Performance, nutrient digestibility, blood profile and carcass yield of broiler chicken fed diets with varying levels of fenugreek seed (*Trigonella foenum graecum)*

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Abstract

*Phytogenic feed supplements (fenugreek seed powder**)** can function as a substitute for antibiotics. Studies have indicated that herbal plants and their components may be beneficial in enhancing over performance of livestock due to some phytochemicals it contains. Two hundred unsexed 1-day-old Ross 308 chicks were used to determine the effect of fenugreek seed on growth performance, haematology, serum biochemistry, nutrient digestibility and carcass yield of broiler birds. The birds were randomly allotted into five dietary treatments of 40 birds per treatment and 4 replicates of 10 birds per replicate. The treatments included: T1- 0g/kg control, T2- 10g/kg of fenugreek seed, T3-15g/kg fenugreek seeds, T4- 20g/kg fenugreek seed and T5- 25g/kg fenugreek seed and were arranged in a completely randomized design. Data were collected on growth performance, carcass characteristics, organ, haematology and serum biochemistry and were analyzed using ANOVA as contained in SAS (2002). The results revealed significant difference on (P<0.05) on all parameters measure. Highest daily weight gain (p<0.05) of 53.12g was recorded with broiler chickens fed control diet (0g of fenugreek seed/kg of diet) while broiler chickens feed diet containing 25g/kg had the least value (48.18g) at starter phase. Birds, fed 20g/kg feed of fenugreek seeds (T4) recorded the lowest feed to gain ratio compared to other dietary treatments. Higher values of PCV, Hb and WBC were recorded in birds fed fenugreek seeds except birds fed 15g/kg feed of fenugreek seeds that has similar (p>0.5) value compared to those fed control diets. Relative weight of thigh of the experimental birds on T4 (15.65%) was significantly (p<0.05) higher although similar to those on T2, T3 and T5 while birds on control diets had the lowest value (13.75%). Cholesterol value (85.72mg/dL) at finisher phase was significantly higher in broiler chickens fed control diets while broiler chicken fed diet containing 25g/kg of fenugreek seeds had the least value (70.34mg/dl). It is however concluded in this study that the inclusion of fenugreek seed in the diets broiler chicken at 20g/kg improved the growth performance, carcass yield, health status and nutrient digestibility with no detrimental effect on broiler chickens.*

Keywords*:* Fenugreek seeds, Broiler, Growth, Carcass and Blood profile

Running title: effect of fenugreek seed powder on broiler chicken

Performance, digestibilité des nutriments, profil sanguin et rendement en carcasse de poulets de chair nourris avec des régimes contenant différents niveaux de poudre de graines de fenugrec (*Trigonella foenum graecum*)

Résumé

Les suppléments alimentaires phytogéniques (poudre de graines de fenugrec) peuvent servir d'alternative aux antibiotiques. Des études ont montré que les plantes médicinales et leurs composants peuvent améliorer les performances du bétail grâce aux composés phytochimiques qu'elles contiennent. Deux cents poussins Ross 308 d'un jour, non sexés, ont été utilisés pour évaluer l'effet des graines de fenugrec sur la performance de croissance, l'hématologie, la biochimie sérique, la digestibilité des nutriments et le rendement en carcasse des poulets de chair. Les oiseaux ont été répartis aléatoirement en cinq traitements alimentaires de 40 oiseaux par traitement, avec 4 répétitions de 10 oiseaux chacune. Les traitements

