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Evaluation of Growth Performance, Carcass Characteristics, and Blood Profile of Broiler Turkeys Reared Under Different Housing Systems

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ABSTRACT

The experiment was carried out at Livestock Teaching and Research Farm, Federal University Dutsin-Ma, Katsina State to evaluate growth performance, carcass characteristics and blood profile of broiler Turkeys reared under different housing systems. A total of 48-day-old poults were brooded for 4 weeks. The poults were moved to the experimental pens and placed in a 2 x 2 factorial arrangement in a completely randomized design with two housing types (Deep Litter without outdoor (DL-O) access and Deep Litter with outdoor access (DL+O) and two sexes (Jakes and Hen poults) as the factors. Data were collected on body weight, feed intake, mortality, carcass and blood profile of the turkeys. The result indicated that there were significant ($P < 0.05$) differences between male and female Turkeys in terms of final body weight, body weight gain, and total feed intake (11.52, 7.28, 15.60 & 2.17 male and 9.54, 5.88, 14.78, 2.56% female). The carcass characteristics results obtained in this study revealed that, live weight, dress weight and dressing percentage of Turkeys (LW= 9.54 - 11.52, DW= 6.74 – 8.70, DP= 70.58 – 75.48%) had significant ($P < 0.05$) differences between the treatments, while there were no significant differences across all the treatments with regard housing. The result of the of white blood cells, heterophil, and lymphocytes obtained were influenced ($P<0.05$) by sex. However, all other parameters, such as packed cell volume, haemoglobin, monocytes and eosinophil were not affected by sex and were within the normal range of Turkeys. In addition, glucose, total protein, total cholesterol, high density lipoprotein, total bilirubin and conjugated bilirubin were not affected by sex and housing.

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INTRODUCTION

The poultry industry in general requires that producers consider production costs and improve profit margins to enhance productivity and sustainability (Noonari *et al.,* 2015). Nevertheless, confining high-proficiency production is another good area of concern, especially now that consumers demand meat products derived from poultry reared in the optimum environment to ensure their welfare (Ferrante *et al.,* 2019). In the past, attentions on animal regulation has driven changes on how these animals were fed and managed, and will continue, possibly in an accelerated way, with high expectations on considering an environmentally fit and economically suitable approach (Suleiman *et al.,* 2023). The type of compounds to which (these birds) were exposed includes the housing system, the feed they consumed, the climate they were exposed, and the management systems employed, which appeared to affects the performance of the birds (Suleiman *et al.,* 2023). Nicholas White Turkeys (*Meleagris gallopavo*) are adaptable to different types of weather and climates and can be reared in almost any part of the world (Odutayo *et al.,* 2015). The Turkeys industries in Nigeria today has significantly improved from 1.5 to about 2 million tons of Turkeys meat locally annually. This sudden improvement in the Turkeys industries was turned to reality by

strengthening of production and improvement of large breeds like Nicolas White with standard live weights ranging from 15 to about 17 kg for male and 8 to about 10 kg for female at 15 to about 16 weeks of age. At this age, Turkeys are expected to reach table size and be ready for consumption, even with those produced from homesteads (Oyeagu *et al.,* 2022). Turkeys' production is carried out in almost all parts of Nigeria with little or no religious, social, or cultural inhibitions or taboo associated with its consumption (Oyeagu *et al.,* 2022).

Turkey's production is vital, viable, and profitable due to the increased demand for its meat globally. Turkeys are more tolerant of heat than chickens, perform well in the tropics, and produce meat of better quality, which is used for human consumption (Yakubu *et al.,* 2013). In many parts of the world today, turkey production has greatly improved; it has experienced a significant improvement since 1980 (Rasha *et al.,* 2024). Despite the availability of many rearing systems that could be used in rearing poultry, it was indeed obvious that no better housing system was present since each possesses disadvantages and advantages in terms of welfare and health (Lay *et al.,* 2011; Hartcher and Jones, 2017).

