



Physicochemical characteristics of pea nut butter fruit (*Bunchosia armeniaca*)

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Abstract

The scope of this study is to determine the physicochemical properties of the pulp of the *Bunchosia armeniaca*. The proximate composition of flesh were determined by using AOAC methods and pH, titratable acidity, total soluble solids and ascorbic acid were also analyzed. The colour and texture in six maturity stages were determined. Moisture and dry matter content were 74.17% and 25.82% respectively. Crude protein, crude fat, crude fiber, ash and carbohydrates content in were 0.32%, 3.35%, 45.29%, 0.87% and 50.16% respectively. Potassium was the most abundant mineral in flesh of peanut butter fruit, followed by Na, K, Mg, Ca, Zn, Fe and As. Vitamin C content of peanut butter fruit was 9.43 ± 0.13 mg/100ml. Skin colour of Peanut butter fruit from raw to ripen stage changes green to orange to red colour. Hardness of the flesh of peanut butter fruit increases from raw stage to ripen stage and then hardness decreases gradually up to fully ripen stage.

Keywords: *Bunchosia armeniaca*, peanut butter fruit, physicochemical, proximate composition

1. Introduction

Bunchosia armeniaca being a member of family "Malpighiaceae" is a native plant to America. Malpighiaceae, a family of flowering plants, comprises approximately 75 genera and 1300 species of the tropics and sub tropics [1]. Although the Malpighiaceae family has a large number of species, only 2 % of these were studied under the chemical aspect. *Bunchosia* is one of three arborescent genera of Malpighiaceae with fleshy, bird-dispersed fruits. *Bunchosia (Bunchosia armeniaca)* is grown from seed; this small tree is the ultimate in fast-food of hardwood fruiting species. It produces many small, thumb-sized fruits. Fruit of *Bunchosia armeniaca* is eaten fresh or processed form. When the red fruits soften, they taste like strawberry jam with the consistency of peanut butter. *Bunchosia armeniaca* tree is very popular with Central Africans [2]. In traditional medicine, this plant has been used for endocrine, infectious, inflammatory, nutritional and metabolic disorder treatments and also some kind of cancer treatment [3]. This study was conducted to identify the physicochemical properties of the flesh of peanut butter fruit and to develop a sauce from the pulp of fruit according to an industrial requirement. Initially a proximate analysis of the peanut butter fruit was conducted to determine the moisture content, dry matter content, ash, mineral, crude protein, crude fat, crude fat and carbohydrate content in dry basis. Additionally the ascorbic acid content, titratable acidity and total soluble solids were also quantified.

2. Materials and Method

2.1 Sample preparation

The fully ripen and unripen fruits of *Bunchosia armeniaca* were collected from the Sapugaskanda, Western province, Sri Lanka. The peanut butter fruit were first diced in to cubes of 0.2cm x 0.2cm x 0.2cm separately. Then they were dried separately by placing in the dehydration oven at 60 °C for

about 72 hours until the moisture content was about 10 %. Then the dried samples were ground in to a powder and passed through 50 µm sieve. This powder was sealed in LDPE bags and stored at room temperature and was used for the proximate analysis in dry basis.

2.2 Proximate analysis of flesh of peanut butter fruit

2.2.1 Determination of Moisture Content (Oven Drying Method)

The moisture content was determined according to the AOAC (Association of Analytical Communities) official method 925.10

2.2.2 Determination of Dry matter content

The dry matter content was calculated from the samples used to determine the moisture content.

2.2.3 Determination of Crude Protein Content (Micro Kjeldhal Method)

Crude Protein Content was determined according to the AOAC method 978.04

2.2.4 Determination of Total Fat content (Majonnier Ether Extraction Method)

Total fat was determined according to the AOAC official method 922.06.

