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Full Length Research

Effect of dietary supplementation of *Moringa oleifera* leaf meal on the carcass characteristics and meat quality of broiler chickens

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ABSTRACT: A research was conducted with four weeks old mixed sex Arbor Acres strain of broiler chickens (n = 200) to study the effect of equi-protein replacement of soybean meal (SBM) with *Moringa oleifera* leaf meal (MLM) on carcass characteristics and meat quality potentials of broiler finishers. Five experimental diets were formulated in which the dietary SBM was partially replaced with MLM at 0, 12.50, 25, 37.50, and 50% graded levels to form T_1, T_2, T_3, T_4 and T_5 respectively. Each treatment was allotted 40 birds with 10 birds per replicate to make up 4 replicates in a treatment. The experiment lasted for 28 days during which feed and water were offered without restrictions. At the end of the feeding trial, 2 birds per replicate were sacrificed after initial mechanical stunning to assess carcass and organ characteristics, skin and shank pigmentation and palatability of cooked meat. The weight of broiler prime cuts such as the thigh, breast and drum stick were significantly ($p<0.05$) affected by the dietary treatments. Abdominal fat pad reduced significantly ($p<0.05$) with increased level of MLM supplementations in broilers' diets. No significant ($p>0.05$) difference in the values recorded for cooking loss, however, in thaw loss, breast and drumstick recorded the highest ($p<0.05$) values of 15.48±1.81 and 4.05±0.78 in T_1 respectively. Skin and shank pigmentation scores increased ($p<0.05$) with increased levels of dietary MLM but the general acceptability scores of boiled chicken meat revealed no significant ($p>0.05$) difference. The present results indicate that MLM replacing SBM in broiler diets can improve significantly ($p<0.05$) carcass yield and abdominal fat reduction. Skin and shank colouration improved ($p<0.05$) and no adverse effect was observed in various internal organs compared with birds on the control diet.

Keywords: Broiler chickens, carcass, moringa leaf meal, soybean meal.

INTRODUCTION

The current trend in poultry research and advances have garnered knowledge of the biochemical, metabolical and physiological mechanisms towards improving the efficiency of feed utilization to obtain the desired carcass attributes in response to changing dietary constituents and requirements (Nkukwana, 2012; Imoru, 2018). Therefore, the need to monitor livestock production process from 'farm to fork' is increasingly needful to ascertain the effects of feed ingredients on livestock and their products (Nkukwana, 2012; Imoru, 2018). Since the global trend with consumer perceptions influencing the quality and safety of animal products and feed manufacturing have become exponentially more complex in terms of accountability, traceability and residual effects of feeds and their component ingredients on carcass (Leeson, 2008). There is increasing awareness of consumers about the relationship between what they consume and their health status. Therefore, one major determinant of a healthful living is healthful eating. The effect of livestock feed ingredients and component parts is traceable to the products animals produced hence the need to utilize safe supplemental natural ingredients to avert the problem of substandard products in livestock production system (Imoru, 2018). Currently, various natural alternative ingredients have been researched, and many botanicals reported to contain high profile nutritional and phytochemicals that could have productive impacts on gut micro-flora, nutrient digestibility, intestinal morphology and carcass quality of livestock preferable to the actions of synthetic antibiotic growth promoters which are becoming less popular across the globe due to its possible adverse health implications on humans (Cross et al., 2007; Imoru, et al., 2018a; Imoru et al., 208b).

Moringa oleifera which is accorded the most widely grown specie of the genus *Morigacaea* has been affirmed through various research to possess essential nutrients such as minerals, vitamins and proteins with various phenolic compounds in its leaves and other parts that can enhance performance and carcass quality in poultry (Anwar et al., 2007; Olugbemi et al., 2010; and Imoru et al., 2018b). Nutritional and chemical characterisation of MLM showed that it contained 25.21% crude protein, 7.69% ash, 7.21% crude fibre, 2.281% ether extract, 53.99% nitrogen free extract and a wide range of vitamins with various phenolic compounds (Imoru et al., 2018b). *Moringa oleifera* leaves have been reported to contain nutrients needed by livestock and humans (Ogbe and Affiku, 2013) and can therefore replace conventional plant protein sources such as SBM and groundnut cake (GNC) that are associated with high cost of purchase and competitive demands as food for humans (Imoru et al., 2019). The growing demand for poultry meat has resulted in pressure on breeders, nutritionists and farmers to increase the broiler growth rate, feed efficiency, size of breast muscle, thigh and drum stick cuts (Petracci and Cavani, 2012; Nkukwana, 2012; Imoru, 2018), but the aspect of carcass quality attributes should not be compromised. Major among these attributes and quality indicators at storage and processing are thaw and cooking losses. Since animals are influenced in terms of performance and product quality by the quality and quantity of what they consume, the current study is therefore aimed at determining the effect of MLM at graded levels on the skin pigmentation, carcass and organs characteristics, thaw and cooking losses of broiler meat. It was hypothesized that equi-protein replacement of soybean meal (SBM) with *Moringa oleifera* leaf meal (MLM) would not affect carcass characteristics and meat quality of broiler finishers.

