Journal of Animal Science and Veterinary Medicine
Volume 8(4), pages 117-124, August 2023
Article Number: 54D537F95
ISSN: 2536-7099
https://doi.org/10.31248/JASVM2023.388
https://integrityresjournals.org/journal/JASVM

Full Length Research

Effect of graded levels of *Awara* (A soy-food) waste on feed intake, growth performance, and carcass yield of broiler chickens

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Received 18th June 2023; Accepted 8th August 2023

ABSTRACT: Large quantity of *Awara* waste (or residue) is generated in most parts of Nigeria year round and little or no economic importance attached to it. This study was designed to determine the effect of graded levels of *Awara* waste (AW) on feed intake, growth performance and carcass yield of broiler chickens. Four hundred kilogram (400 kg) AW was collected and allowed to dry under a shade and milled. It was incorporated into 5 isonitrogenous and isocaloric starter and finisher diets (designated as T_1, T_2, T_3, T_4 and T_5) in which the content of soybean meal was substituted with *Awara* waste by 0, 5, 10, 15 and 20% respectively. Two hundred day-old broiler chickens of ROSS 308 strain were used. They were randomly distributed into the five dietary treatments. Each treatment had 40 birds with 4 replicates of 10 birds each. The design used was completely randomized design (CRD). Feed and water were supplied *ad libitum*. Required management practices were strictly observed. The experiment lasted 42 days. Birds fed 0% and 5% AW significantly ($p<0.05$) had highest final weight, total weight gain and daily weight gains; low daily feed intake and total feed intake; and had best feed conversion ratio followed by those fed 10% in most cases while those fed 15% and 20% had lowest growth indices and feed intake as well as poorest feed conversion ratio. Similarly, the birds fed 0% and 5% AW significantly ($p<0.05$) had highest dressed weight followed by those fed 10% while those fed 15% and 20% again had lowest. The entire cut parts and organs' weights were not significantly different ($p>0.05$) by the treatments. Also, the proximate composition of the experimental diets was significantly similar ($p>0.05$) among treatments. The contents of protein, ether extract and nitrogen free extract in the faeces increased with increased AW in the diets. Treatments T_3, T_4 and T_5 had higher protein, ether extract and nitrogen free extract in the faeces while T_1 and T_2 had lower. Birds fed T_1 and T_2 had higher digestibility while those fed T_3, T_4 and T_5 had lower. It can be concluded that soybean meal can be substituted with AW by 5% without deleterious effect on feed intake, growth performance and carcass yield of broiler chickens.

Keywords: *Awara* waste, growth rate, feed consumption, carcass and organs' weights.

INTRODUCTION

Globally feed cost constitutes 65 to 70% of the cost of poultry production (Desta and Wakeyo, 2013; Summers, 2001). In most developing countries including Nigeria, feed cost is usually higher than the 65 to 75% cost of poultry production because of the scarcity and higher prices of maize and soybean which form bulk of poultry feeds (Abbas, 2013; Abdel-Hafeez *et al*., 2016; Summers, 2001). Also, alternative energy and protein sources such as sorghum, millet, sunflower meal, groundnut meal, rice bran, palm meal, cottonseed meal, linseed meal, fish meal, some by-products of grains and seeds are not readily available (NIAS, 2021). Therefore, to maintain the normal cost bracket of poultry feed, it becomes necessary to exploit novel feed ingredients that are readily available, cheap, composed of high nutrient quality, minimal anti-nutritional factors and have no competing demand. One of these novel feed ingredients is AW (also called *Awara* residue). It is the remains of *Awara* (a native soy-food). The production of *Awara* involves soaking of soybean seeds overnight in water and is ground (using hammer mill) after is removed from the water. After grinding more water would be added and the mixture would be sieved. The curd that is collected during sieving is further processed into *Awara* while the residue that retained in the sieve is the AW (*Awara* residue) and it is allowed to dry for proper storage. *Awara* is the major form of utilizing soybean in Nigeria particularly in the northern zone. It is sold in cities and villages. Tons of AW are thrown as waste in Nigeria littering the environment in the midst of scarcity of conventional and alternative feed ingredients. It contains 25% crude protein (Sudik *et al*., 2020). The most challenge against the use of most plant feedstuffs is the presence of anti-nutritional factors (Omosowone and Ogunrinde, 2018), but the soaking of soybean, grinding, sieving, and drying in producing *Awara* are evident that the inherent trypsin inhibitor in soybean is reduced (Kuku *et al*., 2014). Despite the availability and high protein content of *Awara* waste in Nigeria, there is less or no information on its use as poultry feed ingredient. Therefore, this study aimed at determining the effect of graded levels of *Awara* waste on feed intake, growth performance and carcass yield of broiler chickens.

