Original Research Article

Effect of the ripening stages on some biochemical and nutritional properties in *Carica papaya* L. (cv. Solo 8) pulp, skin, and seeds

ABSTRACT

The present study was aimed at investigating some biochemical properties and mineral contents in pulp, skin, and seeds of *Carica papaya* cv. solo 8 as a function of ripening stage. C. papaya cv. solo 8 fruits were obtained from a village plantation in Azaguié area's (5° 38′ 00″ N and 4° 05′ 00″ W) in Côte d'Ivoire. Papaya fruits were harvested at four ripening stages especially unripe, 1/8 advanced, ¼ advanced and advanced. Skin, pulp and seeds were separated, and they were oven dried and ground to obtain the crude flour. Proximate composition and mineral contents were investigated using standard methods. Results showed significant differences in moisture dry matter, protein, carbohydrate, ash, crude fibre, and total sugar contents as a function of the ripening stage, and from a fruit part to another. Pulps exhibited the highest contents of moisture (93.67 %), carbohydrate (96.62 g / 100 g DW), total and reducing sugars (4.28 and 1.10 %, respectively) which increase during ripening. The better ash (0.86 %) and protein (21.52 %) contents were obtained in skin at the advanced stage. The highest crude fibre content was found in seeds at unripe stage (1.86 %) and the pulps recorded the lowest values (between 0.19 and 0.28 %). As concerned mineral elements, there were increase in potassium, phosphorus, calcium, and magnesium contents in skin during ripening, while these mineral contents decrease in seeds and pulp. Skin recorded highest content in potassium (2344.80 to 6865.50 mg /100 DW), phosphorus (691.51 to 1958.34 mg /100 DW), calcium (306.32 to 632.27 mg /100 DW), and magnesium (173.86 to 569.82 mg /100 DW) especially at ¼ advanced and advanced stages. Iron and zinc contents (respectively, 15.57 and 14.01 mg/ 100 g DW) were also greater in skin at advanced stages. All the parts of *C. papaya* cv. solo 8 fruit at different ripening stages, especially the skin would provide significant portion of the Recommended Daily Allowances of several nutrients.

Keywords: Ripening stage, pulp, skin, seeds, Carica papaya var. Solo 8, biochemical characteristics

1. INTRODUCTION

Increasing attention is paid to the consumption of tropical fruits worldwide due to growing recognition of their value to human health [1]. Among them, papaya (*Carica papaya* L.) is one of the most cultivated and consumed fruits in tropical and subtropical regions in the