MATERIALS AND METHOD

Preparation of MLM

Moringa oleifera leaves were harvested from Owo, Ondo State, Nigeria. The leaves were air-dried in a well-ventilated and clean shed with no access to direct sunlight for 5 days, then pulverized to a fine powder to pass through a 0.15 mm sieve as described by Imoru et al. (2019). Thereafter, MLM was tightly packaged in polythene bags and kept at room temperature until required.

Experimental birds and design

A day old Arbor Acres strain of broiler chicks (n = 200) obtained from a reputable farm in Ibadan, Oyo State Nigeria were used for the research after a four-week, pre-experimental period during which the birds were fed a similar starter diet containing 23% crude protein. Five experimental diets were formulated in which the dietary SBM was partially replaced with MLM at 0, 12.5, 25, 37.5, and 50% graded levels to form T_1, T_2, T_3, T_4 and T_5 respectively. Thereafter, birds were randomly distributed to treatments with each treatment replicated 4 times with10 birds per replicate. Percentage composition of experimental diets are presented in Table1 while the proximate composition of the diets as carried out following the methods of AOAC (1994) are presented in Table 2.

Slaughtering procedure and cut parts measurement

The birds were individually weighed at the age of 56 days and sacrificed after 12 hours pre-slaughter fast though drinking of water was allowed. Two birds per replicate of adjusted weight were selected for slaughtering after initial mechanical stunning. Carcass were then scalded and defeathered manually, washed and allowed to drain on slanting ceramic slabs designed for the purpose. Thereafter, evisceration was performed by a ventral cut and visceral as well as organs in the thoracic region were carefully removed. Eviscerated carcasses were weighed and internal organs such as the heart, liver, the kidneys, lungs, pancreas, gizzard, proventriculus, spleen as well as abdominal fat were harvested and weighed on treatment basis and expressed as g/kg live weight. Cut parts like thigh, drumstick, breast, wings, back, head, neck and shank, were also weighed (g/kg live weight). Samples from thigh, breast and drumstick were separated from each replicate and freezed for the determination of thaw loss, cooking loss and eating quality. Palatability test was carried out using the thigh muscle after boiling individually in a low density white polythene bags with a cooking gas for 30 minutes. Ten trained taste panelists were used to assess the general acceptability of the meat.

Cooking loss

The cooking loss was done on thigh, drumstick and breast muscles. The meat samples were weighed (W1) and placed in low density white polythene bags separately. The bags containing the samples were carefully suspended with copper wire and placed in boiling water for 30 minutes. Thereafter, the samples were removed from the boiling water, drained and allowed to cool then reweighed (W2) to

Table 1. Percent composition of experimental finisher diets

Parameters	Treatments				
	1	2	3	4	5
% equi-protein replacement of SBM with MLM	0	12.5	25	37.5	50
Ingredients					
Maize	53	53	53	53	53
Maize offal	8	7.64	7.58	7.48	7.38
Groundnut cake (44%)	12	12	12	12	12
Soyabean meal (42% CP)	16	14	12	10	8
Palm kernel cake	7	6	4.7	3.44	2.18
Moringa leaf meal (25% CP)	0	3.36	6.72	10.1	13.4
Bone meal	2.8	2.8	2.8	2.8	2.8
Limestone	0.3	0.3	0.3	0.3	0.3
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Salt	0.4	0.4	0.4	0.4	0.4
Total	100	100	100	100	100
Calculated energy and nutrient composition					
Crude Protein (%)	19.2	19	18.7	18.5	18.3
Metabolisable Energy (kcal/kg)	2940	2903	2867	2831	2796
Crude fibre (%)	3.86	3.65	3.45	3.24	3.04
Calcium (%)	1.22	1.22	1.21	1.2	1.2
Phosphorus (%)	0.57	0.56	0.55	0.54	0.54
Lysine (%)	1	0.96	0.91	0.86	0.81
Methionine (%)	0.56	0.56	0.54	0.53	0.52
Energy:Protein	153:1	153:1	153:1	153:1	153:1