2.2.5 Determination of crude fiber

The crude fiber content was determined according to AOAC 978.10

2.2.6 Determination of Total Ash (Gravimetric Method)

Total ash Content was determined according to the AOAC official method 923.03

2.2.7 Determination of Metals - Dry ashing

Dry ashing and the metals were quantified by Atomic Absorption Spectrometer (Thermo Scientific iCE 3000) Determination of Carbohydrate

2.2.8 Determination of Carbohydrate

% Carbohydrate content m/m = $100 - (\text{Total fat} + \text{Crude protein} + \text{Crude fibre} + \text{Total ash})$ (dry basis)

2.3 Other physicochemical parameters of flesh of peanut butter fruit

2.3.1 Sample extraction

Initially cleaned and fresh flesh of *Bunchosia armeniaca* fruits were blended and filtered through a muslin cloth to obtain the extracts for the analysis of Brix, Titratable acidity and Vitamin C.

2.3.2 Determination of Titratable Acidity

Titrate acidity was determined according to the AOAC method [4].

2.3.3 Determination of vitamin C

Vitamin C was measured by using AOAC 1965 with some modification

2.3.4 Determination of pH

Initially the pH meter was calibrated using standard buffer solutions. Then the probe was washed with distilled water. About 50 mL of the peanut butter fruit extract was taken to a beaker and the probe was dipped. The reading of the pH meter was recorded.

2.3.5 Determination of total soluble solids

Initially a drop of distilled water was placed on the lens of the brix meter OPTIKA HR-150 - Italy and the reading was taken by looking through the eye piece. Then the lens was cleaned using a tissue paper and one to two drops of peanut butter fruit extract was placed and the lens and the reading were taken.

2.3.6 Colour analysis at different maturity stages

Surface colour of the individual peanut butter fruit in each maturity stage was determined using a reflectance Chroma-Meter (Model CR-400, Konica Minolta Camera Co. Ltd, Osaka, Japan) based on the L* (lightness or brightness), a* (redness/greenness), b* (yellowness/blueness) values, Chroma (C) and hue angle (H^0) according to the procedure described by Cristina *et al.*, (2014) with some modifications. Hue was used as the attribute to determine the colour. The reflectance Chroma-Meter was standardized using a white plate; reflectance values of $Y = 93.93$, $x = 0.3131$, $y = 0.3189$ were used as standards. To increase the effectiveness of the results obtained for the skin colour of peanut butter fruits, 3 measurements were taken from each maturity stage at 3 different positions. The equation, $[H^0 = \tan^{-1} (b^*/a^*)]$ was used to calculate the Hue angle (H^0).

2.3.7 Determination of textural properties at different maturity stages

Apparatus

Texture Analyzer (Brookfield CT3 50 K)

Method

Compression test was carried out for peanut butter fruit at different stages using probe (T44). Test parameters were set as below.

Test type: Compression test

Pre-test speed: 2.0 mm/s

Test speed: 1.0 mm/s

Return speed: 1 mm/s

Target type: Distance

Target value: 0.5 mm

Trigger force: 5.0 g

3. Results and Discussion

3.1 Determination of proximate analysis of the flesh of peanut butter fruit

The proximate analysis is a set of methods to get information about the nutritional value of food. The moisture content, dry matter, ash, fat, protein, crude fiber and carbohydrate content of the peanut butter fruit obtained in proximate analysis are given as a percentage of dry basis in the table 1.

Table 1: Proximate analysis of the flesh of the peanut butter fruit

Parameter	Peanut butter fruit
Moisture %	74.17±0.72
Dry matter %	25.82±0.72
Proximate analysis (g/100 g of dry flesh)	
Crude protein	0.32±0.02
Total fat	3.35±0.12
Crude fiber	45.29±0.93
Ash	0.87±0.05
Carbohydrates	50.16±0.97

Proximate Analysis is a partitioning of compounds in a food into six categories based on the chemical properties of the compounds. The six categories are moisture, ash, crude protein (or Kjeldahl protein), crude lipid, crude fibre and nitrogen-free extracts (digestible carbohydrates). Moisture and dry matter content of flesh of peanut butter fruit was given in table as a percentage. Crude protein, crude fat, crude fiber, ash and carbohydrates content were given as grams in 100g of flesh.

