



The Potential of Bambara Groundnuts (*Vigna subterranean*) as an Ingredient in Animal Feed Formulations

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Abstract

Bambara groundnuts (*Vigna subterranea*) is a legume indigenous to tropical Africa with considerable adaptation to environments that would be considered marginal for many other crops. This review was carried out in order to study the potential of this legume in animal feed formulations. Information was obtained from more than thirty (30) peer reviewed publications that focused on evaluating the potential of Bambara groundnuts as an ingredient in chicken, fish, rabbit and pig feed formulations. This review established that the inclusion of bambara groundnuts in chicken diets has a positive effect on growth and productivity parameters at much lower inclusion levels compared to the effect of the same dietary component in fish, rabbit and pig diets as these animals showed much higher tolerance to increased levels of bambara groundnuts in the diets. Overall, the highest potential for bambara groundnut feeding is with pigs which can be fed 100% bambara groundnuts without adverse effects on growth.

Introduction

Bambara groundnuts (*Vigna subterranean*) is an indigenous African legume crop widely cultivated in both humid and semi-arid zones of sub-saharan Africa. The crop is actually considered as the third most important crop after cowpea (*Vigna unguiculata*) and groundnuts (*Arachis hypogea*).

Bambara groundnuts is extensively cultivated in West Africa where about 0.35 million tons of dry seeds are produced from 0.4 million hectares annually. The major producers of Bambara groundnuts in Africa are Nigeria, Niger and Ghana. In Zambia, Bambara groundnuts was planted on 7,253 ha with grain production estimated at 7,039 mt during the 2018/2019 season (CSO, 2018) [1].

Bambara groundnuts in Zambia is largely utilized for human consumption as relish [2] and generally considered as having low commercial value because of the limited market and value addition opportunities [2]. This in contrast with other legume crops like soybeans and groundnuts whose value chains have been relatively well-developed [3-5].

The advent of climate change has put the production and productivity of currently commercialized legume crops such as soybeans and groundnuts under considerable pressure and risk [6]. This scenario has resulted in increased focus on the search for alternative crops and cropping systems that are more resilient to climate change [7]. The exceptional adaptive ability of Bambara groundnuts to semi-arid and poor soil conditions coupled with its rich nutrient composition has resulted in increased focus on this crop as a future crop [7].

This review seeks to synthesize and highlight some of the key findings from research efforts aimed at evaluating the potential of Bambara groundnut grain as an ingredient in animal feed formulations.

Nutritional Composition of Bambara Groundnuts

Pulse crops are generally regarded as food sources with relatively high levels of nutrients such as protein (20-40%) and fiber (almost 20%) compared to cereal grain crops. Furthermore, their fat composition is lower (mostly below 10%) [7].

Potential of Bambara Groundnuts as Chicken Feed

Several studies have evaluated the effect of including bambara groundnuts in broiler chicken diets on growth and physiological performance of the chickens. These studies have ranged from those attempting to understand the effect of pre-treatment of bambara groundnut to those investigating the effect of different bambara groundnut inclusion levels on growth and physiological performance of chickens [8].

A comparative study on the effects of raw and heat-treated bambara groundnuts on body composition of broiler chicks by Fru Nji et al, (2003) established that raw bambara groundnut had no effect on daily feed intake. However, bambara groundnuts in broiler feed resulted in general drop in performance of the chicks with noticeable reduction in metabolizability of energy, efficiency of metabolizable energy and body weight gain [8]. It was further observed that autoclaved bambara groundnuts was better than raw bambara groundnut [8]. Heat treatment of legume seeds has been used to reduce the levels of anti-nutritional factors such as tannins hence the better performance of autoclaved bambara groundnuts in this study can be attributed to reduced levels of antinutritional factors in the grains.

