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Nutritive Value of Raw and Processed Jack Fruit Seeds (*Artocarpus heterophyllus*): Chemical Analysis

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Abstract: The nutritive value of raw and processed jackfruit seeds was investigated using the following parameters-proximate composition, gross energy, mineral composition and anti-nutritional factors. The raw seeds were cooked for 20, 40 and 60 min, respectively. Both the raw and processed seeds were later dried, milled and chemically analyzed. The raw seeds had values that were significantly ($p<0.05$) higher with the exception of dry matter for all the parameters considered for proximate composition and energy content. For mineral content of processed seeds, those subjected to 60 min duration of cooking had the highest value for both macro and micro minerals. Also, seeds subjected to 60 min of cooking had the highest percentage reduction in all the anti-nutritional factors with 49.72% reduction in phytin, 32.98% reduction in tannin, 50% reduction in oxalate, 44.25% reduction in saponin and 100% reduction in trypsin inhibitors. With appreciable value of crude protein (22.92%), energy content of 2.92kcal g^{-1}, better values for macro and micro minerals and highest percentage reduction in all the anti-nutritional factors for the seeds cooked for 60 min, 60 min of cooking is therefore recommended for usage in livestock and poultry nutrition.

Key words: Nutritive value, raw, processed, jackfruit seeds, chemical analysis

INTRODUCTION

Feed accounts for about 70-80%of total cost of production in livestock and poultry[1]. Convectional energy and protein sources are the costliest among the feed ingredients[2,3]. The need then to search for alternative cheap energy and protein sources, one of the envisaged alternative feed stuffs is jackfruit seeds (*Artrocharpus heterophyllus*)[4].

It belongs to family Moraceae. It is also called jackfruit, jak, jaca and in Malaysia and Philippines, nangkas, in Thailand Khanun. It is adapted only to humid tropical and near tropical climates. Yield of about 500 fruit per tree annually has been reported[4]. It is a food prized in some areas of the world. (India and Malaysia) and a waste in others (Nigeria). Food value per 100 g of edible portion of fresh seeds for crude proteins is 6.6 g, fat 0.4 g, Carbohydrates 38.4 g; fiber 1.5 g, ash 1.25 g-1.50 g and moisture, 51.6-57.77 g[4]. Information on food value per 100 g of edible portion of dried seeds is scanty. Presence of anti-nutritional factors such as tannin and trypsin inhibitor has been reported, resulting in digestive ailment when eaten raw[4]. Also wet heat treatment has been reported to be effective in detoxifying trypsin inhibitor in particular. Cooking is a common and acceptable means of detoxification among the rural dwellers in humid tropical part of Nigeria. Hence its usage as a means of detoxification. The objective of this study is to determine the nutritive value of jackfruit seeds using proximate composition, gross energy, mineral composition and anti-nutritional factors of both raw and seeds subjected to different duration of cooking.

MATERIALS AND METHODS

Analytical procedure: Proximate composition, mineral composition and gross energy determination, the proximate constituents of both processed and the raw seeds were determined by the method of the association of official analytical chemists[5]. The sodium and potassium contents were determined by flame photometry while phosphorus was determined by the vanodo-molybdate method[5]. The other mineral elements were determined, after wet digestion with a mixture of nitric acid, H_2SO_4 and HCl using Atomic Absorption spectrophotometer. Gross energy of the dried materials was determined using bomb calorimeter[5].

Tannic acid: The tannic acid in the test feedstuffs was determined according to the method of Maga[6]. Thus 2 g

of each sample were weighed into a beaker. Each was soaked with solvent mixture (80 mLs of acetone and 20 mL of glacial acetic acid) for 5 h to extract tannin. Each filtrate was in water bath for 4 h, after which the filtrates were removed. The samples were filtered through double layer filter paper to obtain the filtrate.

