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Studies on the Nutritional Properties Variability in Pawpaw (*Carica papaya, L.*) Fruit

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ABSTRACT:

The current research aimed to determine the chemical composition, anti-nutritional factors, minerals content, and quality of pawpaw fruit pulp phytochemical contents, total phenols, total flavonoids, and antioxidant activity. As a percentage of dry weight, the results indicated that the pawpaw fruit pulp's protein, fat, ash, fiber, carbs, and energy value had been 7.35%, 4.28%, 4.00%, 15.53%, 68.84 and 343.28 kcal/100g, respectively. Copper, lead, and cadmium had the lowest recorded values in the pawpaw fruit pulp, whereas calcium, potassium, and sodium had the highest mineral concentrations. Pawpaw fruit pulp has the following percentages of total phenols, flavonoids, and antioxidant activity (DPPH): 79.51 mg/100g GAE, 138.30 mg/100g as quercetin, and 76.48%, respectively. Three of the pawpaw fruit pulp's most abundant phenolic components are ferulic, p-coumaric, and caffeic. Meanwhile, vanillic acid, protocatechuic acid, and chlorogenic acid have the lowest concentrations of these compounds. The pawpaw fruit pulp's high nutritional value and antioxidant content can protect against heart disease, reduce inflammation, aid digestion, and boost the immune system.

Keywords: *Pawpaw, nutritional value, antioxidant activity, minerals*

1. INTRODUCTION

Carica papaya, L. belongs to the Caricaceae family and is also known as papaya, pawpaw, and tree melon in certain regions of the world [1]. Nutritionally, the major components of pawpaw fruit pulp dry matter are carbohydrates. The total dietary fiber content of ripe fruit varies from 11.9 to 21.5 g/ 100 g/ dry matter, crude protein ranges from 3.74 to 8.26 g/100 dry matter [2]. Pawpaw fruit pulp is beneficial to man and animals and contains the essential nutrients like minerals and vitamin required in the body. Significant variation has been shown to exist in the pawpaw morphotypes for nutritional trait [3]. Fresh pawpaw fruit, with its low energy content material of 34.26 Kcal/100g, can also reduce the desire to eat high-calorie items that lead to weight gain when eaten in sufficient quantities before lunch

and/or dinner. Pawpaws' high fiber content smoothest the stool and preserves colon water, which balances nutrients in the small intestine and inhibits the absorption of excess fats [4]. It is a healthy component that is used to prevent specific dietary-related disorders. Relatively high levels of beneficial vitamins C and E, flavonoids, polyphenols, and **β**-carotene are found. It contains a real amount of beta-carotene, which throughout the weight loss regimen the body transforms into vitamin A [5]. It is a highly nutritious tropical fruit that includes several different biologically active phytochemicals, including flavonoids, glycosides, phytosterols, and enzymes like papain and chymopapain, as well as dietary fiber, minerals, complex carbohydrates, proteins, and vitamins [6]. Additionally, ripe, and unripe pawpaw fruit exhibit a variety of beneficial therapeutic effects, including liver protection, anthelmintic, anti-amoebic, antibacterial, anti-malarial, and anti-fertility properties [7 and 8]. It is used in a wide variety of inventive ways both raw and cooked throughout the world. When still green, it can be consumed as a vegetable. It can also be processed for use in medications, drinks, sweets, jams, and jellies [9].

The ripest fruit had changed physicochemical characteristics, including higher levels of antioxidant activity and total phenolic and flavonoid components, as well as differences in moisture content, titratable acidity, and total soluble solids [10].

The purpose of this research was to identify the nutritional value of pawpaw fruits

2. Materials and Methods

2.1. Materials

2.1.1 Pawpaw fruit:

The Horticultural Research Institute, Agric. Res. Center, Giza provided the fresh pawpaw fruit (Carica papaya), which was once then transported, refrigerated, and stored at 5 oC till processing and analysis.

2.1.2 Chemicals

All different chemical substances and reagents, which include standard components and folin-Ciocalteu reagent, have been received from Al-Ghomhoria Co. for the cause of Trading Drugs, Chemicals, and Medical Instruments in Egypt. These have been of analytical reagent quality.

2.2 Methods:

2.2.1 Preparation of pawpaw fruit pulp

Fresh fruit was dried by air dryer for about six hours at 45 °C, then ground into a powder by using grinding tools that used to be on hand locally. It used to be then saved in plastic sachets at room temperature (25 °C) [11].