world. C. papaya is typical of these regions, require temperatures sited between 21 and 33 °C and does not tolerate cold weather (less than 15 °C) [2].
The economic and nutritional potential of the plant has made it a fruit and vegetable of choice [3]. Ripe papaya is most consumed as fresh fruit whereas green papaya as vegetable usually after cooking or boiling [4]. Papaya fruit is an excellent source of pro-vitamin A and ascorbic acid. Indeed, it's ranked as one of the top fruit sources of ascorbic acid [5] with averages ranged between 45 and 60 mg/100 g fresh weight (FW), and reported values up to 154 mg/100 g FW [6]. Also, it is regarded as an excellent source of ascorbic acid, a good source of riboflavin and a fair source of iron, calcium, thiamin, niacin, pantothenic acid, vitamin B-6 and vitamin K [3].
The fruit is not just delicious and healthy, but whole plant parts, fruit, roots, bark, peel, seeds and pulp are also known to have medicinal properties. It has wide consumption owing to its pharmacological properties and can be used as a folk remedy for various disorders [7]. Extracts from different parts of C. papaya plant have shown their positive effects when used as anti-microbial, antioxidant, antimalarial, anti-ulcer, anti-HIV, anti-inflammatory, anti-cancer, anti-hypertensive, anti-fertility, anti-fungal and anti-diabetic [3, 8, 9, 10]. Thus, in India, unripe and ripe fruits are made into juice and drinks for treatment of stomach problems, obesity and urinary tract infection. Also, they are made into paste as topical dressings or cosmetic (ointment, soap) to treat burns and skin diseases and to remove snakebite poison [11, 12]. The leaves are used for colic, fever, beriberi, abortion, asthma [12]. In many Africa countries, papaya fruit is widely used as topical paste or dressing for treatment of paediatric burns [13]. Yoruba tribe of Nigeria used unripe fruit and leaf for the treatment of jaundice, malaria, hypertension, diabetes mellitus and hypercholesterolemia [14, 15, 16, 17]. It is noteworthy that different parts (skin, pulp, and seeds) of the fruit is used at different ripening stages.
According to Gayosso-Garcia et al. [18] and Ikram et al. [6], many factors including stage of ripeness can have significant effects on the chemical composition of papaya fruit. Thus, the progression of fruit through different maturity stages results in physiological and biochemical changes that modify fruit composition and encourages its consumption as a fresh fruit [1, 19]. The loss of fruit firmness is a consequence of changes in plant cell wall constituents that lead to weak cell-to-cell links and thus loss of rigidity and firmness, with softening indicating ripeness [19]. Many studies have focused on physicochemical or biochemical constituents variation during the ripening in the different parts of papaya fruit or the cultivar [1, 20, 21, 22]. As far as concerned papaya cv. solo 8, a cultivar widely produced in Côte d'Ivoire and exported to the countries of the European Union, there is no information concerning the biochemical composition during fruits ripening. In this paper, we report on some biochemical and nutritional properties in the different parts of *C. papaya* cv. solo 8 at four ripening stages.

2. MATERIAL AND METHODS

2.1. Raw Material

C. papaya cv. *solo 8* fruits were obtained from a village plantation in Azaguié area's (5° 38′ 00″ N and 4° 05′ 00″ W) in Côte d'Ivoire. Papaya fruits were harvested at four ripening stages especially unripe, 1/8 advanced, ¼ advanced and advanced. These ripening stages were defined according to the skin colour. unripe stage corresponds to skin totally green; 1/8 advanced stage corresponds to fruit with up to 12,5% of yellow skin; ¼ advanced stage corresponds fruit with up to 25% of yellow skin; advanced stage corresponds to fruit with up to 75% of yellow skin. After harvest, fruits were transported in refrigerated truck at 10 ºC to food science laboratory, Nangui Abrogoua University (Abidjan, Côte d'Ivoire).

2.2. Sample preparation

The fruits selected were washed and sanitized with a 200 ppm sodium hypochlorite solution. They were then manually peeled, and the skin, pulp and seeds were separated. The pulp was cut into small pieces. For each ripening stage, the different parts of the fruit were oven-dried at 45°C for 72 h. After drying, the samples were ground using a Mill IKA (Germany/Deutschland) blender. Fine crude flours were then obtained and placed in sealed containers for biochemical analyses.

2.3. Proximate Analysis

The moisture content was determined by drying in an oven at 105°C during 24 h to constant weight AOAC [23]. The crude protein content was calculated from nitrogen contents (N×6.25) obtained using the Kjeldahl method by AOAC [23]. The crude fat content was determined by continuous extraction in a Soxhlet apparatus for 8 h using hexane as solvent AOAC [23]. The total ash content was determined by incinerating in a furnace at 550°C [23]. The crude fibre content was determined by taking about 3.0 g sample as a portion of carbohydrate that resisted sulfuric acid (1.25%) and NaOH (1.25%) digestion followed by sieving (75 µm), washing, drying and ignition to subtract ash from fibre [23]. The carbohydrate content was determined by deference that is by deducting the mean values of other parameters that were determined from 100. Therefore % carbohydrate = 100- (% moisture + % crude protein + % crude fat + % ash).

2.4. Mineral Analysis

The method described by AOAC [23] was used for mineral analysis. Flours were digested with a mixture of concentrated nitric acid (14.44 mol/L), sulfuric acid (18.01 mol/L) and perchloric acid (11.80 mol/L) and analysed using an atomic absorption spectrophotometer. As for the total phosphorus, it was determined as orthophosphate following the ascorbic acid method after acid digestion and neutralization using phenolphthalein indicator and combined reagent [23].

