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EVALUATION OF CARCASS CHARACTERISTICS, AND HEAMATOLOGICAL INDICES OF BROILERS FED DIETS SUPPLEMENTED WITH NEEM LEAF *(AZADIRACHTAINDICA*) MEAL IN COLD AND HOT SEASONS OF KEBBI STATE SUDAN SAVANNA

[1]Mohammed Ibrahim Ribah*, [2]Aminu Bawa, [2]Bello Suleiman, [2]Misbau A. Muftau
Corresponding Author: ibrahim.ribah73@kiu.ac.ug (+256 706708248, +2347036333707)

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Abstract
Two feeding trials were conducted in the cold and hot seasons of 2023/2024, involving 144 unsexed day-old broiler chicks each, to determine the optimum level of supplementation of Neem Leaf Meal (NLM) in broiler diets in cold and hot seasons. The experiment was conducted in a completely randomized design (CRD). The birds were randomly allocated to four treatment groups of thirty-six birds per treatment; each treatment was replicated three times with 12 birds per replicate. The four groups were randomly allocated to four diets containing varying levels of NLM of 0, 3, 6, and 9% representing diets 1 to 4, respectively. At the end of the experiment, carcass characteristic and hematological indices were determined. Result on carcass characteristic shows no significant difference ($P>0.05$) in all the parameters measured, except for the weight of the feather, shank, and liver, which increased with the increase level of NLM. The result of hematological indices shows no significant difference ($P>0.05$) except in eosinophils, HP, MCH, and platelets. The second phase of the experiment, which was conducted in the hot season, indicated that both carcass characteristics and hematological indices were not significantly affected ($P>0.05$) by NML in all the parameters measured, except carcass weight. Hematological values were within the reference range. The results of the t-test only showed a significant ($P<0.05$) difference in the carcass characteristics of broilers supplemented with NLM in relation to the season. The result of hematological indices of broiler also shows no significant effect ($P>0.05$) when supplemented with NLM with relation to seasons. NLM supplementation should be adopted in the cold season in an inclusion of up to 9% for broiler production because it has been shown to influence carcass weight without showing a deleterious effect on the hematological characteristics of the birds.

[1] Department of Animal Science, School of Agricultural Sciences, Kampala International University, Ggaba road, Kansanga, Kampala, Uganda
[2] Department of Animal Science, Faculty of Agriculture, Kebbi State University of Science and Technology, Aliero, PMB 1144, Birnin Kebbi, Nigeria

INTRODUCTION

The high prices of conventional feed ingredients used in poultry feed has resulted into research of alternative cheaper sources, the need for alternative sources of feeds, which has led to the exploitation of leaf meals of some tropical legumes and browse plants as ingredients in poultry diets (Unigwe *et al,* 2016). The high production cost is pushing poultry farmers out of business. Currently some factors such as unfair competition from expired imported frozen dressed chicken, low purchasing power of consumers, high cost of feed among other factors are hampering the growth of the sector (Ogbuewu, 2008).

Poultry is by far the simplest source of meat for many people around the globe because of its many benefits. Meat among other foods of animal origin, make a valuable contribution to human nutrition, poultry meat contains a lower amount of saturated fatty acids (33% of total) and a higher amount of polyunsaturated fatty acids (PUFA) (14%) than lean meat of mammals, which contains 45% saturated fatty acids (SFA) and PUFA 4%.(Defra ,2008).

In an effort to develop new feedstuff for animal feeding, a number of researchers have investigated the proximate composition of neem seed cake (Agrawal *et al* 1997), leaf meal (Ansari *et al* 2016; Ogbuewu*et al.*, 2010.), and its use as feedstuff in poultry (Ansari *at el*, 2016) and rabbits (Unigwe, 2016 and Egbunike, 2000).