MATERIALS AND METHODS

Study area

This study was carried out in the Poultry Unit of the Teaching and Research Farms of the Department of Animal Science, Faculty of Agriculture, Federal University Gashua, Yobe state Nigeria. Gashua lies on latitude 12°,52.547/12.8758°N and longitude 11.0120°/11°00.719E. This area is in the Sahel Savanna zone of Nigeria. Its experiences longer dry season (October to May) and shorter raining season (June to September) with average annual temperature usually between 38-43°C, average annual rainfall of 500-1000 mm and average annual relative humidity of 30-35% (Ovimaps, 2014).

Source and processing of *Awara* waste

Four hundred kilogram (400 kg) of fresh AW was collected in Gashua town of Bade LGA of Yobe State, Nigeria at various households immediately after production and was allowed to dry under the shade for the period of 5 days.

Preparation

The house used had two opposite sides (along the length) without walls and were covered with wire mess. All equipment and materials in the room were removed and washed. The entire room containing twenty pens (Replicates) of 150 square feet was thoroughly cleaned, and washed using detergent. Thereafter, the room was disinfected using potassium permanganate and formaldehyde solution and sealed for two weeks by covering the open-sides with thick polythene to kill any surviving organisms. Drinkers and feeders were washed and dried in the sun. Electricity appliances were properly fixed to ensure adequate light distribution. Dry batteries and torch lights were provided to supply light in an event of electricity failure. The floor of the room was covered with clean newspaper in the first week of the experiment and was covered with dried wood shaving from the second to the sixth week. A day to the arrival of the chicks, the door was allowed open to release the built-up toxic. Six hours to the arrival of the birds, heat was supply in the room using charcoal. Each replicate was equipped with drinker and feeder. Tray feeders were used in the first week and conical feeders were used from the second to the sixth week.

Feed

Five iso-nitrogenous and iso-caloric diets (starter: 23% CP and 3200 ME, and Finisher: 20% CP and 3000ME) designated as T_1, T_2, T_3, T_4 and T_5 were formulated in which the content of soybean meal in the diets was replaced with AW by 0%, 5%, 10%, 15% and 20% respectively. The 0% AW diet served as control (Table 1 and 2). All the diets were formulated following the nutrient requirements of broiler starter and finisher as specified by National Research Council (1994).

Experimental birds and management

A total of 200-day old Ross strain broiler chicks were purchased from Agrited Distributor in Jos Plateau State, Nigeria. The birds were randomly allotted into five dietary treatments containing 40 birds per treatment, after which each group was further subdivided into four replicates consisting of 10 birds each. The chicks were given starter feed from 0-21 days of age and the finisher feed from 21-42 days. Heat was not supplied during the starter phase due to the prevailing temperature (ranging from 41 to 43°C). However, the open side of the house was kept close using polythene during the starter phase to prevent cold particularly in the early part of the day, but the polythene was completely removed during the finisher phase to allow adequate ventilation. The birds were supplied with their respective dietary treatment and drinking water *ad libitum*. The edge of the conical feeder in each replicate was raised to the average level of the chicks' backs. Multivitamin was administered from 0-3 days of arrival to mitigate stress

Table 1. Ingredients and composition (%) of broiler starter.