2.5. Statistical analysis

All chemical analyses and assays were performed in triplicate, unless otherwise indicated. Results were expressed as mean values ± standard deviation (SD). Analysis of variance (ANOVA) followed by Duncan's test was performed to test for differences between means by employing Kyplot (version 2.0 beta 15, c1997-2001, Koichi Yoshioka) statistical software.

3. RESULTS AND DISCUSSION

3.1. Proximate composition

Many factors such as physiological, biochemical, and molecular changes would affect proximate and nutritional composition of *C. papaya* during ripening [1]. Table 1 presents biochemical parameters in different parts of *C. papaya* cv. solo 8 as a function of ripening stage. Significant differences were observed for moisture dry matter, protein, carbohydrates, ash, crude fibre, and total sugars depending on the ripening stage. Moisture content in different parts of *C. papaya* cv. solo 8 increases with the ripening stage. Therefore, dry matter decreases from unripe to ripe stages. These moisture contents varied between 77.35 and 93.67 % (Table 1). These values were similar to those reported (varying from 84.57 to 90.05 %) for *C. papaya* L. cv *Eksotika* at five different maturity stages [24]. The highest moisture content was observed in the pulp at advanced stage (93.67 %) and lowest in seed at unripe stage (77.35 %). Hunt et al. [25] and Addai et al. [24] argue that moisture contents in unripe papaya were lower than those of hard ripe and very ripe fruits. Similar observations were reported by Nwofia et al. [26] for leaves, fruit, pulp, and seeds in some *C. papaya* L morphotypes. It is well known that the moisture level in a fruit is an important factor as it may affect its consistency and overall acceptability [27].

C. papaya cv. solo 8 skin and seeds exhibited highest ash contents than pulps. This ash content increases in skin (from 0.77 to 0.86 %), while it decreases in seeds (from 0.80 to 0.62 %) from unripe to advanced or ripe stages. It is well known that ash of food samples gives an idea of the organic content from where the mineral contents could be obtained [28, 22]. This means the studied papaya skin (at the advanced stage) and seeds (at the unripe stage) would contain more mineral elements than the pulp which is the most consumed part. The ash contents obtained for skin and seeds of *C. papaya* cv. solo 8 were higher than those found by Tripathi et al. [29] for mature green and ripe Rainbow papaya harvested in Hawaii (from 0.364 to 0.460 %).

The carbohydrate contents were found to be higher in pulp at all ripening stages. Then, the maximum value was of 96.62 g / 100 g DW found in pulp at ¼ advanced (very ripe) stage while skin at advanced (very ripe) stage presents the lowest carbohydrate content (77.45 g / 100 g DW). It is noteworthy that these carbohydrate contents increase during ripening in pulp and seeds, while it decreases in skin. Values obtained in this study were very higher than those reported by Chukwuka et al. [30] for *C. papaya* L. pulps, seeds, and peels at different stages of ripening. These authors recorded in the different ripening stages, values ranged between 18.47 – 32.18 %, 14.63 – 29.03% and 9.95 – 27.50% for unripe, hard ripe and very ripe, respectively. The high carbohydrate content suggests that *C. papaya* cv *solo 8* pulp and other parts can be considered as a potential of carbohydrate for energy.

Total and reducing sugars increase during the studied fruit development from unripe to ripe stages. Similar observations were noted for *C. papaya* cv. solo from Brazil [31]. Total sugar as well as reducing sugar contents were recorded highest in the pulps varying, respectively from 1.15 to 4.28 % and 0.94 to 1.10 %. Increase in sugar contents could be due to the enzymatic hydrolysis of polysaccharides into sugars, which occurs during fruits ripening [32, 33].

