Research in
ISSN : P-2409-0603, E-2409-9325
AGRICULTURE, LIVESTOCK and FISHERIES
An Open Access Peer-Reviewed International Journal

Article Code: 507/2025/RALF
Article Type: Research Article

Res. Agric. Livest. Fish.
Vol. 12, No. 3, December 2025: 455-464.

Effect of Processing and Partial Substitution of Baobab Seed Meal on Commercial Ross Broilers' Growth Performance

Pauline Matambo[1,2], Tinotenda Nhovoro[1], Rumbidzai Blessing Nhara[3], Faith Matiza Ruzengwe[1], Tinoziva Hungwe[1], Prosper Bright Muvhuringi[4], Jameson Madzana[1], Tendai Mujati[5]* and Ngavaite Chigede[1]

[1]Great Zimbabwe University, Gary Magadzire School of Agriculture and Engineering, Department of Livestock, Wildlife and Fisheries, P.O. Box 1235, Masvingo; [2]Ministry of Lands, Agriculture, Fisheries and Rural Development, Department of Veterinary Field Services, Beitbridge; [3]University of Zimbabwe, Faculty of Agriculture and Environmental Systems, Department of Livestock Science, University of Zimbabwe, Zimbabwe; [4]Zimbabwe Open University, Faculty of Agriculture, Department of Agricultural Management, Mashonaland Central Region, 209 Hayroad, Bindura, Zimbabwe; [5]Zimbabwe Open University, Faculty of Agriculture, Department of Agricultural management, Masvingo Regional campus, Masvingo, Zimbabwe.

***Corresponding author:** Mujati Tendai; E-mail: mujatit@zou.ac.zw

ARTICLE INFO

Received
19 October 2025

Revised
05 November 2025

Accepted
06 November 2025

Key words:

Anti-nutritional factors
Ash-treated
Carcass
Non-competing
Three-phase feed

ABSTRACT

The increasing global population and climate-related challenges have intensified the search for alternative, non-competing protein sources to replace conventional feed proteins. This study evaluated the effects of partially substituting roasted soybean meal with baobab seed meal on growth performance and carcass characteristics of commercial Ross broiler chickens in Tongwe, Ward 4, Beitbridge District, Zimbabwe. A completely randomized design (CRD) was used with two iso-nitrogenous dietary treatments, each replicated six times with eight birds per replicate. Sorghum served as the primary energy source, while soybean and baobab seed meals provided protein. Sorghum was ash-treated to reduce tannins, soybeans were roasted to inactivate trypsin inhibitors, and baobab seeds were boiled for one hour to reduce tannins and phytates. Feed formulation was carried out using FeedSoft software to achieve crude protein levels of 20% in grower and 18% in finisher diets. After six weeks, no significant differences ($p = 0.7$) were observed in live body weight between treatments. Meat taste and carcass color parameters also showed no notable differences. The study concludes that partial replacement of soybean meal with baobab seed meal during the finisher phase is feasible without compromising broiler growth performance, meat quality, or carcass color. Further research is recommended to assess the protein quality and optimal inclusion levels of baobab seed meal.

To cite this article: Matambo P., T. Nhovoro, R. B. Nhara, F. M. Ruzengwe, T. Hungwe, P. B. Muvhuringi, J. Madzana, T. Mujati and N. Chigede, 2025. Effect of processing and partial substitution of baobab seed meal on commercial Ross broilers' growth performance. Res. Agric. Livest. Fish. 12(3): 455-464.

