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Growth performance and blood profile of Cobb strain of broiler chickens fed diets containing different additives

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Abstract

Feed additives are groups of non-nutritive products added to rations to improve the efficiency of animal production via an improve intake, gastrointestinal microflora, production characteristics, meat quality, eggs of poultry, vitality and health condition In this study the performance of Cobb strain of broiler chickens fed diets containing different additives was investigated . A total of 150 day old broilers of Cobb strain were purchased and brooded. two weeks of broodingafter which the birds were balanced for weight and assigned to five (5) treatments designated as T_1—T_5, with each treatment containing 30 birds of 10 birds in replicates of 3.The T_1 consist of Basal diet with no additive, T_2=Basal diet + 4g/kg of cloves, T_3 =Basal diet + 4g/kg of turmeric, T_4 =Basal diet + 2.0 mg of Selenium and T_5 =Basal diet + 0.25mg/kg of Butylated Hydroxytoluene (BHT) were assigned to the five treatment groups. The feeding trial lasted for 6 weeks. Data obtained were analysed using the one – way Analysis of variance. Results revealed that the supplementation of Clove (4g/kg)in T_1 and turmeric (4g/kg) inT_2 of the diets of cob strain of broiler chickens lowered their feed intake (from 1456g to 1017g in the starter phase and 3844g to 3548g in the finisher phase) while improving their feed conversion ratio (2.70 - 2.10 in the starter phase and 2.80 – 2.53 in the finisher phase) while the inclusion of 2mg/kg of selenium inT_4 if their diets had a negative net profit (-1729).Most of the serum indices and haematological parameters studied in the experiment fell within the normal range despite the addition of different additives. In this study we concludede that the addition of 4g/kg of cloves and turmeric powder improved the performance of Cobb strain of broiler chicken compared to the group of birds fed BHT and selenium

Keywords: Cobb starain of broiler chicken, Additives, *Butylated Hydroxytoluene, clove, selenium*

Performances de croissance et profil sanguin de la souche Cobb de poulets à griller nourris avec des régimes contenant différents additifs

Résumé

Les additifs alimentaires sont des groupes de produits non nutritifs ajoutés aux rations pour améliorer l'efficacité de la production animale via une amélioration de l'apport, de la microflore gastro-intestinale, des caractéristiques de production, de la qualité de la viande, des œufs de volaille, de la vitalité et de l'état de santé Dans cette étude, les performances de la souche Cobb de des poulets à griller nourris avec des régimes contenant différents additifs ont été étudiés. Un total de poulets âgés de 150 jours de souche Cobb ont été achetés et couvés. Deux semaines de couvaison, après quoi les oiseaux ont été équilibrés en fonction du poids et affectés à cinq (5) traitements désignés comme T_1—T_5, chaque traitement contenant 30 oiseaux de 10 oiseaux en répétitions de 3. Le T_1 consiste en un régime de base sans additif, T_2 = Régime de base + 4 g/kg de clous de girofle, T_3 = Régime de base + 4 g/kg de curcuma, T_4 = Régime de base + 2,0 mg de sélénium et T_5 = Régime de base + 0,25 mg/kg de Hydroxytoluène Butylé (BHT) ont été attribués au cinq groupes de traitement. L'essai d'alimentation a duré 6 semaines. Les données obtenues ont été analysées à l'aide de l'analyse de variance unidirectionnelle. Les résultats ont révélé que la supplémentation en clou de girofle (4 g/kg) en T_1 et en curcuma (4 g/kg) en T_2 des régimes de

souche cob des poulets de chair a réduit leur consommation alimentaire (de 1456 g à 1017 g en phase de démarrage et de 3844 g à 3548 g en phase de finition) en améliorant leur taux de conversion alimentaire (2,70 - 2,10 en phase de démarrage et 2,80 - 2,53 en phase de finition) tandis que l'inclusion de 2mg/kg de sélénium dans T_4 si leurs régimes avaient un bénéfice net négatif (-1729). La plupart des indices sériques et des paramètres hématologiques étudiés dans l'expérience se situaient dans la plage normale malgré l'ajout de différents additifs. Dans cette étude, nous avons conclu que l'ajout de 4 g/kg de clous de girofle et de poudre de curcuma améliorait les performances de la souche Cobb de poulet à griller par rapport au groupe d'oiseaux nourris au BHT et au sélénium.

Mots-clés : Étoile de Cobb de poulet à griller, Additifs, *Hydroxytoluène Butylé*, *clou de girofle*, *sélénium*

Introduction

Consumption of poultry meat is constantly increasing and the meat nutrition quality depends largely on the composition of poultry feed (Kafi *et al*., 2017). The basic poultry diet consists of cereals (wheat, corn, maize, millet, guinea corn etc.) in general, but biologically active additives are widely used in commercial broiler feed. These biologically active additives like cloves, turmeric, thyme and anise have established a great consideration as feed supplements for numerous purposes in poultry production throughout the recent years (Akbarian *et al.,* 2012).

Feed additives are groups of non-nutritive products added to rations to improve the efficiency of animal production via an improve intake, gastrointestinal microflora, production characteristics, meat quality, eggs of poultry, vitality and health condition (Hashemi *et al.,*2010). Natural feed additives are a relatively young class of feed additives and in recent years these feed additives have gained considerable attention in the feed industry. These feed additives may exert multiple functions in the animal body like increased feed intake and digestive enzyme secretions (Windisch *et al.,* 2006). Naturals feed additives are derived from herbs, spices or aromatic plants and have shown antimicrobial, antifungal, antiviral, antioxidant and sedative properties (Hashemi *et al.,* 2010) examples are turmeric, ginger, thyme, cloves and garlic. Turmeric (*Curcuma longa*), is a rhizomatous herbaceous perennial flowering plant of the ginger family – Zingiberacea (Priyadarsini, 2014). It contains an active compound called curcumin which has powerful anti-inflammatory and antioxidant properties (Kris, 2017). Jingfei *et al*. (2015) reported that incorporation of curcumin into basal diet of broiler chickens lowered excess production of reactive oxygen species, enhanced the antioxidant defense system as well as improved colour and water holding properties of broiler meat. Clove *(Syzygium aromaticum)*, unlike Turmeric is a dried flower buds from the clove tree (Megan, 2018). Friedman *et al.* (2002) documented that one teaspoon of clove contain a decent amount of manganese, fibre, vitamin C and K, which boost immunity and prevent blood clotting. Over the years, Selenium (Se) has been defined as an essential dietary supplement which is essential in improving health and performance of birds as well as the meat quality for human consumption. Selenium has been reported to enhance the immune function and reduce cancer risk as well (Yoon *et al*., 2007). Oliveira *et al.* (2014) demonstrated that increasing the dietary level of Selenium especially the one enriched with yeast as supplement may improve some of the physicochemical functions of birds. They further reported that pH and shear force were not affected by treatment. For many years, Butylated

