

PHYSICAL CHARACTERISTICS AND PROXIMATE COMPOSITION OF RAW AND SALINE-FERMENTED EARTH BALL (*Icacina mannii*) TUBER MEAL

^{1,2*}Nte, Iyakutye Jacob, ²Uchegbu, M.C., ²Ahiwe, E.U. and ²Etuk, E.B.

¹Department of Animal Science, Rivers State University, Port Harcourt, Rivers State.

²Department of Animal Science and Technology, Federal University of Technology, Owerri, Imo State.

*Corresponding author: nte.iyakutye@ust.edu.ng

ABSTRACT

*This study was conducted to evaluate the physical characteristics of raw and saline-processed *Icacina mannii* tuber meals. Whole harvested tubers were washed and sliced into small pieces without peeling. Saline was prepared by dissolving 1kg of NaCl in 50L of water. The sliced tubers were divided into three batches - I, II and III. Batch I was sundried while batches II and III were soaked in the saline solution, in the ratio of 1:1½ parts, and allowed to ferment naturally for 3 and 5 days, respectively. Thereafter, the saline was drained and the materials were thoroughly rinsed with clean water and boiled for 30 min in fresh water, drained, rinsed again in clean water, and sundried for 3-5 days. The experimental treatments were: T1 (control - raw), T2 (3 days' fermentation), and T3 (5 days' fermentation). After sun-drying, each of the batches was milled and subjected to analysis for physical and proximate characteristics. Packed bulk density, specific gravity, and water holding capacity were significantly ($p < 0.05$) higher in the fermented meals, while oil absorption capacity was highest in the raw sample. All the proximate fractions, except crude fibre, significantly ($p < 0.05$) reduced in the fermented samples. Crude fibre and gross energy were significantly ($p < 0.05$) highest in the meal fermented for 3 days. Fermentation in saline prior to boiling for 30 minutes improved some physical characteristics and enhanced the gross energy. Fermentation for 3 days could be used to improve the nutritional value of *I. mannii* tubers.*

Keywords: Saline, Physical characteristics, Proximate composition, Gross energy, *Icacina mannii*.

INTRODUCTION

Several feed evaluation strategies have been developed and modified for the assessment of the nutritional composition of feed ingredients (Dijkstra *et al.*, 2005). Feed evaluation strategies applied to feed ingredients and finished feeds are aimed at establishing their nutritional components and relevance in animal nutrition. They also furnish nutritionists and feed producers with facts for effective formulation of feed and hence of feeding farm animals. Owing to the high cost of conventional feed ingredients, particularly maize – the main energy source in animal diets, nutritionists are encouraging the use of a large number of novel ingredients (Omede *et al.*, 2011), which need to be evaluated. According to Abdollahi and Ravindran (2019), since the global feed resource base is limited, it is evident that the future demand and supply of ingredients will always be tight. In this context, the evaluation and use of alternative raw materials is an important strategy for the industry to expand in the future.

Information on the nutritional composition of alternative feed ingredients can be derived first from physical characteristics and proximate composition, and then from digestibility studies. However, the physical characteristics of such ingredients are not usually the first thought in the minds of farmers or feed professionals as they plan animal rations or diets. Nevertheless, they are very important factors to note in feed processing and production. This is because the efficiency of handling, processing, production, quality and storage of feed in feed mills not only requires information about their chemical nature and nutritive value, but also their physical properties (Jaelani and Firahmi, 2007).

Efforts are being made worldwide to use alternative sources of energy to substitute for maize in the diets of monogastric animals due to the fiercely competing uses of maize leading to its escalating costs (Noblet *et al.*, 2022). Up to 95% of feed cost (60 -80% of the total cost of animal production) is dominated by energy and protein (Wongnaa *et al.*, 2023). In line with the above, Kleyn and Ciacciariello (2021) opined that new or alternative ingredients are a means of driving the sustainability of feeding poultry. It becomes imperative that the physical characteristics and proximate composition, as well as gross energy, of such ingredients should be known, hence this study.