DOI: https://doi.org/10.3329/ralf.v12i3.86176

Introduction

The global demand for poultry products continues to escalate as the world's human population continues in its growth trajectory, with predictions to reach nine billion by 2050 (United Nations, 2019). As human populations, together with the preference and acceptance of broiler meat, continue to increase, the global broiler sector is expected to continue to grow, as the motivation for production is driven by high demand levels (Mottet and Tempio, 2017). In Zimbabwe, broiler chicken production continues on a growth path and has become one of the top livestock sources of livelihoods for both urban and rural farmers (Zimbabwe Vulnerability Assessment Committee (ZimVAC, 2022). Family poultry farming has been increasingly recognized as one of the entry points to address the challenges of food insecurity, malnutrition and income depressions for smallholder farmers (Gororo and Kashangura, 2016; Nchinda et al., 2011). In developing countries, feed raw materials, particularly protein sources, are a limiting factor in the poultry industry. Climate change-induced droughts are part of this challenge. Soyabean seed is the most common and widely used protein source in broiler chicken feed in Zimbabwe, while other legume-based protein sources are also used depending on their availability. The increase in the cost of soya-based broiler feed is hugely linked to low yield and consequently limited access to soyabeans for livestock feed formulations (Chisoro et al., 2018). Soyabeans' current production is not sufficient to meet the protein demands of the increasing human population and expanding livestock industry (Saulawa et al., 2014).

Farmers in Zimbabwe have also tried alternative protein sources, such as baobab seed, moringa leaves, aquatic proteins and lucerne biomass with limited success. The adoption of moringa leaves and aquatic proteins has been hindered by availability challenges. On the other hand, it was found out that lucerne has good dry matter with a protein content range of 16 to 22% crude protein (CP) (Habtemariam, 2021; Poel et al., 2013). Baobab seeds have good dry matter and a reasonably high protein value, which makes them an alternative protein source for use in broiler feeds in areas where it is available (Madzimure et al., 2011). In addition, baobab seeds are available in certain arid parts of Zimbabwe in large quantities, enough for them to be used to formulate poultry feeds (Chisoro et al., 2017). Availability of baobab seed in Zimbabwe makes it a potential complement to soyabeans in broiler feeds, which might resultantly turn out to be cost-effective by partly eliminating the costs of soyabeans (Chimvuramahwe et al., 2011). However, utilisation of these protein sources can be hampered by the presence of antinutritional factors in them. These antinutrients include tannins, trypsin inhibitors and phytates, which negatively impact on digestibility and availability of certain key nutrients (Chisoro et al., 2019). Therefore, for the effective utilisation of protein sources, some form of treatment must be done to inactivate and reduce the concentration of these antinutritional compounds. Such methods include roasting, decortication, soaking and boiling (Nhara et al., 2024).

Introduction of other low-cost, alternative plant-based protein sources can help alleviate pressure on soyabeans, thereby reducing the cost of rearing broiler chickens. These alternative sources of broiler feed protein should be of lower demand by other industries or for human consumption, for them to be effective (Fatima et al., 2022). Farmers can effectively and economically use locally available resources to formulate broiler feeds as guided by the recommended nutritional requirements for broiler chicken feed (Thirumalaisamy et al., 2016). The current study examined the effectiveness of methods used to reduce antinutritional factors in soyabean, sorghum and baobab seed. As well as the effects of partial substitution of soyabean meal with baobab seed meal as a protein source on broiler chicken growth performance during the growing and finishing phase of their production cycle.

Materials and methods

Study site

An on-farm study was carried out at Tongwe village, 22°3'23"S; 29°49'30"E, ward 4 in rural Beitbridge. The Tongwe area falls under natural farming region V. The area is characterised by hot, dry weather conditions that are characterised by high temperatures where the annual average temperature is 23.1 ºC while hot periods average 34 ºC (Dhliwayo et al., 2023). The rainfall is erratic at an annual average of 332 mm and this negatively impacts most cropping activities (Dhliwayo et al., 2023). The area is characterised by sandy loam soils. Production of traditional grain crops like sorghum and millet and fodder crops like *Lucerne* and *Mucuna pruriens* (velvet bean) are common as they endure and thrive in the climatic conditions. Vegetation is dominated by sweet veld with annual grasses and mopane woodlands. The baobab tree (*Adonsonia digitata*) dominates the woodlands in the area. Cattle, goats, donkeys and poultry are common livestock classes in the area (Tui and Baudron, 2023).