A set of standard solution of tannic acid was prepared ranging from 10ppm to 50ppm. The absorbance of the standard solution as well as that of the filtrates was read at 50 nm on a specteromic 20. The percentage tannin was calculated using the formular:

$$\% \text{ Tannin} = \frac{\text{Absorbance X Average gradient X Dilution factor}}{100}$$

Phytic acid: The phytic acid was determined using the procedure described by Lucas and Markakas[7]. This entails the weighing of 2g of each sample into 250 mLs conical flask. 100 mLs of 2% concentrated hydrochloric acid was used to soak each sample in the conical flask for 3 h. This was filtered through a double layer of hardened filter papers. 50 mLs of each filtrate was placed in 250 mks beaker and 107 mLs of distilled waster was added in each case to give proper acidity.

10 mLs of 0.3% Ammonium thiocyanate solution was added into each solution as indicator. This was titrated with standard iron, chloride solution, which contained 0.00195g iron per ml. The end point was slightly brownish-yellow persisted for 5 min. The percentage phytic acid was calculated using the formula:

$$\% \text{ phytic acid} = \text{♀ X } 1.19 \text{ X } 100$$

Where X = Titre value X 0.00195 g.

Oxalate estimation /determination: Oxalate determination was carried out as described by Fasset[8]. 2 g of sample was boiled in 40 mL of water for 30 min in a reflux condenser. 10 mL of 20% Na_2C0_3 was added and boiled for another 30 min. The liquid was extracted and the residue was washed with hot water until the wash water stopped showing any alkaline reaction. The combination of wash water and filtrate were concentrated to a small volume and cooled. With constant stirring, HCl was added (1:1) drop wise until the final acid concentration after neutralization was about 1% at which stage, a heavy precipitate appeared (which was allowed to flocculate). The extract was carefully filtered into a 250 mL flask and made-up to mark. It was kept over-night, then the supernatant liquid was filtered through a dry filter paper in a dry beaker.

An aliquot of this filtrate was taken into a 400 mL beaker, diluted with water to 200 mL and made just ammonia cal and reacitified with acetic acid. In the cold medium, 10 mL of a 10% calcium chloride solution was added and stirred well to induce calcium oxalate precipitate to appear and it was allowed to settle overnight. The clear supernatant liquid was carefully decanted off through whatman No 42 filter paper, without disturbing the precipitate. The precipitate was dissolved in HCl (1:1). Oxalic acid was re-precipitated by adjusting the pH with ammonium hydroxide solution. Contents were boiled and allowed to settle overnight. Oxalic acid was determined by titrating against 0.05N $KMnO_4$ Solution.

Calculation

1ml of 0.05N KMnO4 = 0.00225 an hydrous oxalic acid.

$$\% \text{ Oxalic acid} = \frac{\text{Titre value X } 0.00225}{2}$$

= T.U X 0.1125.

Saponnin: The spectrophotometric method of Brunner[9] was used for saponin analysis. 1g of finely ground sample was weighed into a 250 mL beaker and 100 mL of 150tyl alcohol was added. The mixture was shaken on a UDY shaker for 5 h to ensure uniform mixing. Thereafter, the mixture was filtered through a whatman No 1 filter paper into a 100 mL beaker and 20 mL of 40% saturated solution of magnesium carbonate was added. The mixture obtained with saturated $MgCo_3$ was again filtered through a whatman No 1 filter paper to obtain a clear colourless solution. 1 mL of the colourless solution was pipetted into 50 mL volumetric flask and 2 mL of 5% $FeCl_3$ solution was added and made up to mark with distilled water. It was allowed to stand for.