The moisture content of food products has a bearing of their dry matter content. In the analysis, the moisture content of the flesh of peanut butter fruits (Table 1) was 74.17 ± 0.72 %. A previous research states that *Malpighiaglabra Linn* of Malpighiaceae family contains a moisture content of 97.17 % [5]. The moisture content of peanut butter fruit is significantly lower than the moisture content of *Malpighiaglabra Linn*. In this study, the dry matter content of the flesh of peanut butter fruit (Table 1) was 25.82 ± 0.28 %. According to previous research, *Malpighiaglabra Linn* of Malpighiaceae family contains a dry matter content of 2.83 % [5]. The dry matter content of peanut butter fruit is significantly higher than the dry matter content of *Malpighiaglabra Linn*. The amount of dry matter in food is inversely related to the amount of moisture it contains. The dominant constituent of fruit is water, with carbohydrate, minerals, lipids, proteins, organic acids, phenolic compounds, vitamins making up the remainder [6]. Once water is excluded these constituents can collectively be referred to as 'dry matter'. The crude protein content of the peanut butter fruit (Table 1) was 0.32 ± 0.02

g/100 g of flesh. According to previous researches, Crude protein values of avocado, pineapple, papaya, passion fruits, water melon varied from 4.4 ± 1.0 to $23.3 \pm 0.5\%$ Dry basis [7]. A research done by [5] states that *Malpighiaglabra Linn* contains a crude protein content of 8.75%. Generally the fat content of fruits and vegetable are low. The crude fiber content of the peanut butter fruit (Table.1) was $3.35 \pm 0.12\%$. Previous research states that different parts of fruits presented total lipids values in the range of 1.1 ± 0.2 to $28.7 \pm 7.9\%$ Dry basis [7]. Crude fibre, as defined by the association of Official Analytical Chemists is the residue of a feeding material after treatment with boiling sulphuric acid, sodium hydroxide, water, alcohol, and ether. It is a measure of the cellulose and lignin content mainly. The crude fiber content of the peanut butter fruit was $(45.29 \pm 0.93 \text{ g/100 g of flesh})$. A previous research carried out by [7] and his team states that crude fiber content of avocado, pineapple, papaya, passion fruits water melon range from $1.9 \pm 0.3\%$ to $56.7 \pm 0.5\%$. DR Singh states that *Malpighiaglabra Linn* of Malpighiaceae family

contains a crude fiber content of 15.45%. According to these researches, crude fiber content of flesh of peanut butter fruit is comparatively high. The ash content of the peanut butter fruit was $0.87 \pm 0.05 \text{ g/100 g of flesh}$. According to previous research, *Malpighiaglabra Linn* of Malpighiaceae family contains ash content of 4.45%. The carbohydrate content of the flesh was $50.16 \pm 0.97 \text{ g/100 g}$. In this analysis the carbohydrate content was determined by calculation. Therefore the calculated results also include amount simple sugars such as monosaccharides and disaccharides [8] and also the carbohydrates were not further analysed.

3.2 Mineral content of flesh and seed of peanut butter fruit

Minerals play a key role in various physiological functions of the body, especially in the building and regulation processes. Fruits are considered as a good source of dietary minerals. The results of calcium, magnesium, potassium, sodium, iron, and zinc pertaining to the peanut butter fruit are given in table 2.

