International Journal of Agriculture and Earth Science (IJAES) E-ISSN 2489-0081 P-ISSN 2695-1894
Vol 11. No. 4 2025 www.iiardjournals.org

Effect of Decorticated Brown Sorghum Meal on the Growth Performance, Carcass Quality, Haematological, and Serum Parameters of Japanese Quails

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DOI: 10.56201/ijaes.vol.11.no4.2025.pg1.9

Abstract
The widespread cultivation of brown sorghum in semi-arid regions worldwide, including Nigeria, has led to the need for processing its hulls, which are high in tannins, to enhance its nutritional value as an alternative to maize in poultry feed. This paper aimed to assess the effect of decorticated brown sorghum at different inclusion levels on the performance, carcass traits, hematological, and serum parameters of Japanese quails. To create decorticated brown sorghum meal (DBSM), brown sorghum seeds were soaked overnight, hulled, and dried before milling. Three dietary treatments were developed: Control (100% maize or 0% DBSM), 50% DBSM (50% maize + 50% DBSM), and 100% DBSM (0% maize or 100% DBSM). A total of 150 day-old quail chicks were assigned to these treatments, with 50 quails per treatment replicated five times in a completely randomized design. The quails had ad libitum access to feed and water for 42 days. The study measured weight gain, feed intake, feed conversion ratio, carcass traits, and hematological and serum parameters. Results indicated a significant difference ($P < 0.05$) in total weight gain and carcass weight by day 42, with quails on a 100% DBS diet exhibiting greater weight gain and carcass percentage than those on the control and 50% DBS diets. The conclusion drawn from the study is that decorticated brown sorghum can effectively replace maize in poultry diets without compromising performance or blood parameters.

Keywords: *Decorticated brown sorghum, Japanese quails, maize, performance, carcass and blood parameters*

Introduction

Japanese quails (Coturnix coturnix japonica), which were introduced to Nigeria in 1992, are increasingly favored by poultry farmers due to their nutritional advantages, lower fat levels, and the growing popularity of quail meat compared to chicken (Khaleel *et al.*, 2021). Quails possess several beneficial traits, including disease resistance, adaptability to extreme environments, early maturity, and rapid growth rates (Mnisi *et al.*, 2017). Poultry feed, which constitutes 70-80% of raising costs, heavily depends on maize, which is facing increased competition and scarcity. Alternatives like sorghum could alleviate the rising costs of feed and energy shortages. Beriso (2022) noted that the poultry industry has been more affected than other livestock sectors due to feed supply issues and ongoing price increases. The primary expense in poultry production, both for egg and meat production is feed, with energy levels dictating intake as birds typically eat to meet their energy needs. Continuous increases in feed ingredient prices pose significant challenges, particularly in developing nations, making it essential to create diets focused on locally available cereal options that meet birds' energy requirements. Cereals are vital energy sources for poultry diets in tropical regions (Etuk *et al*., 2012). The use of maize as a primary energy source is hindered by competition from both human consumption and ethanol production (Beriso, 2022). Maize (*Zea mays* L) serves as a crucial global staple and livestock feed, but its availability is limited in non-farming regions, like many parts of northern Nigeria, which require substantial rainfall (Sudik *et al*., 2024). Currently, maize utilized for food and on-farm feeds in Nigeria are typically imported, further increasing feed costs. The encroachment of desert land hampers maize production, necessitating the cultivation of drought-resistant crops. Sorghum, an indigenous African cereal, thrives in arid and semi-arid climates and is a staple in semi-arid sub-Saharan Africa (Beriso, 2022). In Nigeria, sorghum spans 4.5 million hectares and provides nutritional benefits while serving as a maize alternative, particularly for poultry (Papanikou, 2020). Although its nutritional composition is akin to maize, sorghum exhibits superior drought resistance and requires fewer fertilizers on less fertile land. However, whole sorghum grains contain 73% carbohydrate and 10% protein, with anti-nutritional factors like tannins that can hinder the absorption of important nutrients (Asropi and Novita, 2022; Beriso, 2022). The hull, constituting 10-15% of the seed's weight, is high in fiber and tannins, which lower sorghum's nutritional value by inhibiting protein absorption (Asropi and Novita, 2022). Tannin content can impact palatability, affecting quail feeding habits, with yellow varieties having lower tannins (0.2-0.5%) compared to brown varieties (which can exceed 3%). The negative effects of tannins are evident in growth performance, meat flavor, egg production, and shell quality (Gualtieri and Rapaccini, 2016). To enhance the nutritional profile of sorghum, particularly high-tannin varieties, it is essential to remove the hull. Studies have indicated that detoxifying high-tannin sorghum can improve growth and feed efficiency in poultry on threonine-deficient diets, whereas low-tannin grains do not provide such benefits (Teeter et al., 1986). Soaking sorghum seeds can decrease tannin levels, improving both nutritional quality and grinding efficiency (Asropi and Novita, 2022). Methods to reduce tannins also tend to increase feed costs; meanwhile, low-tannin sorghum is generally secure for poultry but is vulnerable to wild birds in the fields (Papanikou, 2020). Sorghum with 0.5%-1% tannins may compromise diet formulations, while high-tannin levels should be cautiously used in older animals (Papanikou, 2020). Quail farming is advantageous due to the birds' rapid growth, effective use of space, high egg production, adaptability, and resistance to diseases, making it a viable lucrative enterprise (Sudik *et al*., 2024). Studies show that 100% low-tannin sorghum negatively affects broilers, while high-tannin sorghum adversely affects their performance at any level (Torre *et al*., 2013). Therefore, cost-effective methods to manage tannins in feed production are necessary. This study aims to evaluate how varying inclusion levels of decorticated brown sorghum affect the performance of Japanese quails as a drought resilient crop.

