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Potentials of ripe *Carica papaya* seed meal using different processing methods as alternative feed ingredients in monogastric animal nutrition

Kolu, P., Olumide, M.D. and *Akintunde, A.O.

Department of Agriculture & Industrial Technology, Babcock University, Ilishan-Remo, Ogun State, Nigeria.

***Corresponding Author:** adeyinka.akintunde@gmail.com, https://orcid.org/0000-0002-6013-0902*

***Target Audience:** Animal Scientists, Processors, Farmers*

Abstract

Phytomedicinal plants include various types of plants used in place of antibiotics or other synthetic drugs in order to reduce the residual effects of drugs on man hence the clamour for organic livestock. Carica papaya is one of such plants that are underutilized as the seeds of the fruits waste on a yearly basis especially in Africa as the focus of many consumers are on ripe fruits of Carica papaya. Ripe fruits of Carica papaya were obtained from Ilishan-Remo environs in Ogun State, Nigeria and the seeds were carefully removed and processed by sun-drying and oven drying. The data were subjected to t-test. The phytochemical analyses, proximate composition, vitamin and mineral concentrations were determined using standard procedures. The proximate composition of sun-dried and oven-dried seeds of ripe Carica papaya were significantly different ($p<0.05$) while the oven-dried samples had significantly higher ($p<0.05$) crude fat, ash and crude fibre. The phytochemicals were significantly different ($p<0.05$) from each other such that the values are saponin (8.14mg/100g and 5.54mg/100g), alkaloid (7.18mg/100g and 5.00mg/100g), hydrogen cyanide (0.64mg/100g and 0.26mg/100g), tannin (52.92mg/100g and 66.50mg/100g) for the sun-dried and oven-dried seed samples of Carica papaya. The sun dried and oven-dried seeds of Carica papaya fruits contained essential minerals which are significantly different ($p<0.05$) from each other. The sun-dried samples however had significantly higher ($p<0.05$) vitamins A, B1 and B6. The nutrient composition of Carica papaya seed meal revealed that it contains some bioactive components which can serve as feed supplements in animal production and improve human health.

***Keywords:** Carica papaya, Processing, Feed resources, Alternative*

Description of Problem

Nutritionists are becoming increasingly interested in agro-industrial by-products as poultry feed ingredients. In order to combat environmental contamination and high poultry feed costs, the use of agro-industrial by-products as feed ingredients is beneficial to environmental health and long-term poultry production (1). Due to its large quantities of crude protein, fat, and ash, papaya (*Carica papaya L.*) seed is one of the agro-industrial by-products that has been used in poultry rations (2). For poultry, papaya seed has certain functional properties that can serve as growth promoters (3), anti-microbial and antiparasitic factors (4, 5, 6), immunomodulatory and anti-inflammatory agents (7, 8). Taking these facts into account, papaya seed may be used as a feed ingredient to minimize feed costs as well as a practical feed to improve poultry health and well-being.

Papaya is a tropical fruit that is available all year long (9). New papaya fruit is commonly eaten as a snack or juice. The seeds of papaya are black and trapped in the fruit pulp (7). In general, the seed from ripe papaya is considered a by-product and accounts for around 16 percent of the fresh fruit weight.

The abundance of papaya by-products throughout the year and the lower economic value of papaya seed have sparked interest in using them as a possible substitute feed ingredient and usable feedstuff for monogastric animals. The current study evaluates the nutritional contents of ripe papaya seed, the potential of papaya seed as an alternative to traditional feed ingredient, the growth promoting impact of feeding papaya seed, the vitamins and mineral contents, and antioxidative potential of papaya seed.

Materials and Methods

Experimental site

The study was conducted at the Animal Laboratory of the Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State, Nigeria.

Freshly ripe *Carica papaya* fruits were purchased from the market around Ilishan-Remo, Ogun State, Nigeria.

Samples Preparation

The ripe pawpaw fruits were thoroughly washed in clean water before being cut longitudinally into two equal sections with a home-made knife. The seeds were carefully removed from the pulp and washed in clean water. After that, the newly collected seeds were divided into two groups. A part of the *Carica papaya* seeds was spread out in the shade to dry in the sun at 35^{o}C for 3-5 days, while the other portion was well arranged and put in the oven at105^{o}C.