MATERIALS AND METHODS

The experiment was conducted at the Livestock Teaching and Research Farm, Federal University Dutsin-Ma, Katsina State. Forty-eight (48) day-old poults were sourced from a reputable commercial hatchery company, and the poults were reared for 4 weeks indoors (brooding). At the end of the 4th week, the poults were moved to the experimental pens. The poults were placed in a 2 x 2 factorial arrangement in a completely randomized design (CRD). The factors were two housing types (Deep Litter without outdoor (DL-O) access and Deep Litter with outdoor access (DL+O) and two sexes (Jakes and Hen poults). The poults were separated according to sex and each having four (4) treatments and three (3) replicates in a completely randomized design. The treatments allocated were Treatment 1: Jakes under DL (Deep Litter) housing (JDL), Treatment 2: Jakes under DLO housing (JDLO), Treatment 3: Hen poults under DL housing (HpDL), and Treatment 4: Hen poults under DLO housing (HpDLO), respectively. All the birds were given same feed types *ad libitum* containing 30% CP and 2800 ME kcal/kg at week 0 to 8 (starter phase) and 23% CP. and 3000 ME kcal/kg at week 8 - 16 week (grower phase) according to recommendations of Ogundipe *et al.,* (2022). Data collected includes; growth performance, body weight and body weight gain, feed intake, feed conversion ratio, mortality, and carcass characteristics (AGW, 2023). All data generated were obtained and analyzed. General Linear Model (GLM) procedures of the Statistical Analysis System package version 9.2 software, and statistical significance were set at $P<0.05$. Statistical difference was separated using DMR Test method.

RESULT AND DISCUSSION

Growth Performance

The result of the study, as presented in Table 1, indicated that there were significant ($P<0.05$) differences between sexes of the turkeys in terms of final body weight, weight gain, and total feed intake. The males have the higher ($P<0.05$) values compared to the female turkeys.

Housing type had no influence ($P>0.05$) on the growth performance of the turkeys. This is similar to the findings of Suleiman *et al.* (2023), who reported that there was no significant difference ($P>0.05$) between indoor and outdoor with pasture (*Lablab purpureus*) in term of final body weight, and body weight gain of Noiler birds reared under different housing types. They also reported similar total feed intake (TFI) among all the treatments. However, Oyegunle *et al.* (2021) findings were not in support of the present study, they reported that animals had higher energy demand living outside or outdoors because they are expending more energy walking around and using more energy to stay warm/cool.

Except for feed conversion ratio and mortality rate (FCR= 2.17 – 2.56% & Mort= 10.00 – 3.33%), which indicated an insignificant statistical difference between the two sexes. For the housing, TFI obtained shows a significance ($P<0.05$) difference between treatments. This means that final body weight, weight gain, feed conversion ratio, and mortality were statistically the same.

Table 1: Performance Characteristics of broiler turkeys on different housing systems

Parameters	IBWg/kg	FBWg/kg	WGg/kg	TFIg/kg	FCR	MORT%
Sex						
Male	4.24[a]	11.52[a]	7.28[a]	15.60[a]	2.17	10.00
Female	3.66[b]	9.54[b]	5.88[b]	14.78[b]	2.56	3.33
SEM	0.17	0.34	0.36	0.24	0.17	4.08
Housing						
Indoor	4.04	10.62	6.58	15.10	2.31	6.67
Outdoor	3.86	10.43	6.58	15.28	2.42	6.67
SEM	0.17	0.33	0.36	0.24	0.17	4.08
Interaction						
Sex * Housing	NS	NS	NS	NS	NS	NS

[a-b] means within rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means, IBW: initial body weight, FBW: final body weight, WG: weight gain, TFI: total feed intake, FCR: feed conversion ratio, and MORT: mortality, NS: non-significant

Weekly feed intake

It can be observed from Figure 1 that feed consumed by the turkeys varies across the sexes and weeks. There were no significant (P>0.05) differences in feed consumption at weeks 9, 10, 11, 13, 15, and 16. Male turkeys consumed a higher (P<0.05) amount of feed compared with female turkeys at weeks 12 and 14. But the housing systems do not influence feed intake across the weeks of the study.