hydroxyanisole(BHA) and Butylated hydroxytoluene (BHT) has been used as supplements in meat and poultry products (Jayathilakan *et al.,*2007). It is generally recognized as safe by the Food and Drug Administration (FDA) and is commonly added to foods to maintain freshness and prevent spoilage. It is justified that over the last century, the amount and proportion of fats in human diets have increased in many societies, this increase has been associated with cardiovascular diseases (Kathak,2014). With this great concern, poultry researchers and nutritionist have sought for feed additive for broilers birds that will be able to absorb the additives in dietary component directly in their tissues (Onibi *et al.,* 2000), thereby getting the bioactive compounds in this supplements through broiler meat into the human food chain while avoiding the resentment due to its direct consumption (Onibi *et al.,* 2009). Also, poultry feed additives, natural herbs and some synthetic additives have been widely advocated due to their reports on widespread beneficial effects (Khan *et al.,*2012). Turmeric, cloves and selenium are potential feed additives which have been reported as having wide range of beneficial effects on the production performance, physiological biochemistry, feed efficiency as well as stimulation of immune system and increasing the shelf-life of broiler birds (Khan *et al.,*2012). However, BHT have also been reported to improve production performance in broiler chickens. This research is therefore designed to examine growth performance and blood analysis of Cobb strain of broiler chickens fed dietary clove, turmeric, selenium and Butylated hydroxytoluene as additives.

Materials and Methods

Experimental location and source of materials *of the study*

The experiment was carried out at the Poultry Unit of the Livestock Teaching and Research Farm of the Federal University of Agriculture Abeokuta, Ogun State of Nigeria.Abeokuta lies within the rain forest vegetative zone of south Western Nigeria. Latitude7˚ 13′49. 46 ′N, longitude 3˚S 21′ 11.98 ′ E and latitude 76m above sea level (Google Earth, 2019). Turmeric (*Curcuma longa*) and cloves (syzygium aromaticum) were purchased from a reputable market. It was sun-dried until constant weight is attained and milled into a fine powder of 2mm sieve size. Selenium and Butylated Hydroxytoluene (BHT) were also purchased from a reputable pharmacy in Abeokuta, Ogun state Nigeria.

Experimental Animal/Diets and Design

One hundred and fifty (150) cob strain of broiler chickens were used for this study. All routine management practices, including recommended vaccinations and medications were strictly observed throughout the brooding period and water was provided *ad-libitum.*The broiler chickens were subjected to a 2-period feeding regime consisting of a starter phase (1-4 weeks) and finisher phase (5-8 weeks). The experimental diets were assigned to each of the five (5) treatment groups and fed *ad libitum* after the two weeks of brooding and also, fresh and clean water was adequately provided daily.

The experimental diets were formulated to meet the nutritional requirements of each stage of development, according to the recommendations of Rostagno *et al*. (2011).

The treatment arrangement were as follows:

T1: Basal diet with No additives
T2: Basal diet +cloves (400g/kg)
T3: Basal diet + Turmeric (4 g/kg),
T4: Basal diet + Selenium (3.0g/kg)
T5: Basal diet + Butylated Hydroxytoluene (0.25 mg/kg).

Determination of Growth Performance

Weekly feed consumption of each group was determined. Mean initial and weekly body weight of birds for each group were determined and body

weight gain was calculated. The following growth performance parameters were also measured

1. ***Average feed intake***:

Average feed intake(g)=$\frac{\text{Feed supplied – Leftover given}}{\text{Number of birds}}$

2. ***Total Body weight gain:***

Daily weight gain (g)=$\frac{\text{Final weight – initial weight}}{\text{Number of weighed birds}}$

3. ***Feed conversion ratio (FCR):***

Feed conversion ratio (FCR)=$\frac{\text{Total feed intake}}{\text{Total Body weight gain (g)}}$

Blood analysis

At the end of the starter and finisher phases (end of feeding trial), blood samples were collected from fifteen birds (3birds/dietary treatment/) via the wing vein. Blood was put in to two different carefully labeled bottles for hematological and serum metabolite investigations. The blood samples for hematological parameters were collected into bottles pretreated with Ethylene Diamine Tetra Acetic acid (EDTA), an anti-coagulant. Blood samples for biochemical indices was collected into another sample bottles containing non EDTA. Serum biochemical indices that were investigated include: Total Protein (following the procedures of Tiez (1995) as described in Randox kit total protein manual), Globulin, Albumin, Globulin ratio, Cholesterol and Glucose (using the method of Barham ad Trinder (1972) as described in Radox Glucose kits manual). Blood hematological indices that were investigated include: Packed Cell Volume (PCV), Red Blood Cell count (RBC), White Blood Cell (WBC) and Hemoglobin was determined by Wintrobe's microhaematocrit, improved Neubauer hemocytometer and cyanometaemoglobin methods, respectively. Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corupuscular Hemoglobin Concentration (MCHC) was calculated as described by Jain (1993).

Statistical Model

Data collected were subjected to analysis of variance (ANOVA) in a Complete Randomized Design. Differences among the mean was compared using Duncan's multiple range tests of the same statistical at 0.01 level of significance Package.

The model of analysis as follows

$Y_{ijk} = \mu + T_i + Z_j + TZ_k + \delta_{ijk}$

Where;

Y_{ij} = Observed mean value of dependent variable

μ = Population mean

Ti = Effect of treatment

δ_{ij} =The random residual error

Results

Growth performance of Cobb strain of broiler chickens fed diets containing different additives

The growth performance of Cobb strain of broiler chickens at starter and finisher phases fed diet containing Cloves (*Syzygium aromaticum*) , Turmeric (*Curcuma longa*), Selenium and Butylated Hydroxytoluene is presented in Table 1. At the starter phase, the mean values were found to be statistically similar ($p>0.05$) for initial weight gain, final weight gain, total weight gain and daily weight gain. However, significant differences were observed ($p<0.05$) for total feed intake and feed conversion ratio with the highest mean (total feed intake) in birds fed the control diet while the lowest mean was observed in the group of birds fed cloves. Poor feed conversion ratio was observed in the control and turmeric groups with the best mean values recorded in the groups offered cloves and selenium.

At the finisher phase however, most of the parameters considered were not influenced ($p > 0.05$) by the test ingredients except total feed intake. Comparable mean value for total feed intake were observed in all treatment groups except for the group of birds fed diet containing cloves that recorded lower mean values.

