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# THE NUTRITIONAL COMPOSITION OF DIFFERENTLY PROCESSED ICACINA MANNII (EARTH BALL) MEALS

**By**

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***Abstract***

*This study investigated the nutritional composition of differently processed Icacina mannii (earth ball) meals. The fresh Icacina mannii tubers were harvested, washed, peeled, milled and divided into four portions. A portion each was sundried, oiled, toasted and fermented and hereby referred to as SIM (Sundried Icacina mannii meal), OIM (Oiled Icacina mannii meal), TIM (Toasted Icacina mannii meal), and FIM (Fermented Icacina mannii meal). They were analysed for their: proximate, minerals, antinutrients, and fibre fraction compositions. The results obtained from proximate analysis revealed significant (P<0.05) differences among the treatments except for the gross energy content. The crude protein content ranged from 5.60% in OIM to 6.29% in TIM. Fat content ranged between 2.24% in FIM and 7.13% in OIM. The crude fibre ranged from 7.38 to 8.72%. The ash content ranged between 3.95 and 9.97%. FIM had the highest and the least values for nitrogen free extract (70.50%) and dry matter (90.25%) respectively. The gross energy (3.21 - 3.58 kcal/g) and manganese (0.48 – 0.52 mg/100g) were similar across treatments. The antinutrients (tannins, phytates, oxalates and hydrogen cyanide), macro and micro minerals analysed revealed that all the parameters measured were significantly (P<0.05) higher in OIM while the other processed methods also contained appreciable amount. TIM had the highest value of galactosamine. The fibre fraction decreases with the different processing methods, being lowest in OIM. From the results Icacina mannii should be processed before being used as a substitute for maize in animal feed most especially the fermented and sundried methods that helps in the reduction of hydrogen cyanide and galactosamine which are the most dangerous antinutrients in Icacina mannii tubers.*

***Keywords:*** *Icacina mannii meal, sundried, processing, antinutrients and nutrient composition*.

## INTRODUCTION

The goal of livestock production is the attainment of sustainable production and maximum returns. This has however been difficult to achieve due to high cost of feed and feed ingredients (Adeniyi and Balogun, 2002). Maize is a major ingredient in the poultry diets, and its availability and price are influenced by competition between man, industry and livestock. According to Dei *et al. (*2011) maize makes up to 40-70% of the bulk of poultry feeds, as it is the major energy source used in the poultry industry. The cost of maize has increased considerably in recent years due to competition with the human food industry, increased production of biofuel and droughts in some parts of Africa (USDA, 2015).

However, the exploration of other potential energy feed resources for the poultry industry has become very important research option to address the urgent need for alternative replacement that will arrest the high cost of maize. An effort to tackle this issue requires the use of non-conventional feed ingredient such as *Icacina mannii*, commonly known as false yam or bush yam, as an alternative dietary source of energy for non- ruminants, Dei *et al. (*2011).

The proximate analysis reported by Umoren *et al.* (2007) showed that the raw tuber contained 5.60%, crude protein,

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16% crude fibre, 3.60% either extract and 12% ash. The authors also gave 2276.86 Kcal/kg as the metabolizable energy of the raw *I. manni*. Umoren *et al*., (2008) noted that the raw *I. manni* is rich in macro minerals like calcium (0.11mg/g), magnesium (0.09mg/g), sodium (0,18mg/g), potassium (0.97mg/g), copper (1.00mg/g), iron (0.17mg/g) and manganese (0,09mg/100g).

Consequently, its nutritional potential is limited by the presence of certain anti-nutritional factors as reported by (Effiong *et al*., 2017 and Effiong and Akpan, 2017; Umoren *et al*., 2008) such as hydrogen cyanide acid, phytates, oxalates, and tannins with which may reduce nutrient availability or exhibit toxic effects when consumed in excess (Cheeke and Shull, 1985). Ekpo and Udebibie (2012) also reported that *Icacina mannii* contains gummy substances such as galactosamine that limits or reduces it digestibility when consumed by animals. These compounds, though naturally occurring can be effectively minimized through various processing methods such as soaking, boiling, fermentation or charcoal treatments (Dei *et al.* 2015). Among these methods, soaking has been established as the best approach to the removal of the anti-nutritional elements from false yam as the soaking technique reduces the antinutritional elements in the false yam while improving the nutritional quality (Dei *et al*., 2015).