Chemical analysis of feed ingredients

The formulations of broiler diets in this study were guided by results that were obtained from a laboratory-based proximate analysis (McDonald et al., 2010) of nutrient composition of soyabean, baobab and sorghum seed meals, Table 1.

Table 1. Nutritive value of feed ingredients

Feed ingredient	Dry matter (%)	Crude protein (%)	Crude lipid (%)	Total ash (%)	Crude fiber (%)
Soyabean seed meal	88.8	35.4	19.8	5.6	3.2
Sorghum seed meal	85.5	11.8	3.9	1.9	2.2
Baobab seed meal	86.4	16.7	17.5	5.5	14.9

Proximate analysis by IDITECH Laboratories, Beitbridge, Zimbabwe

Processing techniques for the feedstuffs to curb anti-nutritional factors

Though the levels of antinutritional factors they contain are deemed low for poultry (Chisoro et al., 2017), treatment was done so as to counter the potential for cumulative effects. The raw materials were treated differently to reduce the antinutritional factors. An analysis was done to reflect on the effectiveness of the employed treatments, that is, soaking in ash solution for sorghum to deal with tannins, boiling for baobab seed to deal with tannins and phytates, and roasting to deal with trypsin inhibitors in soyabeans (Table 2).

Table 2. Feed ingredients' anti-nutritional factor status before and after treatment

		Tannins (mg/g)	Phytates %	Trypsin inhibitors (mg/g)
Soyabean meal	Untreated	1.95	1.22	6.35
	Treated	0.55	0.04	2.21
Sorghum meal	Untreated	4.95	5.92	0
	Treated	0.09	1.8	0
Baobab meal	Untreated	0.45	0.16	0
	Treated	0.01	0	0

Antinutritional factors analysis by IDITECH Laboratories, Beitbridge, Zimbabwe

Untreated: whole seed meals: soyabeans meal, sorghum meal and baobab seed meal; Treated: roasted soyabeans meal, ash solution-soaked sorghum meal and 1 hour boiled baobab seed meal

Baobab seed treatment

Baobab seeds were boiled for 1 hour, sun-dried and then ground through a 3 mm sieve. Boiling has previously been reported to have a favourable effect on the crude protein of baobab seeds and great effects on antinutritional factors than other methods (Saulawa et al., 2014).

Sorghum seed treatment

Wood ash from the Mopane tree was used to make the soaking medium at a rate of 1 kg ash to 20 l of water (Kyarisiima et al., 2005). A weak wood ash extract solution ensures that protein quality and availability is not compromised. The ash-water mixture was thoroughly stirred for 5 mins and then left to stand for 15 hours to allow maximum leaching to take place (Kyarisiima et al., 2005). The resulting supernatant was filtered with mutton cloth and then used to soak sorghum grain at the rate of 1 kg of grain to 2 litres of ash extract for 12 hours and the seed was allowed to dry in the sun before milling.

Soyabean seed treatment

Soya bean seed was roasted for 20 minutes at 100^{o}C to inactivate trypsin and other anti-nutritional factors (Gombwe et al., 2022).

Dietary treatment formulation

All the diets were farm-formulated using the Trial-and-Error Iteration software developed by Mpofu (2006). Two (2) differently formulated broiler diets, control and experimental, were produced utilising sorghum as the energy source. The traditional protein source, soya bean seed meal, was substituted for baobab seed meal in the experimental diet to come up with iso-nitrogenous diets containing 20% and 18% CP for growers and finisher meal diets, respectively (Table 3). Baobab meal at 28.8% inclusion in growers' meal diet reached the targeted CP content of 20%, while for finisher meal, an inclusion level of 42.5% was used. The choice to use 28.8% and 42.5% baobab seed meal inclusion levels in replacing soya bean as a protein source was based on the need to mirror tri-phase broiler feeds on the market utilising 20% grower and 18% CP in finisher diets. Vitamin-mineral pre-mix from Agrifoods Pvt Ltd feed company were added accordingly to each growth phase to all diets.