Table 1: Growth performance of Cobb strain of Broiler Chickens at starter and finisher phase fed diets different additives

Parameters	Control	Additives				SEM	P-value
		Cloves	Turmeric	Selenium	BHT		
Starter phase							
IW(g)	296.33	285.33	309.67	281.67	287.67	4.33	0.26
FW (g)	841.67	770.00	788.33	860.00	801.50	12.02	0.06
TWG(g)	545.33	484.67	478.67	578.33	513.83	13.21	0.06
DWG(g)	38.95	34.61	34.19	41.31	37.42	0.93	0.08
FI/bird/day(g)	10.46[a]	7.27[c]	8.51 [b]	8.85 [b]	9.13[b]	2.52	0.00
TFI (g)	1465.16[a]	1017.37[c]	1190.88[b]	1239.67[b]	1278.60[b]	40.44	0.00
FCR	2.70[a]	2.10[b]	2.70[a]	2.14[b]	2.49[ab]	0.09	0.02
Mortality	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finisher phase							
Initial body wt(g)	841.67	770.00	788.33	860.00	801.50	12.02	0.66
Final body weight (g)	2216.67	2170.00	2238.33	2310.00	2293.33	20.42	0.17
Total weight gain (g)	1375.00	1400.00	1450.00	1450.00	1491.83	16.42	0.16
Daily weight gain (g)	49.11	49.99	51.78	51.78	53.28	0.58	0.16
Feed intake/bird/day(g)	90.15	80.44	80.96	90.17	90.36	10.52	0.14
Total feed intake(g)	3844.41[a]	3548.59[b]	3766.92[ab]	3855.59[a]	3933.29[a]	46.00	0.05
Feed coversion ratio	2.80	2.53	2.60	2.66	2.63	0.04	0.30
Mortality (%)	0.00	0.00	0.00	0.0	0.00	0.00	0.00

[a b c] Means across rows with different superscripts are significantly (P< 0.05 different)SEM = Standard error of mean,

Cost analysis of production of Cobb strain of broiler chicken fed diets containing different additives

Table 2 shows the cost analysis of production of Cobb strain of broiler chicken fed diets containing different additives. High cost of production (₦/bird) was recorded for diets supplemented with selenium (₦3729.30) and having a negative net profit while the lowest was recorded in the control diet (₦973.26), having the highest net profit. A comparable numerical value was calculated in the diets supplemented with BHT, cloves and turmeric.

Table 2: Cost analysis of production of Cobb strain of broiler chicken fed diets containing different additives

Parameters	Control	Additives			
		Cloves	Turmeric	Selenium	BHT
Cost of day old chick (₦/bird)	230.00	230.00	230.00	230.00	230.00
Total feed intake (kg/bird)	5.31	4.57	4.96	5.09	5.21
Total cost of feed (₦bird)	743.26	639.10	694.12	713.30	729.68
Miscellaneous expenses (₦/bird)	120.00	120.00	120.00	120.00	120.00
Cost of additives used(₦/bird)	-	400.00	133.00	2666.00	266.66
Total cost of production(₦/bird)	973.26	1389.10	1177.12	3729.30	1343.34
final live body weight(kg/bird)	2.22	2.17	2.24	2.31	2.29
Broiler sales rate (₦/bird)	2000	2000	2000	2000	2000
Net profit(₦/bird)	1026.74	610.90	822.88	-1729.	656.66

BHT= Butylated hydroxytuluene, miscellaneous = cost of vaccines, cost of labour, cost of brooding charcoal, glucose and premix

Haematological parameters of Cobb strain of broilers chickens at starter and finisher phases fed diet containing different additives

Table 3 shows the haematological parameters of Cobb strain of broiler chickens at starter and finisher phases fed diets containing Cloves (*Syzygium aromaticum*) , Turmeric (*Curcuma longa*), Selenium and Butylated Hydroxytoluene. At the starter phase, the mean values were found to be statistically similar ($p>0.05$) for packed cell volume, haemoglobin, red blood cell, white blood cell, heterophill, eosinophil, monocyte and mean corpuscular heamoglobin.. However, significant ($p<0.05$) difference was observed for basophil with the highest mean in birds on the control diet and selenium (1.00), while the lowest mean was observed in the group of birds fed cloves and turmeric. On the other hand, the addition of the feed additives statistically influenced ($p<0.05$) all the parameters considered except for the white blood cell which was not significant ($p>0.05$).

Serum indices of Cobb strain of broiler chicken at starter and finisher phase fed diet containing different additives

Table 5 shows the serum indices of Cobb strain of broiler chickens at starter and finisher phases fed diets containing Cloves (*Syzygium aromaticum*) , Turmeric (*Curcuma longa*), Selenium and Butylated Hydroxytoluene. At the starter phase, no significant ($p>0.05$) influence were observed for the total protein, albumin, globulin, AST, ALT, total cholesterol, triglyceride, high density lipoprotein, low density lipoprotein and very high density lipoprotein. Meanwhile, significant difference ($p<0.05$) were recorded for glucose, creatinine and AST at this phase. While at the end of the finisher phase, all the serum indices parameter considered showed significant ($p < 0.05$) variations except for globulin, glucose and creatinine which were ($p>0.05$) similar.

Carcass characteristics of Cobb strain of broiler chickens fed diets containing different additives

Table 5 shows the carcass characteristics of Cobb strain of broiler chicken at finisher phase fed diet containing Cloves (*Syzygium aromaticum*) , Turmeric (*Curcuma longa*), Selenium and Butylated Hydroxytoluene. The addition of various additives to the diets did not influence ($p> 0.05$) the live weight, eviscerated weight and dressed weight. Most of the prime cuts considered were found to be similar ($p > 0.05$) except for back which was influence by the addition of the additives. The supplemented diets significantly influence ($p<0.05$) the abdominal fats and meat to bone ratio; while the spleen, crop, small intestine and large intestine were not influenced ($p> 0.05$).

Discussion

The best feed conversion ratio observed in experiment 1 was testified in the group fed cloves however comparable to the study of Al-mufarej *et al.* (2019) who reported better feed conversion ratio of 1.56 when fed broiler birds with 3% of cloves powder. Higher feed conversion ratio (FCR) obtained from control and turmeric supplemented groups is in contrast to the study of Nouzarian *et al.* (2011) who demonstrated that supplementing broiler diet with 3.3g/kg of turmeric improved feed conversion ratio compared to the control. However, Qasem *et al*. (2011) did not find any positive effect either on body weight gain or FCR when turmeric was supplemented at the different rates of 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0%.