Table 2: Metal content in flesh and seed of peanut butter fruit

	Na	K	Ca	Mg	Fe	Zn
Unit	mg/100g	mg/100g	mg/100g	mg/100g	mg/100g	µg/100g
Flesh	78.83 ± 1.44	80.76 ± 2.56	29.10 ± 6.70	50.50 ± 1.99	7.26 ± 0.51	418.30 ± 7.6
Seed	62.46 ± 4.29	108.79 ± 2.36	10.40 ± 0.95	101.02 ± 3.56	7.30 ± 0.46	645.3 ± 70.5

Arsenic (As) was not recorded in this experiment. The studies of [9] had reported that several factors like variety, state of ripeness, soil type, soil condition, and irrigation regime may cause variation in the mineral and trace elemental contents in different types of fruits as well as within different parts of the same fruit. Minerals are essential for the maintenance of human health. The average daily reference values of recommended dietary allowances (RDA) for adults established by USA National Institute of Health (NIH) 26 for men and women, from 19 to 70 years, are: 1,000-1,200, 310-420, 4,700, 1,200-1,500, 0.9, 8-14, 1.8-2.3 and 8-11 mg per day of Ca, Mg, K, Na, Cu, Fe, Mn and Zn, respectively. According to this experiment, it is confirmed that peanut butter fruit gives considerable amount of human mineral requirement and toxic Arsenic does not contain within peanut butter fruit.

3.3 Other physicochemical parameters of flesh of peanut butter fruit

3.3.1 Titratable acidity, Total soluble solid and vitamin c content of flesh of peanut butter fruit were recorded in table 3

Table 3: Other physicochemical parameters of flesh of peanut butter fruit

Parameter	Flesh
Titrateable Acidity (% anhydrous citric acid)	0.32 ± 0.06
Total Soluble Solids (⁰ Brix)	21.33 ± 0.57
Vitamin C content mg/100ml	9.43 ± 0.13

Titrateable acidity of peanut butter fruit pulp was measured as % anhydrous citric acid. Total soluble solid was given as brix value. Brix is a unit used to describe the percentage of soluble

solids in pulp. The soluble solids are mainly sugars but there are also smaller or larger amounts of acids and other materials. Ascorbic acid content of peanut butter fruit was given as milligram in 100ml of pulp. Titratable acidity of peanut butter fruit is $0.32 \pm 0.06\%$. Previous research done by D R Singh states that titrateable acidity of *Malpighiaglabra Linn* of Malpighiaceae family is 1.18%. Titratable acidity of peanut butter fruit is comparatively low. Ascorbic acid is also known as Vitamin C or L-ascorbic acid or antiscorbutic vitamin. More than 90% of the vitamin C in Human diets is supplied by fruits and vegetables. Vitamin C is an essential nutrient that plays a vital role in protecting the body from infection and disease. It is necessary in the synthesis of collagen in connective tissues, neurotransmitters, steroid hormones, carnitine, and conversion of cholesterol to bile acid and enhances iron bio-availability [9]. Vitamin C content of peanut butter fruit was $9.43 \pm 0.13 \text{ mg/100ml}$. Previous research shows that vitamin C content of Orange, Grapefruit, and Lemon is 12.78 mg/100ml , 10.9 mg/100ml , 12.68 mg/100ml respectively. Vitamin C content of non citrus fruits like Mango, Papaya is 7.84 mg/100ml , 9.31 mg/100ml respectively [10]. There may be considerable differences in the values of vitamin C obtained in the present study with those reported by several other studies for some fruit juice samples. All such differences in the contents of vitamin C in the present study and previous studies might be as a result of variations in maturity stage and regional varieties of fruits. Different techniques of measuring and squeezing process may also affect the vitamin C content of fruit juices. The amount of vitamin C could even vary between the different fruit samples of the same species. Total soluble solids of peanut butter fruit is 21.33 ± 0.57 . Previous research done by D R Singh states that total soluble solid of *Malpighiaglabra Linn* of

Malpigiaceae family is 5.44%. Total soluble solid of peanut butter fruit is comparatively high.