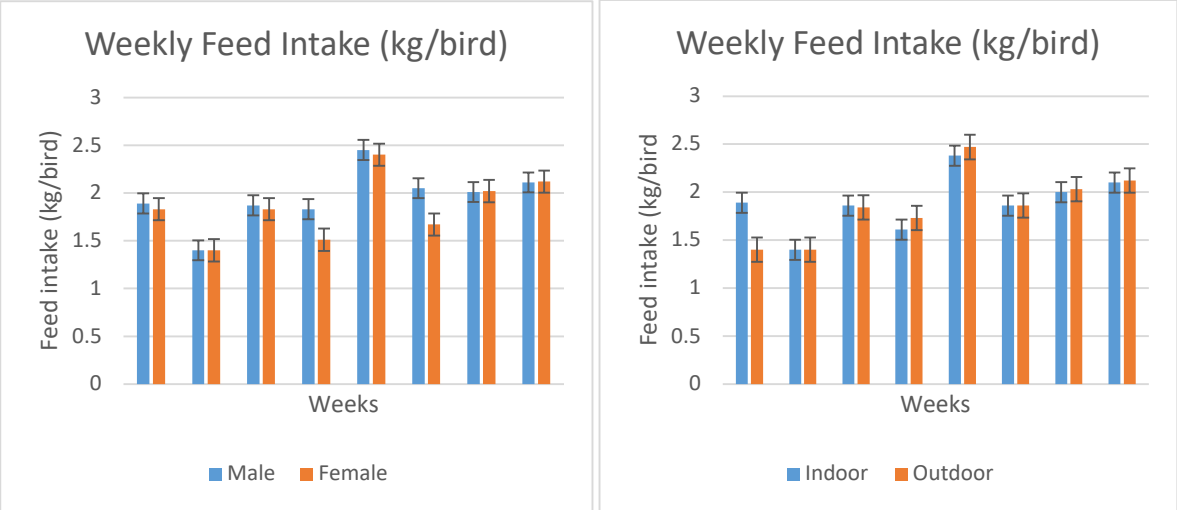

Figure 1: Influence of Sex, and Housing on weekly feed intake of Nicholas White Turkeys

Weekly Body Weight

Figure 2 indicates that there were significant (P < 0.05) differences between male and female turkeys in terms of body weight. The male turkeys presented higher body weight compared to female turkeys across all the weeks. However, the result shows that there was no significant (P > 0.05) difference between turkeys reared under the different housing systems.

Carcass characteristics

The results of the carcass characteristics of Turkeys as shown in Table 2 below revealed that live weight, dressed weight and dressing percentage were lower (P<0.05) in hens compared to toms (9.54 vs 11.52, 6.74 vs 8.70 and 70.58 vs 75.48% respectively). Housing did not affect carcass parameters of the turkeys. The results of the present study are in agreement with the finding of Suleiman *et al.* (2023),

who revealed that housing type did not influence live weight, dressed weight and standard meat cuts of Noiler chickens. On the contrary, Castellini *et al.* (2002), found that the breast and thigh weights increased when broiler chicken had outdoor access and a lower stocking density in an organic production system because of forced motor activity.

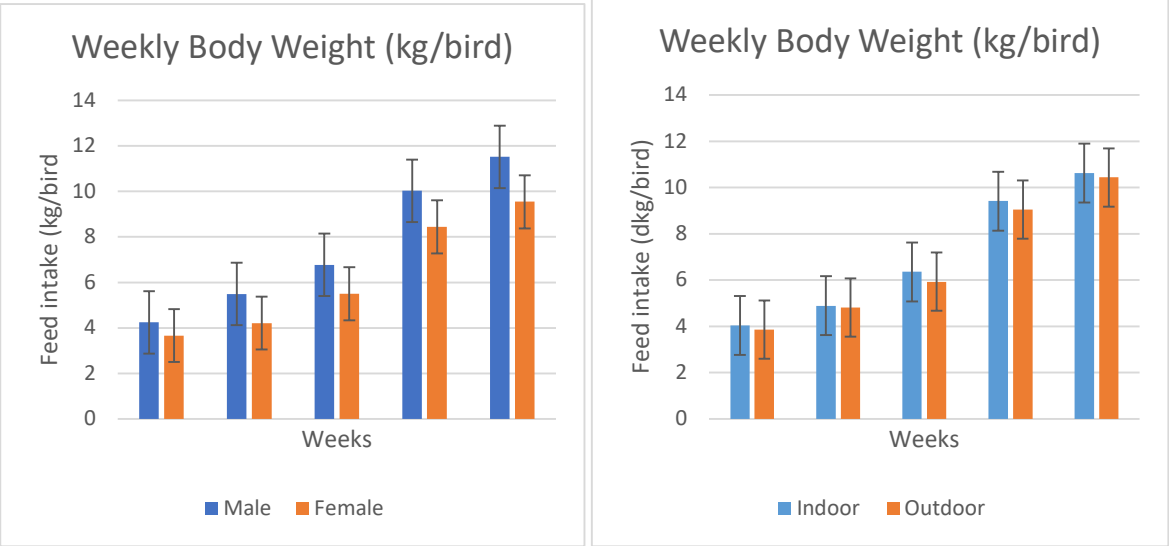

Figure 2: Influence of Sex and Housing on weekly body weight of Nicholas White Turkeys