Azadirachta indica, commonly known as neem, and *dogon yarn* (local name) is a tree in the mahogany family Meliaceae. Essentially, all parts of the plant (stem, leaves and seeds) and its products (neem seed oil) have been used for different purposes by humans, most importantly for pharmaceutical and animal feeding (Yigrem, *et al.*, 2024; Anuoluwapo *et al.*, 2022). In animal husbandry, various research findings indicated that neem leaves have been reported to offer multiple benefits, such as antimicrobial (Udeh, 2013), anti-parasitic, immune system booster, appetite stimulant (Agrawal *et al* 1997), growth promoter (Obua *et al.*,2019), reproductive enhancer (Linus.,2016), general performance, stress reducer, increased egg production, antioxidant (Udeh, 2013) and mold inhibitor. This is because of its richness in significant biomolecules and nutritional value (Nakamura *et al*., 2022 and Hossain *et al.,* 2021). *Azadirachta indica* belongs to the meliaceae family and is widely distributed in Asia, Africa, and other tropical parts of the world (Unigwe *et al*., 2016). Neem leaf contains between 17.5% and 20.69% CP, 4.12% EE, 752 kcal/kg metabolizable energy (Udeh, 2013), 92.42 kcal/kg dry matter, 7.58 kcal/kg moisture, 7.10 kcal/kg ash, and 43.91% nitrogen-free extract; thus, it can be used as an alternative source of feed for poultry, (Ogbuewu, 2008)

The work of Obikaonu *et al*. (2011) on the hematological and serum biochemical indices of starter broilers fed diets containing Neem (*Azadirachta indica*) leaf meal. They suggested that Neem leaf meal can be included in the diets of broiler chicks up to 10% without any deletions effect on their hematological and serum biochemical constituents. The study also showed that Neem leaf diets reduce blood cholesterol and tend to maintain the integrity of both kidney and liver. However, little or no available information has been documented on the effect of such organic inclusions in relation to production seasons. This research was therefore designed to investigate the effect of the feeding value of the graded level of neem leaf (*azadirachtaindica*) meal (NLM) on carcass characteristics and hematological indices of broilers in cold and hot seasons.

MATERIALS AND METHODS

Experimental Site

The study was conducted in the cold and hot seasons of 2023/2024 at the poultry Unit of the Department of Animal Science, Kebbi State University of Science and Technology Aliero (latitude 12^0 12.997'N; longitude 004^0 29.848'.Elevation 262) in Sudan Savannah ecological zone of Nigeria. The climate of the area is semi-arid with an average annual rainfall of about 500mm-650mm per annum, relative humidity ranging from 21% to 47%, and temperature ranging from 20-30^0C during cold dry season and 27-41^0C during hot rainy season (Kabir, 2014).

Experimental Diets

Four experimental broiler starter and finisher diets were formulated containing 22% and 19% CP, respectively. The neem leaf meal was then incorporated at 0, 3, 6 and 9 percent levels, respectively. The diets were balanced for crude protein and calories to meet the requirements of broilers starter and finisher in the tropics.

Source and Processing of Neem Leaves:

Fresh green neem leaves used in the experiment were harvested from the same plant within the university. The collected leaves were then air-dried at room temperature. They were considered adequately dried when they became crispy to the touch, as described by (Ansari *et al*., 2016).

Ingredient composition of experimental broiler starter diets

Table 1 shows the Ingredient composition for broiler starter experimental diets.

Table 1. Ingredient composition of experimental broiler starter diets (kg/100kg)

Ingredient	T_1 (0% NLM)	T_2 (3% NLM)	T_3 (6% NLM)	T_4 (9% NLM)
Maize	50.90	53.30	53.08	56.09
GNC	17.10	16.7	16.92	17.91
Soy beans	10.00	10.00	10.00	10.00
NLM	0.00	3.00	6.00	9.00
Wheat offal	15.00	11.00	7.00	0.00
Blood meal	3.00	3.00	3.00	3.00
Bone meal	1.00	1.00	1.00	1.00
Lime stone	2.00	2.00	2.00	2.00
Lysin	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100

Calculated analysis for the broiler starter diet				
Diet	T1	T2	T3	T4
Crude protein	22	22	22	22
Crude fiber	3.86.	4.01	4.13	4.11
Either extract	3.95	3.49	3.89	3.89
ME (MJ)	2833*0.004184	2819	2800	2822

Ingredient Composition of Broiler Finisher Experimental Diets

Table 2 shows the Ingredient composition of broiler finisher experimental diets.