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 (10). All of the tests were done in duplicates. The percentages were used to report the proximate values. The moisture content of *Carica papaya* seed samples (5 grams each) was determined by weighing in a crucible and drying in an oven at 105^{o}C until a constant weight was obtained. Ashing at 550^{o}C for around 3 hours was used to determine ash content. The protein content was calculated using the Kjeldah method (10), which involved multiplying the nitrogen value by a conversion factor (6.25). The samples' crude fibre content was calculated using the digestion method, and the lipid content was determined using the Soxhlet extraction method (10). The difference between the aggregate of all the proximate composition and 100 percent was used to calculate total soluble carbohydrate.

Mineral analysis

The atomic absorption spectrophotometer (AAS-Buck 205) was used to determine the mineral contents (elements) of *Carica papaya* seed: calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu), as defined by the Association of Official Analytical Chemists (10). Phosphorus was measured using a colorimetric process (10). All of the tests were carried out twice. Sodium, iron, zinc, phosphorus, manganese, and copper were measured in parts per million, while calcium, magnesium, and potassium were measured in percentages (ppm).

Phytochemical analysis and anti-nutrients

The methods of Sofowora (11) were used to assess qualitative and quantitative

phytochemical analyses of anti-nutrients. All of the tests were done in duplicates

Statistical analysis

Using SPSS Version 22, all data was analyzed using descriptive statistics and t-tests. The mean and standard deviation were measured as statistical values.

Results and Discussion

Proximate and mineral composition of *Carica papaya* Seed (Sun-dried and Oven-Dried Samples)

Table-1 showed the results of proximate analysis of the seeds of ripe *Carica papaya* fruits. The results revealed that the sun-dried and oven-dried seeds of ripe *Carica papaya* fruits contained appreciable amounts of crude fat (27.50% and 29.50% respectively), ash content (11.20% and 15.02% respectively) and crude fibre (23.20% and 28.30% respectively) but low amounts of crude protein (8.63% and 6.58% respectively) and carbohydrate (29.47% and 20.60% respectively)

Table 1: Nutrient composition of ripe *Carica papaya seeds*

Test	Sun-dried samples	Oven-dried samples	Level of significance ($p<0.05$)
Crude Protein (%)	8.63±0.18	6.58±0.11	*
Crude Fibre (%)	23.20	28.30	*
Crude Fat (Lipid) (%)	27.50	29.50	*
Ash Content (%)	11.20	15.02	*
Moisture (%)	3.50	0.50	*
Carbohydrate (%)	29.47	20.60	*

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

Phytochemical composition and anti-nutrients

Table 2. Phytochemical screening of sun-dried and oven-dried *Carica papaya* seed

Test	Sun-dried samples	Oven-dried samples
Terpenoids	++	++
Steroids and Phytosterols	-	-
Tanins	+++	++
Alkaloids	++	++
Cardiacglycosides	++	+
Phenols	+++	++
Flavonoid	++	+++

+++ = Abundantly present; ++ = Moderately present; + = Slightly present; - =Absent

Table-3 showed that the sun-dried and oven-dried samples of *Carica papaya* seeds contained saponin (8.14mg/100g and 5.54mg/100g), alkaloid (7.18mg/100g and 5.00mg/100g), hydrogen cyanide (0.64mg/100g and 0.26mg/100g), tannin (52.92mg/100g and 66.50mg/100g). There was significant difference ($p<0.05$) between the different processing methods employed. The saponin, alkaloid and hydrogen cyanide contents were significantly higher ($p<0.05$) in sun-dried samples when compared to the oven-dried samples.