Table 2: Carcass Characteristics of broiler turkey on different housing systems

Parameters	LWg/kg	DWg/kg	DP%	WWg/kg	BWg/kg	BRSWg/kg	THWg/kg	SHWg/kg	NWg/kg	HWg/kg
Sex										
Male	11.52[a]	8.70[a]	75.48[a]	13.01	14.36	32.89	28.78	4.26	4.27	2.42
Female	9.54[b]	6.74[b]	70.58[b]	12.14	17.90	31.16	27.89	4.15	4.70	2.06
SEM	0.34	0.30	0.92	0.49	1.71	2.53	0.45	0.22	0.47	0.17
Housing										
Indoor	10.62	7.86	73.71	12.73	17.46	29.78	28.91	4.13	4.67	2.32
Outdoor	10.43	7.58	72.34	12.42	14.81	34.26	27.76	4.28	4.31	2.16
SEM	0.33	0.30	0.92	0.49	1.71	2.53	0.45	0.22	0.47	0.17
Interaction										
Sex * Housing	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a-b] means within rows bearing different superscript differs significantly at $p > 0.05$; SEM: Standard error of means, LW: live weight, DW: dress weight, DP: dressing percentage, WW: wings weight, BW: back weight, BRSW: breast weight, THW: thigh weight, SHW: shank weight, NW: neck weight and HW: head weight, NS: non-significant

Haematological Parameters

From the result of the study shown in Table 3, WBC, H and L were influenced ($P < 0.05$) by sex. WBCs defend the body against invasion by foreign organisms and supply antibodies for the immune response. All other parameters, such as PCV, Hb, M and E, were not affected by sex, and were within the normal range for Turkeys. Hb levels are direct reflection of the amount of oxygen in the blood. An increased Hb result in serious dehydration, acute obstructive pulmonary disease while, it decreased Hb. result in anaemia, blood loss, liver disease and

others. Crespo and Grimes (2024) stated that PCV. plays a role in determining the state of health in livestock. Crespo and Grimes (2024) further evaluated that, the haematological profile of animals, which usually provides important information about the bird's response to its internal and external surroundings. Which indicated that the information obtained about the physical wellbeing of the Turkeys in the present study was not compromised by sex (Crespo and Grimes, 2024).

Packed Cell Volume, and haemoglobin values recorded in this study was within the normal range as reported by Agina *et al.* (2015). Total White Blood Cells, Monocytes, and Eosinophil values were also normal as described by Bounous et al. (2000). This may also reflect a good body immune system, as the latter performed better. The white blood cells increase in the presence of infection and some cancer conditions, including leukemia. Diminished WBCs are also caused by bone marrow disorder, acute and severe illness, and so on (Peter, 2002). The WBC fraction is composed of heterophils, lymphocytes, monocytes, and eosinophils etc. Lymphocytosis (with or without heterophilia) and eosinophilia may be a result of stress-induced factors and allergic or parasitic states, respectively. A chronic disease state may show an increase in monocyte count (monocytosis) (Peter, 2002). Each of the WBC components observed in the present study was within the normal limits (Christine *et al.,* 1990; Gulland and Hawkey, 1990).

This finding is in contrast with Agina *et al.* (2015), who observed a higher PCV in male than female turkeys, and this was attributed to a higher level of testosterone in adult male turkeys, which tends to promote erythropoiesis. Similarly, Agina *et al*. Sex-related differences in all the haematological parameters were nonsignificant in turkeys (Wang et al. Furthermore, Gattani *et al.* 2016) and Kim *et al.* (2010) observed that female turkeys show lower Hb and PCV in comparison to males; this might be due to high oestrogen concentration in females.

In this regard, the haematological studies conducted showed that although haematocrit values differed with the ambient temperature of the turkey, all parameters were not affected by the housing system used in this study. Following the results of Diktas *et al.* (2015), he reported that differences in housing systems associated with white corpses (eosinophils) were not significant. Similarly, Sekeroglu *et al.* (2009) reported that the housing system did not affect white blood cell and blood levels in birds raised under different housing systems. Furthermore, Olaniyi *et al*. (2012) reported no significant differences in haemoglobin concentrations in the housing system. Bounous *et al*. (2000) found high total white blood cells, haeterophyletic lines, and lymphocyte counts. Furthermore, Schmidt *et al.* (2009) within their study showed that heterophils are the most frequently discovered white blood cells in Turkeys. Furthermore, their reports showed that Waveless (Agina *et al.,* 2015), Helmguinea-Gewügel (Nalubamba *et al.,* 2010), Ducks (Okeudo *et al.,* 2003), and Muskovishucks (Sulaiman *et al.,* 2015).