Ingredients	T_1	T_2	T_3	T_4	T_5
Maize	49.00	48.85	48.85	49.00	49.00
Wheat offal	8.00	8.00	7.80	7.55	7.45
Awara waste	0.00	0.95	1.90	2.85	3.80
Full fat soybean	19.00	18.05	17.10	16.15	15.20
Groundnut cake	12.00	12.15	12.35	12.65	12.85
Fish meal	4.00	4.05	4.10	4.20	4.20
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.00	1.00	1.00	1.00
Premix*	0.25	0.25	0.25	0.25	0.25
L-Lysine HCL	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.15	0.15	0.15	0.15	0.15
Common salt	0.25	0.25	0.25	0.25	0.25
Vegetable oil	3.00	2.95	2.90	2.60	2.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Nutrients					
Crude protein	22.08	22.06	22.05	22.07	22.06
Metabolizable energy (kcal/kg)	3031.40	3031.43	3030.77	3031.04	3031.03
Calcium	1.10	1.10	1.10	1.10	1.10
Phosphorus	0.52	0.51	0.51	0.52	0.52
Lysine	1.21	1.21	1.22	1.21	1.22
Methionine	0.60	0.60	0.61	0.61	0.61
Crude fibre	3.11	3.13	3.14	3.16	3.17

Vitamin premix supplied per kg diet to supply vit A 8,000.00iu, D3, 1440 iu; VitE, 21.6 mg; Vit K3, 2.7 mg, VitB1, 1.8 mg; VitB2, 3.6 mg: Vit B6, 2.7 mg; Niacin, 21.6 mg; VitB12, 0.018 mg; Folic Acid, 0.54 mg; Panthothenicacid, 9.0 mg; Biotin, 0.036 mg; Cholinechloride, 270 mg; Zinc,27 mg; Mn,108 mg; Fe,18 mg; I2, 0.72 mg; Se, 0.072 mg; Cu, 1.44 mg; Co, 0.144 mg.

incurred from transit and the new environment. Gumboro disease vaccine was administered on day 7 and 21, Newcastle disease vaccine (Lasota) on day 14 and 28. Broad spectrum and coccidiostat were occasionally administered as prophylaxes. Light was provided all nights. The birds were reared using deep litter system. The litter material was replaced at weekly interval and the experiment lasted 42 days.

Data collection

Growth performance

Live weight: As at the time of commencing the experiment, the chicks were weighed in a group of 10 and average was taken to determine the initial average body weight. Subsequently, individual live body weight of the bird was taken on day 7, 14, 21, 28, 35 and 42. The live body weight of the previous week was subtracted from current week to determine weekly body weight change (gain). The cumulative weekly weight gain gave the total weight gain (TWG) and TWG divided by 42 days to determine the average daily weight gain (DWG) for the period of the experiment.

Feed intake: A known quantity of feed was supplied for each replicate. The difference between the feed supplied in the previous day and the leftover of the following gave daily feed intake (DFI) per replicate. The cumulative 42 days' daily feed intake gave total feed intake (TFI) per replicate. The TFI per replicate divided by 10 gave the TFI per bird and the TFI per bird divided by 42 days gave the daily feed intake (DFI) per birds.

Feed conversion ratio (FCR): feed consumed by bird per particular time divided by weight gain of the bird for the same period of time. Mathematically,

$$\text{FCR} = \frac{\text{Feed consumed}}{\text{Weight gain}}$$

Carcass, cut parts and organs

On the last day of the experiment, 3 chickens with live

Table 2. Ingredients and composition (%) of broiler finisher.

Ingredients	T_1	T_2	T_3	T_4	T_5
Maize	52.00	51.50	51.45	51.00	51.00
Wheat offal	8.00	8.00	8.00	8.00	7.85
Awara waste	0.00	0.85	1.7	2.55	3.4
Full fat soybean	17.00	16.15	15.30	14.45	13.60
Groundnut cake	12.10	12.60	12.60	13.05	13.30
Fish meal	4.00	4.00	4.05	4.05	4.05
Bone meal	3.00	3.00	3.00	3.00	2.90
Limestone	1.00	1.00	1.00	1.00	1.00
Premix*	0.25	0.25	0.25	0.25	0.25
L-Lysine HCL	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.15	0.15	0.15	0.15	0.15
Common salt	0.25	0.25	0.25	0.25	0.25
Vegetable oil	2.00	2.00	2.00	2.00	2.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Nutrients					
Crude protein	20.56	20.60	20.49	20.51	20.46
Metabolizable energy (kcal/kg)	3208.50	3208.60	3208.11	3207.96	3208.01
Calcium	1.08	1.09	1.09	1.09	1.06
Phosphorus	0.51	0.51	0.51	0.50	0.50
Lysine	1.09	1.10	1.11	1.11	1.12
Methionine	0.52	0.53	0.55	0.54	0.55
Crude fibre	3.65	3.67	3.69	3.71	3.72