Oyeagu et al (2016) [9] evaluated the effects of different levels of toasted bambara groundnut offal (TBO) with enzyme supplementation on cost implications and hematological traits on commercial broiler chicks. Feed intake increased significantly while body weight, daily weight gain, total weight gain and protein efficiency ratio decreased significantly with increased levels of toasted bambara offal in the diet [9]. Furthermore, mean cell hemoglobin (MCH), mean cell hemoglobin concentration and mean cell volume were not significantly affected by increasing levels of toasted bambara offal in the diet [9]. However, toasted bambara offal had a significant negative effect on hemoglobin concentration, packed cell volume (PCV), red blood cell count (RBC) and white blood cell count (WBCC) [9]. This study further recommended that toasted bambara offal with enzyme supplementation can be included in broiler chick diets at a maximum proportion of 10% without significant negative effects on hematological and growth performance of the chicks [9].

Akanji (2015) [9] investigated the effect of dry-heated, aqueous heated and dehulled bambara groundnuts on performance characteristics and organ morphology of broiler chicks. Whereas daily feed intake was not affected by the addition of bambara groundnuts to broiler diet, other performance indicators such as daily weight gain and feed conversion efficiency were significantly reduced when broiler

chicks were fed on diets containing dehulled and dry-heated bambara groundnuts [10]. These reductions in broiler performance were also accompanied by increases in the weight of the pancreas and kidneys of the chicks. Aqueous heated bambara groundnut had the best effect on broiler chick performance among all the treatments administered [10]. The intake of antinutritional factors such as trypsin inhibitors has been implicated in kidney and liver morphological aberrations in chickens [11].

Nwaigwe et al (2010) also studied the effects of incorporating bambara groundnuts at 25% of feed formulation on the growth and feed intake of broiler chicks. It was observed that the chicks that had no bambara groundnuts in the diet had superior feed intake and weight gain [12]. Bambara groundnuts in the broiler chick diet had no significant effect on organ weights, observable abdominal fat and gross pathology of internal organs [12].

The effects of incorporating bambara groundnuts in layer chickens diets have also been investigated. Enyanwu et al (2008) established significantly depressed performance of layer chickens after feeding on diets containing a combination of cassava meal and bambara groundnuts offal's. Other research efforts have found no significant adverse effects of including 5% bambara groundnut meal in laying pullet diets on egg laying performance [13].

Obih and Ekenyemi (2010) also found no adverse effects of incorporating bambara groundnuts meal at 5% of broiler chicken diet on growth and feed conversion efficiency. Furthermore, daily feed intake was not significantly affected by bambara groundnut inclusion levels of 10, 15, 20 and 25%. Ironkwe and Esonu (2012) [14] investigated the effects of raw and toasted bambara groundnuts on growth performance of finisher broiler chickens and recommended that bambara groundnut meal can be incorporated in broiler chicken diet up to as much as 30% without any significant adverse effects on growth and physiological performance of the chickens. Ogunbade et al (2017) [15] evaluated the effect of variously treated bambara groundnuts such as boiled, soaked, fermented without decantation, roasted and raw bambara groundnuts on growth performance of broiler chickens. This study established significant positive effect of feeding bambara groundnuts fermented without decantation on growth performance parameters for broiler chickens Ogunbade et al (2017) [15].

Potential of Bambara Groundnuts as Rabbit Feed

Rabbits have been used as a cheap source of animal protein in many African countries including Zambia [16]. Their relatively low management requirements and rapid multiplication rates makes rabbit rearing a favorite option for many smallholder farmers. One major challenge associated with rabbit rearing is that of feed availability. A number of feeding alternatives have been studied and recommended for smallholder rabbit production operations. Bambara groundnuts as a component of rabbit has also been among the feed alternatives studied.

