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Full Length Research Paper

Physicochemical and nutritional qualities of *Carica papaya* seed products

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***Carica papaya* Linn. is known for its nutritional values. The seeds are often discarded after eating the fruits. This research work was carried out to determine some *in vitro* qualities of its products. The oil qualities are: specific gravity (0.918 ± 0.002), refractive index (1.469 ± 0.003), free fatty acid (0.277 ± 0.006 mgKOH/g), thiobarbituric acid (0.451 ± 0.005 µm/g), and saponification (32.900 ± 0.739 mgKOH/g). The oil has high fat (26.660 ± 0.052%), carbohydrates (72.69 ± 0.062%) and the energy values (524.913 ± 0.591 kcal/100g). The seed coat possessed high crude fibre (30.451 ± 6.209%), ash (9.042 ± 0.012%), crude protein (32.680 ± 0.035%), and thiobarbituric acid (1.819 ± 0.004 µM/g). It also possesses antioxidant reducing activity (39.167 ± 0.722 µg/ml), free radical scavenging power (42.923 ± 5.825%) and polyphenol (119.917 ± 2.626 µg/ml). Both products could provide nutritional and health benefits when consumed.**

Key words: *Carica papaya* seed, oil, seed coat, qualities, antioxidant, nutrition, wastages.

INTRODUCTION

The papaya, *Carica papaya* Linn is commonly known for its food and nutritional values throughout the world. The genus *Carica papaya* Linn is the most widely cultivated and best known species of the four genera that belongs to a small family Caricaceae (Krishna et al., 2008). The seeds are numerous, small, black, round and covered with gelatinous aril. Medical research in animals has confirmed the contraceptive and abortifacient capability of papaya. Its seeds also have contraceptive effects in adult male Langur Monkeys, possibly in adult male humans (Lohiya et al., 2008; Oderinde et al., 2002). The seed of papaya has antimicrobial activity against *Trichomonas vaginalis* trophozoites. It could also be used in urinogenital disorder like trichomoniasis with care to avoid toxicity (Calzada et al., 2007). The seeds, irrespective of its fruit maturity stages have bacteriostatic activity on gram positive and negative organisms which could be useful in treating chronic skin ulcer. The papaya seed macerate has a clinical potential on conjugal R plasmid transfer from *Salmonella typhimurium* to *Escherichia coli in vitro* and in the digestive tract of genotobiotic mice (Krishna et al., 2008). The seed being consumed offers a cheap, natural, harmless, readily available monotherapy and preventive strategy against intestinal parasitosis (Okeniyi et al., 2007). Benzylisothiocynate present in seeds is the chief or sole antihelminthic (Kermanshai et al., 2001). There is increasing interest in the *C. papaya* seed due to its medicinal value. The seed has been shown to be a good source of oil (25.6%) that may be useful for medicinal, biofuel, and industrial purposes (Afolabi et al., 2011). The physicochemical properties of oils determine their quality and whether they are suitable for consumption (Fokou et al., 2009). This work was therefore aimed at determining the physicochemical and nutritional values of the oil and resultant waste (seed coat).

MATERIALS AND METHODS

Chemicals and reagents

The following chemicals were used during this study: Chloroform, sodium thiosulphate, cathecol, potassium iodide (KI), 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferric chloride, potassium ferricyanide, thiobarbituric acid and trichloroacetic acid; all were products of Sigma Aldrich Chemicals (U.S.A). D-Glucose, potassium

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Table 1. The physicochemical properties of *C. papaya* seed oil.

Oil quality	Value
Refractive index	1.469 ± 0.003
pH	5.556 ± 0.006
Specific gravity	0.918 ± 0.002
Melting point (°C)	47.333 ± 1.155
Saponification value (mg KOH/g)	32.900 ± 0.739
Free fatty acid (mg KOH/g)	0.277±0.006

Value is a mean of five determinations ± standard deviation.

dihydrogen phosphate, disodium hydrogen phosphate were products of BDH Lab Chemicals (England). However, soluble starch, perchloric acid, octanol, and Folin Ciocalteau reagent were products of Mallinckrodt Baker Incorporation (U.S.A), Eagle Scientific (England), J.T. Bakers (USA), and Sisco Research (India) respectively. All chemicals used were of analytical grade.

Collection of samples

C. papaya fruits were purchased from a local fruits market located at Ota, Ogun State, Nigeria. The pawpaw fruits were cut open with the aid of a knife to collect the seeds.

Extraction of oil from seeds

The seeds were dried in an oven at a temperature of 50°C for a period of 20 h. After which the seeds were grinded with the aid of a mortar and pestle. The golden yellow oil was extracted with the aid of Soxhlets apparatus using a non polar solvent (n-Hexane).