As shown in table 1, crude fibre content was highest at the unripe stage and, it decreases during ripening in the three studied parts of *C. papaya* cv solo 8. The highest crude fibre content was found in seeds at unripe stage (1.86 %) and the pulps recorded the lowest values (between 0.19 and 0.28 %). The crude fibre content in pulp obtained in this study is lower compared to the values obtained by Egbuonu et al. [34] for peels and seed of *C. papaya* oblong shaped variety. It is noteworthy that pulps of the studied papaya cultivar are not recognized good sources of fibers. Knowing benefits of fiber in the digestive tract, consumption of the skin could be recommended to helps to have normal bowel movements; thereby reducing constipation and aids nutrient absorption [35].

There was increase in protein content of different parts *C. papaya* cv *solo 8* as a function of fruit ripening process. It seems that during ripening, protein synthesis is more required as mentioned by Iroka et al. [36]. So, the increase in protein contents *C. papaya* cv. solo 8 during ripening could be attributed to increased enzyme conversion or protein synthesis [37]. At the different ripening stages, skin of the studied papaya exhibited the best protein contents followed by the seeds and pulp, respectively. Crude protein contents varied from 3.10 to 21.52 %. The highest amount of crude protein was found in the skin at advanced stage (21.52 %), while the lowest was found in the pulp at unripe stage (3.10 %). Protein contents obtained for skin and pulp are higher than those found by Chukwuka et al. [30], who reported values between 1.46 and 0.29 % in pulp, and 10.56 and 6.89 in peel. Also, unlike to our results, these authors argued that crude proteins decrease with the ripening advanced in different parts of *C. papaya* L.

Table 1. Proximate composition of *C. papaya* cv. solo 8 skin, pulp and seeds in different ripening stage.