Table 3: Phytochemicals of sun-dried and oven-dried *Carica papaya* seeds

Test	Sun-dried samples	Oven-dried samples	Level of significance (p<0.05)
Saponin (mg/100g)	8.14±0.03	5.54±0.08	*
Alkaloid (mg/100g)	7.18±0.04	5.00±0.02	*
HCN (mg/100g)	0.64±0.02	0.26±0.01	*
Tannin (mg/100g)	52.92±0.04	66.50±0.02	*
Flavonoid	26.82mg/g	33.36mg/g	*
Phenolic	116.42mg/g	147.12mg/g	*

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

Table 4 showed that the sun dried and dried seeds of *Carica papaya* fruits contained essential minerals, Calcium (0.15% and 0.42%), Magnesium (0.15% and 0.22%), Potassium (0.15% and 0.07%), Sodium (0.08% and 0.05%), Phosphorus (0mg/Kg and 9.65mg/Kg), Manganese (31.21mg/Kg and 32.62mg/Kg) and Iron (486.97mg/Kg and 850.31mg/Kg). The minerals contents of the sun-dried and oven-dried seeds of *Carica papaya* fruits are however significantly different ($p<0.05$) from each other. This implies that the processing methods significantly influenced ($p<0.05$) the mineral composition thus, the oven-dried samples have significantly higher ($p<0.05$) concentration of the minerals.

Table 4: Mineral composition of ripe and unripe seeds of *Carica papaya* fruits

Test	Sun-dried samples	Oven-dried samples	Level of significance (p<0.05)
Ca, %	0.15±0	0.42±0	*
Mg, %	0.15±0	0.22±0	*
K, %	0.15±0	0.07±0	*
Na, %	0.08±0	0.05±0	*
P, mg/kg	0±0	9.65±0.01	*
Mn, mg/kg	31.21±0.01	32.62±0.02	*
Fe, mg/kg	486.97±0.02	850.31±0.01	*

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

***Legend:** Ca – Calcium, Mg – Magnesium, K – Potassium, Na – Sodium, P – Phosphorus, Mn – Manganese, Fe - Iron

Vitamin composition

Table 5 showed that the sun-dried and oven-dried seed samples of ripe *Carica papaya* fruits contained Vitamin A (2266IU/Kg and 1897IU/Kg), Vitamin B_1 (1.57mg/100g and 1.39mg/100g), Vitamin B_2 (0.75mg/100g and 0.81mg/Kg), Vitamin B_3 (3.88mg/100g and 3.90mg/100g), Vitamin B_6 (1.88mg/100g and 1.49mg/100g), Vitamin B_{12} (0.76mg/100g and 0.77mg/100g) and Vitamin C (7.51mg/100g and 7.84mg/100g). The sun-dried samples however had significantly higher ($p<0.05$) vitamins A, B1 and B6.

Table 5: Vitamin composition of sun-dried and oven-dried samples of ripe *Carica papaya* seeds

Parameter	Sun-dried samples	Oven-dried samples	Level of significance (p<0.05)
Vitamin A (IU/Kg)	2266±1.41	1897±2.83	*
Vitamin B1 (mg/100g)	1.57±0.01	1.39±0.01	*
Vitamin B2 (mg/100g)	0.75±0.01	0.81±0.02	NS
Vitamin B3 (mg/100g)	3.88±0.01	3.90±0.01	NS
Vitamin B6 (mg/100g)	1.88±0.01	1.49±0.01	*
Vitamin B12 (mg/100g)	0.76±0.01	0.77±0.01	NS
Vitamin C (mg/100g)	7.51±0.03	7.84±0.03	NS