Statistical calculation

Five determinations were carried out for each analysis. The mean values and standard deviation were calculated using a statistical software.

Analysis

Physicochemical properties of oil was determined by the method of AOAC (1990). It was employed for the determination of pH, melting point, refractive index, specific gravity, saponification value, and free fatty acids of the oil. The method of AOAC (1990) was employed for the determination of moisture and ash contents. The method of Osborne and Vogt (1978) was used for the extraction of the sugars. The total sugar content was assayed using the method of Rao and Pattabiraman (1989).

The Macro Kjedhal method described by Osborne and Vogt (1978) was used for crude protein determination. The % crude protein was calculated using the formula stated:

% Crude protein = % Nitrogen × 6.25

Where: % Nitrogen = Titre value × 0.0014/ Weight of sample × 100

The method described by Theander and Aman (1982) was used for the crude fibre determination. The fibre content was thereafter calculated, and expressed as percentage fibre content. The energy value was calculated by using the formula stated by Pattee (1914) thus:

Energy value (KCal/100g) = [(% crude protein × 4) + (% carbohydrate × 4) + (% Fat × 9)]

Carbohydrate was determined by difference of the sum of all the proximate composition from 100%, as described by Osborne and Vogt (1978).

Antioxidants determination

Dried grounded *C. papaya* seed coats (2 g.) were homogenized in 100 ml of 70% acetone solution, and filtered. The filtrate was kept in a water bath at a temperature of 30°C for 2 h under continuous shaking at a speed of 120 rev/min. The extract was used as a sample source for estimation of polyphenol, and other antioxidants activities. Polyphenol content was assayed using the method of Swain and Hills (1959).

The antioxidant reducing power of seed extracts was determined spectrophotometrically at 700 nm according to the method of Yuan et al. (2005). The antioxidant activity of the seed extract was measured by using the DPPH assay method described by Atoui et al. (2005). Antioxidant activity was expressed as percentage inhibition (% I) of the DPPH radical using the following formula:

% Inhibition = [1- (abs of sample/ abs of control)] × 100/1

The method of Yagi (1987) was employed for the determination of thiobarbituric acid spectrophotometrically at 532 nm and the concentration of TBARS was calculated using extinction coefficient $\varepsilon = 1.56 \times 10^5\ M^{-1}\ cm^{-1}$. The data were expressed as μmol of TBARS per gram of wet weight of grain.

RESULTS AND DISCUSSION

Physicochemical qualities of *C. papaya* seed oil

The physicochemical qualities are as shown in Table 1. The refractive index (1.469 ± 0.003) of *C. papaya* seed oil is similar to that reported for coconut oil (1.4480 to 1.4492) (CODEX, 1981), and its pH value (5.556 ± 0.006) is slightly low indicating the slightly acidic nature of the oil. The oil may contain mostly long chain saturated fatty acids due to its high melting point (47.333 ± 1.155°C). Short chain and unsaturated fatty acids had been

Table 2. The nutritional qualities of *C. papaya* seed oil and coat.

Component	Oil	Seed coat
Moisture content (%)	0.223 ± 0.035	0.013 ± 0.001
Ash content (%)	0.590 ± 0.017	9.042 ± 0.012
Protein (%)	0.823 ± 0.012	32.680 ± 0.035
Fat (%)	26.660 ± 0.052	6.230 ± 0.017
Crude fibre value (%)	0.603 ± 0.006	30.451 ± 6.209
Carbohydrate by difference (%)	72.690 ± 0.062	21.493 ± 6.211
Total sugar (µg/ml)	ND	9.667 ± 0.289
Energy value (K cal /100 g)	524.913 ± 0.591	273.493 ± 24.960
Thiobabituric acid value (µM/g)	0.451 ± 0.005	1.819 ± 0.004

Value is a mean of five determinations ± standard deviation. ND = not determined.

attributed to the low melting point of its oil (Dzulkefly et al., 2001; Waheed et al., 2010). The saponification value (32.900 ± 0.739 mgKOH/g) of *C. papaya* seed oil is relatively low compared to that of almond nut seed oil having a value of 163.398 ± 15.800, and palm kernel seed oil having a value of 191.976 ± 3.164 (Afolabi, 2008). This result indicates that the papaya seed oil contains high molecular weight fatty acids since the saponification values have been reported to be inversely related to the average molecular weight of the fatty acids in oil fractions (Abayeh et al., 1998).