Determination of trypsin inhibitors: The determination of trypsin inhibitors was carried out according to the procedure outlined by Kakade *et al.*[10]. This involves weighing of 0.2 g of the samples into a screw cap centrifuge tube. 10 mL of 0.1 M phosphate buffer was added and the contents shaken at room temperature for one hour on a UDY shaker. The suspension obtained was centrifuged at 5000 rpm for 5 min and filtered through whatman No 42 filter paper. The volume of each was adjusted to 2 mL with phosphate buffer. The test tubes were placed in water bath, maintained at 37°C. Six millilitres of 5% TCA solution was added at one of the tubes to serve as a blank. 2 mL of casein solution was added to all the tubes, which were previously kept at 37°C. These were incubated for 20 min. The reaction was stopped 30 min for blood red colour to develop. 0-10 ppm standard saponin were prepared from saponin stock solution. The standard solutions were treated similarly with 2 mL of 5% $FeCl_3$ solution as done for 1 mL sample above.

The absorbances of the sample as well as standard saponin solutions were read after colour development on a spectronic 21D spectrophotometer at a wavelength of 380 nm.

$$\% \text{ saponin} = \frac{\text{Absorbance of sample X Gradient factor X Dilution factor}}{\text{wt sample X 10,000}}$$

after 20 min by adding 6ml of TCA solution to the experimental tubes and the tubes were shaken. The reaction was allowed to proceed for 1 h at a room temperature. The mixture was filtered through whatman No 42 filter paper. Absorbance of filtered from sample and trypsin standard solutions were read at 280 mm. The trypsin inhibitors in mg g^{-1} was calculated using the formula:

$$\text{T.I. mg}^{-1}\text{g} = \frac{\text{A standard-A sample X Dilution factor}}{\text{0.1 g X sample wt in g}}$$

$$\text{1000 X sample size}$$

Statistical analysis: The design of the experiment is Completely Randomized Design (CRD). Data collected were subjected to the Analysis of Variance according to the method of Steel and Torrie[11]. Significant means were separated using Duncan Multiple Range Tests[12].

RESULTS AND DISCUSSION

The proximate composition and the gross energy of both raw seeds and seeds subjected to various duration of cooking is as shown in Table 1.

There was significant ($p<0.05$) difference for all the parameters considered. The values for the raw seeds were significantly ($p<0.05$) higher than that of the processed seeds with exception of dry matter and nitrogen free extract. Raw seeds cause digestive ailments in man and probably same in non-ruminant animals due to common gastro intestinal tract shared by man and livestock[4,13]. This explains the emphasis on processed seeds.

The value of processed crude protein decreased significantly ($p<0.05$) as the duration of cooking increased. The decrease in crude protein values as a result of cooking is in line with the observation of earlier reporters[13,14]. This has been attributed to the leaching of nutrients due to cooking. This probably explain why the seeds cooked for 60 min had the lowest value that was significantly ($p<0.05$) different from others (seeds cooked for 20 and 40 min).

3.65% occurred in seeds cooked for 60 min. Despite this, the value is higher than the conventional feedstuffs such as groundnut cake (3.61) E.E and soybean (1.52) E.E.[15] and guinea corn (3.0%) E.E. [16]and alternative envisaged feedstuffs like Comparing the least value 22.92% for the processed seeds with other envisaged alternative leguminous protein sources such as cooked sword bean seeds, cooked bambara groundnut and cooked lima bean having crude protein content of 19.5, 18.85 and 21.5%, respectively as reported by Izundu,[17] and Omoikhoje and Arijeniwa,[18], the jackfruit seeds is a better alternative source for both livestock and poultry.

The crude fiber significantly ($p<0.05$) decreased as duration of cooking increased. This is in agreement with the report of Akinmutimi[19] who reported same in one of the envisaged alternative seeds. The values obtained from the processed seeds were lower than the conventional feedstuffs like soybean meal and groundnut cake with 6.5 and 5% crude fiber, respectively, but higher than some conventional feedstuffs such as maize and guinea corn with 2.0% crude fiber, respectively[16]. The values obtained for the processed seeds tend to be advantageous to monogastric animals especially poultry, knowing fully that they have low ability to handle fibrous materials[19].