Table 3: Heamatological parameters at starter and finisher phases of Cobb strain of broilers chicken fed diets containing different additives

Parameters	Range	STARTER PHASE							FINISHER PHASE						
		control	Turmeric	Se	BHT	Cloves	SEM	p-values	control	Turmeric	Se	BHT	Cloves	SEM	p-values
PCV(%)	22-35	29.50	26.00	27.00	33.00	34.00	1.41	0.31	38	33.5	36	30.5	32.5	1.47	0.62
HB(g/dl)	7-13	9.90	8.75	9.05	11.10	11.35	0.47	0.31	12.7	11.15	12	10.1	11	0.49	0.62
RBC(*10^2)	2.5-3.5	2.50	2.15	2.25	2.75	2.75	0.12	0.38	2.5	2.5	2.55	2.6	2.5	0.06	0.99
WBC(cumm ^{2} x 10^2)	12-30	11.30	11.00	10.30	10.70	11.25	0.43	0.97	11.7	11.85	11.1	9.1	9.5	16.37	0.50
HET(%)	71-75.5	28.50	38.00	36.00	35.50	27.50	1.80	0.23	38.5	31.5	28.5	30	36.5	1.47	0.08
LYP(%)		71.50	60.50	61.00	63.50	70.00	1.83	0.14	65.1^{c}	84.1^{a}	64^{d}	62^{e}	69^{b}	2.65	0.00
EOS(%)		0.00	1.00	0.00	0.00	0.50	0.21	0.57	0.5	0	0	0.5	0	0.13	0.59
BAS(%)		0.00^{b}	0.00^{b}	1.00^{a}	0.50^{ab}	1.00^{a}	0.17	0.05	0.5	0.5	0.5	0.5	0.5	0.17	1.00
MONO(%)		0.00	0.71	0.00	1.41	1.0	0.29	0.25	1	1	1	0.5	1.5	0.15	0.39
MCV	90-140	117.95	121.10	119.95	120.10	123.65	0.78	0.22	56	57.75	55.7	58.9	60.8	2.71	0.10
MCH	33-47	39.60	40.85	40.20	40.35	41.30	0.27	0.37	39.65	39.85	40	41.85	42.2	0.61	0.63
MCHC(g/dl)	26-35	33.55	33.70	33.55	33.60	33.35	0.08	0.85	33.4	33.25	33.3	33.2	33.8	0.11	0.56

$^{a\ b\ c\ d\ e}$Means across rows with different superscripts are significantly (P< 0.05 different), Se= selenium, PCV= packed cell volume, WBC= White blood cells, HET= Heterophils, LYP =Lymphocytes,EOS=Eosinophils,BAS = Basophils, MONO= Monocytes, MCV= Mean corpuscular volume, MHC=Mean corpuscular hemoglobin, MHC=Mean corpuscular hemoglobin content,HB=Hemoglobin, RBC=Red blood cell, Range*=Bounous and Stedman,2000)

Table 4: Serum indices at starter and finisher phases of Cobb strain of broiler chicken fed diets containing different additives

Parameters	R-values	Starter							Finisher						
		Control	cloves	Turmeric	Se	BHT	SEM	p-value	Control	Cloves	Turmeric	Se	BHT	SEM	p-value
TPRO(g/dl)	4.63-4.81	6.10	6.00	5.85	6.05	6.05	0.07	0.89	5.30^{c}	5.10^{c}	4.60^{d}	6.10^{a}	5.60^{b}	0.17	0.01
ALB(g/dl)	3.28-3.48	3.30	3.15	3.35	3.15	3.10	0.06	0.74	2.80^{c}	2.61^{bc}	2.50^{bc}	3.90^{a}	3.00^{b}	0.16	0.00
GLOB(g/dl)	1.15-2.53	2.80	2.80	2.50	2.90	2.95	0.09	0.63	2.60	2.41	2.55	2.30	2.70	0.08	0.72
GLU(mg/dl)	197-299	235.6^{a}	196.75^{b}	139.8^{d}	147.25^{c}	157.85^{b}	13.45	0.05	174.7	251.2	121.2	121.5	172.7	24.39	0.34
CREAT(mg/dl)	0.41-1.41	1.75^{a}	1.35^{b}	1.00^{ab}	1.85^{a}	2.05^{a}	0.14	0.05	1.30	0.70	1.00	1.20	1.00	0.07	0.48
AST(U/L)	70-79	65.5^{ab}	81.00^{a}	62.00^{b}	64.00^{ab}	66.00^{ab}	2.74	0.05	69.10^{b}	65.10^{c}	84.10^{a}	64.10^{d}	62.10^{e}	2.64	0.00
ALT(U/L)		24.00	28.00	26.50	28.50	25.00	0.86	0.15	23.10^{b}	22.10^{c}	24.10^{a}	21.10^{d}	20.10^{e}	0.47	0.00
T.CHOL(mg/dl	87.0-192	102.10	84.25	97.65	93.75	73.05	7.16	0.49	112.50^{a}	98.45^{b}	96.90^{c}	79.00^{d}	75.50^{e}	4.53	0.00
TRIG		138.5	98.35	104.5	121.75	105.35	7.47	0.81	127.70^{a}	93.80^{d}	90.10^{e}	98.00^{c}	115.20^{b}	4.70	0.00
HDL		52.30	40.80	48.50	45.45	31.25	4.02	0.62	65.4^{a}	56.00^{b}	51.80^{b}	42.80^{c}	39.00^{c}	3.21	0.01
VHDL		27.70	19.70	20.90	24.35	21.10	1.49	0.52	25.60^{a}	18.80^{d}	18.10^{e}	19.70^{c}	23.10^{b}	0.95	0.00
LDL		22.10	23.75	28.25	23.95	20.70	2.72	0.96	26.20^{b}	23.80^{c}	27.20^{a}	16.70^{d}	13.60^{e}	1.80	0.00

$^{a\ b\ c\ d\ e}$Means across rows with different superscripts are significantly (P< 0.05 different)

TPRO= Total protein, ALB =Albumin,GLOB= Globulin, GLU= Glucose, CREAT=Creatinine, ALT= Alanine transaminase, AST = Aspartate aminotransferase, T.CHOL=Total cholesterol, TRIG= Triglyceride, HDL= High density lipoprotein, VHDL =Very high density lipoprotein, LDL=Lowdensity lipoprotein, R.values= refrence values, R.Values for creatnine:Café*etal*.,(2012), R.values Source: en.wikivet.net/Chicken_Biochemistry

Table 5: Carcass characteristics of Cobb strain of Broiler Chickens fed diets containing different additives

