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Nutritive and Phytochemical Values of Unripe Seeds of *Carica papaya* and Prospects in Animal Nutrition

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ABSTRACT

Several unripe fruits of *Carica papaya* drop in various orchards and farms hence contributing to environmental burden and wastage. The nutritive and ethno-medicinal potentials (proximate, mineral, vitamins and phytochemicals) of the unripe seed in livestock production were evaluated using AOAC methods. Data were analysed using means and standard deviation. The proximate evaluation of the unripe seeds of *Carica papaya* showed that it contained crude protein (8.90±0.28%), crude fibre (29.00±1.41%), crude fat (29.50±2.12%), ash (8.65±0.64%), carbohydrates (23.95±4.45%) and moisture (5.45±0.21%). The mineral contents were calcium (0.39±0.00%), magnesium (0.13±0.00%), potassium (0.11±0.00%), sodium (0.04±0.00%), phosphorus (5.71±1.41 mg/kg), manganese (26.91±1.41 mg/kg) and iron (105±1.41 mg/kg). The vitamins contents obtained were 2162.50±1.41 IU/kg, 1.27±0.00 mg/100g, 0.64±0.00 mg/100g, 3.57±1.41 mg/100g, 1.94±1.41 mg/100g, 0.86±0.00 mg/100g and 8.99±1.41 mg/100g for Vitamins A, B1, B2, B3, B6, B12 and C respectively. The values of the phytochemicals were 7.42±1.41 mg/100g, 5.94±1.41 mg/100g, 0.31±0.00 mg/100g and 84.12±1.41 mg/100g for saponin, alkaloid, hydrogen cyanide and tannin respectively. Thus, the unripe seeds of *Carica papaya* could be a reliable source for minerals, vitamins, fibre, fat and carbohydrate with broader activity and higher potentials for therapeutic. Harnessing the results of this study may enhance the use of these samples in diets and phytobiotics to ultimately reduce their environmental burden.

Keywords: Antibiotics, Minerals, Phytobiotics, Proximate, Vitamins

INTRODUCTION

Antibiotics are utilized as growth promoters at sub-therapeutic levels and for treatment of diseases in monogastric animals. The beneficial effects of antibiotic in combating bacterial problems and as growth promoters are well documented. Medication of water using antibiotic helps birds to recover from certain diseases of bacterial origin. However, there may be problems associated with usage of antibiotics such as drugs toxicity, residual effects and development of microbial resistance. The negative impact on consumers of meat or poultry products due to residual effects has also raised some concern. This has led to the ban on the use of antibiotics as growth promoters since 2006 by the European Union. Animal scientists and veterinarians are now turning attention towards alternative sources of natural ingredients such as herbs or plants (phytobiotic) to replace antibiotic [1-3].

Herbs and mushrooms, which are utilized as feed supplements or medicines in chickens, have been shown to have therapeutic effects [4-8]. The therapeutic (medicinal) advantages of several bioactive compounds found in plants, herbs, and mushrooms have been reported [4, 7]. Secondary metabolites are biologically active chemical substances found in plants (such as saponins, tannins, oxalates, phytates, trypsin inhibitors, and cyanogenic glycosides) [9]. Secondary metabolites can be used in food as well as as pharmacologically active substances [9]. Plants are also recognized for having a high concentration of important nutrients, vitamins, minerals, fatty acids, and fiber [10].

The therapeutic efficacy of plant oil extracted from seeds and leaves is in high demand. *Carica papaya* fruits and ripe seeds have been claimed to be a good source of vitamins and amino acids, in addition to its medical properties [11-13]. Carotene and ascorbic acid (Vitamin C) are abundant in the seeds of ripe *Carica papaya* fruits [13]. They are also used in animal feed, and the twigs are said to be highly tasty to ruminants and have an effect on the color of laying birds' yolks [14, 15].