Evaluating the proximate, mineral, and antinutrient composition of *Icacina manni* tubers is essential for determining their nutritional value, assessing processing efficiency and promoting their use as a sustainable food source in Nigeria and beyond. Therefore, to enhance utilisation, processing methods such as sundried *Icacina mannii* meal, *Icacina mannii* meal pressed with oil (IPO), *Icacina mannii* meal pressed and toasted (IPT) and fermented and pressed *Icacina mannii* meal (FPI) become necessary to investigate which will further eliminate or reduce the anti-nutritional factors that limit its use as animal feed ingredient. This research was therefore aimed at investigating the proximate, minerals, anti-nutritional factors and fibre fraction composition of the raw and differently processed *Icacina mannii* meals.

## 2 Materials and Methods

### 2.1 **Processing of *Icacina mannii***

The fresh *Icacina mannii* tubers were harvested and processed into four different forms namely, sundried *Icacina mannii* meal, oiled *Icacina mannii* meal (OIM), toasted *Icacina mannii* meal (TIM) and fermented *Icacina mannii* meal (FIM) for analysis of proximate, minerals anti- nutrients and fibre fraction composition. Preparation was carried out according to the method reported by Ndife *et al*. (2019).

Sundried *Icacina mannii* meal (SIM) was prepared by peeling fresh *Icacina mannii* tubers to remove the stalk using knife, sliced, thoroughly washed and grated into fine mash using a grating machine. The grated tubers were put into a clean jute bag and with a jack, force was applied between wooden platforms and left for 48 hours to remove excess water and then dried in the sun for two days and hand mashed and kept prior to feed compounding.

The oiled and dried *Icacina mannii* meal (OIM) was prepared by getting fresh *Icacina mannii* tubers which were peeled, sliced, thoroughly washed and grated with a grating machine. 20mls of palm oil was added per kg of *Icacina mannii* meal mashed and mixed thoroughly. The mixed *Icacina mannii* meal mashed was put in sacks to allow for escape of extra water and with a jack, force was applied between wooden platforms to remove excess water until the grated mash crumble for 12 hours. The mash was dried and hand mashed with home-made sieve to obtain *Icacina mannii* meal pressed with oil and kept prior to feed compounding.

Toasted *Icacina mannii* meal (TIM) was prepared by procuring fresh *Icacina mannii* tubers which were peeled, sliced, thoroughly washed and grated with a grating machine to crush the tubers into fine mash. The grated tuber was put in sacks and with a jack, force was applied between wooden platforms to remove excess water. The mash was sieved with a traditional sieve made of splinters of cane. After sieving, it was toasted traditionally in earthen pot over fire for 45 minutes at $60^0$C. After toasting, the toasted product was air dried to remove excess heat from the 'garri form" of *Icacina mannii* meal. A simple home-made sieve was used to sieve the toasted product to remove lumps. This was done to obtain high quality free flowing products and kept prior to feed compounding.

Fermented Icacina *mannii* meal (FIM) was prepared by fermenting fresh *Icacina mannii* tubers anaerobically according to the procedure reported by Umoren *et al*. (2007). The fresh *Icacina mannii* tubers were peeled, sliced, thoroughly washed, then put in a basin filled with water and left for 72 hours (3 days) to ferment at an optimum temperature of $35^0$C. Thereafter, it was grated with a grating machine. The grated tuber was put in sacks and with a jack, force was applied between wooden platforms and left for 12 hours to drain out excess water. The *Icacina mannii* meal was hand mashed with home-made sieve to obtain FPI and kept prior to feed compounding.

### 2.2 Laboratory Evaluation of processed *Icacina mannii*

Samples of the differently processed *Icacina mannii* meals were analysed for their proximate composition (AOAC, 2005) and the gross energy was determined using the Gallenkamp Ballistic Calorimeter. The tannin, phytate, oxalate and hydrogen cyanide respectively were determined using the non-laborious spectrophotometric method of Bradbury *et al.* (1999) and Maya (1982).

### 2.3 Data Analysis

The data collected were subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980). The means were separated using the Duncan's Multiple Range Test as described by Duncan (1955).