Table 2. Ingredient Composition of Broiler Finisher Experimental Diets

Ingredient	T_1 (0%)	T_2 (3%)	T_3 (6%)	T_4 (9%)
Maize	59.93	60.89	61.80	65.00
GNC	13.30	13.11	13.20	14.00
Soy beans	5.00	5.00	5.00	5.00
NLM	0.00	3.00	6.00	9.00
Wheat offal	15.00	11.00	7.00	0.00
Blood meal	3.00	3.00	3.00	3.00
Bone meal	1.00	1.00	1.00	1.00
Lime stone	2.00	2.00	2.00	2.00
Lysin	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**

Calculated analysis for the broiler starter diet

Diet	T1	T2	T3	T4
Crude protein	19	19	19	19
Crude fiber	3.51	3.66	3.81	3.77
Either extract	3.91	3.88	4.17	3.85
ME Kcal/kg	**2901**	**2885**	**2865**	**2888**

Experimental Birds and their Design

One hundred and forty-four (144) day old broiler starters were employed for this experiment and were randomly assigned to four treatment groups in a completely randomized design (CRD).Each treatment was replicated three times such that each replicate had 12 birds.

Management of the Experimental Birds

Before the arrival of the chicks, the pens for the experiment were washed and disinfected. Heat sources ware provided using 100 watt electric bulbs, and wood shavings were used as litter material. The temperature and relative humidity were monitored. Feed and water were provided ad libitum. Vaccination and medication schedules were administered.

Data Collection

Carcass characteristics: The birds were weighed before slaughtering. After bleeding, the carcass was reweighed to obtain the weight of the blood that is different between the weight before slaughtering and the weight after slaughter. The dressing percentage was then measured.

For hematology, blood samples of 1.5ml were drowned from the wing vein of two randomly selected birds from each replicate and placed in a sample bottle and carried to the hematological laboratory for analysis of pack cell value (PCV), hemoglobin, white blood cell (WBC), red blood cell (RBC), and lymphocyte.

Ethical consideration

The full ethical protocol and permission have been sorted and approved before the research.

Data Analysis

Data collected on carcass characteristics and hematological indices were subjected to analysis of variance ANOVA. Significant means were separated using Tuckey test at the 5% level of significance. Student's t-test was used to compare all parameters between the cold and hot seasons.

RESULTS AND DISCUSSION

Carcass Characteristics of Broilers Fed with Neem Leaf Meal in Cold and Hot Seasons

Table 3 shows the effect of graded levels of neem leaf meal on carcass characteristics of broilers in cold and hot seasons. The result of the cold season showed a significant difference ($P>0.05$) among the treatments in the weight of the feather, shank, and liver. However, no significant difference ($P>0.05$) among treatments in all other organs evaluated. The result for the hot season shows no significant difference ($P>0.05$) in all observed parameters.

Table 3. Effect of graded levels of neem leaf meal on broiler carcass and organ weight in cold and hot seasons.