Table 3. Composition and nutritional value of the experimental diet

		Experimental ration		Control ration	
Item	**Starter**	**Grower**	**Finisher**	**Grower**	**Finisher**
Ingredient %					
Sorghum	56.5	42.3	36.5	60.0	70.0
Soybean meal	43.5	29.0	18.7	36.5	27.6
Baobab seed meal	*Nil*	28.8	42.5	*nil*	*nil*
Vit/min premix*	5.0	5.0	5.0	5.0	5.0
Nutritional content %					
Dry Matter	86.9	86.7	84.5	83.7	84.4
Crude protein	22.1	20.0	18.0	20.0	18.0
Crude fiber	2.6	6.1	7.7	2.5	2.4
Calcium	0.80	0.80	0.80	0.80	0.80
Phosphorus	0.40	0.40	0.40	0.40	0.40
Metabolizable energy (MJ/kg)	12.9	13	12.7	12.3	12.3

*Vit/min premix = 5 mg vitamin B_{12}; 4000 mg B_2; 20 000 IU vitamin E; 2000 000 IU vitamin D_3; 8000 000 IU vitamin A; 2000 mg vitamin K; 5000 mg B6; 10 000 mg pantothenic acid; 30 000 mg nicotinic acid; 1000 mg folic acid; 250 000 mg choline; 5000 mg copper; 75 000 mg manganese; 1000 mg iodine; 50 000 mg zinc; 100 mg selenium; 150 mg biotin (Supplier: Agrifoods Pvt Ltd company Zimbabwe).

More feed is consumed during the growers and finishing stages of the broiler chicken cycle; hence, the study introduced the alternative protein source, baobab seed meal, from the growers' phase, at 12 days of age.

Management of the Broiler chickens during the experiment

All other broiler management practices, except for the experimental treatments, were applied uniformly on all broiler clusters to minimize non-treatment variation. The pen and all feed and water equipment were cleaned and disinfected using virukill at least 14 days before the reception of the broiler chicks. Forty-eight hours before the arrival of the chicks, bedding of wood shavings and grass was evenly applied to a depth of between 70 mm and 100 mm in the pen. Clean, cool, fresh water with a vitamin-mineral supplement (stress pack) was available *ad-libitum* 6 hours before chick arrival and continued to be supplied with the stress pack for the next 3 days in water. All 96 chicks were initially reared in a single pen as they were fed the same starter diet, Table 3. Feed was introduced 30 mins after all the chicks had settled and consumed water. Feed and water were made available *ad libitum* throughout the experimental period.

At day 11, the chicks were randomly allocated to the dietary treatments and were managed in their replicate compartments from which the experimental diet was introduced. The chicks were initially stocked at a rate of 33 chicks per square meter and reduced to 10 chicks per square meter by the beginning of week two. Temperature was monitored and maintained at a range of 32 -35ºC during the first week, 29 – 32ºC for the second week and 26-29ºC for the third week of age. Heating of the house was done using an infra-red lamp (250 watts) with a back-up of charcoal drums (drum brazier) in cases of electrical failure. Closing and opening of curtains at the housing units was done to control ventilation.

Experimental design and Treatments

A Completely Randomized Design (CRD), was employed in the study with two dietary treatments replicated 6 times with 8 birds in each replicate, resulting in a total of 48 birds per treatment. Prior to the experiment, broiler chicks were fed on a 22% CP diet formulated from sorghum and soyabean seed meal. The experimental diet was gradually introduced from day 12 to day 16.

Measurements

Measurements taken during the experiment were feed intake and weight gain. Water intake was monitored during the experiment to determine the amount of intake. The taste and colour of the meat were measured at the termination phase of the project, after slaughtering the broiler chickens. Twelve hours prior to slaughter, feed was removed and only water was given to the birds to empty their gut. After recording live slaughter weight, six (6) birds were selected from each treatment for slaughter. Birds were then killed by cervical dislocation, sticking and then fully bled.