2.2.2 Analytical methods

The AOAC [12] approved techniques to be used to measure moisture, protein, fats, fiber, and ash.

2.2.3 Carbohydrates and energy value

Carbs calculated by differences as follows:

% Carbohydrates = 100 - (% moisture + % protein + % fat + % ash + % fiber).

According to FAO [13], the estimation of energy value was calculated by multiplying protein and carbs by 4.0 and fats by 9.0.

2.2.4 Determination the minerals content of fruit pulp

Inductively coupled plasma atomic emission spectrometer (ICP-AES, Thermo- model ICAP 6000 series) used to be used to measure the levels of minerals (Na, Ca, and K) in the diluted solution of ash samples. Using the method outlined through [14], the other tested minerals (Cu, Zn, Mn, Fe, P, and Mg) had been recognized the use of an atomic absorption spectrophotometer (Perkin-Elmer Instrument Model 2380, Germany). While lead and cadmium were determined using solar thermos-elemental atomic absorption spectrophotometer (Flame AAS), Burner, Hollow cathode lamps, Graphical display and recorder, Pipette (micro liter with disposal tips), Pressure reducing valves, Glassware, Volumetric flask of suitable precision and accuracy according to [15].

2.2.5 Measuring of phytochemicals of pawpaw fruit pulp

Total phenol compounds were determined using the photometric method at detection wavelength of 765 nm (UV-1800, Shimadzu Instruments Mfg. Co., Ltd, Kyoto, Japan) with the Folin-Ciocalteu reagent, in accordance with method of [16]. Zhuang et al., [17] provided a method for extracting and determining flavonoids. The following procedure was used to quantify antioxidant activity in accordance with method of [18].

2.2.6 Identification of phenolic compounds

Phenolic compounds were extracted, separated, and quantified using the procedure outlined by [19]. An auto sampler, a column thermostat, and a binary pump made up the Perkin Elmer PE200 HPLC system. The experimental parameters are as follows: 20 µL injection volume, 0.7 ml/min flow rate, ESI negative ionization, 50 ms dwell duration, and multiple reaction monitoring (MRM) transitions. To create functional standard solutions, stock solutions of the standards were diluted in the mobile phase. Using calibration curves as a guide, concentrations of the chemicals were determined from chromatogram peak regions. Prior to use, all solvents were filtered and degassed and were of HPLC grade.

2.2.7 Determination of physicochemical properties

2.2.7.1 Measurement of pH value

The pH value was measured using a pH meter of a glass electrode. After giving the pH meter (model BA 350 EDT instruments, UK), a minute to stabilize, the samples' pH used to be immediately stated the use of the authorized evaluation procedure [20].

2.2.7.2 Estimation of titratable acidity

Titratable acidity (TA) was determined by method of [21], samples were titrated against 0.1 N NaOH until pH 8.2 was achieved. The analysis was done in quadruplicate and reported as grams of citric acid/100 g of fresh weight (gram citric acid/100 g FW).

2.2.7.3 Determination of total soluble solids (TSS)

A sample (10 g) was blended with 60 ml of distilled water (pH 7) and filtered. The supernatant was analyzed directly with a digital refractometer (Palette Digital PR-10, Atago, Japan) to obtain the total soluble solids (°Brix) [22].

2.2.7.4 Determination of vitamin C

Vitamin C was determined using 2,6- di-chloro-indophenol titrimetric methods, respectively according to [20].

2.2.7.5 Estimation of viscosity

The viscosity of each sample (50 ml) was measured according to the method of [23] using Brookfield viscometer, spindle no. 4, speed 30 rpm at room temperature. The viscosity was expressed in centipoises (cps).

2.2.7.6 Determination of total carotenoids

Total carotenoids of pawpaw fruit pulp were determined according to the method described by [24].

2.2.7.7 Determination of total and reducing sugars

Total and reducing sugars were determined according to Lane and Enon titrimetric methods AOAC [20].

2.2.7.8 Estimation of hunter color parameters

The Hunter color parameters (L*, a* and b* values) of the dragon fruit was also carried out by a spectrophotometer colorimeter (CM-2500D, Minolta) where the L* value corresponds to lightness and varies from 0 for black to 100 for perfect white, the a* value measures [25].

2.2.8 Statistical analysis

All chemical analyses were performed in triplicate. Results were expressed as the mean ± SD according to the statistical package program (SPSS version 17.0) [26].