comprenaient : T1 - 0g/kg (témoin), T2 - 10g/kg de graines de fenugrec, T3 - 15g/kg, T4 - 20g/kg et T5 - 25g/kg, disposés selon un plan complètement randomisé. Les données recueillies sur la croissance, les caractéristiques de la carcasse, les organes, l'hématologie et la biochimie sérique ont été analysées par ANOVA avec le logiciel SAS (2002). Les résultats ont révélé des différences significatives (P<0,05) pour tous les paramètres mesurés. Le gain de poids quotidien le plus élevé (p<0,05) (53,12g) a été enregistré chez les poulets nourris avec le régime témoin (0g de fenugrec/kg), tandis que ceux nourris avec 25g/kg ont présenté la valeur la plus faible (48,18g) en phase de démarrage. Les oiseaux du traitement T4 (20g/kg) ont montré le ratio aliment/gain le plus bas par rapport aux autres traitements. Des valeurs plus élevées d'hématocrite (PCV), d'hémoglobine (Hb) et de globules blancs (WBC) ont été observées chez les oiseaux consommant du fenugrec, sauf pour ceux nourris avec 15g/kg, dont les valeurs étaient similaires (p>0,5) au groupe témoin. Le poids relatif de la cuisse chez les oiseaux du traitement T4 (15,65%) était significativement plus élevé (p<0,05), bien que comparable à T2, T3 et T5, tandis que le groupe témoin présentait la valeur la plus faible (13,75%). Le taux de cholestérol (85,72 mg/dL) en phase de finition était significativement plus élevé chez les poulets témoins, alors que ceux nourris avec 25g/kg de fenugrec avaient la valeur la plus basse (70,34 mg/dL). En conclusion, l'incorporation de graines de fenugrec à raison de 20g/kg dans l'alimentation des poulets de chair améliore les performances de croissance, le rendement en carcasse, l'état de santé et la digestibilité des nutriments, sans effet néfaste.

Mots-clés : Graines de fenugrec, Poulet de chair, Croissance, Carcasse, Profil sanguin.

Introduction

The use of phytochemicals has shown an increasing trend over the years because the use of antibiotics as growth promoters is banned in poultry and livestock production in many parts of the world (Toghyani, 2010). Spices are among the phytogenic substances which were included as feed additives in chicken's diets. Windisch *et al*. (2008) reported that the antimicrobial and growth promoting effects of a range of phytogenic feed additives include fenugreek (*Trigonella foenum graecum* L). Nazar and El- Tinay (2007) on the other hand reported that fenugreek the seed contains 28.4% crude protein and other phytochemicals. The endosperm of the seed has high content of saponin (4.63%) and protein (43.8%) (Naidu *et al*., 2010). Fenugreek seeds are rich in protein, fat, total carbohydrates and minerals, calcium, phosphorous, iron, zinc, magnesium (Gupta *et al.,* 1996), fatty acids, linoleic, oleic and palmitic (Schryver, 2002). It becomes imperative to ascertain the feed additives of the plant supplements so that the appropriate feed additive can be assessed. Therefore, essential materials which are feed additives can increase the efficiency of the utilization of feed and the performance of animals. The prospect of using new natural alternative feed additives in animal diets instead of synthetic antibiotics and hormones has recently been exploited (Abbas, 2010). Phytogenic additives, which include a group of natural feed additives from herbs, spices or other plants are one of the potential alternatives identified in poultry production (Windisch *et al*., 2008). The additive extracts improved feed conversion ratio, increased the quality of carcasses, decreased the broiler's market age and decreased the cost of rearing (Javed *et al*.,2009). Fenugreek (*Trigonella foenum gracum*), a medicinal plant and strong spicy and seasoning type of sweet flavor is one of the phytogenic plants available for use in poultry (Blank, 1996). The seeds are available in whole or ground form and is used to flavour many foods mostly in blends with other spices such as curry powder and teas. Fenugreek seed has central hard and yellow embryo which is surrounded by corneous and comparatively large layer of white and semi-transparent endosperm (Betty,2008). The chemical composition of Fenugreek seeds,

husk and cotyledon showed that endosperm had the highest (4.63g/100g) saponin and (43.8g/100g) protein content. As against the, husk that contains higher total polyphenols. The extracts of endosperm husk, and fenugreek seed at about 200µg concentration exhibited antioxidant activity 72, 64 and 56%, respectively by free-radical scavenging method (Naidu *et al*., 2010). Improvement in broilers growth performance has been recorded due to inclusion of fenugreek seed to their diets. Khan *et al*. (2011) stated that the addition of fenugreek seed extract at the rate of 30 ml/L aqueous extract accelerate muscle growth of broilers. Toaha *et al*. (2016) observed that diet supplemented with fenugreek improved the productive performance, reduced the feed cost and increased profit as compared to diet supplemented with antibiotic growth promoters.

The study was aimed at providing insights into the effect of including different levels of fenugreek (*Trigonella foenum gracecum* L) seeds powder on growth performance, nutrients utilization, haematology indices, serum characteristics, carcass characteristics and relative organs.