The ripe fruit is mainly eaten fresh but large quantities of unripe fruits are always found under the trees and these go as waste. Presently, there is paucity of information as it relates to the nutritive and phytochemical values of the seeds from unripe *Carica papaya* fruits.

This study therefore aims to assess the potentials of the unripe seeds of the fruits of *Carica papaya* in livestock nutrition as the fruits are available all year round.

MATERIALS AND METHODS

Collection and processing of sample

The unripe fruits of *Carica papaya* were harvested from the Teaching and Research Farm of Babcock University, Ilishan-Remo, Ogun State, Nigeria. The unripe seeds were air-dried at room temperature for 3-5 days. The dried unriped seeds of *Carica papaya* were then ground into powder.

Proximate analysis

The moisture, crude fibre, crude protein, fat, ash, and cyanide content of the samples were determined using the Association of Official Analytical Chemists (AOAC) methods [16]. All of the tests were done in duplicates. The percentages were used to report the proximate values. Weighing unripe *Carica papaya* seed samples (5 grams each) in a crucible and drying in an oven at 105 ^{o}C until a constant weight was used to assess the moisture content. The ash concentration was determined by ashing at 550 ^{o}C for around 3 hours. The kjeldah technique [16] was used to compute the protein content, which involved multiplying the nitrogen value by a conversion factor (6.25). The digestion method was used to determine the crude fiber content of the samples, and the soxhlet extraction method was used to estimate the lipid content [16]. Total soluble carbohydrate was calculated using the difference between the sum of all proximate composition and 100 percent.

Mineral analysis

The atomic absorption spectrophotometer (AAS-Buck 205) was used to determine the mineral contents (elements) of unripe *Carica papaya* seeds: calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), and manganese (Mn), as stated by the Association of Official Analytical Chemists [16]. Phosphorus was measured using a colorimetric method [16]. All the determinations were done in duplicates.

Phytochemical analysis and anti-nutrients

The methodologies of Sofowora [17] were used to determine quantitative phytochemical assessments of anti-nutrients. Saponin, alkaloids, hydrogen cyanide and tannin were determined quantitatively. All determinations were done in duplicates.

Statistical analysis

All data generated were analyzed using descriptive statistic. Statistical values that were calculated include mean and standard deviation.

RESULTS AND DISCUSSION

Table 1: Proximate Analysis of Unripe *Carica papaya* Seeds

TEST	COMPOSITION
Crude Protein (%)	8.90±0.28
Crude Fibre (%)	29.00±1.41
Crude Fat (Lipid) (%)	29.50±2.12
Ash Content (%)	8.65±0.64
Moisture (%)	5.45±0.21
Carbohydrate (%)	23.95±4.45

Legend: *Data are mean values ± standard deviation (SD) of duplicate results

The quantitative proximate analysis of unripe *Carica papaya* seed is presented in Table 1. The proximate composition of the unripe seed of *Carica papaya* showed that it contained carbohydrate, protein, fats, fibre, moisture and ash. The unripe seeds contained 8.90% crude protein, 29.00 crude fibre, 29.50 crude fat, 8.65% ash, 5.45% moisture and 23.95% carbohydrate.

Table 2: Mineral Composition of Unripe *Carica papaya* Seeds

PARAMETER	COMPOSITION
Calcium (%)	0.39±0.00
Magnesium (%)	0.13±0.00
Potassium (%)	0.11±0.00
Sodium (%)	0.04±0.00
Phosphorus (mg/kg)	5.71±1.41
Manganese (mg/kg)	26.91±1.41
Iron (mg/kg)	1052.59±1.41

Legend: *Data are mean values ± standard deviation (SD) of duplicate results

The mineral analysis of unripe seed of *Carica papaya* is presented in Table 2. The mineral composition analysis of the unripe seed of *Carica papaya* indicates the presence of calcium (0.39%), potassium (0.11%), magnesium (0.13%), sodium (0.04%), phosphorous (5.71 mg/kg), manganese (26.91 mg/kg) and iron (1052.59 mg/kg).