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## 3.0 RESULTS AND DISCUSSION

### 3.1 Proximate composition of the differently processed *Icacina mannii* meals

The proximate composition of the differently processed *Icacina mannii* meals is presented in Table 1. The statistical analysis revealed that significant (P<0.05) differences existed among the differently processed *Icacina mannii* meals for all the parameters measured. The fermented *Icacina mannii* meal had the least dry matter content value (90.25%) while oiled *Icacina manni* meal had the highest dry matter content of 91.91%.

The crude protein content values obtained ranged from 5.60 to 6.29%. The highest value was recorded for toasted *Icacina mannii* meal and the least value for oiled *Icacina manni* meal. The crude protein values reported in this study fell within the range (4.58 - 6.25%) reported by Ekeno (2014) in the study of performance of broiler birds fed raw and processed *Icacina mannii* (earth ball) and Umoren *et al*. (2007) who reported crude protein value of 5.60%. The result of this study is also in line with the findings of Effiong and Jimmy (2019) who reported that toasting could serve as an alternative method of processing *Icacina mannii* meal for poultry feeding as toasted *Icacina mannii* meal had the highest crude protein of 6.29%.

The fat content values recorded were between 2.24 and 7.13%. Oiled *Icacina manni* meal and fermented Icacina *mannii* meal had the highest and the least values respectively. The addition of oil to *Icacina mannii* meal increases the fat content because oil is made up almost entirely of lipids (fat and fatty acids). This result agrees with the findings of Ndife *et al.* (2019) who reported that addition of oil during processing of cassava tubers increased the lipid content. It is also in line with the findings of Asegbeloyin and Onyimonyi (2007) who also reported that the addition of oil during processing of cassava tubers increased the lipid content.

The sundried *Icacina mannii* meal had the highest crude fibre content (8.72%) while oiled *Icacina manni* meal had the least value (7.38%). The high crude fibre content recorded by the sundried *Icacina mannii* meal could be attributed to the processing method since sun drying is a mild process and there is no microbial or intense heat to break down the fibrous cell wall materials therefore, the cellulose and lignin in the tuber remain largely intact, resulting in high crude fibre content.

The ash content of the oiled *Icacina manni* meal (9.87%) was the highest while the toasted *Icacina mannii* meal had the least value (3.95%). Addition of oil to *Icacina mannii* meal increases the ash content as recorded in the result and was higher than the recommended maximum of 2.75% (Makanjuola *et al.*, 2012) as ash content of foods is an indication of mineral content (Ndife *et al.*,2019).

The nitrogen free extract content values ranged from 67.93 to 70.50%. The highest value was recorded for fermented Icacina *mannii* meal while oiled *Icacina manni* meal had the least value. The fermented *Icacina mannii* meal had the highest nitrogen free extract while oiled *Icacina manni* meal recorded the least nitrogen free extract which is in line with the report by Ojo *et a*l. (2013) and Karim *et a*l. (2016) that addition of palm oil and enrichment led to the reduction of carbohydrate in garri.

The range of values obtained for the gross energy content was between 3.21 to 3.58kcal/g with oiled *Icacina manni* meal having the highest gross energy value and the lowest values was obtained for sundried *Icacina mannii* meal and fermented Icacina *mannii* meal respectively. Oiled *Icacina manni* meal recorded highest dry matter and energy contents in the study and this may be attributed to the fact that, when oil is added to *Icacina mannii* meal, the total moisture percentage decreases and the proportion of dry components increases thereby resulting in a higher dry matter content and addition of oil raises the total energy density of the meal and provides more calories per unit weight. The energy content of the sample ranged from 3.21 to 3.58 kcal/g.

**Table 1: Proximate composition and gross energy and differently processed *Icacina mannii* meals**

| Processing methods | SIM | OIM | TIM | FIM | SEM |
|---|---|---|---|---|---|
| *Parameters (%):* | | | | | |
| Crude Protein | $5.91^{b}$ | $5.60^{c}$ | $6.29^{a}$ | $5.64^{c}$ | 0.39 |
| Ether Extract | $2.34^{c}$ | $7.13^{a}$ | $2.44^{b}$ | $2.24^{d}$ | 0.58 |
| Crude Fibre | $8.72^{a}$ | $7.38^{d}$ | $8.22^{b}$ | $7.80^{c}$ | 0.41 |
| ASH | $4.22^{b}$ | $9.87^{a}$ | $3.95^{d}$ | $4.07^{c}$ | 0.61 |
| NFE | $69.23^{c}$ | $67.93^{d}$ | $69.70^{b}$ | $70.50^{a}$ | 0.48 |
| Dry Matter | $90.42^{c}$ | $91.91^{a}$ | $90.60^{b}$ | $90.25^{d}$ | 5.56 |
| GE (Kcal/g) | 3.21 | 3.58 | 3.25 | 3.24 | 0.02 |