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

Discussion

Seeds that had been sundried had a moisture level of 3.50%, while oven-dried samples had a moisture content of 0.050%. Low moisture content indicates a long shelf life, particularly for goods that are properly packed against external conditions. The protein content of ripe papaya seeds that had been sundried and oven dried was 8.63% and 6.58%, respectively, demonstrating that oven-dried papaya seeds had more protein. Protein is a necessary component of the food for the survival of both animals and humans, and its primary job is to deliver the requisite amount (12). The protein content of seeds processed in both ways is higher than that reported by (13) on the change in nutrient content of popcorn and groundnut composite flours subjected to solid substrate fermentation, as well as (14) on the chemical composition of sesame seeds and oils grown in Congo-Brazzaville. Fibre, according to (15), aids in human health maintenance and has been shown to lower cholesterol levels in the body. High-fiber diets widen the interior wall of the colon, allowing waste to move through and preventing constipation. Fibre also lowers the risk of cancer and intestinal disorders, as well as improving overall health and well-being. According to (16), the ash of food samples can be used to determine the organic content from which the mineral content can be derived. Both processing procedures resulted in a large level of ash in papaya seeds (11.20% and 15.02% respectively). The current study's ash content of papaya seeds utilizing both processing procedures is higher than the 6.51% reported by (17) and the 7.86% reported by Bello et al (2008). Sundried and oven-dried seeds samples had fat contents of 27.50% and 29.50%, respectively, indicating papaya seeds as an excellent source of oil that can be used as an energy source, particularly for poultry. This opens up the possibility of substituting papaya seed oil for palm oil in poultry nutrition. Using both processing procedures, the carbohydrate content of the sun dried and oven dried seeds of *Carica papaya* were 29.47% and 20.60% respectively. The result (29.47%) obtained from sun-dried seed of ripe *Carica papaya* is greater than that provided by (18) (26.00 percent) but the value for oven-dried seeds of *Carica papaya* was a little bit lower than the value reported by (18), implying that papaya seeds can be regarded considerably an alternate source of carbohydrate for energy in combination with other carbohydrate or energy sources.

Table 2 shows the results of selected mineral content of sundried and oven-dried seeds of ripe papaya fruits. Calcium helps to

keep bones and teeth healthy. Calcium is also used by cells to activate enzymes and aids in the movement of ions across the cellular membrane, as well as keeping a regular heartbeat. As a result, the oven-dried ripe papaya seeds could be used as a calcium source for cattle. The potassium content of both sundried and oven-dried ripe papaya seeds was low (0.15% and 0.07% respectively). These figures are greater than those published in a similar study by (19). Potassium has been discovered to be a vital component in the body's cellular and electrical functions. Iron is stated to be a crucial nutrient that pregnant women, nursing mothers, newborns, convulsing patients, and the elderly need in their diets to avoid anemia and other disorders (20). Iron is also a critical mineral for pregnant and lactating animals. Both sundried and oven-dried papaya seeds had iron content of 486.97 mg/kg and 850.31 mg/kg, respectively. As a result, the oven-dried samples provide a better source of iron for livestock.

Papaya is low in Saturated Fat, Cholesterol, and Sodium as claimed by (20), and the findings supported this claim. It is high in dietary fiber and potassium, and it's especially high in Vitamin A, Vitamin C, and folate. (21) also stated that vitamin C is one of papaya's strong points, with a whopping 144 percent of the daily recommended value per serving, making it an excellent infection fighter as well as a free radical-scavenging antioxidant, which further supported the high values obtained in this study for both sun-dried and oven-dried seeds of *Carica papaya* fruit.

Other vitamins (aside from vitamin C) found in papaya, according to (21), include 31 percent of the daily value in vitamin A, which is needed for healthy skin, mucous membranes, and vision, and is notably beneficial against macular degeneration. Papaya contains 13% of the daily recommended folate, as well as good amounts of fibre and potassium, a cell and body fluid component that helps control heart rate and blood pressure, and this is in line with the high Vitamin A values found in this study, indicating that it is a good source of vitamins in monogastric animal production.

The B vitamins found in papayas, such as folic acid, pyridoxine (vitamin B6), riboflavin, and thiamin (vitamin B1), are dubbed "essential" because they are needed by the body but not created by it, therefore they must be obtained through the diet to provide what needs to be digested. Papaya is a natural medicine for a variety of conditions, including atherosclerosis, heart disease, and rheumatoid arthritis, and it aids in the maintenance of a healthy digestive and immunological system. Papaya also includes beta carotene, a flavonoid that has been shown in trials to help protect against lung and oral cancers. Other flavonoids, such as lutein, zeaxanthin, and cryptoxanthins, are powerful antioxidants that fight free radicals, which can wear down your body and cause premature aging and degenerative disease (21).

Conclusion and Applications

1. It can be concluded from this study that both the sun-dried and oven-dried seeds of ripe *Carica papaya* hold good potential as dietary nutrient source in livestock production and therapeutic purpose to further facilitate the choice or preference for organic animal production.
2. The seeds of ripe fruit of *Carica papaya* can thus be safely included in the diets of livestock for optimum performance.

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