Parameters (g / 100 g DW)	Fruit parts	*C. papaya* cv. *solo 8*			
		Ripening stage			
		Unripe	1/8 advanced	1/4 advanced	Advanced
Moisture	**Skin**	88.76 ± 0.20^{f}	89.67 ± 0.01^{g}	90.58 ± 0.04^{h}	91.12 ± 0.00^{i}
	Pulp	88.60 ± 0.02^{a}	88.5 ± 0.01^{a}	92.65 ± 0.02^{j}	93.67 ± 0.04^{k}
	Seeds	77.35 ± 0.02^{b}	80.04 ± 0.01^{c}	82.52 ± 0.04^{d}	83.93 ± 0.04^{e}
Dry matter	**Skin**	11.39 ± 0.01^{ab}	10.33 ± 0.01^{g}	9.42 ± 0.01^{f}	8.86 ± 0.01^{d}
	Pulp	11.36 ± 0.04^{a}	11.41 ± 0.01^{b}	7.33 ± 0.01^{d}	6.32 ± 0.01^{c}
	Seeds	22.64 ± 0.01^{k}	19.96 ± 0.01^{j}	17.48 ± 0.02^{i}	16.04 ± 0.01^{h}
Proteins	**Skin**	14.33 ± 0.58^{h}	14.98 ± 0.01^{i}	15.74 ± 0.02^{j}	21.52 ± 0.01^{k}
	Pulp	3.10 ± 0.02^{b}	3.43 ± 0.01^{c}	6.19 ± 0.02^{a}	5.96 ± 0.01^{a}
	Seeds	8.20 ± 0.02^{d}	9.41 ± 0.02^{e}	10.45 ± 0.02^{f}	11.42 ± 0.02^{g}
Carbohydrates	**Skin**	83.32 ± 0.14^{f}	84.67 ± 0.43^{a}	84.15 ± 0.04^{a}	77.45 ± 0.50^{e}
	Pulp	93.39 ± 0.12^{c}	93.66 ± 0.10^{c}	96.62 ± 0.12^{d}	96.30 ± 0.10^{d}
	Seeds	86.55 ± 0.37^{b}	86.13 ± 0.46^{b}	88.54 ± 1.06^{g}	89.45 ± 0.46^{h}
Fats	**Skin**	0.01 ± 0.00^{c}	0.02 ± 0.00^{e}	0.03 ± 0.00^{g}	0.01 ± 0.00^{c}
	Pulp	0.00 ± 0.00^{a}	0.00 ± 0.00^{b}	0.00 ± 0.00^{d}	0.00 ± 0.00^{b}
	Seeds	0.00 ± 0.00^{a}	0.03 ± 0.00^{h}	0.04 ± 0.00^{i}	0.02 ± 0.00^{f}
Fibres	**Skin**	0.49 ± 0.01^{c}	0.44 ± 0.00^{c}	0.33 ± 0.01^{f}	0.25 ± 0.02^{a}
	Pulp	0.28 ± 0.00^{a}	0.27 ± 0.01^{a}	0.16 ± 0.02^{b}	0.19 ± 0.01^{b}
	Seeds	1.86 ± 0.01^{e}	1.82 ± 0.10^{de}	1.79 ± 0.02^{d}	1.58 ± 0.00^{g}
Ash	**Skin**	0.77 ± 0.0^{d}	0.72 ± 0.01^{g}	0.75 ± 0.00^{c}	0.86 ± 0.00^{i}
	Pulp	0.29 ± 0.01^{e}	0.17 ± 0.00^{ab}	0.18 ± 0.00^{b}	0.16 ± 0.00^{a}
	Seeds	0.80 ± 0.02^{h}	0.74 ± 0.01^{c}	0.78 ± 0.01^{d}	0.62 ± 0.01^{f}
Total sugars	**Skin**	1.02 ± 0.01 ^{de}	1.46 ± 0.01^{a}	1.12 ± 0.02^{ae}	1.45 ± 0.01^{a}
	Pulp	1.15 ± 0.01^{cd}	2.17 ± 0.01^{f}	1.26 ± 0.01^{ae}	4.28 ± 0.02^{h}
	Seeds	0.36 ± 0.01^{b}	0.64 ± 0.01^{bc}	0.68 ± 0.02^{bcd}	2.63 ± 0.02^{g}
Reducing sugars	**Skin**	0.60 ± 0.02^{g}	0.84 ± 0.01^{b}	0.85 ± 0.01^{b}	0.93 ± 0.06^{c}
	Pulp	0.94 ± 0.01^{c}	1.07 ± 0.02^{de}	1.00 ± 0.00^{h}	1.10 ± 0.02^{e}
	Seeds	0.09 ± 0.02^{a}	0.46 ± 0.01^{f}	0.09 ± 0.00^{a}	1.06 ± 0.03^{d}
Energy values	**Skin**	394.40±0.73^{bc}	394.61±1.12^{bc}	394.78±1.62^{bc}	390.44±0.18^{ab}
	Pulp	401.53±0.99^{cd}	403.58±0.55^{cd}	403.19±0.81^{cd}	401.84±0.21^{cd}
	Seeds	391.76±0.15^{ab}	390.96±1.29^{ab}	392.35±0.44^{ab}	392.40±0.36^{ab}

Values are mean ± standard deviation of three measurements (n = 3). For each parameter, ^{a,b,c}Identical script indicate no significant difference between mean values.

3.2. Mineral contents

It is noteworthy that minerals play an important part in biological processes especially during fruits ripening. The recommended dietary allowance (RDA) and adequate intake are generally used to quantify suggested daily intake of minerals. Table 2 presents the mineral composition in different parts of *C. papaya* cv. solo 8 as a function of ripening stage. Results reveal that potassium, phosphorus, calcium, and magnesium were the most preponderant minerals in the different parts of the studied papaya cultivar. Similar observations were reported by Tripathi et al. [30] and Santos et al. [38] for Rainbow papaya and for *Havai* and *Calimosa* papaya, respectively. Also, significant differences in mineral content were observed between all parts at all the ripening stages.