Nutritional constituents of *C. papaya* seed oil

The values for the nutritional qualities are as indicated in Table 2. The low moisture content (0.223 ± 0.035%) of the oil is also a pointer to its storage stability. The low ash content (0.590 ± 0.017%) also indicates the low mineral value. The free fatty acid value of the seed (0.277 ± 0.006 mgKOH/g) is relatively low compared to that of almond nut seed oil having a value of 0.388 ± 0.050 and palm kernel seed oil having a value of 5.297 ± 0.885 (Afolabi, 2008). This indicates that the *C. papaya* seed oil will not readily undergo spoilage since free fatty acid is usually indicative of spoilage due to enzymatic activity (Orak et al., 2010). Also, the free fatty acid is a measure of the acidic component of the oil (Naghshineh et al., 2009). Therefore, the low free fatty acid value of the *C. papaya* oil is indicative of its slightly acidic nature as observed in this study.

The low protein (0.823 ± 0.012 %) and crude fibre (0.603 ± 0.006 %) contents of the oil indicates that the dietary fibre content in the oil is low since crude fibre makes up 50% of dietary fibre content (Cummings, 1981; Anderson et al., 2009). The fat content (26.660 ± 0.052%) of the oil is relatively high compared to its protein content. Also, the carbohydrate content (72.690 ± 0.062 %) of the oil is relatively high compared to its protein, crude fibre and fat contents. This indicates that most of the carbohydrate component could be bonded to the lipids forming glycolipids; a reflection of the high amount of glycolipids in the oil. The papaya oil contains the required energy (524.913 ± 0.591 kcal/100 g) to provide about 1500 kcal/g per day energy requirement for men (Warwick and Baines, 2000). The energy rich nature of the oil may give credence to its usefulness for biofuel purpose.

The thiobarbituric acid value (0.451 ± 0.005 µM/g) is low in the oil indicating that the oil has a relatively low lipid peroxidation. Hence, the oil may be rich in antioxidant and will undergo little or no oxidative deterioration upon its consumption and during storage. Consequently, the oil will cause little or no cellular injury when consumed (Asakawa and Matsushita, 1979).

Nutritional constituents of *C. papaya* seed coat

Table 2 indicates the nutritional constituents of *C. papaya* seed coat. Its seed coat has a relatively low moisture content (0.013 ± 0.001%) compared to the oil while it has a relatively high ash content (9.042 ± 0.012%) than the oil. It can be observed that the seed coat has a relatively higher protein (32.680 ± 0.035%) and crude fibre (30.451 ± 6.209%) contents than that of the oil. Hence, the dietary fibre in the seed coat is high since crude fibre makes up 50% of dietary fibre content (Cummings, 1981; Maria and Przemyslaw, 2006; Anderson et al., 2009). Therefore the seed coat will serve as a good source of dietary fibre, and protein for livestock and human consumption. The fat content (6.230 ± 0.017%), and the energy value (273.493 ± 24.960 kcal/100 g) of the seed coat are relatively low compared to that of the oil. A maximum consumption of 1000 g per day of the seed coat will provide the required energy (about 1500 kcal/g per day) for men (Warwick and Baines, 2000). The high thiobarbiturate value (1.819 ± 0.004 µM/g) indicates that the seed coat has a relatively high lipid peroxidation. The fact that the thiobarbituric acid value in the seed coat is higher than that of the oil (0.451 ± 0.005 µM/g) indicates that it contains lesser antioxidants than the oil. The oil may therefore prevent

Table 3. The antioxidant properties of *C. papaya* seed coat.

Antioxidant property	Value
DPPH radical scavenging power (% inhibition)	42.923 ± 5.825
Total polyphenol (μg/ml)	119.917 ± 2.626
Antioxidant activity by reducing power (μg/ml)	39.167±0.722

Value is a mean of five determination ± standard deviation.

cellular damage more effectively than the seed coat. However, the carbohydrate content (21.493 ± 6.211%) in the seed is low compared to that of the oil.

The antioxidant qualities of *C. papaya* seed coat

The antioxidant qualities of *C. papaya* seed coat are as indicated in Table 3. It possesses significant antioxidant activity that may provide beneficial health effects when consumed. This antioxidant capability of the seed coat can be attributed to the recently reported medicinal importance of *C. papaya* seed (Calzada et al., 2007; Krishna et al., 2008).

Conclusion

The *C. papaya* seed oil is stable upon storage, and possesses little or no cellular injury (that is, low toxicity) when consumed. Both the oil, and seed coat can provide the daily energy requirement for men. The oil is a good antioxidant source than the seed coat. Although, both the seed coat and the oil possess reasonable antioxidant properties, this gives credence to their potential nutritional and health benefits. This report may provide a good quality standard for both the seed and the oil as commercialisation may increase due to the increasingly realization of the medicinal value of the *C. papaya* seed and its oil. The oil could also be useful for biofuel purposes. The seed coat may equally be developed into edible coatings or packaging materials for shelf-extension of agro-crops.

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