Composition of premix per kg of feed: Vitamin A (E-672) = 4 800 000 IU**,** Vitamin D3 = 1 200 000 IU**,** Vitamin E = 6 000 mg, Vitamin K3 = 1 200mg**,** Vitamin B1= 400 mg**,** Vitamin B2=2 000 mg**,** Vitamin B6 = 1 200 mg, Vitamin B12 = 8 mg**,** Folic acid = 400 mg**,** Niacine =12 000 mg**,** Panthotenic acid = 2 800 mg**,** Choline chloride = 240 000 mg**,** Iron (E-1) (Ferrous =10 000 mg, Iodine =120 mg, Cobalt = 80 mg, Copper = 2 400 mg, Manganese = 40 000 mg, Zinc = 20 000 mg, Selenium = 50 mg, dl-Methionine = 80 000 mg, Ethoxyquin (antioxidant = 40 000 mg, Biotin = 28, mgandCarrier ad = 1 000 g.

Table 2. Proximate composition (%) of experimental diets.

Parameters	Treatments				
	1	2	3	4	5
% equi-protein replacement of SBM with MLM	0	12.5	25	37.5	50
Moisture content (%)	9.54	9.39	9.36	9.52	9.91
Crude protein (%)	19.21	19.2	19.11	19.01	18.99
Ash (%)	8.11	9.46	11.06	12.12	12.01
Crude fibre (%)	4.05	4.95	4.94	5.87	6.15
Ether extract (%)	3.55	2.96	3.03	2.91	2.71
Nitrogen free extract (%)	55.55	54.04	52.5	50.57	50.11

obtain the cooking loss.

$$\%\ \text{cooking loss} = \frac{\text{W1} - \text{W2}}{\text{W1}} \text{x}100$$

Where W1 = initial weight of meat and W2 = final weight of meat.

Sample preparation and sensory evaluation

The meat samples were cooked using a gas cooker preset to a constant heat generation to the endpoint temperature of 100°C of the cooking water. Samples were prepared for sensory analysis by cutting a 1.9 cm-wide strip parallel to

Table 3. Carcass characteristics of broiler chickens fed graded levels of moringa leaf meal-supplemented diets.

Parameters	Treatments				
	1	2	3	4	5
% Equi-protein replacement of SBM with MLM	0	12.5	25	37.5	50
live weight (kg)	2.36±0.15	2.29±0.16	2.38±0.12	2.31±0.11	2.33±0.18
Dressed weight (%)	95.29±2.00	93.77±2.30	94.23±2.14	93.77±1.47	93.74±2.61
Eviscerated weight (%)	81.89 ± 2.67	81.69±1.79	81.74±2.73	81.41±2.13	81.17±2.18
Thigh (g/kg live weight)	118.12± 9.11^{b}	108.09±8.31^{c}	119.83±7.00^{b}	111.15±10.17^{c}	160.44±159.59^{a}
Drumstick (g/kg live weight)	106.90±8.49^{b}	109.31±7.59^{a}	108.55±5.67^{a}	104.05±3.44^{c}	101.51±5.53^{c}
Breast (g/kg live weight)	231.72±24.58^{b}	227.21±22.57^{b}	231.40±13.80^{b}	288.61±14.17^{a}	228.07±23.40^{b}
Wing (g/kg live weight)	84.97±5.30	79.62±4.81	80.03±5.66	79.65±3.80	76.51±3.71
Back (g/kg live weight)	145.78±17.93^{b}	150.24±8.02^{b}	147.31±14.07^{b}	149.01±12.25^{b}	156.31±19.14^{a}
Head (g/kg live weight)	21.94±3.00	24.65±5.11	21.80±2.58	20.66±0.91	20.57±1.69
Neck (g/kg live weight)	42.12±5.22	44.80±7.16	44.86±6.24	43.86±4.64	44.26±9.04
Shank (g/kg live weight)	36.55±3.16	36.79±3.23	35.22±2.39	36.07±2.57	34.61±2.16
Abdominal Fat (g/kg live wt)	8.66±4.60^{a}	6.44±7.33^{b}	6.43±3.47^{b}	5.64±2.80^{b}	4.27±1.27^{c}