Table 3: Vitamins Composition of Unripe *Carica papaya* Seeds

PARAMETER	COMPOSITION
Vitamin A (IU/Kg)	2162.5±1.41
Vitamin B1 (mg/100g)	1.27±0.00
Vitamin B2 (mg/100g)	0.64±0.00
Vitamin B3 (mg/100g)	3.57±1.41
Vitamin B6 (mg/100g)	1.94±1.41
Vitamin B12 (mg/100g)	0.86±0.00
Vitamin C (mg/100g)	8.99±1.41

Legend: *Data are mean values ± standard deviation (SD) of duplicate results

The vitamins compositions of unripe seed of *Carica papaya* are presented in Table 3. The vitamin composition analysis of the unripe seed of *Carica papaya* indicates the presence of Vitamin A (2162.5), Vitamin B1 (1.27), Vitamin B2 (0.64), Vitamin B3 (3.57), Vitamin B6 (1.94), Vitamin B12 (0.86) and Vitamin C (8.99).

Table 4. Phytochemicals of Unripe *Carica papaya* Seeds

PARAMETER	COMPOSITION
Saponin (mg/100g)	7.42±1.41
Alkaloid (mg/100g)	5.94±1.41
HCN (mg/100g)	0.3±0.00
Tannin (mg/100g)	84.12±1.41

Legend: *Data are mean values ± standard deviation (SD) of duplicate results, HCN- Hydrogen Cyanide

Phytochemical compositions of unripe *Carica papaya* seeds are presented in Table 4. Quantitatively, tannin was found to be the abundant constituent making about 84.12%, followed by saponin, alkaloid and hydrogen cyanide constituting 7.42%, 5.94% and 0.30% respectively.

The abundance of moisture, ash, fat, and protein in the seeds of unripe *Carica papaya* fruits implies that they may be beneficial for bodybuilding and anti-aging, while the high dietary crude fiber content aids bowel movement [4]. The presence of key nutrients in the seeds of unripe *Carica papaya* fruits supports the idea that the seed could be employed as a feed supplement. The protein content in the unripe seeds of *Carica papaya* fruits was in variance with 21.67% reported by Akintunde and Toye [8] for *Moringa oleifera* seed meal and the range of 5.6- 6.62% reported by Osabor *et al.* [18] for leaves and roots of miracle fruit (*Synsepalum dulcificum*) but in agreement with 8.63% reported by Kolu *et al*. [13] for sun-dried seeds of ripe *Carica papaya* fruits. The ash content in the unripe seeds was lower than the range (11.20-15.02%) reported for seeds of ripe fruits of *Carica papaya* by Kolu *et al* [13].

The carbohydrate content (%) in the seeds of unripe fruits of *Carica papaya* was lower than the values of sun dried ripe seeds (29.47%) but higher than the values of oven-dried ripe seeds (20.60%) as reported by Kolu *et al* [13] and 22.37% reported by Egbuonu *et al* [19]. The fibre content in the seeds of unripe fruits of *Carica papaya* was higher than that in ripe seeds of *Carica papaya* [13, 19], asparagus bean (5.72%) [20, 21], *Moringa oleifera* seed meal (17.88%) (8), African breadfruit (1.55%) and soybean (6.46%) [22] and water melon rind and seeds [23] hence could be a better dietary fibre source. The fat content in the seeds of unripe *Carica papaya* was in proximity with the range of 27.50-29.50% reported for ripe seeds of *Carica papaya* by Kolu *et al.* [13] and 29.62% reported by Egbuonu *et al* [19] but lower than the 36.50% of *Moringa oleifera* seed meal reported by Akintunde and Toye [8] thus indicating that the pawpaw seeds could be a rich fat source. The proximity of the fat content to the ripe seeds might be due to little morphological change.