There were increase in potassium, phosphorus, calcium, and magnesium contents in skin during ripening, while these mineral contents decrease in seeds and pulp. Skin recorded highest content in potassium (2344.80 to 6865.50 mg /100 DW), phosphorus (691.51 to 1958.34 mg /100 DW), calcium (306.32 to 632.27 mg /100 DW), and magnesium (173.86 to 569.82 mg /100 DW) especially at ¼ advanced and advanced stages. The lowest potassium (1506.26 to 860.39 mg /100 DW), phosphorus (305.42 to 66.39 mg /100 DW) and magnesium (275.55 to 54.17 mg /100 DW) contents were found in pulps, while seeds exhibited the lowest calcium (387.69 to 128.23 mg /100 DW) content. These mineral contents were higher than those reported for six *C. papaya* L. cultivars (*Guinea Gold* (Australia), *Sinta* (Philippines), *Honeydew* (India), *Cartagena* (Dominican Republic), *Maradol* (Cuba) and *Solo* (Barbados)) from different countries [39]. Moreover according Food and Nutrition Board [40] data, it should be noted that skin of the studied papaya cultivar would provide from 98.78 to 279.76 %, 49.89 to 146.07 %, 43.47 to 142.45 % and 30.63 to 63.23 % of the Recommended Dietary Allowances (RDA) of phosphorus, potassium, magnesium and calcium, respectively.

As regards Iron and Zinc contents, they were found to be higher in skin (varying from 7.56 to 15.57 mg/ 100 g DW for iron, and from 4.97 to 14.01 mg/ 100 g DW for zinc) as ripening advances. The lowest values were recorded in pulps (varying from 3.30 to 5.35 mg/ 100 g DW for iron, and no determined for zinc at 1/8 advanced, ¼ advanced and advanced stages). Iron contents obtained in this study were higher than those reported for peel (0.19 mg/ 100 g DW), pulp (0.37 g/ 100 g DW) and seeds (0.016 mg/ 100 g DW) of an Indian variety of *C. papaya* L. [21]. So, the iron content of 15.57 mg/ 100 g DW obtained in the skin at advanced stage would provide about 195 % of the Recommended Dietary Allowances (RDA) of iron, while the pulp (at ¼ advanced stage) would bring to human body about 67 % of this RDA [40]. This suggests that inclusion of C. papaya cv. solo 8 in the daily diet could improve iron status and help prevent anaemia, especially in developing countries where one in two pregnant women and about 40 percent of preschool children are believed to be anaemic. Indeed, as reported by FAO/WHO [41], health consequences include poor pregnancy outcomes, impaired physical and cognitive development, increased risk of morbidity in children and reduced work productivity in adults. Anaemia is a preventable deficiency but contributes to 20 percent of all maternal deaths.

Table 2. Mineral composition of *C. papaya* cv *solo 8* skin, pulp and seeds in different ripening stage

Minerals (mg / 100 g DW)	Fruit parts	*C. papaya* cv. *solo 8* — Ripening stage: Unripe	1/8 advanced	1/4 advanced	Advanced
Na	Skin	17.42 ± 0.06^{d}	18.44 ± 1.66^{e}	20.05 ± 1.56^{g}	20.24 ± 1.06^{h}
	Pulp	26.95 ± 1.34^{k}	15.24 ± 1.48^{c}	11.92 ± 1.64^{b}	6.91 ± 1.16^{a}
	Seeds	20.93 ± 1.50^{i}	25.77 ± 0.13^{j}	27.51 ± 1.95^{l}	29.60 ± 1.88^{f}
Mg	Skin	173.86 ± 0.12^{b}	201.50 ± 0.21^{c}	568.15 ± 1.02^{l}	569.82 ± 0.54^{l}
	Pulp	275.55 ± 1.16^{h}	238.27 ± 0.83^{e}	207.68 ± 1.14^{d}	54.17 ± 0.29^{a}
	Seeds	373.12 ± 1.29^{j}	250.70 ± 0.25^{g}	248.37 ± 1.38^{f}	238.45 ± 1.07^{i}
P	Skin	691.51 ± 0.11^{i}	829.71 ± 0.17^{j}	922.97 ± 0.02^{k}	1958.34 ± 1.15^{l}
	Pulp	305.42 ± 1.84^{f}	268.40 ± 1.84^{e}	130.30 ± 0.70^{a}	66.39 ± 0.59^{b}
	Seeds	545.90 ± 0.85^{h}	198.11 ± 0.27^{d}	186.21 ± 0.26^{c}	111.38 ± 1.21^{g}
K	Skin	2344.80±1.23^{g}	3094.07±0.91^{j}	3903.15±1.44^{k}	6865.50 ± 0.92^{l}
	Pulp	1506.26±1.63^{e}	1147.33±0.33^{b}	950.17±0.21^{c}	860.39±0.46^{a}
	Seeds	2638.99±0.7^{i}	2435.29±1.52^{h}	1639.02±1.17^{f}	1424.83 ± 1.8^{d}
Ca	Skin	306.32 ± 0.11^{g}	469.29 ± 1.45^{j}	552.83 ± 1.89^{k}	632.27 ± 0.94^{l}
	Pulp	253.10 ± 0.52^{f}	245.48 ± 1.83^{e}	194.11 ± 0.54^{d}	163.27 ± 1.98^{c}
	Seeds	387.69 ± 1.29^{i}	160.88 ± 0.18^{b}	145.92 ± 1.49^{a}	128.23 ± 0.57^{h}