Ironkwe and Amaefule (2012) [17] studied the effect of feeding graded levels (0-20%) of Bambara groundnuts offal's to weaner rabbits. This study established that there were significant differences in performance among rabbits fed different levels of bambara groundnuts. Diets including 15% of bambara groundnuts resulted in the best performance for weaned rabbits in terms of daily weight gain, final live weight, feed conversion ratio, protein efficiency ratio and cost per live weight gain [17]. Joseph et al (2000) [18] also investigated the influence of toasted bambara groundnuts on rabbit carcass characteristics. In this study, feeding graded levels of bambara groundnuts had a positive effect on a number of rabbit growth and carcass quality parameters such as rabbit daily weight gain, feed efficiency, dressed carcass weight, dressing percentage and meat: bone ratio. The diet containing 5% bambara groundnuts resulted in the least feed efficiency and meat: bone ratio while dressed weights of rabbits fed a diet containing 25% bambara groundnuts had the highest dressed carcass weight. Furthermore, it was established that bambara groundnuts in rabbit diets did not adversely affect carcass cut-up parts as well as internal organs. However, the pelt weight, empty gut weight and moisture contents were significantly influenced by levels of bambara groundnuts in the diets. Ani (2007) [19] examined the effects of feeding graded levels of bambara groundnuts to weaned rabbits and recommended that bambara groundnuts in rabbit diets up to 10% had positive effects on rabbit performance. This was based on the results which showed that bambara groundnuts in rabbit diet had positive effects. Usman et al (2019) [20] studied the nutrient digestibility of growing rabbits fed with cooked bambara groundnuts. This was a comparative study which investigated the influence of replacing groundnut cake with bambara groundnuts in rabbit diets. Results indicated acceptable levels of nutrient digestibility as well as growth parameters in rabbits fed with bambara ground diets. It was ultimately recommended that bambara groundnuts should be included in rabbit diets up to an inclusion level of 50% for optimum performance of the animals.

Potential of Bambara Groundnuts as Fish Feed

Overfishing due to the ever increasing human population has given rise to the growth of fish farming as an alternative way of satisfying human fish requirements. Feeding costs in aqua cultural operations have been estimated to account for more than 50% of operating costs [21]. Fish meal has been the major source of protein in fish feed formulations. However, the ever increasing prices of this ingredient has justified the need to search for alternative sources of protein in fish feed formulae. Bambara groundnut is a grain legume which has been found to contain as much as 63% carbohydrates, 16.3% protein and 6.3% fats with a relatively higher proportion of lysine and methionine as a percentage of proteins [22].

Aliu and Egwemi (2018) [23] investigated the effect of decorticated bambara groundnuts on growth response of Clariid catfish (*Heterobranchus bidorsalis*) fingerlings. It was established that incorporating bambara groundnuts in the fingerlin diets at different rates (0%, 10%, 20%, 30% and

40%) did not significantly affect the specific growth rate and percentage weight gain. However, the feed conversion ratio was significantly affected by the incorporation of bambara groundnuts in the diet with the highest conversion ratio recorded with the control (2.93) while the 30% level had the second highest feed conversion ratio (2.86). This entails that replacing soybean meal with heat-treated bambara groundnuts did not adversely affect the feed conversion ratio of catfish fingerlings [24].

Oso et al (2013) [25] studied the effects on growth of feeding *Clarias gariepinus* fingerlings with bambara groundnuts as a dietary source of proteins. It was established that incorporation of bambara groundnuts in fish diets did not significantly compromise the growth performance of the fingerlings. The study further recommended that the optimal bambara groundnut incorporation rate should be in the range of 25-75% [24]. Similar results were obtained by Enyidi and Mgbenka (2012), Adewumi and Odeyemi (2018) and Uchechukwu and Mgbenka (2014)

Kumar et al (2017) analyzed the effect of incorporating bambara groundnuts in tilapia (*Oreochromis niloticus*) diets as a carbohydrate source and established no significant adverse effect on specific growth rate and average weight gain. It was further recommended that the optimum bambara groundnut inclusion level can be more than 50% but less than 100%. Similar results were obtained by Fakunmoju et al (2016) who assessed the potential of replacing maize with bambara groundnuts with maize in tilapia (*Oreochromis niloticus*) diets. Fakunmoju et al (2016) further established that inclusion of bambara groundnuts in tilapia diets resulted in reduced feed costs thus making the case for economic justification of using bambara groundnuts in fish feed formulations.

Potential of Bambara Groundnuts as Pig Feed

The rapid population increase in the world requires production of protein from fast growing animals such as pigs with the utilization of cheap and locally available feedstuffs in order to produce them at an affordable cost [12]. A number of research efforts have been expended to try and assess the potential of bambara groundnuts as an ingredient in pig feed formulations [26, 27].