Means ± SD with similar superscripts are not significantly (p>0.05) different.

fibers following the procedures described by Zhuang and Savage (2008). Palatability test (flavor evaluation) was carried out in the sensory evaluation laboratory, Nutrition and Dietetics Department, Rufus Giwa Polytechnic, Owo, Ondo State Nigeria that has individual booths with lights. Unseasoned cooked thighs which were evaluated by a 10 member trained descriptive panel with at least 3 hours of training in flavor profiling were used. Sachet water and unsalted crackers were provided to the panelists for mouth washing between samples assessment (Zhuang and Savage, 2008). Skin pigmentation assessment was also carried out using 10 trained visual assessors.

Statistical analysis

Organoleptic characteristics, carcass and relative organs weight were subjected to one-way and factorial analysis of variance (ANOVA). Where significant differences were found, means were compared using the Fisher's test. The Minitab Statistical Package was used for the analysis.

RESULTS AND DISCUSSION

Experimental diets

The calculated feed composition (Table 1) tends to show a decrease in the crude protein and energy in the diets as the inclusion levels of MLM increased but energy to protein ratio across treatments were unchanged. In the analysed diets however, percentage crude protein and nitrogen free extracts were relatively similar but the ash and the crude fibre increased slightly as the level of MLM increased (Table 2).

Relative carcass characteristics

The relative weight of various cuts in relation to live weight is shown in Table 3. Live, dressed and eviscerated weight across treatments indicated no significant (p>0.05) difference. The current results agree with the reports of Nkukwana (2012) who showed that broilers fed 1 to 5% MLM (DM) did not differ significantly (p>0.05) compared to those of control. However, it disagrees with the report of Igugo (2014) that recorded improved (p<0.05) live weight, dressed weight and dressing percentage for broilers fed MLM supplemented diets compared with those given synthetic mineral + vitamin premix. Thigh, drumstick and the breast cuts (Table 3) showed significant (p<0.05) difference with cut parts obtained from birds fed MLM supplemented diets obtaining the best results. Gadzirayi et al. (2012) reported significant (p<0.05) effect of broiler cut parts when MLM was used to replace SBM with MLM100% obtaining the least value. There was no significant (p>0.05) difference in the weight of wings, head and shank. This result is in tandem with what was reported by Talha and Mohammed (2012) that showed no significant (p>0.05) effect in various cut parts when *Moringa oleifera* seeds was used as supplement in broiler diets. The abdominal fat pad reduced consistently (p<0.05) with increase in MLM content of the diets. This might be due to activities of antioxidant and phenolic compounds in MLM playing hypolipidemic role in broiler chickens. This however contradicts the report of Talha and Mohammed (2012) that recorded a gradual increase in abdominal fat pad for broilers fed moringa undecorticated seeds powder.

Relative organ weight

Relative weights of various organs are presented in Table 4.

Table 4. Relative Organ weight (g/kg live weight) of broiler chickens fed graded levels of moringa leaf meal-based diets.

Parameters (g/kg live weight)	Treatments				
	1	2	3	4	5
% Equi-protein replacement of SBM with MLM	0	12.5	25	37.5	50
Heart	3.94±0.57	3.94±0.64	4.64±0.66	3.71±0.77	4.29±0.85
Liver	17.99±1.69	16.21±2.07	18.37±2.67	17.46±1.59	19.64±1.76
Kidney	3.47±1.67	4.03±1.17	5.49±1.46	4.34±1.18	4.62±1.96
Lungs	5.32±0.81	5.22±0.44	6.26±1.65	5.54±1.48	5.36±0.57
Pancreas	2.20±0.28	2.21±0.33	1.98±0.43	1.76±0.37	1.61±0.32
Gizzard	16.45±2.83	16.53±1.57	16.79±0.86	16.80±2.11	17.08±1.72
Proventiculus	3.91±0.89	3.55±0.43	4.48±0.60	4.78±0.67^{a}	3.00±0.43
Spleen	0.66±0.14	0.83±0.21	0.80±0.23	0.73±0.19	0.81±0.30

Means ± SD with similar superscripts are not significantly (p>0.05) different.