3.4 Determination of textural properties at different maturity stage of peanut butter fruit

Textural properties of peanut butter fruit during ripening stages was monitored, results are shown in figure 1

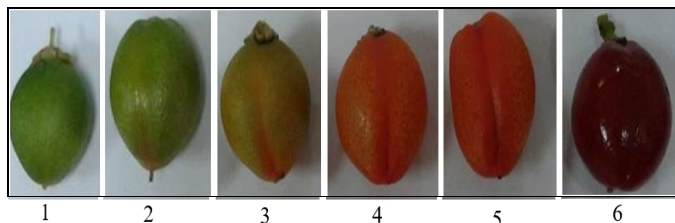


Fig 1: Peanut butter fruit at six maturity stages

Ripening is accompanied by changes in flavour, texture, colour, and aroma. Ripening is associated with change in composition. Climacteric fruits undergo a number of changes during fruit ripening. Peanut butter fruit is a climacteric fruit. The major changes include fruit softening, sweetening, decreased bitterness, and colour change. Colour change is the result of pigments, which were always present in the fruit, becoming visible when chlorophyll is degraded additional pigments is also produced by the fruit as it ripens. Skin colour of peanut butter fruit changes green to orange to red colour. Climacteric fruit show a burst of ethylene biosynthesis and an increase in respiration during ripening.

The cell walls are mainly composed of polysaccharides including pectin. During ripening, a lot of the pectin is converted from a water-insoluble form to a soluble one by certain degrading enzymes. These enzymes include polygalacturonase. This means that the fruit become less firm as the structure of the fruit is degraded. Acids are broken down in ripening fruits and this contributes to the sweeter rather than sharp tastes associated with unripe fruits.

Hardness, hardness work and hardness at deformation of skin of peanut butter fruit at six maturity stages was measured and evaluated. Results are given in figure 2 and figure 3.



Fig 2: Hardness of peanut butter fruits at different maturity stages

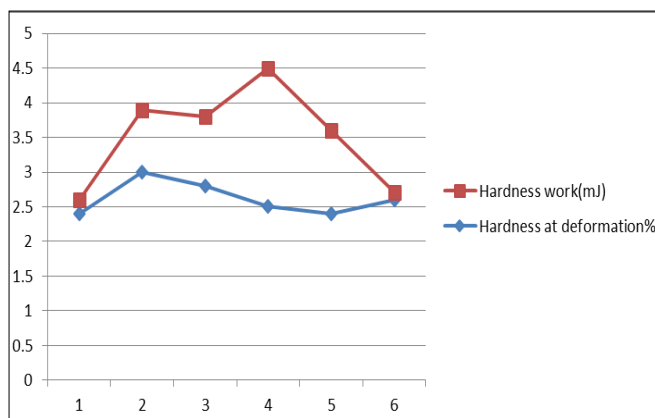
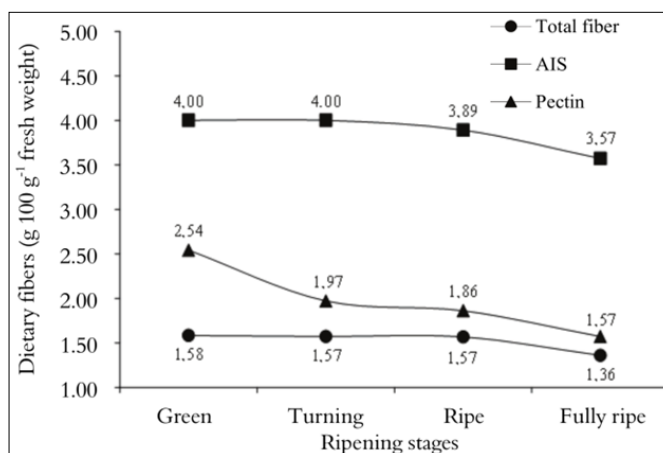


Fig 3: Hardness work and hardness at deformation of peanut butter fruit at different maturity stages

According to figure 3, maturity stage 6 (fully ripen stage) had a lowest hardness value and maturity stage 4 had a highest hardness value. According to figure maturity stage 4 had highest hardness work and maturity stage 2 had a highest hardness at deformation.