Blood haemoglobin levels in chickens varies from 9.8-13.5 mg/ dl as reported by Diktaş *et al.* (2015). Variations in Heterophil (H), Lymphocyte (L) ratios, and leukocyte counts are considered as a stress factor, as opined by (Altan *et al.,* 2000; Puvadolpirod and Thaxton, 2000). The findings of Altan *et al.* (2000) further revealed that lymphocyte, eosinophil, monocyte counts, and haematocrit values decrease, while basophil, heterophil counts increase under stress conditions. In addition, the heterophil (H), or Lymphocyte (L) ratio of 0.2 shows low stress levels, whereas 0.5 shows medium stress levels, while 0.8 indicates high stress levels (Gross and Siegel, 1983). Altan *et al.* (2000) stated in their findings that exposure of chickens to high temperatures could cause a decrease in blood haematocrit values, therefore, decreased haematocrit values were expected with increasing temperatures.

Table 3: Haematological Properties of Nicholas White Turkeys

Parameters	PCV (%)	Hb (g/dl)	WBC (10^3/µl)	M (%)	H (%)	L (%)	E (%)
Sex							
Male	42.67	14.17	35.33[b]	1.17	37.00[b]	61.50[a]	0.33
Female	42.00	13.97	43.50[a]	0.17	49.33[a]	50.50[b]	0.00
SEM	1.14	0.40	0.80	0.53	2.95	3.00	0.24
Housing							
Indoor	42.17	14.02	35.83	1.17	42.17	56.67	0.00
Outdoor	42.50	14.12	43.00	0.17	44.17	55.33	0.33
SEM	1.14	0.40	0.80	0.53	3.00	3.00	0.24
Interaction							
Sex * Housing	NS	NS	NS	NS	NS	NS	NS

[a-b] means within rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means, PCV: packed cell volume, Hb: Haemoglobin, WBC: white blood cell, M: Monocyte, H: Heterophil, L: Lymphocyte, E: Eosinophils, NS: non-significant

Serum Biochemical Parameters

The serum biochemical parameters as presented in Table 4, revealed that glucose, TP, TC, HDL, TG, TP, TB, CB, ALT, Alb, and Glo were not affected by sex. Serum chemistry was usually used to detect organ disease in livestock, and the amount of protein available in the diets, Edeh *et al.,* 2023). The serum parameters obtained were within the normal range in birds as recorded by Edeh *et al.* (2023). In agreement with this finding, Ibrahim *et al.* (2012) explained that, no sex-related differences in serum TP, Alb, and Glo. Irfan *et al.* (2017) finding contradicts the result of this study, where they reported that, significantly higher values of cholesterol were recorded from the serum of male turkeys. However, they reported similar total protein between male and female turkeys. The insignificant increase recorded in TP. Alb., and Glo. in some treatments group could be attributed to the reduced water intake by Turkeys, although, water was provided *ad libitum* during the research period. A high level of globulin often causes high level of infection due to abnormal increase production of antibodies, as reported by Esubonteng (2011). Excess of Alb. in the body usually causes dehydration, whereas, lower concentration of Alb. may be attributed to the liver problem and adequately due to factors such as malnutrition and infection Esubonteng, 2011). Fischbach, and Dunning (2009) reported that, albumin is responsible for transporting insoluble substances in the blood and aids in maintaining oncotic pressure.

Blood biochemical profile, such as LDL, AST, and ALT levels, is of diagnostic value for various disease conditions and has particular reference to liver disorders and kidney diseases, etc, as described by Gattani *et al.* (2016). Ibrahim *et al.* (2012) report contradicts the result of the present study, where they reported that no sex-related differences in ALP, AST, and ALT. On the contrary, Agina *et al.* (2015) reported that the serum aspartate aminotransferase of turkeys was not affected by sex. However, in agreement with this study, they also observed similar alanine aminotransferase and alkaline phosphatase in females and males.