Table 5. Organoleptic properties, thaw and cooking losses of broiler chickens fed graded level of moringa leaf meal-based diets.

Parameters	Diets				
	1	2	3	4	5
% Equi-protein replacement of SBM with MLM	0	12.5	25	37.5	50
No. of birds	40	40	40	40	40
Thaw loss (%)					
Breast	15.48±1.81^{a}	11.59±2.52^{b}	9.90±2.46^{c}	9.65±4.12^{c}	12.18±1.92^{b}
Thigh	5.28±1.37	3.90±3.14	4.51±1.01	4.95±3.23	3.85±0.77
Drumstick	4.05±0.78^{a}	0.12±0.38^{b}	1.66±2.80^{b}	4.59±2.20^{a}	1.74±0.20^{b}
Cooking loss (%)					
Breast	23.91±3.20	23.05±2.81	25.34±1.60	24.51±1.83	25.87±2.81
Thigh	20.36±4.00	21.12±5.601	21.30±4.02	21.11±3.21	25.49±3.11
Drumstick	14.72±1.50	19.75±1.51	17.79±2.38	18.13±1.97	15.83±6.86
Organoleptic properties					
Skin pigmentation	1.00±0.00^{c}	2.50±0.71^{c}	3.20±0.79^{b}	3.90±0.74^{a}	4.60±0.97^{a}
Shank pigmentation	1.20±0.42^{c}	2.60±0.97^{b}	3.20±1.32^{ab}	3.40±1.70^{ab}	3.90±0.74^{a}
General acceptability	5.90±2.51	5.60±1.90	6.50±1.35	6.10±0.88	6.80±1.93

Means ± SD with similar superscripts are not significantly (p>0.05) different.

All parameters were not significant (p>0.05) compared to the control. This result agrees with the report of El Tazi (2014) that showed no significant (p>0.05) effect on birds fed MLM supplemented diets at varying levels but in contrast with that of Igugo (2014) who reported higher (p<0.05) values for gizzard, liver and heart in broilers that received MLM supplements in their diets compare to those treated with mineral + vitamin premix.

Percentage thaw and cooking losses

Table 5 shows the results of thaw and cooking losses of broiler chicken meat fed varying levels of MLM supplemented-diets. The breast muscle was significantly (p<0.05) affected by the diets. The breast meat of the T_3 and T_4 fed birds had lower thawing loss values than the T_2 and T_5 fed birds values when compared to T_1. The activities of MLM in thaw loss reduction numerically or statistically might be due to the regulatory effects of its nutritional and biochemical components in broiler tissue. Cooking loss showed no significant (p>0.05) difference and the values were not consistent across treatments though the reason for this could not be explained. The current result is in contrast with the reports of Sebola et al.

(2018) that showed that cooking loss percentages were significantly influenced ($p<0.05$) by MLM supplemented diets in certain strains of chickens.

Sensory evaluation

The results of sensory evaluation (general acceptability, skin and shank pigmentation) are also presented in Table 5. Skin and shank pigmentation scores increased ($p<0.05$) with corresponding increases in MLM inclusion levels in the diets. The values for skin pigmentation indicated a significant ($p<0.05$) difference with Treatments 1, 2, 3, 4 and 5 had 1.00±0.00, 2.50±0.71, 3.20±0.79, 3.90±0.74 and 4.60±0.97 respectively. Shank pigmentation followed a similar trend like that of skin. The increase in pigmentation scores with increase in MLM inclusion levels has been attributed to xanthophylls and carotenoids pigments in MLM (Austic and Neishen, 1990; Gadzirayi et al., 2012). The general acceptability scores revealed no significant ($p>0.05$) difference.

Conclusion

Replacing SBM with MLM as indicated in the current study enhanced carcass yield of prime cuts, fat reduction, carcass pigmentation and reduction in thaw loss in broiler finishers' carcass. Hence, MLM can replace SBM up to 50% equi-protein to enhance meat and carcass quality attributes of broiler chickens

CONFLICT OF INTEREST

The author declares no conflict of interest.

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