Parameters	Control	Additives				SEM	p-value
		Cloves	Turmeric	Selenium	BHT		
Live weight (g)	2266.67	2208.33	2266.67	2333.33	2325	24.4	0.51
Eviscerated weight(g)	1606.67	1635	1620	1753.33	1743.3	25.5	0.19
Dressing weight (g)	1460	1420	1358.33	1526.67	1570	29.5	0.16
Prime cuts (%live weight)							
Shank (%)	3.25	3.19	3.89	3.56	3.76	0.37	0.35
Thigh (%)	10.14	9.50	10.46	10.28	10.76	0.3	0.79
Breast (%)	20.53	22.36	21.41	20.04	22.81	0.66	0.68
Neck (%)	3.51	3.49	4.09	4.17	3.40	0.59	0.51
Back (%)	15.36 [a]	15.89 [a]	9.75 [c]	18.73[b]	19.35[b]	0.83	0.01
Wing (%)	7.64	7.16	7.43	7.47	8.30	0.14	0.14
Drum stick (%)	9.63	9.59	10.83	10.07	10.14	0.19	0.23
Head (%)	2.00	1.63	1.73	1.95	2.26	1.84	0.67
Organs(% LW)							
Kidney (%)	0.33	0.22	0.36	0.23	0.26	0.02	0.47
Lungs (%)	0.57	0.52	0.55	0.51	0.46	0.02	0.76
Liver (%)	2.27	1.89	1.99	2.02	1.84	0.08	0.59
Gizzard (%)	1.59	2.01	1.89	1.99	1.72	0.13	0.12
Offals							
Spleen (%)	0.08	0.07	0.09	0.08	0.08	0	0.9
Crop (%)	0.51	0.56	0.56	0.53	0.47	0.03	0.91
Small intestine (%)	0.88	0.29	1.05	1.29	0.81	0.26	0.38
Large intestine (%)	1.17	1.34	1.16	1.10	1.28	0.07	0.88
Abdominal fat (%)	2.72 [a]	0.73 [c]	1.26 [b]	1.30 [b]	1.42 [b]	0.15	0.01
Proventiculus(%)	0.57	0.45	0.45	0.47	0.43	0.04	0.07
Meat to bone ratio	3.64 [ab]	3.64 [ab]	5.03[a]	4.14[b]	3.62[ab]	0.15	0.01

[a b c]Means across rows with different superscripts are significantly (P< 0.05) different, Se= Selenium, SEM = Standard error of mean, BHT=Butylated hydroxytuluene, L.I=Large intestine, S.I=Small intestine,

The comparable higher mean values obtained for most of the additives is in agreement with the results published by Niu *et al*. (2009), Da Silva *et al*. (2010) and Cai *et al*. (2012), who observed similar feed intake in birds offered selenium supplementation when compared to control diet.

From this study, cloves and selenium had the best feed conversion ratio (FCR). The beneficial influence of the phytogenic feed additive (PFA) on improved performance and feed conversion ratio could be also explained due to the antioxidant activity of bioactive compounds such as carvacrol, cuccumin, eugenol, thymol, cineol and pinene (Faleiro *et al*., 2005; Hazzit *et al*., 2006).As well,from improved enzyme activity in the alimentary tract, stimulation of useful and inhibition of pathogenic microflora were eventually resulted in improved absorption and utilization of nutrients (Windisch *et al*., 2008; Frankic *et al*.,2009).

Both at the starter and finisher phase, the group of birds fed cloves had the lowest total feed intake compared to other treatments this is comparable to the result reported by Al-mufarej *et al* . (2019) whom observed gradual decrease inbody weight gain (BWG) and daily feed intake (FI) with a gradual increase in FCR when 2% and 6% of cloves powder was added to the feeds of broiler

chickens. They attributed this to the adverse effect on the palatability of the feed. However similar results were obtained by Mohammadi *et al.* (2014) who found that broilers supplemented with clove oil (100 mg/kg, 300 mg/kg, and 500 mg/kg) did not grow linearly and had decreased growth performance and total feed intake with the addition 500 mg of cloves/kg of diet. Similarly, Agostini *et al*. (2012) used various levels of clove oil (100, 200, 1000, and 2500 mg/kg), which exhibited decreased growth performance at 1000 and 2500 mg/kg. In contrast to this study, Mukhtar (2011) reported that adding clove oil at 200, 400, and 600 mg/kg in the diet of birds improved feed intake. Natural compounds used as feed additives in poultry production increase the absorption surface of intestine there by increases the Apparent Ileal Digestibility (AID) of nutrients favours the growth of broilers (Jang *et al*., 2007). Improvement in the growth performance due to supplementation of turmeric was attributed to the beneficial properties of phytochemicals in turmeric that possess antimicrobial, antifungal and antioxidant activities in broiler chickens that may improve the utilization of dietary nutrients (Moorthy, 2009). On the other hand, some reports showed that turmeric had the ability to stimulate the digestive system, such as stimulate the intestinal lipase, sucrose and maltase activities as well as the secretion of pancreatic lipase, amylase, trypsin and chymotrypsin enzymes (Nadia, 2008; Morakinyo, 2011). Nouzarian (2011) reported dietary supplementation of turmeric in diets increased villus length and width in the duodenum, jejunum and caeca of broiler chickens therefore, there is a possibility to improve the growth performance due to dietary turmeric meal in broiler chickens which is attributed to improve digestive system. Onu (2010) also recorded positive effect of dietary turmeric on broiler performances.

The packed cell volume values obtained at the finisher phase in experiment 1 is slightly higher than the normal range of 22-35 reported by Bounous and Stedman, (2000) and 30 -35 reported by Campbell *et al*.(2003) for domestic chickens . The haemoglobin concentration valuesobtained were within the reference value of 7-13 reported by Bounous and Stedman, (2000) and 6.0 -13.0 g/dl reported by Iheukwumere and Herbert (2003) for domestic chicken. Likewise,Red blood cell values recorded were also within the reference values of 2.11-2.88×10^{12} for broiler chickens as reported by Olukomaiya (2014). The values obtained for MCH, MCHC were within the normal range reported by Bounous a Stedman, (2000). Similarly, the MCV values at the starter phase were also within the normal range of 90-140 as reported by Bounous and Stedman, (2000) but lower values were observed at the finisher phase. Any increase in mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration could be an indication of anemia as suggested by Bush (1975) and Ojediran *et al*. (2012). However, values obtained from this study indicated that the birds in the entire treatment groups were not anemic.

White blood cell is known to play an important role in antibody production and recognition of foreign bodies. The results on lymphocytes(which are the granulocyte of white blood cells) were within the reference value of 47.2 to 85.0 % reported by Riddell, (2011); while the monocytes (which are also granulocytes of the white blood cell) were lower than the reference values of 0.06 to 5.0 %, respectively for healthy domestic chickens (Riddell, 2011). Basophills are necessary for the immune system natural responds to invaders, such as infectious germs. A significant difference was observed for basophills at the starter phase but numerically falls within the normal rangeas reported by Riddell, (2011).

