.09	0.17	NS
<u>Minerals (mg)</u>					
Magnesium	39.60 $\pm$ 2.16	27.20 $\pm$ 1.51	66.28	1.08	4.23*
Zinc	0.77 $\pm$ 0.02	0.30 $\pm$ 0.01	1390.00	0.03	0.12*
<u>Vitamin (mg)</u>					
Ascorbic acid	5.04 $\pm$ 0.67	5.42 $\pm$ 0.67	16.96	0.39	NS

Note: Mean  $\pm$  SD; C. D. – Critical difference; S.Em.  $\pm$  - Standard error of mean; \*- Significant at 5 % level; NS-Non-Significant

controls cholesterol and blood glucose level, cures constipation and improves bowel motility. The ascorbic acid of wood apple in present research is similar to the finding of Anitha *et al.* (2016).

### Conclusion

The wood apple fruit shell weight (55.67%) was higher than its pulp weight (43.77%). Fruit pulp with seed had acidic pH (4.23), less acidity (1.68 %), high TSS (16.9°Brix), protein (11.71 g), fat (9.41 g), ash (6.39 g), crude fiber (11.32 g), energy (350 Kcal), calcium (138.14 mg), phosphorus (260.7 mg), magnesium (39.6 mg) and zinc (0.77 mg). Moisture (77.02 g), carbohydrate (80.01 g), total sugars (7.05%), reducing sugars

(4.33%), iron (2.33mg) and total dietary fiber (7.33 g) were found high in wood apple pulp without seed per 100 g. Soluble dietary fiber, insoluble dietary fiber and ascorbic acid of wood apple fruit pulp with and without seed did not differ significantly.

Wood apple is normally cultivated on a small scale in rural areas, which are marketed in local shanties. If these fruits are collected and processed into commercial products they serve as a source of nutritional basket for community. This can also provide employment opportunity to the unskilled energetic youth. The medicinal values of this fruit has additional attraction and there is tremendous scope for their further exploration.

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