The values obtained for ether extract (E.E) and ash followed similar pattern in that they decreased significantly ($p<0.05$) as duration of cooking increased. The least value of cooked *Mucuna utilis* (2.86) E.E.[19] and cooked sword bean (2.89) E.E.[13]. It shows that the seeds could be reckoned with as minor oil seeds.

The ash values obtained for the raw seeds was higher than the earlier worker[4] who reported 2.90%. The difference may be attributed to different sources of the seeds[20]. For the processed seeds, the ash content ranges between 3.68% for seeds cooked for 20 min to 3.39% for seeds cooked for 60 min, making seeds cooked for 20 min to have the highest ash content. When this value is compared with the conventional feedstuff and alternative feedstuffs, it falls within the range. Olomu[15] reported ash content of 6.4% for soybean, 3.1% for broad bean and 3.4% for kidney bean. This suggests the use of seeds cooked for 20 min when the seeds are to be used to supply ash.

The nitrogen free extracts ranges between 57.11% to 50.99% with seeds cooked for 60 min being the highest and the raw seeds the lowest. When compared with conventional and alternative feedstuffs such as groundnut cake (23.84%)[21] soybean meal (28.6%)[15] and *Mucuna utilis* (47.82%)[19], it is slightly higher. This implies higher total digestible nutrient when the seeds are used[22].

Table 1: Proximate composition of cooked jack fruit seeds (*Artocarpus heterophyllus*) (%DM basis)

		Duration of cooking			
Constituents	Raw	20	40	60	± SEM
Dry matter	89.88[c]	89.95[a]	89.91[b]	89.88[c]	0.00
Crude protein	27.57[a]	24.53[b]	23.83[c]	22.93[d]	12
Ether extract	3.06[a]	2.99[b]	2.89[c]	2.88[d]	0.02
Crude fiber	4030[a]	3.99[b]	3.78[c]	3.65[d]	0.03
Ash	4.00[a]	3.68[b]	3.50[c]	3.39[d]	0.02
Nitrogen free extract	50.99[a]	54.76[c]	56.11[b]	57.11[c]	0.00
Gross energy kcal g^{-1}	3.13[a]	2.95[b]	2.93[c]	2.92[c]	0.00

Mean values with different superscripts on the same column differ significantly ($p<0.05$)

Table 2: Mineral composition of both raw and processed jack fruit seed (*Artocarpus heterophyllus*)

Forms	Phosphorus	Iron	Copper	Manganese	Zinc	Calcium	Potassium	Sodium
Raw	0.4667[b]	67.0000[b]	7.0500[b]	28.8500[b]	73.4000[a]	0.09900[a]	1.2100[b]	0.02500[b]
2	0.4100[c]	58.9000[c]	6.4000[c]	26.4500[c]	69.8500[b]	0.09300[c]	1.1267[c]	0.01900[c]
3	0.3600[d]	55.1500[d]	6.2000[c]	22.4500[d]	67.3667[b]	0.09000[c]	1.0600[d]	0.01700[c]
4	0.5500[a]	73.1500[a]	7.9500[a]	33.1500[a]	75.9000[a]	0.11300[a]	1.3567[a]	0.03567[a]
± SEM	0.00	0.44	0.09	0.44	0.83	0.00	0.00	0.00

Mean values with different superscripts on the same column differ significantly ($p<0.05$)

Table 3: Anti nutritional factors of raw and processed jack bean seed (*Artocarpus heterophyllus*)

	Tannin % reduction	Phytin % reduction	Oxalate % reduction	Sapanin % reduction	Trypsin % reduction
Raw	0.09400,[a] –	0.5967[a] –	0.6600[a] –	0.08467[a] –	28.6067a –
2	0.08300,[b] –11.7	0.5000[b] –16.21	0.5600[b] –15.15	0.07100[b] –16.15	0.000[b] 100
3	0.07400[c] –21.28	0.3700[c] –37.99	0.4567[c] –30.80	0.06000[c] –29.14	0.000[b] 100
4	0.0633[d] –32.98	0.3000[d] –49.72	0.3300[d] –50.00	0.05100[d] –44.25	0.000[b] 100
± SEM	0.00	0.00	0.00	0.00	0.00

Mean values with different superscripts on the same column differ significantly ($p<0.05$)

For gross energy, the least value occurred in seeds cooked for 60 min (2.92 kcal g^{-1}). This value compared favourably with other feedstuffs such as groundnut cake 2.64 kcal g^{-1} and boiled jack bean with 2.97 kcal g^{-1} as reported by Ogbonna *et al*.[23,24] , respectively.