Materials and Methods

Experimental site

The experiment was conducted at the Poultry Unit of Teaching and Research Farm, Ladoke Akintola University of Technology Ogbomoso, Oyo State Nigeria. The area is in derived savannah zone of Nigeria. It lies on longitude 4.5^0East of Greenish Meridian and latitude 8.5^0North-East towards Ibadan the capital of Oyo State. The mean annual rainfall is 1247mm while relative humidity is between 75% and 95%. It is situated at about 300-600 meters above the sea level with a mean annual temperature of 27^0C (Ayinla and Odetoye, 2015).

Collection of test ingredient

The Fenugreek seeds (*Trigonella foenum-graecum*) were purchased from a mini retail market at Ogbomoso, Oyo State. Fenugreek seeds were grounded using an electric blender to a fine powder. After that, it will be sieved and kept until use in an airtight container as describe by (Okanlawon, *et al.,* 2020a).

Experimental design

Two hundred 200 unsexed 1-day-old Ross 308 chicks were purchased from a reputable hatchery and used for experiment. The birds were randomly allotted into five dietary treatments of 40 birds per treatment and 4 replicates of 10 birds per replicate in a completely randomized design. Five experimental diets were formulated such that, treatment 1 (T1) contains 0g/kg of fenugreek, T2 has 10g/kg fenugreek seed, T3 contains 15g/kg fenugreek seed, T4 has 20g/kg fenugreek seed and T5 contains 25g/kg fenugreek seed. The birds at were fed on a starter diet which contained 23% crude protein and 2800kcal metabolizable energy/kg from 0-3 weeks of age and finisher diets at 4 -6weeks which contained 20% crude protein and 3000kcal/kg metabolizable energy. Feed and water were given *ad libitum* throughout the period of the trial which lasted 6 weeks. Data were collected on growth performance and haematology and serum biochemistry.

Table 1: Gross Composition of Experimental Diets for Broiler Chicken

	STARTER PHASE					FINISHER PHASE				
Diets	1	2	3	4	5	1	2	3	4	5
Inclusion Levels of Fenugreek Seed (g/kg)	0	10	15	20	25	0	10	15	20	25
Nutrient Composition of feed										
Crude Protein (%)					22.00					20.00
Crude fibre (%)					3.50					3.50
Calcium (%)					1.00					1.00
Phosphorus (%)					0.48					0.48
Metabolization energy (kCal)					3000					3200
Lysine (%)					1.38					1.38
Methionine (%)					0.68					0.68
Salt (%)					0.30					0.30
Moisture (%)					14.00					14.00
Ash (%)					6.50					6.50

Data Collection

Growth performance

Feed intake (g)= (Feed given – Leftover)

Weight gain (g) = Final weight gain (g) – Initial weight (g)

Feed Conversion Ratio (FCR) = Average feed intake (g) / Average weight gain(g)

Nutrient digestibility

Towards the end of the experiment, four birds were randomly selected from each treatment (one per replicate) and transferred to metabolic cages. They were allowed to acclimatize for three days before the fecal samples were collected daily for five days. The droppings were weighed and oven dried for 72 hours at 50^0C. The oven dried samples were grounded, bulked together and sub-samples were analyzed for proximate composition according to AOAC (2000) methods.

Blood Analysis

Four birds were randomly selected from each treatment About 2.5 mL of blood were collected in tubes containing EDTA anticoagulant, The blood was slowly expressed into EDTA tubes to reduce the risk of haemolysis after removing the needles from syringes (Haen, 1995) and analyzed to determine the parameters (haemoglobin concentration, packed cell volume, red blood cells count, total white blood cells count, differential white blood cell count, platelets count, and red cell) indices as describe by Iranloye *et al.* (2002) and Venkatesan *et al.* (2006).