Materials and Methods

Debris was removed from sorghum grains, which were soaked overnight in clean water to loosen the seed coats for easier removal. A grain mill was employed to effectively detach the seed coats without grinding the grains. The mill was designed to blow air, eliminating lighter fragments while retaining clean sorghum grains. The grains were rinsed again using a mesh strainer to prevent seed coat residues and were then dried for storage to avoid spoilage. Five diets were formulated, designated as follows: 0% DBS (Control), 50% DBS (low-sorghum), and 100% DBS (high-sorghum), following the formulation method outlined by Torres *et al*. (2013).

Table 1: Ingredients and composition of the experimental diets

Ingredients %)	Control	50% DBS	100% DBS
Maize	50.24	25.12	0.00
Sorghum	0.00	25.12	50.24
Soybean	20.06	20.06	20.06
Groundnut cake	8.25	8.25	8.25
Wheat offal	10.00	10.00	10.00
Fishmeal	4.45	4.45	4.45
Bone meal	3.45	3.45	3.45
Limestone	2.45	2.45	2.45
Premix	0.50	0.50	0.50
Lysine	0.20	0.20	0.20
Methionine	0.20	0.20	0.20
Salt	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**
Nutrients			
Crude protein (%)	20.27	20.34	20.48
Metabolizable energy (kcal/kg)	2995.14	2987.45	2980.16

One hundred and fifty day-old quail chicks, weighing around 12.24 grams, were acquired from Shikka, Zaria, Nigeria. The chicks were randomly assigned into five treatment groups, each containing 50 quails, with five replicates of 10 quails. A completely randomized design was implemented, and the quails were housed in hutches measuring 150 x 90 cm. The hutch floors were covered with thick removable paper, and 24-hour light was provided. The chicks had ad libitum access to feed throughout the experiment, and vaccinations for Newcastle disease (day 7) and infectious bursal disease (day 14) were administered. Weekly measurements of body weight and feed consumption were recorded to calculate performance metrics (feed intake, weight gain, feed conversion), and any mortality was noted. On days 21 and 42, two birds from each replicate were randomly selected and fasted for 12 hours to clear the intestines before slaughter (Mendes, 2001). Following fasting, the quails were stunned and killed via cervical dislocation, and blood samples were collected on day 15 at the times of observation (12, 24, and 48 hours). A 5 mL blood sample was collected into EDTA tubes, followed by preparation of blood smears with Giemsa staining to evaluate leukocyte count. Total white blood cell and red blood cell counts were determined using a Neubauer hemocytometer, applying a modified diluent from Rees and Ecker as detailed by Anggraeni *et al*. (2016). Carcass yield was calculated (including whole carcass weight and parts like breast, thigh and drumstick), with whole carcass weight expressed as a percentage of live body weight, while carcass parts were given as a percentage of absolute carcass weight. Data collected were analyzed using ANOVA through the Statistical Analysis System (SAS, 1990); significant differences were evaluated with Duncan's multiple-range test ($P < 0.05$).