Nwakpu et al (2010) investigated the effects of feeding graded levels of bambara groundnuts on growth and hematological characteristics of weaner pigs. This research effort established that feeding bambara groundnuts to pigs did not adversely affect growth and hematological parameters. Bambara groundnut inclusion rates of up to 100% did not affect the studied pigs in growth and hematological parameters. However, Okah and Ehuriah (2016) established that incorporating more than 30% of bambara groundnut offals in pig diets had significant adverse effects on multiple physiological parameters in weaner pigs.

Discussion and Conclusion

We have reviewed numerous research articles on the potential of bambara groundnuts as an ingredient in livestock feed formulations. The reviewed papers indicate that chickens can respond positively to bambara groundnuts inclusion in diets up to about 30% without significant adverse effects on growth and physiological traits. There is generally much higher tolerance to heat-treated than raw bambara groundnuts among chickens. Bambara groundnuts inclusion levels above 30% in chicken diets significantly reduces growth and physiological performance. Although rabbits have much higher tolerance levels to bambara groundnuts in the diets (maximum of 50%), the trend in terms of response is similar to that observed in chickens where increased levels of bambara groundnuts in the diet increasingly results in suboptimal performance of the animals in growth and physiological parameters. Fish has better ability to metabolize bambara groundnuts than both chickens and rabbits as evidenced by the ability of this livestock species to respond positively to increased levels (maximum at 75%) of the legume in the diet. Among the three major livestock species studied, pigs have the best tolerance to diets comprising bambara groundnuts as they have been found to respond positively through improved growth and physiological performance even with diets comprising 100% bambara groundnuts as protein source. It can thus be concluded that bambara groundnuts can be a good option as protein source in rabbit, fish and pig feed formulations.

References

1. Central Statistical Office (2018) Crop Forecast Survey, Lusaka, Zambia
2. Bbebe N, Boonabaana B, Mutambo J (2019) Intra-household gender relations in Bambara groundnut Production in Kapiri Mposhi District of Zambia. Proceedings of the Symposium on Seed Politics, University of Zambia.
3. Lubungu M, Burke WJ, Sitko NJ (2013) Analysis of the soya bean value chain in Zambia's Eastern Province (No. 1093-2016-88052).
4. Ross SR, Klerk MD (2012) Groundnut Value Chain and Marketing Assessment in Eastern Province, Zambia Prepared for the Conservation Farming Unit.
5. Curtis S, Fehringer J, Hattori A, Markiewicz M, Barry M, Namonje T (2018) Gender and Groundnut Value Chains in Eastern Province, Zambia, IAPRI, Lusaka, Zambia.
6. Mohanty M, Sinha NK, McDermid SP, Chaudhary RS, Reddy KS, et al. (2017) Climate change impacts vis-a-vis productivity of soybean in vertisol of Madhya Pradesh.
7. Mayes S, Ho WK, Chai HH, Gao X, Kundy AC, et al. (2019) Bambara groundnut: an exemplar underutilised legume for resilience under climate change. *Planta*, pp.1-18.
8. Nji FF, Niess E, Pfeffer E (2003) Effects of raw and heat-treated bambara groundnut (*vigna subterranea*) on the performance and body composition of growing broiler.
9. Oyeagu CE, Ani AO, Egbu CF, Udeh FU, Omumuabuike JN, et al. (2016) The effect of feeding toasted Bambara nut (*Vigna subterranea* (L) verdc) offal and supplementary enzyme on performance of broiler chicks. *Trop. Archives of Animal Nutrition* 57: 443-453.
10. Akanji AM (2015) Effect of processed bambara groundnuts and benne seeds on growth and organ morphology of broiler. *Bangladesh Journal of Animal Science* 44: 26-32.
11. Emiola IA, Ologhobo AD, Gous RM (2007) Performance and Histological Responses of Internal Organs of Broiler Chicken Fed Raw, Dehulled, and Aqueous and Dry-Heated Kidney Bean Meals. *Poultry Science* 86: 1234-1240.
12. Nwaigwe CO, Akwuobu CA, Kamalu TN (2010) Response of broiler chicks to diets with bambara nut (*Voandzeia subterranea*) as a protein source. *Archivos de zootecnia*, 59:141-144.
13. Amaefule KU, Osuagwu FM (2005) Performance of pullet fed graded levels of raw Bambara groundnuts (*Vigna subterranean*) (L) offal diets as a replacement for soybean meal and maize. *Livestock Research for Rural Development* 17: 55.
14. Ironkwe MO, Esonu BM (2012) Effect of raw Bambara groundnut (*Vigna subterranean* (L) Verdcourt) on the performance of broiler finisher birds. *Global Journal of Bioscience & Biotechnology* 1: 29-32.
15. Ogunbode SM, Raji AO, Usman MD, Sulyman FO, Salau AK, et al. (2017) Partial Protein Replacement With Processed Bambara Groundnut Meal: Effect On Selected Tissue Enzyme Activities In Broiler Chicken (Starter Phase)-FUNAI *Journal of Science and Technology* 3: 1-13
16. Amaefule KU, Mbonu UE, Amaka V (2011) Performance and nutrient utilization of growing rabbits fed graded levels of raw Bambara Groundnut [*Vigna subterranean* (L) Verdc] offal diets. *Pakistan Journal of Nutrition* 10: 463-469.
17. Ironkwe MO, Amaefule KU (2012) Response of Weaner Rabbits Fed Graded Levels of Bambara Groundnut (*Vigna subterranean* (L) Verdc) Offal Diets. *Agricultural Journal* 7: 282-285.
18. Joseph JK, Awosanya B, Adeoye PC, Okekunle MR (2000) Influence of graded levels or toasted Bambara