Blood protein in birds is an important indicator in the evaluation of health status and represent a basis in general biochemistry allowing the

identification of metabolic alteration The result of this study is in line with those reported by Werner and Reavill (1999) who reported similar concentrations of serum total protein in all treatments at the starter phase. It is also in agreement with findings of Al-Mufarrej*et al*. (2019) who reported similarities in the serum total protein at day 7 and 14 whenbroilers were fed with clove powder at different levels. The total protein however, significantly ($p<0.05$) reduced at the finisher phase for all the treatments. It is also in agreement with the findings of the same author in decreased in the total protein values at the latter age of the birds. The reduction may be associated with changes in nutrition (transition from starter to finisher), different diet composition (lower content of crude protein in the finisher diet in comparison with the protein-rich starter and grower diets), and food consumption during growth, as well as the metabolic rate and physical condition of the growing chickens. The intensity of the building of proteins into the tissues may significantly influence the concentrations of proteins in the blood, as well as their composition (Scanes, 2015). This factor is very important in chickens due to the extremely rapid accumulation of body mass during the relatively short time of fattening. Furthermore, Chowdhury *et al*. (2018) used dietary clove bud oil at 0.6% and did not report a significant influence on serum total protein in broiler chickens at the initial phase. Many medicinal herbs and plants have similar effects on the blood biochemical profile in poultry. For example, Hassan and Awad (2017) stated that 0.2%, 0.5%, and 0.8% dietary supplementation with thyme powder in broilers did not affect serum total protein, albumin, and globulin when compared with that of the control group.

The values of albumin and globulin depend on the blood protein level. The low albumin obtained at finisher phase in experiment 1 was due to the low blood protein as earlier stated. Al-Mufarrej*et al*. (2019) disclosed in their study that Albumin and globulin levels were not influenced at younger ages (7, 14, 21, and 28 days of age) when fed clove powder at different levels which is comparable to the present study. Thus agrees with work of other researchers who reported that total serum protein, albumin, and globulin levels of birds were not affected by 0.5% cloves powder (Tariq *et al*., 2014). Additionally, Saeid *et al*. (2010) reported that 0.4% and 0.6% of ginger had no significant effect on serum total protein, albumin, and globulin when compared with that of the control group in broilers. In contrast to the report of this study, Natsir *et al*. (2017) showed that a mix of garlic and *Phyllanthus niruri* at 1.2% of the broiler diets had no significant effects on serum globulin. In another report byJafari *et al*. (2011) dietary garlic powder supplementation at the levels of 1% and 3% had no effects on serum globulin in broiler chicks, but it tended to decline with age which is comparable to the present study.

Serum glucose level is always maintained with controlled homeostasis mechanism. The requirement for glucose in birds changes with growth, nutrition, production performance and environmental conditions. Glucose concentration varies among bird species and subject to the absorptive state of the animal which tends to change as birds increase in age (Harr, 2002). From the result obtained in experiment 1, the **blood glucose** levels in most of the treatments were within the normal range of 197 -299mg DL^{-1} reported by Sulistyoningsih, (2004).

Creatinine is used to determine the status of the kidney. The functions of the kidney include excretion of waste products resulting from protein metabolism and muscle contraction (Esubonteng, 2011). Creatinine is excreted by the kidney as a by-product of creatinephosphate metabolism which is produced as a result of energy production by the skeletal muscles (Esubonteng, 2011). The values of creatinine obtained in the starter phase of this study were

slightly higher than 0.41 -1.41mg/dL reported at 4th week of age of broilers by Cafe *et al*. (2012). At the finisher phase of this research, the creatinine valueswere higher than the 0.44mg/dl reported by Cafe *et al*., (2012). This could be attributed to excess activity as a responds to increase muscle breakdown.

Alanine transaminase (ALT) and Aspartate aminotransferase (AST) are considered as diagnostic enzymes for liver diseases (Aljaff, 2011). These parameters are generally influenced by nutrition, season, climate change, age, sex, type of birds and management systems (Yokus*et al*.,2006). Elevated levels of ALT and AST are sensitive indicators of hepatocellular disease (Nasiiolesmi and Torki, 2010). In this study, there were significant changes in the serum levels of AST and ALT in the treatment groups but numerically falls within the normal range of 70-79 reported in online source:en.wikivet.net/Chicken_Biochemistry.

Fat deposition in the abdominal area of broilers is regarded as waste in the poultry industry, since it represents a loss in the market and reduced consumer acceptability. The results of the current study indicated that the supplementation of broiler diets with both phytogenic and synthetic additives has the potential to reduce this type of waste by reducing abdominal fat content. Nouzarian *et al*. (2011) reported that the addition of turmeric powder (3.3, 6.6 and 10 g/kg of diet) markedly reduced abdominal fat weight of broilers. In this current study,the abdominal fat values of turmeric group recorded lower compared to (1.41 abdominal fat)that of Nouzarian *et al.,(*2011). The decrease in abdominal fat might be due to the influence of curcumin on adipocyte apoptosis or glucose withdrawn from blood as reported by Sugiharto *et al*. (2011). Cloves had a reduced abdominal fat compared with all the treatment groups. However, Selenium markedly increased eviscerated weight. It is possible that selenium might have enhanced the efficiency of protein depositor water retention in tissues.

Conclusion

In this study we concludede that the addition of 4g/kg of cloves and turmeric powder improved the performance of Cobb strain of broiler chicken compared to the group of birds fed BHT and selenium**.**

References

Agostini, P. S., Solà-Oriol, D., Nofrarías, M., Barroeta, A. C., Gasa, J. and Manzanilla, E. G. 2012. Role of in-feed clove supplementation on growth performance, intestinal microbiology, and morphology in broiler chicken. *Livestock Science*. 147: 113-118.

Akbarian, A., A. Golian, H. Kermanshahi, A. Gilani and S. Moradi. 2012. Influence of turmeric rhizome and black pepper on blood constituents and performance of broiler chickens. *African. Journal of Biotechnology.*11: 8606-8611.

Al-Jaff, F. K 2011. Effect of coriander seeds as diet ingredient on blood parameters of broiler chicks raised under high ambient temperature. *International journal of Poultry Science*. 10: 82-86.

Al-Mufarrej, S. I., Fazea, E. H, Al-Baadani, H. H & Qaid, M. M. 2019. Effects of clove powder supplementation on performance, blood biochemistry, and immune responses in broiler chickens. *South African Journal of Animal Science.9: 5*

Barham, D., and Trinder, P., 1972. An improved colour reagent for the determination of blood glucose by the oxidase system. Analyst 97: 142 – 145.

Bounous, D. and Stedman N. 2000. Normal avian hematology: chicken and turkey. In: Feldman BF, Zinkl JG, Jain NC, editors. Schalm's veterinary hematology. New York: Wiley; .p.1147-1154.