Results

Table 2 demonstrates the effects of decorticated brown sorghum on Japanese quails' performance, indicating significant differences (P < 0.05) in total weight gain among treatments, with increases noted in the 50% and 100% DBS groups compared to the control.

Table 2: Effect of decorticated brown sorghum on performance of Japanese quails

Parameters	Control	50% DBS	100% DBS	SEM	p-value
Weight gain (g)					
d 7	21.17	21.89	23.23	1.05	0.899
d 14	28.05	28.00	30.22	1.27	0.665
d 21	30.82	32.34	33.75	1.47	0.761
d 28	28.32	30.67	31.13	1.51	0.167
d 35	24.12	26.11	27.82	1.85	0.233
d 42	23.01	25.01	26.01	1.53	0.501
Total	155.49^{c}	164.02^{b}	172.16^{a}	8.34	0.001
Average	25.92	27.34	28.69	1.39	0.822
Feed intake (g)					
d 7	71.12	70.74	70.05	0.54	0.883
d 14	105.00	107.38	105.59	1.24	0.255
d 21	161.87	159.19	161.17	1.39	0.545
d 28	185.45	193.07	194.29	4.79	0.498
d 35	198.61	207.51	205.03	4.59	0.876
d 42	195.16	220.23	210.35	12.63	0.576
Total	917.21	958.12	946.48	21.08	0.644
Average	152.87	159.69	157.75	3.51	0.751
Feed conversion					
d 7	3.36	3.23	3.02	0.17	0.611
d 14	3.74	3.84	3.49	0.18	0.176
d 21	5.25	4.92	4.78	0.24	0.521
d 28	6.55	6.30	6.24	0.16	0,736
d 35	8.23	7.95	7.37	0.44	0.588
d 42	8.48	8.81	8.09	0.36	0.489
Average	5.90	5.84	5.50	0.22	0.450

Values with different superscripts are significantly different (p<0.05).

Table 3 assesses the impact of sorghum on the carcass and cuts of quails, with a significant difference (P < 0.05) in carcass percentage observed on day 42, where the 100% DBS group showed higher weight compared to the control and 50% DBS groups.

Table 3: Effect of decorticated brown sorghum on carcass and cuts of Japanese quails

Parameters (%)	Control	50% DBS	100% DBS	SEM	p-value
Whole carcass					
d 21	60.39	62.22	65.78	2.74	0.515
d 42	70.26[b]	71.86[b]	75.85[a]	2.88	0.068
Average	65.33	67.04	70.82	2.81	0.670
Breast					
d 21	44.86	41.43	43.30	1.72	0.577
d 42	42.86	46.08	44.89	1.63	0.548
Average	43.86	43.76	44.10	0.17	0.511
Thigh					
d 21	31.63	32.51	30.56	0.98	0.618
d 42	31.48	29.39	30.98	1.08	0.497
Average	31.56	30.95	30.77	0.41	0.711
Drumstick					
d 21	23.51	26.05	26.15	1.50	0.816
d 42	25.66	24.53	24.13	0.79	0.459
Average	24.59	25.29	25.14	0.37	0.563

Values with different superscripts are significantly different ($p<0.05$).

Table 4 shows the effect of decorticated brown sorghum on hematological parameters of Japanese quails. All the parameters were not significantly ($p>0.05$) affected by dietary treatment.

Table 4: Effect of decorticated brown sorghum on hematological parameters of Japanese quails

Parameters	Control	50% DBS	100% DBS	SEM	p-value
Packed cell volume (%)					
d 21	33.67	33.71	35.18	0.86	0.015
d 42	33.33	33.56	34.37	0.55	0.068
Average	33.50	33.64	34.78	0.70	0.770
Haemoglobin (g/%)					
d 21	12.17	11.25	12.01	0.49	0.569
d 42	12.48	10.74	11.93	0.89	0.735
Average	12.33	11.00	11.97	0.69	0.609
Red blood cells (10^6/mm3)					
d 21	3.27	3.51	3.38	0.12	0.486
d 42	3.01	2.78	3.55	0.40	0.636
Average	3.14	3.15	3.47	0.19	0.634
White blood cells (103 /mm3)					
d 21	5.27	6.01	6.35	0.55	0.880
d 42	6.52	5.68	6.38	0.45	0.714
Average	5.90	5.85	6.37	0.29	0.696

Table 5 shows the effect of decorticated brown sorghum on serum parameters of Japanese quails. All the parameters were not significantly (p>0.05) affected by dietary treatment.