MATERIALS AND METHODS

Icacina mannii tubers were harvested from Gokana Local Government Area of, Rivers State, washed, sliced into smaller pieces (3-5mm thick), and divided into three batches – I, II and III. Saline was prepared by dissolving 1kg of common salt (NaCl) in 50l of water to obtain a 2% solution (Essien, 2021). Batch I was sundried and milled while batches II and II were soaked in saline solution in the ratio of 1:1½ parts in two plastic containers and allowed to ferment naturally for 3 and 5 days, respectively, as per cassava fermentation to produce garri and fufu

(Montagnac *et al.*, 2009; Ray and Sivakumar, 2009). Thereafter, the fermenting medium was drained and the sliced tubers were washed into a pot and set on fire until it boiled for thirty (30) minutes. The water was drained, they were rinsed in fresh water, sun-dried for 3-5 days depending on environmental temperature, milled using a 2mm sieve and stored separately in air tight polyethene bags. Samples of the raw *Icacina mannii* tuber meal (RIM) and those fermented in saline for 3days - SFIM3 and 5 days - SFIM5, were subjected to analysis for physical characteristics - water holding capacity (WHC), specific gravity (SG), packed bulk density (PBD) and oil absorption capacity (OAC), proximate fractions and gross energy at Precision Food and Analytical Laboratory, Ibadan, Oyo State, according to AOAC (2012).

RESULTS AND DISCUSSION

The results of the physical characteristics of raw and fermented earth ball tuber meals revealed significant ($p < 0.05$) differences in all the parameters evaluated (Table 1), with the fermented samples showing higher values, except for oil absorption capacity (OAC). The OAC of RIM was statistically similar to SFIM3, but both samples were significantly ($p < 0.05$) higher than SFIM5. However, SFIM5 was significantly ($p < 0.05$) higher than SFIM3 in BD and SG. The physical characteristics of feed ingredients

Table 1: Physical characteristics of raw and saline-fermented earth ball tuber meals

Parameters	RIM	SFIM3	SFIM5	SEM
Packed Bulk Density (mg/L)	0.36 ^c	0.59 ^b	0.66 ^a	0.028
Specific Gravity	0.37 ^c	0.60 ^b	0.68 ^a	0.029
Water Holding Capacity (%)	200.20 ^c	298.07 ^a	263.00 ^b	12.298
Oil Absorption Capacity (%)	145.10 ^a	139.22 ^a	114.13 ^b	4.987

^{abc} means with different superscripts in each row are significantly ($p < 0.05$) different

play a vital role in feed formulation and animal nutrition. The PBD and WHC are the two bio-physical characteristics that could affect the nutritional value and acceptability of animal feeds (Sundu *et al.*, 2008; Omede *et al.*, 2011). Packed bulk density influences storage and transportation efficiency, while specific gravity provides insights into the nutrient density of the ingredient (Sarkar, 2022). Low PBD diets result in decreased energy:volume ratio of the diets, which could significantly reduce the body weight of growing chicks (Shelton *et al.*, 2005). Conversely, high PBD values signify increased mechanical strength or hardness, which helps to reduce dust formation (Vijayan *et al.*, 2012). Packed bulk density decreases with increase in moisture content (Daheriya *et al.*, 2022). The values obtained for Water Holding Capacity (WHC) (263-298 %) are far higher than the range (64-122%) reported by Omede (2010). This indicates that it could lead to reduced absorption of water in the gastro intestinal tract of animals, since low packed bulk density causes absorption of excess water, trigger false satiety, leading to low feed intake and poor animal growth and performance (Ohanaka *et al.*, 2017). The specific gravity (SG) values in SPIM3 and SPIM5 (0.60 and 0.68), were much higher than the range of 0.33-0.46 reported for conventional feed resources and broiler rations produced in Nigeria (Omede, 2010). This indicates the possibility of poor digestibility if incorporated into animal diets. The Oil absorption capacity of any material is dependent on its surface chemistry, porosity, packed bulk density, affinity for oil and the nature/type of oil to be adsorbed (Bandura *et al.*, 2017). It is inversely proportional to PBD and low PBD favour the formation of capillaries which efficiently absorb oil within their pores (Angelova *et al.*, 2011).