Meat taste quality parameter

Pieces of chicken from the slaughtered 6 chickens from each trial group were boiled in aluminium pot with 300 mm of water. After boiling, the chicken was salted to taste and allowed to simmer, awaiting tasting. Other pieces of chicken were deep-fried and salted to taste. Both boiled and deep-fried meat was cooked using an electric stove at an optimum temperature of 78 ºC. Cooking time was 20 mins. Apple pieces were used to clear residual mouth taste after tasting each meat sample. Consumers were asked for their responses. The attributes evaluated were appearance, smell, texture and taste.

Data analysis

A two-sample t-test in GenStat 18th edition was performed to statistically assess differences in weight gain between the control and the experimental treatment group at a 95% confidence interval. For analysis of carcass quality parameters, frequencies of responses/ratings by broiler meat consumers were compared.

Results

Effect of baobab seed meal on growth performance of Ross commercial broiler chickens

There were no significant differences (p=0.7) in growth performance between baobab and soyabean-based diet up to the marketing stage, Figure 1.

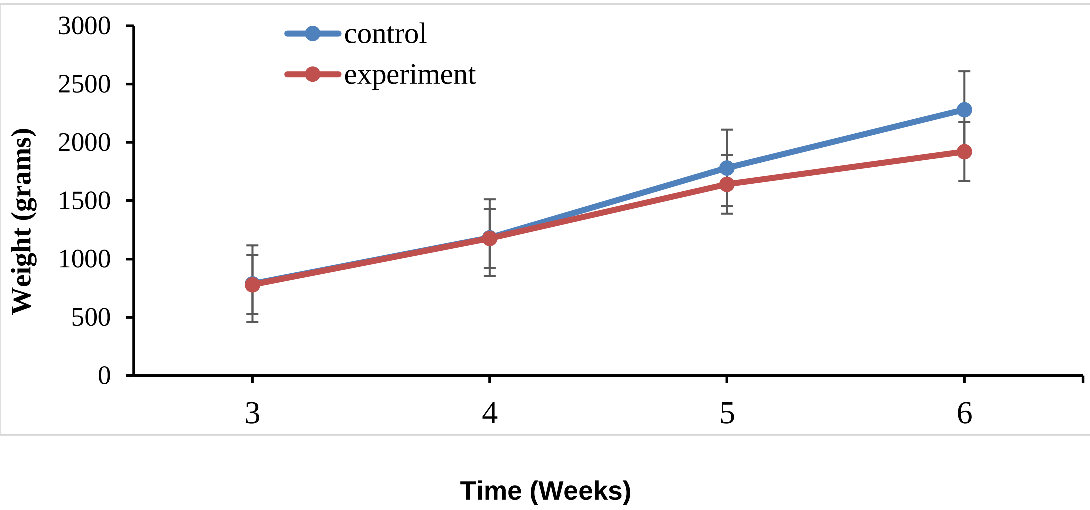

Figure 1. Broiler chicken weekly liveweight growth performance

Less variation to the population mean is expected when using baobab meal in broiler nutrition (Table 4).

Table 4. Average growth performance (grams) of the broiler chickens by day 42

Parameter	Value	SD	Se
Control (g)	2214	2.66	1.09
Experimental (g)	1921	2.56	1.05
Grand mean	2067		
p value	0.70		

Feed intake was not compromised by the inclusion of baobab seed meal

Feed conversion efficiency

Feed consumption and average liveweight gain were used to compute feed conversion efficiency (FCE) for each phase and also for the overall trial period, Table 5.