Serum parameters include, total protein was obtained by biuret method in the assay as described by Kohn and Allen (1995). The globulin concentration was obtained by subtracting albumin from the total protein. Albumin was determined using Bromocresol Green (BCG) method as described by Peter *et al.* (1982). Aspartate transferase (AST) activities were determined using spectrophotometric methods as described by Rej and Hoder (1983). Alanine transferase (ALT) activities were determined using spectrophotometric methods as described by Rej and Hoder (1983). Serum urea was determined using a kit (Quinica clinical spam) having a linear measurement of about 566.6 mL/L of urea concentration. The serum urea will determine calorimetrically. The serum cholesterol was determined using enzymatic

endpoint method as described by Roeschlau *et al*. (1974).

Carcass characteristics and relative organ weights

At the end of 3rd and 6th week of experimental period, four birds were randomly selected, starved of feed for 12 hours and slaughtered by severing the jugular veins. The birds were bled; defeathered after which the visceral organs such as liver, intestine, pancreas, spleen, kidney, proventriculus, and hearts were removed. The bled, defeathered and eviscerated weights were evaluated accordingly. The head and shanks were removed to determine the carcass weight.

Proportional weight of the organs = weight of the organ (g) x 100

Live weight (g)

The carcass was cut into various parts (thigh, breast, back, drumstick and wings) and their weights were expressed in percentage relative to the carcass weight. The weights of the organs were also be expressed in relative values. The following calculations were evaluated:

Relative cut parts weight = Weight of the cut (g)x100

Carcass weight (g)

Data analysis

Data collected were analysed using ANOVA as contained in SAS (2002). Significant means were separated using Duncan Multiple Range Test as contained in (Duncan, 1955) as contained in SAS (2002).

Results and discussion

The growth performance of broiler starter chicken fed diet supplemented with varying levels of fenugreek seed is presented in table 2. No significant difference ($p>0.05$) was observed on average feed intake and feed to gain ratio. However significant differences ($p<0.05$) were observed on final live weight and weight gain per bird per day. The final live weight of the birds decreases as fenugreek seed supplementation level increases across the treatments. Highest weight gain ($p<0.05$) was recorded from broiler chicken fed control diet (53.12g) while broiler chicken feed diet containing 25g/kg had the least value (48.18g) at starter phase. For finisher phase, fenugreek seed supplementation has no significant difference ($p>0.05$) on final live weight, weight gain per bird per day (g) and average feed intake. However, significant difference ($p<0.05$) was observed in the feed to gain ratio. Birds, fed 20g/kg feed of fenugreek seeds (T4) recorded the lowest feed to gain ratio compared to other dietary treatments.

***Table* 2:** Effect of fenugreek (*Trigonella foenum - graecum*) seeds on performances of broiler starter and finisher chicken.

	Starter Phase						***Finisher Phase***					
Parameters (%)	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**(25g)**	**SEM**	**1 (0g)**	**2(10g)**	**3(15g)**	**4(20g)**	**5(25g)**	**SEM**
Initial body wt (g)	45.00	45.00	45.00	45.00	45.00	0.00	1479.13	1479.07	1479.10	1479.20	1479.11	0.01
FLW(g)	1532.25^{a}	1508.50^{ab}	1512.25^{ab}	1449.00^{ab}	1394.00^{b}	18.10	2755.00	2550.00	2542.50	2675.00	2512.50	62.488
ADFI	98.04	94.11	98.35	93.96	85.34	5.01	136.25	151.86	161.15	95.56	152.61	5.26
WG/B/D (g)	53.12^{a}	52.27^{ab}	52.41^{ab}	50.15^{ab}	48.18^{b}	0.68	91.13	79.50	75.95	84.41	73.81	4.46
Feed to gain ratio	1.86	1.81	1.89	1.90	1.77	0.11	1.56^{ab}	2.66^{a}	2.22^{a}	1.20^{b}	2.15^{a}	0.128

^{abc}= Means on the same row bearing the different superscript are significantly different ($p<0.05$)

SEM= Standard error of means, FLW=Final Weight Gain, ADFI-Average Daily Feed Intake, WG=Weight Gain/Bird/Day