PARAMETERS	TREATMENTS*									
	T1		T2		T3		T4		SEM	
	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot
Bird(g)	1757	1287	1777	1347	1867	1314	1730	1281	51.9	38.1
Blood(g)	173.3	147.7	178.3	133	181.7	143.3	150.0	121.7	16.1	9.0
Feather(g)	93.3^{a}	82.7	103.3^{ab}	88.3	100.0^{ab}	100	116.7^{b}	102	5.0	8.7
Carcass(g)	1157	866.7	1145	918	1240	881.7	1202	873.3	68.5	25.9
Breast(g)	483.3	471.7	493.3	483	540.0	473.3	516.7	460.0	32.5	16.9
Drumstick(g)	115.0	108.0	113.3	100	126.7	100.3	110.0	103.3	8.5	8.8
Tight(g)	163.3	140.0	161.7	141	168.3	145.0	150.0	144.0	7.5	6.6
Shank(g)	38.3^{b}	44.0	39.0^{b}	53.0	56.0^{ab}	55.3	58.0^{ab}	39.0	4.2	6.1
Neck(g)	95.0	96.0	107.7	87.7	105.0	95.7	92.7	86.0	7.2	4.5
Wing(g)	76.0	85	84.3	76.7	95.0	79.3	76.7	91.0	7.3	8.2
Head(g)	60.0	66.7	65.0	66.0	69.3	71.7	71.7	61.7	4.5	4.9
Gizzard ful(g)	123.3	86.0	126.7	86.7	130.0	91.7	126.0	91.7	8.3	7.3
Gizzard empty(g)	83.0	58.6	88.3	60.0	101.7	65.5	92.7	56.6	8.6	7.0
Liver(g)	42.7^{b}	58.3	56.0^{ab}	76.0	79.3^{a}	68.3	78.3^{a}	53.7	5.8	10.8
Heart(g)	33.3	29.3	36.3	35.0	43.3	28.3	39.3	28.7	6.6	5.5
Back(g)	230.7	189.7	235.0	201.	338.3	207.3	261.7	192.7	35.5	23.9
Abdominal fat(g)	36.0	51.5	35.7	55.7	63.3	26.00	45.3	48.3	12.8	12.8

a,b =Means on the same row with different superscripts are significantly different (P>0.05)

*T1 = 0% NLM; T2 = 3%NLM; T3 =6%NLM T4=9%NLM

The result for the cold season shows a significant difference in the weight of the feather, shank, and liver. . Treatment 1 with 0% level of neem leaf meal had the lowest feather weight, followed by treatments 2 and 3 with 3% and 6% level of neem leaf meal, respectively, while treatment 4 with 9% level of neem leaf meal had the highest values, which could be a result of high fiber present in the diet containing NLM. . The result also shows a significant difference in liver weight, where treatment 4 has the highest value, followed by treatment 3, and treatments 1 and 2 have similar values. The study also agrees with the result obtained by Obikaonu *et al*. (2011) that Neem leaf diets reduce blood cholesterol and tend to maintain the integrity of both kidney and liver. The result of the hot season shows that there were no significant difference on final body weight, weight of the blood, feather liver, weight of breast, drum stick, tight, neck, wing, head, gizzard full, gizzard empty, heart, back and abdominal fat, and agrees with the result obtained by Ubua e*t al.,(*2019) that the result of carcass characteristic cut up part and internal organs of broiler chickens fed neem leaf meal show no significant different between treatment implying that neem leaf meal may not have an adverse effect on the carcass characteristics of broilers.

Effect of Graded levels of NLM Fed on Broilers on Hematological Indices in the Cold and Hot Seasons

Table 4 presents the results of hematological indices of broilers fed graded levels of NLM in cold and hot seasons. The result in the cold season shows a significant difference (P<0.05) on Eosnophil, HB, and MCHC. The result for the hot season shows that there is no significant difference (P>0.05) in all the observed parameters.

Table 4. Effect of graded levels of neem leaf meal on hematological indices of broilers ingold and hot seasons