$^{a-e}$ means in a row with different superscripts are significantly (P<0.05) different. SEM = Standard error of mean, SIM = Sundried *Icacina mannii* meal, TIM =Toasted *Icacina mannii* meal, OIM= Oiled *Icacina mannii* meal FIM = Fermented Icacina *mannii* meal, NFE= Nitrogen free extract, GE= Gross Energy

### 3.2. Mineral composition of differently processed *Icacina mannii* meals

The results of mineral composition of differently processed *Icacina mannii* meals are shown in Table 2. Significant (P<0.05) differences were observed among the differently processed *Icacina mannii* meals for all the parameters measured except for manganese. Oiled *Icacina manni* meal recorded the highest values for all the macro and micro minerals analysed except for zinc, followed by toasted *Icacina*

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*mannii* meal and the least values for the micro minerals were obtained for sundried *Icacina manni*i meal.

The values obtained for sodium varied between 0.020 and 0.030%. and between 0.016% and 0.017% for potassium. The significantly ($p<0.05$) highest value for sodium was recorded for oiled *Icacina manni* meal.

The values obtained for calcium and phosphorus ranged from 0.30 to 0.40% and 0.010 to 0.011% toasted *Icacina manni*i meal had the highest value, while the sundried *Icacina manni*i meal had the lowest value. Toasted *Icacina manni*i meal had the highest value zinc (24.270mg/kg) content while the sundried *Icacina manni*i meal had the lowest value (4.090mg/kg). The highest (1.250mg/kg) and the lowest values (1.110mg/kg) for iron were for oiled *Icacina manni* meal and sundried *Icacina manni*i meal respectively. The range of values obtained for manganese was between 0.480 to 0.520mg/kg with toasted *Icacina manni*i meal and oiled *Icacina manni* meal having the lowest and highest values respectively. The values obtained for copper ranged from 20.1300mg/kg to 14.450mg/kg with sundried *Icacina manni*i meal and oiled *Icacina manni* meal having the lowest and highest values respectively.

The values obtained for macro minerals followed a similar trend with that of micro minerals in which the oiled *Icacina manni* meal (OIM) had the highest values for all the parameters measured. This study shows that oiled *Icacina manni* meal recorded the highest ash content as ash represent the total minerals in the diet and as a source of essential minerals since some oils like palm oil naturally contain minerals like iron, magnesium, phosphorus and carotenoids and this may be the reason why the minerals content was higher in oiled *Icacina manni* meal which aid in supporting bone health, cell metabolism, nerve impulse, blood clotting, red blood cell formation, antioxidant oxygen transport, enzyme function and making the diet more nutritionally balanced. (Fagbuaro *et al.*, 2006: Abulude *et al.,* 2006). This would prevent deficiencies such as anaemia, lameness, enlarged hocks, crooked and shortened legs, nervous disorders, incoordination and haemoglobin deficient red blood cells (NRC, 1998; Hills and Spears, 2001). From the results obtained for both macro and micro minerals indicates that oiled *Icacina manni* meal recorded higher values followed by toasted *Icacina mannii* meals while the sundried had the least values.