Bush, B. M. 1975. Veterinary laboratory manual. William Heinemann. Medical Book Limited, London, UK. pp. 447.

Café ,M. B., Fabrício P. R., Hugo R., Morais ,M. R., Bueno, M, and, Antônio V. M. 2012. Biochemical Blood parameters of broilers at Different Ages under thermoneutral environment *World's Poultry Science Journal,* WPC2012 - Salvador - Bahia - Brazil • 5 - 9 August – 2012

Cai,B. S., Sun. M., Corke, H. 2012. Antioxidant capacity of 26 Spice extract and characterization of their phenolic constituent.*Journal of Agricultural food chemistry.*52(2):7749-7759

Campbell, J. R., Kencaly, M. D., Campbell, K. I. 2003. Anatomy and physiology of farm animals. In: Animal Sciences. The biology care and the production of domestic animals, 4th edition. McGraw Hill Company Inc., New York, USA.

Chowdhury, S., Mandal, G. P., Patra, A. K., Kumar, P., Samanta, I., Pradhan, S. & Samanta, A. K., 2018. Different essential oils in diets of broiler chickens: 2. Gut microbes and morphology, immune response, and some blood profile and antioxidant enzymes. *Animal Feed Science and Technology*. 236, 39-47

Da Silva Sabo, S.; Pérez-Rodríguez, N.; Domínguez, J. M.; de Souza Oliveira, R. P. 2010. Inhibitory substances production by *Lactobacillus plantarum* ST16Pa cultured in hydrolyzed cheese whey supplemented with soybean flour and their antimicrobial efficiency as biopreservatives on fresh chicken meat. *Food Res. Int. 99*, 762–769.

Esubonteng PKA. 2011. An assessment of the effect of *Moringa olifera* leaf powder as a nutritional supplement in the diet. Kumasi: Kwame Nkrumah University of Science and Technology; 2011

Faleiro L.,Miguel G., Gomes. S., Costa L.,Veancio 2005. Antibacterial and antioxidant activities of essential oils isolated from Thymbra capitata L. (Cav.) and Origanum vulgare L.Journal of Agriculture and. Food Chemistry., 53:23-30

Frankic T.,Voljc M., Salobir J., Rezar V 2009. Use of herbs and spices and their extracts in animal nutrition.Acta Agr.Slov., 94: 95–102.

Friedman M. Henika P. R., Mandrell R. E. 2002. Bactericidal activities of plant essential oils and some of their isolated constituents against *Campylobacter jejuni, Escherichia coli, Listeria monocytogenes* and *Salmonella enterica*.*Journal of food procolcol*. 65(10): 1545-156

Harr, R. W., 2002. an analysis of consumer preferences for value-added seafood products derived from crawfish. *agricultural and resource economics review*, *31*(2), 157–170

Hashemi S. R., Zulkifli I., Davoodi H., HairBejo M., Loh T. C. 2010. Intestinal histomorphology changes and serum biochemistry responses of broiler chickens fed herbal plant (Euphorbia hirta) and mix of acidifier. *Iranian Journal of Applied Animal.Science*., 4: 95–103.

Hassan, F. A. & Awad, A., 2017. Impact of thyme powder (*Thymus vulgari*s L.) supplementation on gene expression profiles of cytokines and economic efficiency of broiler diets.*Environmental Science.Pollution.Research*. 24, 15816-15826

Hazzit M.,Baaliouamer, A., Faleiro, M. L. and Migue, M. G. 2006. Composition of the essential oils of Thymus and Origanum species from Algeria and their antioxidant and antimicrobial activities. Journal Agriculture Food Chemistry., 54: 6314–6321.

Iheukwumere, F. C., Herbert, U. 2003. Physiological responses of broiler chickens to quantitative water restrictions: Haematology and serum biochemistry. *International Journal of Poultry Science,* 2(2):117-119.

Jafari, R. A., Razi-Jalali, M. & Kiani, R., 2011. Effect of fresh dietary garlic powder on

some of the serum biochemical parameters in broiler chicks.*Comprehensive journal of Clinical Pathology*. 20, 295-297.

Jain, N. C. 1993. Schalms veterinary Haematology 4 th edition. Lea and Febiger, Philadelphia

Jang , I. S., Ko, Y.H.,Kang, S. Y., and Lee, C. Y. 2007. Effect of commercial essentials Oil on growth performance of , Digestive enzymes activity and intestinal micro flora population in broiler chickens. Animal Feed Science Technology 134:304-315

Jayathilakan, K., Sharman, G. P.,Radhakrishna, K. and Bawa, S. A 2007. Antioxidant potential of synthetic and natural antioxidant and its effects on warmed over avour in different species of meat. Food Chemistry 105(3) 908-916

Jayathilakan, K., Sharman, G. P.,Radhakrishna, K. and Bawa, S. A 2007. Antioxidant potential of synthetic and natural antioxidant and its effects on warmed over avour in different species of meat. *Foof chemistry* 105(3) 908-916

Jingfei Z. 2015. Effects of supplementation of phytogenic feed additives on performance parameters and meat quality of broiler chickens. *Slovenian veterinary research* 48 (1) 27-34

Kafi, A, Uddin, J., khan, M. M. , Haque, M. E., 2017. Effect of Dietary Supplementation of Turmeric (*Curcuma longa*), Ginger (*Zingiber officinale*) and their Combination as Feed Additives on Feed Intake, Growth Performance and Econo 2017. *International Journal of Poultry Science* 16(7) 257-265

Khan, R.U., Nikousefat, Z., Naz, S., Jdani, M. and Laudadio, V. A. 2012. Garlic (Allium sativum) supplementation in poultry diets: Effect on production and physiology. World Poultry Science Journal., 68: 417–424.

Khattak, F., Ronchi, A., Castelli, A. and Sparks, N. 2014. Effects of natural blend of essential oil on growth performance, blood biochemistry, cecal morphology, and carcass quality of broiler chickens. Journal of Poultry Science., 93: 132–137

Kris, K. H. 2017.The domestication history of chicken. http://www.thoughtco.com/ domestication.com/domestication-history-of - chicken-170653/ accessed 21st of May 2018

Megan, M. 2018. Cloves: nutritional facts and health benefits. Journal of Science of Food and Agriculture, 94(13):2726-2737

Mohammadi, Z., Ghazanfari, S. & Moradi, M. A., 2014. Effect of supplementing clove essential oil to the diet on microflora population, intestinal morphology, blood parameters and performance of broilers. *European Poultry Science* 78, 1-11.

Moorthy, M., S. Ravi, M. Ravikuma, K. Viswanathan and S. C. Edwin, 2009. Ginger, pepper and curry leaf powder as feed additives in broiler diet. *International Journal of Poultry Science*., 8: 779-782.