The results of the present study suggested that several phytochemicals are present in seeds of unripe fruits of *Carica papaya*. Phytochemicals give plants their colour, flavour, smell and are part of a plant`s natural defense system and protect them against herbivorous insects and vertebrates, fungi, pathogens, and parasites [24]. The phytochemicals: saponin, alkaloid, hydrogen cyanide and tannin were present in seeds of unripe fruits of *Carica papaya*.

Tannin and saponin were found in the seeds of unripe *Carica papaya* fruits, according to the findings of this investigation. Saponins have anti-hypercholesterolemic activities as well as antibacterial characteristics. Saponins have also been discovered to have anticancer, antioxidant, and anti-mutagenic properties, and can reduce cancer risk by preventing cancer cell proliferation [25]. Tannins prevented the growth of several fungi, yeasts, bacteria, and viruses [26]. Because of the presence of saponin, tannin, flavonoid, and terpenoid, this study's findings are consistent with those of Aboaba *et al.* [27] who reported that clove extract possessed a broad spectrum of antibacterial action for both bacteria and fungi.

The values of saponin, alkaloid and hydrogen cyanide were within the range reported for ripe seeds of *Carica papaya* as reported by Kolu *et al.* [13] but the value of 83.12 mg/100g observed for tannin for the unripe seed of *Carica papaya* was higher than the range of 52.92-66.50 mg/100g reported by Kolu *et al* [13] for ripe seeds of *Carica papaya.* This variation could be as a result of the unripe status of the *Carica papaya* used in this present study.

According to the result of this study, the mineral analysis of the seeds of unripe fruits of *Carica papaya* contained some important essential minerals such as; calcium (0.39%), potassium (0.11%), magnesium (0.13%), sodium (0.04%), phosphorous (5.71mg/kg), manganese (26.91 mg/kg) and iron (1052.59 mg/kg). The presence of such minerals in the seeds of unripe fruits of *Carica papaya* could be utilized as nutritionally valuable ingredient for feed and possible replacement for commercial mineral premix.

The mineral elements contained in these unripe seeds are very important in animal nutrition. Sodium, potassium, calcium and magnesium play a central role in the normal regulation of blood pressure [28]. They could also be valuable in improving immune system and preventing malnutrition related diseases. Mineral elements are required for normal growth, activities of muscles and skeletal development (such as calcium), cellular activity and transport of oxygen (copper and iron), chemical react ion in the body and intestinal absorption (magnesium), fluid balance and nerve transmission (sodium and potassium), as well as the regulation of acid-base balance (phosphorus). Iron is useful in prevent ion of anemia and other related diseases [29]. Manganese plays a role in energy production and in supporting the immune system [30]. The values observed for calcium, magnesium, potassium, sodium and phosphorus were in agreement with the ranges observed by Kolu *et al* [13] for ripe seeds of *Carica papaya.* The proximity of the mineral contents to the ripe seeds might be due to little morphological change.

However, there was variation as the values observed for manganese and iron were significantly higher than the values of 31.21-32.62 mg/kg and 486.97-850.31 mg/kg for manganese and iron respectively as reported by Kolu *et al* [13].

The values of vitamins (A, B1, B2, B3, B6, B12 and C) analysed are in proximity with the ranges observed for the seeds of ripe fruits of *Carica papaya* as reported by Kolu *et al* [13]. This however suggests the potentials of the unripe seeds of *Carica papaya* as possible replacement for commercial vitamin premix especially for monogastric animals.

CONCLUSION

It can be concluded that the seeds of unripe fruits of *Carica papaya* have rich proximate, vitamins, minerals and phytochemical compositions. The phytochemical components of the seeds of unripe fruits of *Carica papaya* contain alkaloid, saponins, tannin and hydrogen cyanide. The results of the proximate and mineral indicated the presence of considerable amount of

nutrients. The presence of the phytochemicals has authenticated its usefulness for therapeutic purposes and to boost immunity in livestock. In addition to that, the presence of nutrients proves that the seeds of unripe fruits of *Carica papaya* can be used as supplements in livestock nutrition and potential replacement for commercial vitamin/mineral premix.

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