3. Results and Discussion

The chemical constitution of pawpaw fruit is displayed as each wet weight and dry weight in table (1). The pawpaw fruit's percentages of moisture, protein, fat, ash, fiber, carbs, and energy value on wet weight base are readily apparent: 89.25%, 0.79%, 0.46%, 0.43%, 1.67%, 7.40, and 36.90 kcal/100g, respectively. Conversely, as a percentage of dry weight, the pawpaw fruit's protein, fat, ash, fiber, carbs, and energy value content had been 7.35%, 4.28%, 4.00%, 15.53%, 68.84, and 343.28 kcal/100g, respectively. These findings matched with [27], which cited that ripening pawpaws have a total dietary fiber content material that ranges from 11.9 to 21.5 g/100 g dry matter. The ripening pawpaw has a significant amount of carbohydrates (70.7 g/100 g), for the whole fruit, each mature and immature pawpaw provides

significant amounts of vital elements for a healthy diet.

Moreover, the pawpaw fruit pulp's had high moisture content material and low protein content material are constant with an investigation of [28] that discovered that the fruit pulp's moisture level ranged from 85 to 92%.

In general, fruit pulp is a great provider of vital nutrients that are appropriate for ingestion via humans. It ought to be extra advantageous in managing illness due to the fact it has various beneficial constituents [29].

Table (1): Chemical constitution of wet and dried pawpaw fruit pulp

Constitutes %	W/W	D/W
Moisture	89.25± 2.05	------
Protein	0.79± 0.50	7.35± 0.41
Fat	0.46± 0.30	4.28± 0.25
Ash	0.43± 0.40	4.00± 0.23
Fiber	1.67± 0.70	15.53± 0. 60
Carbohydrates	7.40± 1.10	68.84± 1.70
Energy value (Kcal/100g)	36.90± 0.70	343.28±2.40

WW= Wet weight DW= Dry weight. Values are means ± standard deviations of three replicate measurements.

Table (2) displays the minerals content of pawpaw fruit pulp. The biggest amount of recorded mineral content includes calcium, potassium, and sodium. The average readings were, in order, 4597.0, 2875.0, and 1770.0 ppm. Conversely, the smallest located values of mineral content have been for copper, lead, and cadmium. The corresponding mean values have been 0.001, 0.006, and 0.050 parts per million. These findings corroborate those of [30], who reported that each mineral in the flesh of the pawpaw fruit had a highly significant result, except for the content of magnesium, which had previously been insignificant among all kinds. The calcium and potassium concentrations of the fruit pulp had the highest mineral concentration. Furthermore, there are significant variations in the dry matter concentrations and levels of potassium, magnesium, calcium, sodium, zinc, copper, and iron in the pulp of pawpaw fruits [31]. The highest amounts of minerals found in fruit flesh were in the recommended ranges for calcium, phosphorus, and magnesium, which are 385.50, 383.10, and 305.45 mg/100g, respectively. On the other hand, the average amounts of copper, sodium, and potassium in the fruits were the lowest (1.30, 3.60, and 6.65 mg/100 g, respectively) [32].

Table (2): Mineral content of pawpaw fruit pulp

Elements	Concentration (ppm)
Calcium	4597.0±4.68
Magnesium	68.40±1.42
Phosphorus	18.27±1.14
Potassium	2875.0±4.74
Sodium	1770.0±4.67
Iron	91.15±1.21
Magnesium	10.40±0.50
Copper	0.050±0.04
Lead	0.006±0.03
Zinc	0.130±0.30
Cadmium	0.001±0.02

Values are means ± standard deviations of three replicate measurements.

The information provided in table (3) illustrates the pawpaw fruit pulp's anti-

nutritional screening. It is apparent to observe that the pawpaw fruit pulp's concentrations of tannin, oxalate, phytate, and saponin have been 0.64, 0.83, 0.30, and 3.85 g/100 g, respectively. These findings did not agree with those of [33] who found that the pawpaw extract had quantities of tannin and saponin of 310.50 and 898.07 mg/100g, correspondingly. Through hydrogen bonding, iron shortage, or specific interactions with essential proteins like enzymes in cells of bacteria, tannins are recognized to exhibit antibacterial effects.

The cytotoxic influences of pawpaw extract, including intestinal permeabilization, are corroborated via the presence of saponins [34].

Furthermore, though the unique mechanism of motion is unclear, their highly recognized therapeutic characteristics can also additionally be attributed to their large alkaloid concentration. Furthermore, vegetation produces saponins, which are characteristic as herbal antibiotics due to the fact they represent a protective mechanism in opposition to invading infections [35].