Table 5. Feed conversion efficiency of the broiler chickens over a 28-day trial period

Treatment	Feed consumed per bird	Average weight gain	Feed conversion ratio
Control group			
Grower stage (g)	1360	986	1.38
Finisher stage (g)	2000	1998	1.00
Overall (g)	3360	2214	1.52
Experimental group			
Grower stage (g)	1360	978	1.39
Finisher stage (g)	2000	1781	1.12
Overall (g)	3360	192	1.75

Effect of baobab seed meal on carcass parameters

Meat taste quality parameter

Using a 9 point hedonic scale, responses from 100% of sampled broiler meat consumers confirmed taste, texture and appearance of cooked meat from broilers as good. However, the respondents confirmed that deep-fried chicken had good appearance and sensed good.

Discussion of results

Baobab seed meal has a reasonable CP value, though not enough to be used as a standalone protein source due to the need for a higher CP content in the diets of broilers. However, its levels are ideal when used on a partial substitution basis. Chisoro et al (2017); and Madzimure et al (2011), have reported baobab seed meal CP content in the range 17-36% on dry matter basis, 15-25% crude fibre, 5-14% residual oil and energy level ranging 4.19-16.8 kJ/kg. The nutritional value is comparable to sunflower 24.4-36.7% CP and 19.2-210 kJ/kg and soyabeans hulls 10.5-19.2% CP and 17.5-18.7 kJ/kg. The current baobab CP of 16.7% falls within the range that has been reported by other researchers. Also, the crude fibre and crude lipids observed were within the range of values reported in literature (Madzimure et al., 2011). Muthai et al (2017), further stated baobab seeds if incorporated in livestock diets can provide some of the necessary vitamins, fibre and amino acids particularly methionine and lysine which are usually the limiting amino acid in most cereals but vital to livestock production. The results of this study were consistent with Chimvuramahwe et al (2011) who reported that baobab seed cake (BSC) can be included in the diets of broilers as a protein source without compromising growth performance. Alternative cheap protein sources in protein diets are hinged on feed safety, production and nutritional value (Chisoro et al., 2017).

Treated baobab seed meal supports growth in broiler chickens just like roasted soyabean meal. At inclusion levels of 28.8% and 42.5% for growers and finisher phase, respectively, broilers just performed as those on a 100% soyabean-based diet. The inclusion levels of baobab seed meal in the current study were limited by the nutritional value of the baobab seed meal, as the target was to formulate a diet that was iso-nitrogenous to the ones on the market for the respective growth phases. Baobab seed meal used in the current study had nutritional values in the same range as those reported by Chisoro et al (2019). Feed intake was not compromised and this was attributed to the aroma familiar with the baobab seed meal (Lawan et al., 2021). Feed intake is the pacesetter to body weight gain and feed conversion efficiency in broiler chickens (Chimvuramahwe et al., 2011).

The current findings are in support of Rafiu et al (2017) who also observed that higher baobab seed meal inclusion levels up to 40% can be used without any negative effects on the growth performance of broiler chickens. There were higher average daily weight gains of chickens fed 10% and 20% baobab seed meal, as reported by Bale et al (2013). Baobab seed meal produces good carcass parameters, as reported by Chisoro et al (2018), who presented better carcass characteristics in chickens fed up to 20% baobab seed meal.

Chisoro et al (2019), reported that the baobab seed meal, included at 20% can result in higher weight gain. However, baobab seed contains a higher fiber content that may negatively affect feed ingredient intake for avian species, impacting its utility as an alternative feed ingredient. Chisoro et al (2019), reported that inclusion of BSM in poultry improves carcass percentage and increases the passage rate of digester through the digestive tract as well as the physical capacity of intestines in birds.

Effect of feeding baobab seed meal on broiler carcass characteristics

The crude protein content in the current baobab seed meal (16.7%) limits its inclusion above 42.5% in broiler finisher diets, as inclusion levels above that will fail to meet the targeted CP requirements for the broiler chickens. The findings suggest that baobab seed meal can be used as a suitable alternative protein source in broiler chickens' diets up to 42.5% inclusion level without compromising bird performance. The inclusion of baobab seed meal in broiler feed formulations, substituting for soybean meal, has been shown to have no negative impact on consumers in terms of color and taste quality parameters. This comes after consumers made a rating good for quality parameters on both meats from broilers fed a from control diet and experimental diet.