The serum globulin value obtained for male turkeys was similar to that documented by Ibrahim *et al.* (2012), where a significant difference (P<0.05) was observed (male: 3.27% & female: 2.70). Similarly, Agina *et al.* (2015) opined that, the higher protein concentration in female Turkeys could be explained by the high level of oestrogen hormones. Significantly higher counts of sodium and calcium level in female turkeys might be as a result of oestrogen response. In addition, the low blood glucose recorded in female turkeys might be due to the oestradiol effects, that decreased the expression of gluconeogenic genes in the liver. Factors such as dietary calcium source, housing system, and interaction between them affected the serum inorganic mineral values, as opined by Gattani *et al.* (2016). In contrast, Agina *et al.* (2015) reported that the serum total protein, albumin, globulin, and uric acid values were numerically higher in females than in males

Table 4: Effect of Different Housing Systems and Sex on Serum Biochemical Parameters of Nicholas White Turkeys

Parameters	GLU(mg/dl)	TC(mg/dl)	LDL(mg/dl)	HDL(mg/dl)	TG(mg/dl)	TP(mg/dl)	TB(mg/dl)	CB(mg/dl)	AST(iu/l)	ALT(iu/l)	ALP(iu/l)	Alb(mg/dl)	Glo(mg/dl)
Sex													
Male	102.7	51.2	3.27[a]	0.95	20.9	7.07	1.23	0.40	12.50[a]	9.33	191.17[a]	5.20	1.90
Female	89.5	47.2	2.70[b]	1.00	20.8	7.13	1.32	0.47	10.33[b]	8.33	176.33[b]	4.85	2.30
SEM	5.4	1.6	0.16	0.05	0.4	0.08	0.03	0.04	0.30	0.33	3.13	0.14	0.17
Housing													
Indoor	98.7	47.5	2.87	0.92	21.0	7.20	1.32	0.47	11.33	8.33	186.83	4.85	2.35
Outdoor	93.5	51.3	3.09	1.03	20.8	7.00	1.23	0.40	11.50	9.33	180.70	5.20	1.80
SEM	5.4	1.6	0.16	0.05	0.4	0.08	0.03	0.04	0.30	0.33	3.13	0.14	0.17
Interaction													
Sex * Housing	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a-b] means within rows bearing different superscripts differs significantly at $p > 0.05$; SEM: Standard error of means, GLU: glucose, TC: total cholesterol, LDL: Low Density Lipoproteins, HDL: High Density Lipoproteins TG: triglycerides, TP: total protein: Glo: globulin, Nitrite, Urea, TB: total bilirubin, CB: conjugated bilirubin, AST: aspartate transaminase, ALT: alanine amino transferase, ALP: Alkaline phosphatase, Alb: albumin, NS: non-significan

The results also indicate that housing systems did not influence the serum biochemical parameters of turkeys in this study. Therefore, the two different housing types employed in the study did not in any way influence the organ functions of the turkeys. The results agreed with findings of Diktas *et al.* (2015), who found no effect of housing system on serum cholesterol. Similarly, Eggum (1989) opined that there was no significant effect of housing system on plasma protein content because the total protein content of plasma is related to the amount and quality of protein intake. Furthermore, Diktas *et al.* (2015) depicted that there was no difference between housing systems in white blood corpuscle (heterophil, eosinophile, basophile, lymphocyte, monocyte, Heterophil/Lymphocyte ratios). In addition, Abdel-Azeem *et al.* (2020) noted that, there were insignificant differences in most blood parameters, including total protein, total albumin, total globulin, and glucose, due to housing systems. The assertion of Diktas *et al.* (2015) that serum glucose, total cholesterol, total protein, and triglyceride levels in chicken varies significantly with different housings does not agree with the result of the present study. In addition, Irfan *et al.* (2017) reiterated that, rearing systems also influenced biochemical parameters of Turkeys, and significantly higher values of cholesterol was recorded in birds reared under the confined rearing system. Similar with the findings of this study, Olaniyi *et al*. (2012) reported non-significant variations in total protein and albumin among confined and free-range reared turkeys.

Conclusion and Recommendation

It can be concluded that sex influenced growth performance, haematological indices (white blood cell, heterophils and lymphocytes) count, also the serum biochemical indices (Low Density Lipoproteins, aspartate transaminase and Alkaline phosphatase) of the turkeys. However, the housing systems used in this study have no detrimental effect on the growth performance, haematological indices and serum biochemical indices of turkeys reared under different housing systems.

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