Table (3): Quantitative anti-nutrient screening of pawpaw fruit pulp

Parameters	(g/100g)
Tannin	0.64±0.20
Oxalate	0.83±0.51
Phytate	0.30±0.11
Saponin	3.85±0.48

Values are means ± standard deviations of three replicate measurements.

The total phenols, total flavonoids, and antioxidant activity (DPPH) of pawpaw fruit pulp are displayed in table (4). It is evident that the pawpaw fruit pulp's percentages of total phenols, total flavonoids, and DPPH were, respectively, 79.51 mg/100g GAE, 138.30 mg/100g as quercetin, and 77.48 %. These findings concur with [36] which cited that the pawpaw fruit's total flavonoid awareness (mg /100 g fresh samples) used to be 57.80 mg rutin /100 g dry samples. Pawpaw fruit has a total phenolic awareness of 54.50 mg GAE per 100g dry weight.

When pawpaw fruit matured from green to ripe (matured pawpaw), antioxidant activity (DPPH) likewise confirmed a rising tendency, the values which were 29.70 and 65.10% for green pawpaw and red pawpaw in accordance with [37].

Table (4): Quantitative phytochemical screening of pawpaw fruit pulp

Parameters	Concentrations
Total phenol mg (GAE)/100g	79.51±1.62
Total flavonoids mg (QE) /100g	138.30±2.43
DPPH (%)	77.48±1.35

GAE: Expressed as gallic acid equivalents /g of extracts. QE: Expressed as quercetin equivalents /g of extracts. DPPH= 2,2-Diphenyl-1-picrylhydrazyl. Values are means ± standard deviations of three replicate measurements.

The information provided in table (5) demonstrates the pawpaw fruit pulp's phenolic element detection. According to the received results, ferulic acid, p-coumaric acid, and caffeic acid have been the three phenolic compounds discovered in the greatest concentrations in pawpaw fruit pulp. The corresponding

suggests values have been 287.00, 245.00, and 176.00 mg/100g. Conversely, the smallest degrees of vanillic acid, protocatechuic acid, and chlorogenic acid have been observed in the pawpaw fruit pulp. The corresponding suggested values have been 1.80, 9.00, and 9.10 mg/100 g. Gallic acid, however, was once no longer found under these conditions.

These findings are constant with [38], displaying that phenolic compounds with ferulic acid concentrations as excessive as 0.62 mg/DW have been isolated, along with caffeic acid, p-coumaric acid, kaempferol-3-glucoside, p-hydroxybenzoic acid, and quercetin-3-galactoside. Pawpaw isolates and concentrates from pawpaw fruit pulp confirmed strong antioxidant activity and may also have use in each the pharmacy and food industries for nutraceuticals.

Furthermore, the usage of ultraviolet, and high-performance liquid chromatography, 19 phenolic phenolics substances were recently identified as suitable for eating pawpaw fruit pulp for the first time.

A provisional classification of the chemical compounds determined in the pawpaw fruit pulp and active fractions was once hydroxycinnamic acid glycosides for ten of them, and quercetin glycoside derivatives for 9 of them. The pulp of pawpaw fruits consists of these phenolic chemicals, which have powerful antioxidant properties [39].

Table (5): Phenolic compounds of pawpaw fruit pulp

Phenolic compound	Concentrations (mg/100g)
Sinapic acid	41.00
Quercitrin	32.00
Gallic acid	ND
Protocatechuic	9.0
Catechin	82.0
Vanillic acid	1.80
Epicatechin	13.60
Syringic acid	12.10
Chlorogenic acid	9.10
Caffeic acid	176.0
p-Coumaric acid	245.0
Ferulic acid	287.0
Quercetin	34.40

ND= Not detected

The physicochemical characteristics of the pawpaw fruit pulp are displayed by the data in table (6). It is evident that pawpaw fruit pulp has the following values: pH, titratable acidity, total soluble solids (TSS), and viscosity, in that order: 4.84, 0.90 percent as citric acid/100g fresh weight, 8.14 o brix, and 1.35 centipoises, respectively.

Conversely, the pawpaw fruit pulp's concentrations of total sugar and reducing sugar were 13.85% and 4.91%, respectively. The results showed that the amounts of ascorbic acid and total carotenoids in pawpaw fruit pulp were 593.50 mg AAA/100g and 1.52 mg/100g, respectively.