- groundnut meal on rabbit carcass characteristics. Nigerian Journal of Animal Production, 27: 86-89.
19. Ani AO (2007) Effect of feeding graded levels of raw bambara groundnut (*Vigna subterranea* (L) Verdc) waste on growth performance and haematological traits of weaner rabbits. Agro-Sci. J. Trop. Agric. Food, Environ. Extension 6: 82-88.
 20. Usman Y, Husa H, Yusuf SZ, Dunya AM, Njiti MM (2019) "Carcass and Nutrient Digestibility Trial of Growing Rabbits fed Cooked Bambara Nut Meal as Replacement for Groundnut Cake in a Semi-arid Zone of Nigeria". International Journal of Environment Agriculture and Biotechnology (ISSN: 2456-1878). 4: 1147-1152.
 21. Sitjà-Bobadilla AS, Peña-Llopis S, Gómez-Requeni P, Médale F, Kaushik S, Pérez-Sánchez J (2005) Effect of fish meal replacement by plant protein sources on non-specific defence mechanisms and oxidative stress in gilthead sea bream (*Sparus aurata*). Aquaculture 249: 387-400.
 22. Mayes S, Ho WK, Chai HH, Gao X, Kundy AC, et al. (2019) Bambara groundnut: an exemplar underutilised legume for resilience under climate change. Planta, pp.1-18.
 23. Aliu BS, Egwemi AO (2018) Dietary Decorticated Bambara Groundnut (*Vigna Subterranea*) effect on the Growth Responses of Clariid Catfish (*Heterobranchus Bidorsalis*) Fingerlings. International Journal of Scientific and Research Publications 8: 312.
 24. Oso JA, Edward JB, Ogunleye OA, Majolagbe FA (2013) Growth Response and Feed Utilization of *Clarias gariepinus* Fingerlings Fed with Bambara Groundnut as protein source. Journal of Natural Sciences Research www.iiste.org ISSN 2224-3186.
 25. Oyugi MA, Nandi OM, Amudavi DM, Palapala VA (2015) Influence of Gender on Farmers' level of Involvement in Bambara Production Activities in Western Kenya.
 26. Linnemann AR (1987) Bambara groundnut (*Vigna subterranea* (L.) Verdc)—a review. Abstracts on Tropical Agriculture 12: 7.
 27. Hemantaranjan A, Bhanu AN, Singh MN, Yadav DK, Patel PK, et al. (2014) Heat stress responses and thermotolerance. Adv. Plants Agric. Res 1: 10-15406.

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