Table 5: Effect of decorticated brown sorghum on serum parameters of Japanese quails

Parameters (%)	Control	50% DBS	100% DBS	SEM	p-value
Total protein (g/L)					
d 21	41.35	46.36	44.41	2.53	0.646
d 42	45.30	44.32	45.48	0.62	0.742
Average	43.33	45.34	44.95	1.07	0.471
Albumin (g/L)					
d 21	21.27	24.68	24.52	1.92	0.538
d 42	19.6	22.17	26.08	3.26	0.398
Average	20.44	23.43	25.30	2.45	0.801
AST (u/L)					
d 21	119.54	120.11	118.36	0.89	0.461
d 42	121.27	118.17	118.41	1.72	0.563
Average	120.41	119.14	118.39	1.02	0.587
Creatinine (umol/L)					
d 21	19.33	18.91	19.55	0.33	0.991
d 42	17.36	18.36	17.47	0.55	0.835
Average	18.35	18.64	18.51	0.15	0.812
Glucose (mmol/L)					
d 21	2.52	2.88	2.76	0.18	0.359
d 42	3.18	2.56	3.28	0.39	0.942
Average	2.85	2.72	3.03	0.15	0.657

Discussion

Growth rates observed in this study were generally higher than those previously reported (161.70 – 180.10g by Khaleel *et al*. (2021) and Odunsi *et al*. (2007), with non-significant differences in performance metrics showing the feasibility of completely replacing maize with DBS in quail diets. However, feed conversion values were greater than those recorded 4.60 and 3.86 by Moraes *et al*. (2016) and Khaleel *et al*. (2021) respectively). Carcass percentage, crucial for profitability, demonstrated high daily weight gain compared to previously reported figures 0.28-0.25g by Odunsi *et al*. (2007)). A higher carcass percentage indicates that more quail can be sold as meat, critical for the economic evaluation of quail farming. Factors influencing carcass percentage include genetics, diet, and environment, with the study suggesting that DBS provides a more balanced diet (rich in protein, vitamins, and minerals) than maize. At day 21, meat was likely less mature and less flavorful, while the higher percentage at day 42 may stem from continued muscle growth and fat deposition, enhancing carcass appeal for producers and consumers. The lack of significant differences in whole carcass weight and cuts supports the replacement potential of DBS in quail diets, consistent with findings from Carolino *et al*. (2014) and Khaleel *et al.* (2021). The non-significant variances in hematological parameters are promising, indicating that 100% maize replacement is viable. Anggraeni *et al*. (2016) noted that hemoglobin levels are closely related to erythrocytes and hematocrit, serving as indicators of oxygen-carrying capacity. Hemoglobin concentrations in experimental quails fell within normal ranges (Anggraeni *et al*., 2016). Hematocrit indicates the volume percentage of red blood cells, which can be affected by environmental stressors, nutrition, dehydration, and parasitic infections (Challenger *et al*., 2001). Increased water consumption might dilute blood, reducing hematocrit values (Tamzil *et al*., 2013). Results showed leukocyte counts in the control group were comparable to those receiving 50% and 100% DBS, highlighting the immune response role of white blood cells (Anggraeni *et al*., 2016). Various factors impact white blood cell levels in poultry, including genetics, stress exposure, and maintenance practices. Serum aminotransferases indicate liver health, revealing no adverse effects of dietary treatments on liver weights signifying that sorghum inclusion levels don't negatively impact liver function. Similarly, no significant dietary effects were observed in renal function indicators.

Conclusion

The 100% inclusion of decorticated brown sorghum yielded comparable growth performance, carcass quality, and favorable hematological and serum parameters relative to the control diet. Thus, decorticated brown sorghum shows promise as an alternative energy source in Japanese quail production, providing a potential strategy for feed manufacturers to utilize relatively inexpensive, high-tannin sorghum.

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