The levels of L* (lightness), a* (redness), and b* (yellowness), in the pawpaw fruit pulp hue parameters were 46.87, 20.70, and 38.25, respectively, according to the data. These findings had been in settlement with [40] who stated that the

pH, total soluble solids, reducing sugar, and total sugar concentrations were, in that order, 5.30%, 15.60%, 18.00%, and 4.00.

Fruit pulp's acidity is additionally a vital indicator in meals great characteristics considering that it shows food deterioration and fermentation. This is extensive due to the fact taste is influenced by way of the ratio of TSS to acidity [41].

Moreover, metabolic activities like the breakdown of chlorophyll and the manufacture of carotenoids are accountable for the color modifications that take place for the duration of pawpaw ripening, main to a rise in the fruit's yellow-orange hue [42].

Table (6): Physicochemical characteristics of the pawpaw fruit pulp.

Characteristic	Concentrations
pH	4.84
Titratable acidity, (%Citric acid/100 g FW)	0.90±0.21
TSS (oBrix)	8.14±0.60
Viscosity (CP)	1.35±0.32
Reducing sugars, %	4.91±0.50
Total sugars, %	13.85±0.71
Vitamin C (mg AAE/100 g)	593.50±3.58
Total Carotenoids (mg/100 g)	1.52±0.14
Color parameters	
L* (lightness)	46.87±1.31
a* (redness)	20.70±1.13
b* (yellowness)	38.25±1.52

TSS = Total soluble solids. CP = Centipoises, AAE= Ascorbic acid equivalents. Values are means ± standard deviations of three replicate measurements.

The a*, b*, and Chroma values increased along with the increase in yellow-orange intensity on mango pulp and skin, whereas the L* and °Hue values decreased. They discovered a correlation between these color changes and a rise in the quantity of carotenoids [43].

4. Conclusion

Pawpaw fruit pulp possesses a high nutritional value and is rich in antioxidants, underscoring its significance in the context of therapeutic nutrition. The notable nutritional richness and antioxidant composition of pawpaw fruit pulp are associated with potential benefits, including the mitigation of heart disease, reduction of inflammation, support for digestive processes, and reinforcement of the immune system.

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التغذية وعلوم الاطعمة

دراسات على تنوع الخصائص الغذائية في فاكهة الباوباو

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الملخص العربى:

يهدف البحث الحالى إلى تقدير التركيب الكيميائى والعوامل المضادة للتغذية ومحتوى المعادن والتعرف على المحتويات الكيميائية النباتية، بما فى ذلك تقدير المركبات الفينولية باستخدام جهاز الكروماتوجرافى السائل عالي الأداء (HPLC)، والفينولات الكلية، والفلافونويدات الكلية، ونشاط مضادات الأكسدة في لب فاكهة الباوباو. وكنسبة مئوية من الوزن الجاف أشارت النتائج إلى أن نسبة البروتين والدهون والرماد والألياف والكربوهيدرات وقيمة الطاقة فى لب فاكهة الباوباو كانت ٧,٣٥%، ٤,٢٨%، ٤.٠٠%، ١٥,٥٣%، ٦٨,٨٤، ٣٤٣,٢٨ سعر حراري/١٠٠ جرام على التوالى. كان للنحاس والرصاص والكادميوم أدنى القيم المسجلة فى لب فاكهة الباوباو، فى حين كان للكالسيوم والبوتاسيوم والصوديوم أعلى تركيز معدنى. يحتوي لب فاكهة الباوباو على النسب التالية من الفينولات الكلية، الفلافونيدات الكلية، ونشاط مضادات الأكسدة (DPPH): ٧٩,٥١مجم/١٠٠ جم مكافئ حمض الجاليك، ١٣٨,٣٠ مجم/١٠٠ جم كيرسيتين، ٧٦,٤٨%، على التوالى. ثلاثة من المكونات الفينولية الأكثر وفرة فى لب فاكهة الباوباو هى حمض الفيروليك، وحمض الكوماريك، وحمض الكافيين. فى حين أن حمض الفانيليك وحمض البروتوكاتشويك وحمض الكلوروجينيك لديهم أقل تركيزات من هذه المركبات. يمكننا أن نستنتج أنه نظرًا لحقيقة أن لب فاكهة الباوباو يحتوي على قيمة غذائية ومحتوى من مضادات الأكسدة مرتفعين، فيمكن استخدامه لتقليل المشاكل الصحية لدى الأفراد.

الكلمات الكاشفة: البابايا، القيمة الغذائية، نشاط مضادات الأكسدة، الأملاح المعدنية