Conclusion

The study concluded that partial substitution of soyabean with baobab seed meal as a protein source is feasible during the growth phase without compromising broiler growth performance, meat taste and carcass color characteristics. Processing practices employed: roasting, ash-soaking, and boiling were effective in reducing levels of trypsin inhibitors, tannins and phytates. Smallholder farmers with access to baobab seed meal can use it as a feed protein source to partially substitute conventional protein sources like soyabean meal in commercial broiler chicken production. However, further evaluation of the quality of the protein in baobab seed meal for poultry is recommended.

Competing Interests

The authors declare that they have no competing interests.

Acknowledgements

Researchers thank Tongwe farmers for their participation and provision of broiler chicks used in the study. We are grateful to Great Zimbabwe University for data analysis. We also appreciate the IDITECH Laboratories, Beitbridge, Zimbabwe for laboratory analysis.

References

1. Bale JS, Mancha YP, Sanusi M and Doma UD, 2013. Effect of graded levels of Baobab (Adansonia digitata) seed meal on the growth performance and production economic analysis of broiler chickens. International Journal of Poultry Science, 5*:* 273–276.
2. Chimvuramahwe J, Musara JP, Mujuru L, Gadzirayi CT and Nyakudya IW, 2011. Effect of feeding graded levels of Adansonia digitata (baobab) seed cake on the performance of broilers. Journal of Animal and Plant Science, 11(3): 1442–1449.
3. Chisoro P, Kaguru T and Assan N 2017. Baobab seeds as an alternative protein source in poultry feed. Scientific Journal of Review, 6(1): 509–518.
4. Chisoro P, Nkukwana T and Mupangwa J, 2019. Feed intake , growth performance , carcass characteristics and organ sizes of broilers fed baobab seed oilcake supplemented finisher diets. Welwitschia International Journal of Agricultural Sciences, 34(August): 26–34.
5. Chisoro P, Nkukwana TT, Mupangwa JF and Mabusela TP, 2018. Feed intake, growth performance and carcass traits of broilers fed diets with various inclusion levels of baobab seed oilcake. South African Journal of Animal Science, 48(2): 284–294.
6. Dhliwayo I, Muboko N and Gandiwa E, 2023. Local perceptions on poverty and conservation in a community-based natural resource program area: a case study of Beitbridge district, southern Zimbabwe. *Frontiers in Conservation Science*, 4*:* 1–10.
7. Fatima G, Hamdon AA and Mekki D, 2022. Impacts of Feeding Graded Levels of Baobab Seed Meal Instead of Concentrate on Growth Performance and Feed Utilization of Broiler Chicks. Acta Scientific Pharmacology, 3(10): 02–07.
8. Gombwe C, Chigede N, Hungwe T, Nhara RB, Dahwa E, Muvhuringi PB and Maburutse BE, 2022. Feed Management for Smallholder Pig Farming Systems in Zimbabwe. In X. Poshiwa & G. R. Chary (Eds.), Climate Change Adaptations in Dryland Agriculture in Semi-Arid Areas, 301–309.
9. Gororo E and Kashangura MT, 2016. Broiler production in an urban and peri-urban area of Zimbabwe. Development Southern Africa, 33(1): 99–112.
10. Habtemariam AA, 2021. Ecological, Commercial and Economic Significance of the Tree Lucerne: A Review. Proceedings of the National Academy of Sciences India Section B - Biological Sciences, 91(4), 737–741.
11. Kyarisiima CC, Okot MW and Svihus B, 2005. Use of wood ash extract and germination to improve the feeding value of Ugandan Sekedo sorghum (Sorghum bicolor) for broiler chicks. *Animal Feed Science and Technology*, 120(1–2): 67–77.
12. Lawan A, Maidala A, Sudikc S, Abdullahi U, Adullahi A, Mohammed M and Gambo S 2021. Effects of feeding graded levels of treated baobab (Adansonia digitata) seed meal on haematological indices and serum biochemistry of broiler chickens. *Proceedings of 26th Annual Conference of ASAN-NIAS, Uyo, Nigeria*, *September*, 612–617.
13. Madzimure J, Musimurimwa C, Chivandi E, Gwiriri L and Mamhare E, 2011. Milk yield and quality in Guernsey cows fed cottonseed cake-based diets partially substituted with baobab (Adansonia digitata L.) seed cake. Tropical Animal Health and Production, 43(1): 77–82.
14. McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG, 2010. *Animal nutrition* (7th ed.). Prentice Hall. https://doi.org/10.1038/111651a0
15. Mottet A and Tempio G, 2017. Global poultry production: Current state and future outlook and challenges. World's Poultry Science Journal, 73(2): 245–256.