The proximate composition results (Table 2) indicate significant ($p < 0.05$) reduction in all the parameters except crude fibre, which increased significantly ($p < 0.05$) in SFIM3 and SFIM5. There were significant ($p < 0.05$) variations in gross energy, which was highest (3626.46kcal/kg) in SFIM3. Moisture, crude protein and total ash were significantly ($p < 0.05$) highest in RIM. The reduced moisture content of the fermented meals could have positive consequences on their nutrient density (Kemin, 2017). The results of this study agree with Antai & Obong (1992) who reported that fermentation enhances the nutritional profile of *I. mannii*. This study shows that the fermented tubers have high crude protein and gross energy content. The crude protein levels are 9.53 and 9.48% in SPIM3 and SPIM5, respectively, while it is 8.5 and 12.0% for white and yellow maize, respectively (NIAS, 2023). The protein and fat content are higher than that of maize, making the meal more hydrophobic, which can enhance its ability to absorb oils (Knez *et al.*, 2023). The higher metabolizable energy of the SFIM3 as compared to maize underpins the potential of *I. mannii* as an energy ingredient. The elevated crude fiber content of SFIM3 and SFIM5 can improve structural integrity but may reduce digestibility and nutrient absorption, and impacting feed efficiency negatively (Nafees *et al.*, 2023). The reduced ash content may impact negatively on mineral content

of the tubers. High ash content indicates greater mineral uptake, but it may also suggest nutrient dilution at high moisture levels (Jewell and Jackson, 2023).

Table 2: Proximate composition and gross energy of raw and saline-fermented earth ball tuber meals

Parameters	RIM	SFIM3	SFIM5	SEM
Moisture (%)	14.71 ^a	13.57 ^{ab}	13.41 ^b	0.191
Crude protein (%)	11.33 ^a	9.53 ^b	9.48 ^b	0.203
Ether extract (%)	1.03 ^b	0.38 ^c	1.51 ^a	0.110
Crude fibre (%)	8.67 ^c	12.49 ^a	10.98 ^b	0.367
Total ash (%)	4.18 ^a	3.05 ^c	3.73 ^b	0.115
NFE (%)	60.08	60.98	60.89	0.327
Gross Energy (kcal/kg)	3589.94 ^b	3626.46 ^a	3425.90 ^c	26.881

^{abc} means with different superscripts in each row are significantly ($p < 0.05$) different

CONCLUSION

The study showed that fermentation *I. manni* tubers in saline for 3 days prior to boiling for 30 minutes improved packed bulk density, specific gravity, water holding capacity and the gross energy of the tubers. Therefore, fermentation in saline for 3 days could be used to improve the nutritional value of the tubers.