Hardness of peanut butter fruits had increased upto maturity stage 4. Peanut butter fruit contain comparatively high amount of fiber. From raw stage to maturity stage 4, fiber in flesh had become prominent gradually. As result of that, hardness of peanut butter fruit had increased upto maturity stage 4. From maturity stage 4 to maturity stage 6 (ripening stage), hardness of peanut butter fruit had decreased gradually. Pectin is converted from a water-insoluble form to a soluble one by certain degrading enzymes during ripening. Breakdown of the cell wall polysaccharides by pectinase activities during fruit ripening causes softening and less firm of the peanut butter fruit.



Sources: [11]

Fig 4: The dietary fiber contents of cubiu fruits at four ripening stages.

Changes in the structure of the cell wall are associated with dissolution of the middle lamella and disruption of the primary cell wall [12]. Structural changes in pectin, hemicellulose and cellulose together are assumed to be responsible for the

alteration of cell wall structure during ripening-related loss of firmness [13].

3.5 Determination of skin colour at six maturity stages

Many fruits change colour during ripening. Colour change in fruit typically involves chlorophyll loss and an increase in production of yellow, orange, red or purple pigments. The gold, orange and red colours of many fruit such as tomato and citrus are formed by enzymes in the carotenoid biosynthetic

pathway [14]. Carotenoids are divided into two classes: the hydrocarbon carotenes, e.g. lycopene (red) and β -carotene (orange); or the oxygen-containing xanthophylls, e.g. lutein (yellow). The instruments that widely used to measure skin colour of the fruits are Chroma meter. Peanut butter fruit ripening best represents through skin colour changes. The colour value obtained from the six maturity stages for L^* , a^* , b^* , c^* , and h_0 values were recorded as in Table 3.4.

Table 4: Colour parameters of peanut butter fruit at six maturity stages

Maturity stage	L^*	a^*	b^*	c^*	h_0
1 Raw	45.23±2.06	-6.03±1.70	26.36±1.48	27.10±1.12	102.93±4.07
2	45.87±5.65	-1.73±2.32	33.70±3.94	33.77±3.91	93.13±4.03
3	45.67±3.45	26.27±5.66	34.33±2.78	44.47±7.66	51.50±6.04
4	49.26±1.32	35.00±3.78	36.47±8.48	50.63±8.38	45.77±4.47
5	48.57±5.55	32.87±5.17	30.43±5.42	46.10±7.07	41.23±2.10
6 Fully ripen	26.6±1.45	31.47±2.97	9.43±6.69	33.17±4.81	15.80±9.3

L^* , a^* , b^* are measurements of brightness, redness and yellowness, respectively. Hue angle values in accordance with main colours are recorded as Red purple ($h = 0^\circ$), Red ($h = 20.14^\circ$), Yellow ($h = 90.00^\circ$), Green ($h = 164.25^\circ$) and Blue ($h = 237.53^\circ$) in (Macguire, 1992; Fairchild, 2013). The highest and lowest L^* values were recorded as means of 49.26 (Maturity stage 3) and 26.6 (Fully ripen stage), respectively and the highest and lowest H^0 values were recorded as means of 102.93 (Raw stage) and 15.8 (Fully ripen stage), respectively (Table 4).

[15] claimed that the overall colour change has a close relationship with chlorophyll degradation which was indicated by the green colour of the skin. On the other hand, [15] discussed the correlation of a^* value with the carotenoid development in the fruits that responsible for the reddish colour of the skin. According to table, stage 6 (fully ripen stage) of peanut butter fruit had highest a^* value. The decreasing of h_0 colour value shows that the skin colour moves in negative direction in the colour wheel; from green colour to yellow and finally to orange colour during ripening. According to table value, he had decreased gradually.

4. Conclusion

According to the proximate analysis it is seen that *Bunchosia armeniaca* consist of significant amounts of carbohydrates and fiber from its dry weight. Sodium and Potassium are the minerals present in the highest amount in the flesh of *Bunchosia armeniaca*. The flesh of *Bunchosia armeniaca* contains a significant amount of Vitamin C. From unripen stage to fully ripen stage it undergoes a series of changes. The raw form is green in colour and the fully ripen fruit is red orange in colour.

5. References

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