Parameters	**TREATMENTS***										**Reference range**
	T1		T2		T3		T4		SEM		
	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	
WBC(10^9 /C)	41.00	31.00	38.767	33.93	35.43	35.90	38.67	33.38	1.42	1.31	4.07 - 4.32
Lymph. (%)	91.00	92.90	92.400	91.47	92.57	90.9	92.13	92.00	1.74	1.68	31.00-72.00
Monocyte (%)	2.13	1.90	2.067	2.23	2.17	2.37	1.97	2.13	0.24	0.22	1.00-4.00
Neut (%)	3.23	1.83	2.833	3.07	3.83	3.07	2.37	3.30	0.94	0.90	
Eosnophil (%)	1.27[b]	1.53	1.967[ab]	1.77	1.33[b]	1.67	2.00[a]	1.80	0.16	0.27	2.00-14.00
Basophil (%)	0.35	0.25	0.333	0.29	0.27	0.32	0.47	0.26	0.21	0.21	1.00-17.00
RCB10^{12}/C	2.31	2.81	2.813	2.73	2.47	2.58	2.56	2.54	0.14	0.17	4.21 - 4.84
HB	9.40.[a]	7.97	8.23[ab]	9.23	8.20[ab]	8.03	7.67[b]	8.27	0.30	0.39	11.60 - 13.68
PCV	32.50	32.83	29.700	33.03	30.83	31.30	33.90	34.07	1.28	1.48	35.9 - 41.0
MCV	124.5	107.4	102.33	106.7	111.90	118.0	107.13	110.7	9.83	10.18	81.6 - 89.1
MCH	32.67	32.13	29.23	33.80	32.93	31.73	33.60	31.53	1.19	1.48	27.2 - 28.9
MCHC	27.40[b]	27.90	33.80[a]	30.10	30.8[ab]	29.47	30.667[ab]	33.97	1.12	2.07	32.41 - 33.37
Platelets	97.33	110.7	94.33	102.7	98.00	124.0	94.67	142.0	1.47	19.66	

a,b =Means on the same row with different superscripts are significantly($P<0.05$) different

*T1 = 0% NLM; T2 = 3%NLM; T3 =6%NLM T4=9%NLM;

WCV=white blood cell; RCV=red blood cell; HB=hemoglobin; PCV=packed cell value; MCH=mean corpuscular hemoglobin; MCV=mean corpuscular value; MCHC=mean corpuscular hemoglobin concentration.

In the cold season, the significant difference observed in eosinophil conforms with the result obtained by yere *et al. (*2018) who observed that eosinophil levels were significantly higher with increase in dietary NLM at 6% level of inclusion. Hemoglobin (Hb) values of birds fed diets 2 (10.8g/dl) and 5 (10.2g/dl) were similar but significantly higher than those of birds fed diets 1 (8.9g/dl), 3 (8.8g/dl) and 4(9.0g/dl), (Olabode, 2009). Oluremi *et al. (*2009) observed that the hemoglobin of birds was significantly reduced but not below the recommended level. The significant difference observed in MCHC value conforms to the result obtained by Muhammad *et al*., (2016) who observed that MCHC was influence by NLM +GM inclusion in the diet of broilers. In the hot season, the result shows that there is no significant difference observed on WBC, lymphocyte, monocyte, neutrophil, basophil,

RCB, PCV, MCV, and MCH. However, they were all within the acceptable range. The work of Obikaonu *et al*. (2011) on the hematological and serum biochemical indices of starter broilers fed diets containing Neem (*Azadirachta indica*) leaf meal. They suggested that Neem leaf meal can be included in the diets of broiler chicks up to 10% without any deletions effect. This result is similar to that obtained by Akintanide *et al*., (2017), who observed that all parameters recorded for the blood profile of broiler chicks fed a diet containing neem leaf meal viz PCV, RCV, HB, ERS, MCHC, MCH, MCV, lymphocyte, and heterophyl, were not significantly influenced by neem leaf meal.

Conclusion

In conclusion, except for liver and shank at 9% in the cold season, all carcass and organ characteristics were not significantly influenced by supplementing broilers with NLM in both cold and hot seasons. Except for Eosnophil**,** hemoglobin, and mean corpuscular hemoglobin concentration at 9% in the cold season, all other hematological indices were not significantly affected by supplementing broilers with NLM in both the cold and hot seasons. However, all observations were within the standard ranges. Comparing the seasons, the cold season engenders higher carcass yield than the hot season. It is recommended that NLM supplementation should be adopted in the cold season in an inclusion of up to 9% for broiler production because it has been shown to influence carcass weight without having a deleterious effect on the hematological characteristics of the birds.

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