*Premix supplied as per kg diet: vitamin A 10,000.00iu, D3,1440 iu; Vitamin E,21.6mg; Vitamin K3, 2.7 mg; Vitamin B1, 1.8 mg; Vitamin B2, 3.6 mg: Vitamin B6, 2.7 mg; Niacin, 21.6 mg; Vitamin B12, 0.018 mg; Folic Acid, 0.54 mg; Panthothenicacid, 9.0 mg; Biotin, 0.036 mg; Cholinechloride, 270 mg; Zinc, 27 mg; Manganese, 108 mg; iron, 18 mg; I2, 0.72 mg; Selenium, 0.072 mg; Copper,1.44mg; Cobalt ,0.144mg.

weight close to average weight were selected from each replicate, given 12 birds per treatment and a total of 60 birds were selected. They were starved for 24 hours to ensure their gut was empty (Deiltel *et al*., 2012). They were slaughtered using sharp knife following immobilization with chloroform in a desiccator. Thereafter, they were scalded, de-feathered and the carcasses were opened. The liver, heart, kidneys, lungs, spleen and pancreas were excised, weighed using a sensitive scale with a graduation of 0.001 g and each organ was expressed in g/kg body weight.

Faeces (digesta)

Following the slaughtering and opening of carcasses, the length of ileum 2.5 cm from Mikel diverticulum to 2.5 cm away from ileocecal junction was removed in each carcass. The content was evacuated into Petri dish, dried using oven and 60°C for 24 hours as adopted by Sudik (2016); and stored in an airtight container prior to proximate analysis. The proximate composition of the diets and faeces were determined according to Association of Official Analytical Chemists (2000) procedure. The coefficient of digestibility was calculated as follows:

$$\text{Digestibility} = \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in feed}} \text{ x } 100$$

As adopted by Alabi *et al*. (2020).

Statistical analysis

The data were subjected to one-way analysis of variance (ANOVA) and descriptive statistics. The statistical program used to analyze data generated was SPSS (IBM, version 25, Chicago, USA). Variation in means were separated using Duncan’s multiple range test (DMRT) and significant results were declared at 5% probability.

RESULTS

Table 3 shows the performance of 42-day-old broiler chickens f ed diets containing graded levels of *Awara*

Table 3. Performance of 42-day-old broiler chickens fed diets containing graded levels of *Awara* waste

Parameters	T_1	T_2	T_3	T_4	T_5	SEM	LOS
Initial weight (g)	45.12	45.22	46.22	45.67	47.01	0.78	
Final weight (g)	1829.58^{a}	1755.70^{a}	1589.42^{b}	1485.40^{bc}	1454.37^{bc}	164.91	*
Total weight gain (g)	1784.46^{a}	1710.48^{a}	1543.20^{b}	1439.73^{c}	1407.36^{c}	171.56	*
Daily weight gain (g)	42.49^{a}	40.73^{a}	36.74^{b}	34.28^{c}	33.51^{c}	4.08	*
Daily feed intake (g)	95.21^{b}	96.36^{b}	104.32^{a}	107.09^{a}	107.56^{a}	7.89	*
Total feed intake (g)	3998.92^{c}	4047.17c	4381.28^{b}	4497.79^{a}	4517.63^{a}	248.50	*
Feed conversion ratio	2.21^{c}	2.33^{c}	2.76^{b}	3.03^{a}	3.12^{a}	0.41	*

Values are mean of 40 birds.