**Table 2: Macro and micro minerals composition of differently processed *Icacina mannii* meals**

| Parameters (%) | SIM | OIM | TIM | FIM | SEM |
|---|---|---|---|---|---|
| Sodium (%) | 0.020$^{d}$ | 0.030$^{a}$ | 0.027$^{b}$ | 0.023c | 0.001 |
| Potassium (%) | 0.016$^{b}$ | 0.017$^{a}$ | 0.016$^{b}$ | 0.016$^{b}$ | 0.000 |
| Calcium (%) | 0.030$^{d}$ | 0.043$^{a}$ | 0.040$^{b}$ | 0.037$^{c}$ | 0.001 |
| Phosphorus (%) | 0.010$^{b}$ | 0.011$^{a}$ | 0.011$^{a}$ | 0.011$^{a}$ | 0.001 |
| Zinc (mg/kg) | 4.09 | 6.130$^{b}$ | 24.270$^{a}$ | 4.230$^{c}$ | 2.550 |
| Iron (mg/kg) | 1.110$^{c}$ | 1.250$^{a}$ | 1.160$^{b}$ | 1.150$^{b}$ | 0.016 |
| Manganese (mg/kg) | 0.500 | 0.520 | 0.480 | 0.490 | 0.006 |
| Copper (mg/kg) | 14.450$^{d}$ | 20.130$^{a}$ | 16.750$^{b}$ | 16.300$^{c}$ | 0.618 |

$^{a-e}$ means in a row with different superscripts are significantly (P<0.05) different. SEM = Standard error of mean, SIM= Sundried *Icacina mannii* meal, TIM =Toasted *Icacina mannii* meal, OIM= Oiled *Icacina mannii* meal FIM = Fermented Icacina *mannii* meal,

### 3.3 Anti- nutrients composition of differently processed *Icacina mannii* meals

The results of the anti-nutrient composition of the differently processed *Icacina mannii* meals are presented in Table 3. The statistical analysis revealed that there were significant (P<0.05) differences between the differently processed *Icacina mannii* meals for the parameters analysed except for phytate which recorded no significant difference (P>0.05) among the treatment means.

Oiled *Icacina manni* meal and the fermented *Icacina mannii* meal (FIM) had the highest values for tannin (0.028) and was significantly (P<0.05) different from other treatments that were similar (P>0.05).

The values recorded for oxalate ranged from 0.315 to 0.413%. Oiled *Icacina manni* meal recorded the highest value (0.413%) while the sundried had the lowest value (0.315%). The values obtained for hydrogen cyanide content ranged from 1.222 to 1.400 mg/kg with the sundried *Icacina manni*i meal having the least value and the highest value was obtained for oiled *Icacina manni* meal.

The galactosamine values ranged from 0.031 to 0.40% where the highest value was recorded for toasted *Icacina manni*i meal and oiled *Icacina manni* meal (OIM) had the least value. The values obtained in this study fell below the range recommended by FAO/WHO, (1991); Onwuka, (2018) as safe limits for edible tubers.

All the processing methods accessed significantly ($p<0.05$) reduced the anti-nutrient contents in the samples except for oiled *Icacina manni* meal (OIM) whose concentration increased in tannins, phytates, oxalates and hydrogen cyanide except for galactosamine. However, some antinutritional factors have been reported in palm oil such as oxalate (495mg/100g), phytate (0.337mg/100g), tannin (0.13%), alkaloids (0.16%), haemagglutinin (100 Hm/g) and trypsin inhibitor (54.7 TuI/mg) by Inuwa *et al.* (2011). According to the authors addition of palm oil to the grated mash may have increased the antinutritional content of oiled *Icacina manni* meal (OIM) as adding oil does not directly destroy

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antinutrients, but it reduces their measurable concentration due to dilution and chemical interactions.

**Table 3: Anti-nutrients composition(mg/100g) of differently processed *Icacina mannii* meals**

| Parameters | SIM | OIM | TIM | FIM | SEM |
|---|---|---|---|---|---|
| Tannin | 0.269$^{b}$ | 0.283$^{a}$ | 0.270$^{b}$ | 0.277$^{a}$ | 0.000 |
| Phytate | 0.496$^{b}$ | 0.539$^{a}$ | 0.528$^{a}$ | 0.509$^{b}$ | 0.001 |
| Oxalate | 3.153$^{d}$ | 4.127$^{a}$ | 4.093$^{b}$ | 3.249$^{c}$ | 0.014 |
| HCN (mg/kg) | 1.220$^{d}$ | 1.400$^{a}$ | 1.330$^{b}$ | 1.260$^{c}$ | 0.212 |
| Galactosamine | 0.373$^{b}$ | 0.324$^{c}$ | 0.396$^{a}$ | 0.312$^{d}$ | 0.001 |