REFERENCES

- Abdollahi M. R., & Ravindran, V. (2019). Alternative feed ingredients for poultry diets: challenges and prospects. *Australian Poultry Science Symposium*, 30,102–109
- AOAC. (2012). Official Method of Analysis Association of Analytical Chemists. 19th Edition, Washington D. C.
- Angelova, D., Uzunov, I., Uzunova, S., Gigova, A., & Minchev, L. (2011). Kinetics of oil and oil products adsorption by carbonized rice husks. *Chemical Engineering Journal*, 172(1), 306-311.
- Antai, S. P., & Obong, U. S. (1992). The effects of fermentation on the nutrient status of some toxic components of *Icacinia manni*. *Plant Foods for Human Nutrition*, 42: 219-224.
- Bandura, L., Franus, M., Józefaciuk, G., & Franus, W. (2015). Synthetic zeolites from fly ash as effective mineral sorbents for land-based petroleum spills cleanup. *Fuel*, 147, 100–107.
- Dijkstra, J., Kebreab, E., Bannink, A., France, J., & Lopez, S. (2005). Application of the gas production technique to feed evaluation systems for ruminants. *Animal Feed Science Technology*, 123-124(1), 561-578.
- Essien, C. A. (2021). Effect of saline processed *Icacinia manni* (earthball) on performance, egg quality, blood profiles and carcass indices of laying hens. *Journ. of Ani. Sci. and Vet.Med.*, 6(3), 105-112.
- Jaelani, A. & Firahmi, T. (2007). “The quality of the physical properties and nutrient content of palm kernel cake from a variety of processing crude palm oil,” *Al’Ulum*, 33(3), 1-7.
- Kemin, P. N. 2017. Impact of moisture on various dimensions of feed processing. Retrieved from <https://benisonmedia.com/impact-of-moisture-on-various-dimensions-of-feed-processing> on December 20, 2024.
- Kleyn, F. J. & Ciacciariello, M. (2021). Future demands of the poultry industry: Will we meet our commitments sustainably in developed and developing economies? *World's Poultry Science Journal*, 77(2), 267-278.
- Knez, E., Kadac-Czapska, K., & Grembecka, M. (2023). Effect of fermentation on the nutritional quality of the selected vegetables and legumes and their health effects. *Life (Basel, Switzerland)*, 13(3), 655.
- Jewell, D. E., & Jackson, M. I. (2023). Predictive equations for dietary energy are improved when independently developed for dry and wet food which could benefit both the pet and the environment. *Frontiers in Veterinary Science*, 10, 1104695.
- Montagnac, J. A., Davis, C. R. & Tanumihardjo, S. A. (2009). Nutritional Value of Cassava for use as a staple food and recent advances for improvement. *Comprehensive Review in Food Science and Food Safety*, 8, 181-188.
- Nafees, M.S.M., Kamarudin, M.S., Karim, M., Hassan, M.Z., & de Cruz, C.R. (2023). Effects of dietary fiber on growth, feed efficiency and nutrient utilization of Tinfoil barb (*Barbonymus schwanenfeldii*, Bleeker 1853) fry. *Aquaculture Reports*, 32, 101743.
- NIAS. 2023. National listing of approved ingredients for feed mills in Nigeria. NIAS/RA/LAFI/2023.
- Noblet, J., Wu, S. B., & Choct, M. (2022). Methodologies for energy evaluation of pig and poultry feeds: A review. *Animal Nutrition*, 8, 185-203. <https://doi.org/10.1016/j.aninu.2021.06.015>.

- Ohanaka, A.U.C., Duruanyim, V.O., Etuk I.F., Uchegbu, M.C. & Okoli I.C. (2017). Physico – chemical composition of palm kernel shell ash (PKSA) as a potential mineral supplement in livestock nutrition. In: A.A. Adeloje (eds). *Emerging challenges facing animal agriculture in Nigeria and the way forward*. Proceedings of the 42nd Annual Conference of the Nigerian Society for Animal Production, 42: 785-789.
- Omede, A.A. (2010). The use of physical characteristics in the quality evaluation of some commercial poultry feeds and feedstuffs. M.Sc. Thesis, Federal University of Technology, Owerri, Nigeria
- Omede, A.A., Okoli, I.C. & Uchegbu, M.C. 2011. Studies on the physical characteristics of some feed ingredients in Nigeria 1: Protein sources and industrial by-products. *Online J. Anim. Feed Res.*, 1(5): 190-197.
- Ray, R. C. & Sivakumar, P. S. (2009). Traditional and novel fermented foods and beverages from tropical root and tuber crops: review. *Int. Journ. of Food Sci. and Tech.*, 44, 1073-1087.
- Sarkar, T. (2022). *Physical properties of food materials*. In Encyclopedia. <https://encyclopedia.pub/entry/19781>
- Shelton, J. L., Dean, D.W., Southern, L.L. & Bidner, T.D. (2005). Effect of protein and energy sources and bulk density of diets in growth performance of chicks. *Poultry Science* 84: 1547-1554.
- Sundu, B., Kumar, A., & Dingle, J. (2008). The effect of proportion of crumbled copra meal and enzyme supplementation on broiler growth and gastrointestinal development. *Int. J. Poult. Sci.*, 7(5), 511-515.
- Vijayan, S.N., Makesh Kumar, M., & Sridhar, K. (2012). Physical and Chemical Analysis of Activated Carbon Prepared from Coconut Shell Charcoal and Usage-A Case Study. *International Journal of Advanced Scientific Research & Technology*, 2(3): 168-175.
- Wongnaa, C. A., Mbroh, J., Mabe, F. N., Abokyi, E., Debrah, R., Dzaka, E., Cobbinah, S. & Poku, F. A. (2023). Profitability and choice of commercially prepared feed and farmers' own prepared feed among poultry producers in Ghana. *Journal of Agriculture and Food Research*, 12, 100611