Table 4. Carcass, cut parts and organs of 42-day-old broiler chickens fed diets containing graded levels of *Awara* waste.

Parameters	T_1	T_2	T_3	T_4	T_5	SEM	LOS
Dressed weight(g)	1397.56^{a}	1343.31^{a}	1197.44^{b}	1093.60^{c}	1062.18^{c}	148.42	*
Dressed %	76.39^{a}	75.23^{a}	75.34^{a}	70.07^{b}	70.61^{b}	3.15	*
Cut parts							
Drumstick	13.77^{a}	13.66^{a}	12.35^{b}	12.13^{b}	12.43^{b}	0.78	*
Thighs	20.75^{a}	21.08^{a}	19.84^{b}	19.24^{b}	18.94^{b}	0.93	*
Wings	7.65	7.63	6.66	6.31	6.30	0.68	NS
Breast	33.84^{a}	33.81^{a}	31.26^{b}	31.10^{b}	30.80^{b}	1.53	*
Neck	3.55	3.51	3.45	3.25	3.15	0.04	NS
Abdominal fat	1.49^{a}	1.32^{ab}	1.21^{b}	1.16^{b}	1.16^{b}	0.16	*
Organs							
Heart	0.62	0.62	0.68	0.66	0.71	0.04	NS
Liver	3.47	3.49	3.34	3.56	3.70	0.13	NS
Gizzard	2.31	2.35	2.53	2.52	2.67	0.15	NS
Pancreas	0.25	0.25	0.24	0.25	0.25	0.01	NS
Spleen	0.13	0.13	0.12	0.13	0.13	0.01	NS

Values are mean of 12 birds.

waste. The increase in AW in the diets significantly ($p<0.05$) decreased final weight, total weight gain, daily weight gain, daily feed intake and total feed intake as well as feed conversion ratio beyond 5% inclusion level. However, there was no significant difference in these parameters between birds fed 0% and 5%.

Table 4 shows the carcass, cut parts and organs of 42-day-old broiler chickens fed diets containing graded levels of *Awara* waste. Similar to the results in Table 3, dressed weight and dressed percentage ($p<0.05$) decreased beyond 5% AW and were similar between 0% and 5%. Similarly, drumstick, thighs, breast and abdominal fat were ($p<0.05$) higher in birds fed T_1 and T_2. These parts were lower in T_3, T_4 and T_5. However, wing and neck as well as the entire organs were not significantly ($p>0.05$) different

Table 5 shows the proximate composition of diets containing graded levels of *Awara* waste. The proximate composition similar ($p>0.05$) among the treatments.

Table 6 shows the macronutrients of faeces of birds fed diets containing graded levels of *Awara* waste of the experimental birds. The protein, ether extract and nitrogen free extract contents increased with increased inclusion level of AW in the diets. Treatment T_3, T_4 and T_5 had higher values than the control while T_2 had similar values with the control.

Table 7 shows the macronutrient digestibility coefficient of broiler chickens fed diets containing graded levels of *Awara* waste. Birds fed T_2 had higher digestibility as their counterparts on control while those fed T_3, T_4 and T_5 had lower than those fed control.

Table 5. Proximate composition (%) of diets containing graded levels of *Awara* waste.

Parameters	T_1	T_2	T_3	T_4	T_5
Dry matter	91.02	91.09	91.12	91.19	91.11
Crude protein	22.09	22.08	22.08	22.06	22.07
Crude fibre	10.13	10.10	10.80	10.90	10.92
Ether extract	12.25	12.24	12.15	11.94	11.92
Total ash	6.25	6.24	6.26	6.28	6.31
Nitrogen free extract	40.30	40.41	39.83	40.01	39.89
*Metabolizable energy (kcal/kg)	3240.23	3240.12	3215.08	3203.72	3198.21

*ME (Kcal/Kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE as adopted by Kwari *et al*. (2010). Values are average of 3 samples.