Table 2 shows the mineral composition of both raw and processed seeds. For both macro and micro mineral constituents, seeds cooked for 60 min were significantly ($p<0.05$) higher than the raw and processed seeds. This suggests that cooking seeds for 60 min should be considered when the seed is to be used for its mineral composition.

Anti-nutritional factors present in both raw and processed in jack fruit seed is as revealed in Table 3.

The presence of anti-nutritional factors such as tannin, trypsin inhibitors is confirmed[4]. There was general reduction in the content of anti nutritional factors as a result of processing. This reduction increased as cooking period increased and has led to the highest reduction occurring in seeds cooked for 60min with percentage reduction of 100% for trypsin inhibitor, 50% oxalate, 49.72% for phytin, 44.25% saponin and 32.98% tannin.

The 100% reduction in trypsin confirms the report of earlier workers that heat treatment completely destroys trypsin inhibitor[25,26,13]. This implies that protein digestibility will not be hindered when heat-treated seeds are fed to livestock and poultry. Also, problem of pancreatic hypertrophy due to trypsin inhibitors cannot exist[26].

The 50% reduction for oxalate shows the degree of themolability of oxalate. This implies that feeding of this seed meal can result in insoluble complex of calcium oxalate which has been reported to cause irritation of the body in raw cocoyam; and this perhaps may result in irritation of the gut, thereby resulting in low feed intake and its attendant problems[15]. This also can result in deficiency of calcium, leading to poor bone formation and energy metabolism particularly regulation of pyruvate dehydrogenase complex enzyme in the conversion of pyruvate to acetyl CoA[27].

The phytin reduction followed similar trend like that of oxalate with highest reduction occurring in 60 min (49.72%), this shows some degree of thermostability. Its usage may still result in formation of insoluble salt with minerals like calcium and magnesium making them unavailable for metabolic processes. Magnesium for example is required as a co-factor for the conversion of glucose to glucose-6 phosphate, a major step in glycolysis[27,28].

Saponin also followed the same trend like oxalate and phytin, with the highest reduction of 44.25% occurring in seeds cooked for 60 min. This therefore, does not rule out its deleterious effect such as bitter taste, foaming

properties and heamolytic effect on red blood cells, particularly when this seed meal (cooked for 60 min) is fed at high percentage[15].

The least reduction of anti-nutritional content occurred in tannin with 32.98% reduction. This confirms the themostability of tannin[29,30]. Poor detoxification of tannin by cooking has being reported[13]. This he attributed to inability of cooking to hydrolyze the intra molecular forces that exist within tannin. He also reported that the use of the seeds in diet formulation will result in formation of complex linkage with protein by tannin leading to loss of protein and its attendant poor growth.

CONCLUSION

In conclusion, with appreciable value of 22.92% for CP and energy content of 2.92kcal g, better values for both macro and micro minerals and highest percentage reduction in all the anti nutritional factors for the seeds cooked for 60 min, 60 min of cooking is therefore recommended. It is believed that the usage of the seeds cooked for 60 min will reduce the quantity of conventional energy and protein sources thereby reducing the cost of production and unit price of animal products, making animal protein more affordable, leading to an increase in animal protein intake in tropical part of Nigeria.

RECOMMENDATION

Further investigation on processing methods that can enhance the reduction of anti nutritional factors to barest minimum, if not complete removal to enhance better utilization of jack fruit seeds in livestock and poultry nutrition should be carried out.

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