Mn	**Skin**	Nd	3.65 ± 1.55^{c}	11.41 ± 1.56^{i}	10.90 ± 1.14^{h}
	Pulp	4.58 ± 0.41^{f}	4.63 ± 1.68^{g}	1.95 ± 1.01^{b}	0.51 ± 0.70^{a}
	Seeds	3.71 ± 0.42^{d}	4.16 ± 0.05^{e}	6.92 ± 1.80^{j}	Nd
Fe	**Skin**	7.56 ± 0.06^{c}	7.46 ± 1.32^{c}	8.75 ± 1.18^{i}	15.57 ± 1.68^{j}
	Pulp	3.30 ± 1.91^{e}	3.98 ± 1.50^{g}	5.35 ± 1.13^{a}	3.79 ± 1.51^{f}
	Seeds	3.12 ± 0.04^{d}	5.30 ± 0.21^{b}	5.41 ± 1.36^{ab}	5.76 ± 1.28^{h}
Cu	**Skin**	4.60 ± 0.08^{d}	8.38 ± 0.28^{g}	18.87 ± 1.20^{k}	19.24 ± 1.22^{i}
	Pulp	2.67 ± 0.63^{a}	2.75 ± 0.75^{a}	3.98 ± 1.45^{c}	0.67 ± 0.51^{b}
	Seeds	7.42 ± 1.04^{f}	10.15 ± 0.16^{h}	14.99 ± 0.73^{j}	4.90 ± 0.05^{e}
Zn	**Skin**	4.97 ± 0.03^{c}	7.46 ± 1.93^{f}	14.02 ± 0.27^{g}	14.01 ± 0.94^{g}
	Pulp	0.20 ± 0.03^{e}	Nd	Nd	Nd
	Seeds	3.98 ± 1.21^{a}	3.20 ± 0.09^{h}	2.45 ± 0.25^{d}	1.38 ± 0.18^{b}

Values are mean ± standard deviation of three measurements (n = 3). For each mineral, [a,b,c]Identical script indicate no significant difference between mean values.

4. CONCLUSION

Based on the present study results, it appears that *C. papaya* cv. solo 8 is a considerable source of nutrients such as carbohydrate, fibre, protein, and mineral elements. These nutrients are unevenly distributed in the different parts of the fruit (skin, pulp, and seeds) and many variations are observed in these contents during maturation. Then, pulp showed higher moisture and carbohydrate contents at advanced stages, while better ash and fibre contents were found in seeds respectively at advanced and unripe stages. As regards the skin, it exhibited greater protein and mineral contents at advanced stage. Concerning mineral elements, all the parts of the studied fruit especially the skin showed considerable amount of magnesium, potassium, phosphorus, calcium, and iron that can provide a significant portion of the Recommended Daily Allowances.

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