Table 6. Macronutrients (%) of faeces of birds fed diets containing graded levels of awara waste

Parameters	T_1	T_2	T_3	T_4	T_5	SEM	LOS
Protein	4.64^{b}	4.86^{b}	5.30^{ab}	5.52^{a}	5.74^{a}	2.39	*
Ether extract	3.06^{c}	3.18^{c}	3.65^{b}	4.76^{a}	4.77^{a}	1.11	*
NFE	10.08^{c}	10.30^{c}	10.75^{b}	12.00^{a}	12.01^{a}	0.97	*

Values are average of 12 birds.

Table 6. Macronutrient digestibility coefficient of the experimental birds.

Parameters	T_1	T_2	T_3	T_4	T_5	SEM	LOS
Protein	78.77^{a}	77.78^{a}	75.67^{b}	74.82^{b}	73.88^{c}	2.04	*
Ether extract	74.59^{a}	73.65^{a}	69.71^{b}	59.89^{c}	59.73^{c}	7.27	*
NFE	74.63^{a}	74.5^{a}	72.73^{b}	69.77^{c}	69.80^{c}	2.49	*

Values are average of 12 birds.

DISCUSSION

Growth performance

There have been wide variations in responses of chickens to the use of agro industrial byproducts in poultry diets. These were attributed to differences in quality, varieties, storage periods and climatic conditions to mention but a few. However, there are several literature reports on the inclusion levels of these unconventional, agro by-products in broiler diets without adverse effect on performance in the tropics (Duru, 2010; Olaiya and Makinde, 2015; Makinde and Inuwa 2015; Makinde *et al*., 2021).

Final weight, total weight gain and daily weight gain progressively decreased in birds fed treatments 3-5 (10-20% AW replacement of soybean) despite the diets were isonitrogenous and isocaloric. The higher values in birds fed treatment 2 which was (5% AW replacement of soybean) similar to those fed control implies that broiler chickens could tolerate only 5%. The inability of the birds to tolerate treatment 3-5 and the result of lower growth rate may probably due to increasing higher dietary fibre and this corroborated the report of Aduku (1993) and Agbede (2000). These authors reported that high dietary fibre in diet reduce growth rate. Also, Jha and Mishra (2021) reported that high dietary fibre has negative effect on growth rate. According to Abdel-Hafeez *et al*. (2016), Abd El-Hack *et al*. (2020), Agbede (2000) and NRC (1994), a high dietary fibre in diets decreases nutrient utilization. Therefore, for birds to satisfy their energy requirements, they tend to eat more of the diet.

Birds fed diets treatment 2 (5% AW replacement of soybean) better utilized their feed like those fed the control diet, whereas those fed treatment 3, 4 and 5 (10, 15 and 20% AW replacement of soybean) poorly utilized their feed. This implies that the replacement of soybean by 5% was economical as evidence by appreciable turn-over compared with the other AW-based diets.

Carcass, cut parts and organs

It was observed in this study that dressed weight and dressed percentage and some of the cut parts significantly varied by dietary treatments. Birds fed control treatment and those of treatment 2 (5% AW replacement of soybean) recorded impressive values than those fed treatment 3, 4 and 5 (10, 15 and 20% AW replacement of soybean). This finding further implied that broiler chickens can tolerate 5% AW. The dressing percent in the birds fed control, 5% and 10% AW were higher than 70% reported by Aduku and Alukosi (2000), while those fed 15% and 20% were similar to the reports of these authors. Thus, it depicts that the entire treatments support high muscle mass and in part it shows AW had no deleterious effect on broiler chickens. Furthermore, the similarity in the entire internal organs depicts the non-deleterious effect of AW on broiler chickens, rather it promotes identical internal organs development.

Proximate composition of diets

The similarity in proximate composition among the diets uphold the intention of producing isonitrogenous and isocaloric diets. Therefore, difference in means of any parameters would be the function of AW. This finding agrees with the report of Tamasgen *et al*. (2021) who formulated isonitrogenous and isocaloric diets to determine the effects of varied levels of linseed meal on feed intake, growth performance and carcass quality of broilers and not the varied levels of protein or energy.