$^{a-d}$. means in a row with different superscripts are significantly different (P<0.05). SEM = Standard + error of mean, HCN = Hydrogen Cyanide, SIM = Sundried *Icacina mannii* meal, TIM = Toasted *Icacina mannii* meal, OIM = Oiled *Icacina mannii* meal, FIM = Fermented Icacina *mannii* meal

### 3.4 Fibre fraction composition of the differently processed *Icacina mannii* meals

The results of the dietary fibre fraction of the differently processed *Icacina mannii* meals are shown in Table 4. The values of neutral detergent fibre (NDF) were significantly (P<0.05) different with toasted *Icacina manni*i meal having the highest value (42.10) and oiled *Icacina manni* meal with the least value (34.25). Acid detergent fibre (ADF) values obtained were significantly (P<0.05) different, the values ranged from 19.88 % in oiled *Icacina manni* meal to 31.45% in toasted *Icacina manni*i meal (TIM). The acid detergent lignin (ADL) recorded were also significantly (P<0.05) different with oiled *Icacina manni* meal having the least value (5.15%) and the highest value (9.90%) in toasted *Icacina manni*i meal.

The values of the hemicellulose contents were significantly (P<0.05) different, the range for the values were 10.65 to 17.72% in sun-dried *Icacina manni*i meal and fermented *Icacina mannii* meal respectively. Cellulose contents were also significantly (P<0.05) different, the highest value (21.55%) was recorded in toasted *Icacina manni*i meal while the lowest value (14.64%) was recorded in oiled *Icacina manni* meal and fermented *Icacina mannii* meal.

Processing significantly influenced the fibre fractions of *Icacina mannii* meal, with the lowest value recorded in oiled *Icacina manni* meal. The crude fibre content of the sundried *Icacina mannii* meal was high due the presence of intact cell wall materials like cellulose, hemicellulose and lignin. The marked reduction observed in oiled *Icacina manni* meal and fermented *Icacina mannii* meal could be attributed to the fact that since oil contain no fibre and the formation of an oil coating on meal particles, interferes with fibre extractability during proximate analysis(Ogunlade and Adebayo, 2021) and the reduction also observed in fermentation could be attributed to microbial enzymatic activity, particularly the secretion of cellulases and hemicellulases that hydrolyze complex polysaccharides into soluble sugars ,

**Table 4: Fibre fraction composition of differently processed *Icacina mannii* meals**

| Parameters | SIM | OIM | TIM | FIM | SEM |
|---|---|---|---|---|---|
| NDF (%) | 41.07$^{b}$ | 34.25$^{d}$ | 42.10$^{a}$ | 39.77$^{c}$ | 0.91 |
| ADF (%) | 30.27$^{b}$ | 19.88$^{d}$ | 31.45$^{a}$ | 22.05$^{c}$ | 1.51 |
| ADL (%) | 9.69$^{b}$ | 5.15$^{d}$ | 9.90$^{a}$ | 7.41$^{c}$ | 0.58 |
| Hemicellulose (%) | 10.80$^{c}$ | 14.37$^{b}$ | 10.65$^{d}$ | 17.72$^{a}$ | 0.88 |
| Cellulose (%) | 20.58$^{b}$ | 14.73$^{c}$ | 21.55$^{a}$ | 14.64$^{d}$ | 0.88 |

$^{a-d}$. means in a row with different superscripts are significantly different (P<0.05). SEM = Standard error of mean, NDF = Neutral detergent fibre, ADF= Acid detergent fibre, ADL= Acid detergent lignin, SIM= Sundried *Icacina mannii* meal, TIM =Toasted *Icacina mannii* meal, OIM= Oiled *Icacina mannii* meal, FIM = Fermented Icacina *mannii* meal.

## CONCLUSION

- Processed *Icacina mannii* meals have high nutrients and minerals density especially oiled *Icacina manni* meal. Processing of *Icacina mannii* meal with addition of oil improved its energy value, followed by toasted Icacina *manni*i meal and fermented Icacina *mannii* meal. Therefore, processing of *Icacina mannii* meal pressed with oil or toasted are highly recommended due to their high values for proximate and mineral compositions.
- The anti-nutrients analysed were below toxic levels and the obtained values suggest that *Icacina mannii* meals processed under these methods especially the fermented *Icacina mannii* meal are safe for poultry consumption and nutritionally adequate with minimal interference in mineral absorption.

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