Morakinyo, A. O., A. J. Akindele and Z. Ahmed, 2011.Modulation of antioxidant enzymes and inflammatory cytokines: Possible mechanism of anti-diabetic effect of ginger extracts.*African Journal of Biomedicine*. Res., 14: 195-202.

Mukhtar, M. A., 2011. The effect of dietary clove oil on broiler performance.*Australian Journal of Basic Applied Science*. 5, 49-51

Nasiiolesmi, M., and Torki, M. 2016. Including Essential Oils of Fennel (Foeniculum Vulgare) and Ginger (Zingiber Officinale) to Diet and Evaluating Performance of Laying Hens, White Blood Cell Count and Egg Quality Characteristics. *Advance Environmental Bioloy*; 4: 341-345.

Nasir, M. & Aasima, R. & Faneshwar, K. & Vijay, S. & Vivek, S. 2017. Determinants of broiler chicken meat quality and factors affecting them: a review. *Journal of Food Science and Technology*. 54. 1-13. 10.1007/s13197-017-2789-z.

Natsir, M. H., Hartutik, Sjofjan, O., Widodo, E. & Widyastuti, E. S., 2017.Use of acidifiers and herb-acidifier combinations with encapsulated and non-encapsulated intestinal microflora, intestinal histological and serum characteristics in broiler.A.I.P. Conference Procedings. 1844, 20012-20019.

Niu, W., Wang, J., W.Su, D. Wang, Tanomtong, A., Perelman, P.L., Graphodatsky, A.S. and Yang, F. 2009. Chromosomal rearrangements and karyotype evolution in carnivores revealed by Chromosome painting. Heredity (Edinburg). 108(1): 17- 27.

Nouzarian, R., S. A. Tabeidian, M. Toghyani, G. Ghalamkari and M. Toghyani, 2011. Effect of turmeric powder on performance, carcass traits, humoral immune responses and serum metabolites in broiler chickens.*Journal of Animal Feed Science*., 20: 389-400.

Ojediran, T. K., Emiola, I. A., Ogunwemimo, O. and Olayeni, T. B. 2012. The effect of processed Jatropha carcus kernel cake on blood profile and biochemical indices of chickens.Proceedings of the 17th Annual Conference of the Animal Science Association of Nigeria and Nigerian Institute of Animal Science. 9 - 13th September 2012. International Conference Centre, Abuja, pp. 509 – 512. 34.

Oliveira, T. F. B, Rivera, D. F, Mesquita, F. R, Braga, 2014. Effect of Different Sources and levels Of Selenium on performance, meat quality and tissue characteristics. *Journal of applied poultry res.* 23:15-22

Olukomaiya, O. O., Adeyemi, O. A., Sogunle, O. M., Abioja, M. O., Iwuchukwu, P. O.and Emuveyan, U. P. 2014. Effects of feed restriction and ascorbic acid supplementation on haematological parameters of Marshall broiler chickens. Indian Journal of Innovations and Developments, 3(2):18-22.

Onu, P. N., 2010. Evaluation of two herbal spices as feed additives for finisher broilers. *BiotechnologyAnimalHusbandry,*26:383-392.

Priyadarsini, K. I. 2014. The molecules of curcumin from extraction to therapeutic agent.*Journal of molecules* 19(12) 20091-20112.

Qasem M. A. A., Alhajj, M. S., Ger El Nabi, A. R., Al-Mufarrej, S. I. 2011: Effect of turmeric powder as a dietary supplement on performance indicators and immune response sin broiler chickens. Journal of Animal and Veterinary Advances 14(2): 30-35.

Riddell, C. 2011. Comparative anatomy, histology and physiology of the chicken. Department of Pathology, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 0W0. pp.37.

Rostagno, M. H., Susan, D., Eicher,E, Donal, C. 2011. Immunological, physiological and behavioural effect of a *Salmonella enterica* carriage and shedding in experimental infected finishing pigs.*food borne pathogen disease*vol.8, no 5 page 192-201m.

Saeid, J. M., Mohamed, A. B. & AL-Baddy, M. A., 2019.Effect of aqueous extract of ginger (*Zingiber officinale*) on blood biochemistry parameters of broiler.International *Journal Poultry Science*. 9, 944-947.

Scanes, C.G.2015. Protein metabolism in Avian Physiology. 6th ed. Waltham, MA: *Academic Press, Elsevier Inc;* 2015. pp. 455–468.

Sugiharto, S., Isroli, E., Widiastuti,H and Prabowo,N. S. 2011. Effect of turmeric extract on blood parameters, feed efficiency and abdominal fat content in broilers. Journal of Indonesian Tropical Animal Agriculture., 36: 21-26

Sulistyoningsih, M., 2004. Respon fisiologis dan tingkah laku ayam brolier starter akibat cekaman tempratur dan awal pemberian pakan yang berbeda. Magister Ilmu Ternak Program

Pasca, Sarjana Universitas Diponegoro, Semarang.

Tariq, H., Rao, P. V., Mondal, B. C. & Malla, B. A., 2014. .Effect of Aloe vera (Aloe barbadensis) and clove (Syzygium aromaticum) supplementation on immune status, haematological and serum biochemical parameters in Japanese quails.*Indian Journal of Animal Nutrition*. 31, 293-296.

Werner, L. L. and Reavill, D. R. 1999. The diagnostic utilityof serum protein electrophoresis 1999.Veterenary .Clinic.North.Am.*Exotic Animal Practice.* 1999; 2(3):651-662

Windisch, W., Schedle, K., Plitzner, C. and Kroisknayr, A. 2008. Use of phytogenic products as feed additives for swine and poultry.Journal of Animal Science., 86: E140–E148.

Windisch, W., Schedle, K., Plitzner, C., Kroisknayr, A. 2006. Use of phytogenic products as feed additives for swine and poultry.*Journal of Animal Science*., 86: E140–E148.

Yokus, B, Cakir D. U, Kanay Z, Gulten T, Uysal E. 2006. Effects of seasonal and physiological variations on the serum chemistry, vitamins and thyroid hormone concentrations in sheep.*Journal of Veterinary Medicine* ; 53: 271-276.

Yokus, B., Cakir, D. U., Kanay, Z., Gulten, T., and Uysal, J. E. 2006. Effects of seasonal and physiological variations on the serum chemistry, vitamins and thyroid hormone concentrations in sheep. *Journal of Veterinary Medicine* ; 53: 271-276.

Yoon, I., Werner, T. M., and Butler J. M., 2007. Effect of source and concentration of selenium on growth performance and selenium retention in broiler chickens. *Poultry Science journal*. 86:727–730. 38.

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