Proximate composition of faeces

It is a known fact that not all that is ingested is absorbed by the body, some nutrients that are not absorbed are excreted in the faeces (Deiltel *et al*., 2012). The higher protein, ether extract and nitrogen free extract contents in the faeces of birds fed T_3, T_4 and T_5 signified the inability of these birds to adequately utilize their diets which perhaps may be due to increasing crude fibre (Table 1). Experts in animal nutrition reported dietary fibre is not digested by poultry describing it as anti-nutritional factor but little is required to help stimulates gizzard development, endogenous enzyme production, among other benefits (Jha and Mishra, 2021; Mateos *et al*., 2012).

Digestibility coefficient

The significant higher digestibility in broiler fed treatment 2 (5% AW replacement of soybean) than their counterparts fed treatment 3, 4 and 5 (10, 15 and 20% AW replacement of soybean) indicates better feed efficiency. This finding appears to follow the pattern of the results on growth and carcass yield performance, which depicts that the replacement value of soybean by AW is 5% for broiler chickens. However, higher digestibility was reported at 25% AW in domestic grower rabbits (Sudik *et al*., 2020).

Conclusion

In the present experiment, birds fed 5% AW had similar growth rate, feed consumption, feed conversion ratio as well as dressed percentage and cut parts with those fed control, whereas those fed 10%, 15% and 20% AW recorded decrease in these parameters. However, there was no mortality recorded in any of the dietary treatment. Also, the entire internal organs were similar across the treatments. But in view of the effective feed conversion ratio recorded by birds fed 5% AW, 5% AW was therefore recommended as replacement value of soybean meal for broiler chickens.

CONFLICT OF INTEREST

There was no conflict of interest that emanate from this paper.

FUNDING INFORMATION

This research was funded by Tertiary Education Trust Fund (TETFUND), Nigeria as our Institutional Based Research (IBR).

ACKNOWLEDGEMENTS

We sincerely thank the staff of Central Research Laboratory of Federal University, Gashua, Yobe State Nigeria for handling the chemical analysis and the staff of the Department of Animal Science for their technical assistance during the rearing phase of the broilers. Also, we thank TETFUND, Nigeria for sponsoring this study.

REFERENCES

Abbas, T. E. (2013). The use of Moringa oleifera in poultry diets. *Turkish Journal of Veterinary & Animal Sciences*, *37*(5), 492-496.

Abd El-Hack, M. E., Shafi, M. E., Alghamdi, W. Y., Abdelnour, S. A., Shehata, A. M., Noreldin, A. E., Ashour, E. A., Swelum, A. A., Al-Sagan, A. A., Alkhateeb, M., Taha, A. E., Abdel-Moneim, A-M. E., Tufarelli, V., & Ragni, M. (2020). Black soldier fly (*Hermetia illucens*) meal as a promising feed ingredient for poultry: A comprehensive review. *Agriculture*, *10*(8), 339.

Abdel-Hafeez, H. M., Saleh, E. S. E., Tawfeek, S. S., Youssef, I. M. I., & Hemida, M. B. M (2016). Effects of high dietary energy, with high and normal protein levels, on broiler performance and production characteristics. *Journal of Veterinary Medical Research*, 23 (1), 94-108.

Aduku, A. O. (1993). Tropical feedstuffs analysis table. Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. Pp. 1-2.

Aduku, A. O., & Olukosi, J. O. (2000). Animal products processing and handling in the tropics. G. U. publications, Abuja, Nigeria. 2nd edition. Pp. 1-67.

Agbede, J. O. (2000). Biochemical composition and nutritive quality of the seeds and leaf protein concentrate from under-utilized herbaceous legumes. Ph. D Thesis, Federal University of Technology, Akure, Nigeria.

Alabi, O. J., Alemede, I. C., Egena, S. S. A., Obari, C. O., Ewa, C., & Oyinloye, O. (2020). Growth performance and nutrient digestibility of broiler chickens fed wood ashbased diets. *Nigerian Journal of Animal Production*, *47*(2), 144-150.

Association of Official Analytical Chemists (2000). Official Methods of Analysis, AOAC 17th Edition, Washington, D.C, USA.