16. Mpofu IDT, 2006. FeedSoft feed formulation software: an iteration excel assisted feed formulation software featuring pearson square automated, University of Zimbabwe, Harare, Zimbabwe
17. Muthai KU, Karori MS, Muchugi A, Indieka AS, Dembele C, Mng'omba S and Jamnadass R, 2017. Nutritional variation in baobab (Adansonia digitata L.) fruit pulp and seeds based on Africa geographical regions. Food Science and Nutrition, 5(6): 1116–1129.
18. Nchinda VP, Thieme O, Ankers P, Crespi V and Ariste S, 2011. Food security and economic importance of family poultry (chicken) husbandry program in Artibonite and South departments of Haiti. Livestock Research for Rural Development, 23(9).
19. Nhara RB, Pisa C, Chigede N, Gwazani R, Muteveri M, Murimoga L and Ruzengwe FM, 2024. Processing of Millets. In J. T. Timothy (Ed.), *Exploring the world of cereal crops.* (pp. 1–20). IntechOpen. https://doi.org/10.5772/intechopen.1005457 2.
20. Poel van der A F B, Krimpen van M M, Veldkamp T and Kwakkel RP, 2013. Unconventional protein sources for poultry feeding – opportunities and threats. Proceedings of the 19th European Symposium on Poultry Nutrition, Potsdam, Germany, 26-29: 14–24.
21. Rafiu TA, Okunlola DO, Olasunkanmi GO and Pelemo TT, 2017. Nutritional Evaluation of Adansonia digitata (Baobab Fruit) as a replacement for maize in the diet of Broiler Chickens. Nigerian Journal of Animal Science, 2: 39–46.
22. Saulawa LA, Ukachukwu SN, Onwudike OC, Garba MG and Aruwayo A, 2014. Quantitative substitution of raw baobab (Adansonia digitata) seed meal for soyabean meal in broiler starter diet. International Journal of Poultry Science, 13(6): 335–339.
23. Saulawa LA, Yaradua AI and Shuaibu L, 2014. Effect of different processing methods on proximate, mineral and anti nutritional factors content of baobab (Adansonia digitata) seeds. Pakistan Journal of Nutrition, 13(6): 314–318.
24. Thirumalaisamy G, Muralidharan J, Senthilkumar S, Sayee RH and Priyadharsini M, 2016. Cost-Effective Feeding of Poultry. International Journal of Environmental Science and Technology, 5(6): 3997–4005.
25. Tui SH and Baudron F, 2023. *Zimbabwe farm typologies report* (Issue June).
26. United Nations, 2019. World population prospects 2019: Highlights. In *The 26th round of official global population estimates and projections* (Issue 141). https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf
27. ZimVAC, 2022. *Zimbabwe Vulnerability Assessment Committee (ZimVAC) 2022 Rural Livelihoods Assessment Report*. www.fnc.org.zw.