Deiltel, L., Créchet, C., Fornier, E., Leborgne, M. C., Montméas, L. (2012). Nutrition et Alimentation des Animaux d'Elevage (Tome I, 3ème édition). Ed. Educagri: Dijon.

Desta, T. T., & Wakeyo, O. (2013). Village chickens' management in wolaita zone of southern Ethiopia. *Tropical Animal Health and Production*, *45*(2), 387-396.

Duru, S. (2010). Evaluation of three types of rice offal in broiler diets Ph.D Thesis. Department of Animal Science, Ahmadu Bello University, Zaria. Nigeria.

Jha, R., & Mishra, P. (2021). Dietary fiber in poultry nutrition and their effects on nutrient utilization, performance, gut health, and on the environment: a review. *Journal of Animal Science and Biotechnology*, *12*, Article number 51.

Kuku, A., Etti, U. J., & Ibironke, I. S. (2014). Processing of fluted pumpkin seeds, Telfairia occidentals (Hook F) as it affects growth performance and nutrient metabolism in rats. *African Journal of Food, Agriculture, Nutrition and Development,* 14(5), 1992-2014.

Kwari, I. D., Igwebuike, J. U., & Diarra, S. S. (2010). Growth performance and carcass measurements of broiler chickens fed different levels of raw sorrel (*Hibiscus sabdariffa*) seed meal. *Journal of Environmental Issues and Agriculture in Developing Countries*, *2*(2&3), 162-168.

Makinde, O. J., & Inuwa, M. (2015). The use of agro industrial by-products in the diet of grower turkeys. *Tropical and subtropical Agroecosystems*, *18*(3), 371-378.

Makinde, O. J., Ajibade, A. J., Opoola, E., Sikiru, A. B., & Okunade, S. A. (2021). Potential of *Entada africana* guill. & perr. Seed meal as feed ingredient in the diet of broiler chickens. *Tropical and Subtropical Agroecosystems*, *24*(2), Article number 79.

Mateos, G. G., Jiménez-Moreno, E., Serrano, M. P., & Lázaro, R. P. (2012). Poultry response to high levels of dietary fiber sources varying in physical and chemical characteristics. *Journal of Applied Poultry Research*, *21*(1), 156-174.

NIAS (2021). National listing of approved feed ingredients for feedmills in Nigeria. Nigeria Institute of Animal Science. Retrieved from https://nias.gov.ng>2021/07

NRC (1994): The National Academies. Component of poultry diets. Nutrient requirements of poultry. Ninth revised edition. The National Academies Press Openbook.

Olaiya, O. D and Makinde, O.J. (2015). Response of broiler chickens fed diets containing differently processed sesame (*Sesame indicum L.*) seed meal. *Academic Research Journal of Agricultural Science,* 3(2), 13-20.

Omosowone, O. O., & Ogunrinde, A. M. (2018). Effect of partial or total supplementation of soybean meal with fluted pumpkin (*Telfairia occidentalis*) seed meal in the diet of hybrid Catfish (Heteroclarias) fingerlings. *Food Science & Nutrition*, *6*(5), 1190-1195.

Sudik, S. D. (2016). Nutrient distributions and biochemical studies of acha (*Digitaria spp*) in infant weaning foods and poultry diets. Ph. D Thesis, Federal University of Technology, Akure, Nigeria.

Sudik, S. D., Ajiji, I. Bagudu, I. A., Maidala, A. and Lawan, A. (2020). Effect of feeding soybean curd residue on performance of male grower rabbits. *Greener Journal of Agricultural Sciences*, 10(2),114-119.

Summers, J. (2001). Maize: factors affecting its digestibility and variability in its feeding value. In: Bedford, M. R., Partridge, G. G. eds.). *Enzymes in Ofarm animal nutrition*. Wallingford: Cabi. Pp.109-124.

Tamasgen, N., Urge, M., Girma, M., & Nurfeta, A. (2021). Effect of dietary replacement of soybean meal with linseed meal on feed intake, growth performance and carcass quality of broilers. *Heliyon*, 7(11) e08297.