Table 3: shows the carcass characteristics of broiler chicken fed diets supplemented with varying level of fenugreek seed (*Trigonella foenum graecum*) at starter and finisher phase. Results showed that final live weight, defeathered weight, eviscerated weight, carcass weight and back percentage were significantly ($p<0.05$) affected by the dietary treatment. However, the dressed, head, neck, breast, thigh, drumstick and wings percentage were not significantly affected ($p>0.05$) by the dietary treatments. The final live weight had the highest value in chicken fed diet with no supplementation (T1), while the final live weight value was lowest in chicken fed diet supplemented with 20g/kg of fenugreek seed (T5) at starter phase. The bled weight value was highest in chicken fed diet with no supplementation of fenugreek seed (T1), while the bled weight value is lowest in chicken fed diet supplemented with 20g/kg of fenugreek seed (T5). Relative carcass weight of broiler finisher chicken fed diets supplemented with fenugreek seeds (*Trigonella foenum graecum*), the final weight , bled weight, defeathered weight, eviscerated weight, carcass weight, neck, back, breast, drumstick and wings were not significantly ($p>0.05$) affected by the supplementation levels while relative weight of dressing percentage of the experimental birds on T3 (76.32%) was significantly ($p<0.05$) higher than birds on the remaining treatments though similar to those in T1,T4 and T5 while on birds on T2 had lowest value (74.00%). Relative weight of thigh muscle of the experimental birds on T4 (15.65%) was significantly ($p<0.05$) higher although similar to those on T2, T3 and T5 while birds on control diets had the lowest value (13.75%).

Table 3: Carcass and relative cut- up part weights of broiler chicken fed supplemented with varying levels of fenugreek (*Trigonlla foenum graecum*) seeds

	Starter Phase	***Finisher Phase***

Parameters (g)	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**
Final live wt (g)	1532.25a	1508.50^{ab}	1512.25^{ab}	1449.00^{ab}	1394.00^{b}	19.05	2755.00	2550.00	2542.50	2675.00	2512.50	62.49
Bled wt (g)	1477.75^{a}	1454.75^{ab}	1462.00^{a}	1396.50^{ab}	1343.25^{b}	18.62	2660.00	2462.50	2470.00	2575.00	2407.50	58.78
Defeathered wt (g)	1427.50^{a}	1400.00^{ab}	1405.00^{a}	1347.50^{ab}	1292.50^{b}	17.70	2567.50	2370.00	2385.00	2485.00	2322.50	57.58
Eviscerated wt (g)	1238.75^{a}	1200.25^{ab}	1230.25^{a}	1149.00^{ab}	1109.25^{b}	17.29	2318.00	2035.50	2087.25	2175.75	2021.75	52.28
Carcass wt (g)	1129.75^{a}	1099.75^{ab}	1124.75^{a}	1046.75^{ab}	1012.25^{b}	16.12	2095.25	1887.50	1941.75	2022.25	1877.75	47.40
Dressing (%)	73.68	72.90	74.38	72.26	72.61	0.33	76.05^{a}	74.00^{b}	76.32^{a}	75.73^{ab}	74.77^{ab}	0.32
Cut up part (%)												
Neck	6.80	7.09	6.61	7.00	7.21	0.12	5.23	5.27	5.38	6.04	5.89	0.20
Back	17.93^{a}	17.16^{ab}	17.64^{ab}	16.50^{ab}	16.00^{b}	0.27	19.43	18.98	16.98	16.87	17.24	0.54
Breast	37.00	38.20	37.78	36.24	36.61	0.54	37.39	37.63	38.21	37.19	37.67	0.38
Thighs	13.73	13.65	12.80	14.80	14.20	0.29	13.75^{b}	14.04^{ab}	14.89^{ab}	15.65^{a}	14.90^{ab}	0.25
Drumsticks	13.01	12.73	13.23	13.06	13.49	0.14	12.41	12.29	11.87	12.21	12.74	0.24
Wings	10.48	10.27	10.63	10.64	10.86	0.14	9.90	10.07	8.57	9.61	10.00	0.23

^{ab}= Means on the same row bearing the different superscript are significantly different ($p<0.05$) SEM= Standard error of means

FLW-Final Live Weight, BW-Bled Weight, DW- Defeathered Weight, EW- Eviscerated Weight, CW- Carcass Weight, DP- Dressing Percentage.

Table 4: Shows the relative organ weight of broiler starter chicken fed diets supplemented with varying levels of fenugreek seeds. Significant differences ($p<0.05$) were observed on gizzard and lungs. No significant difference was observed on proventiculus, bursal of fabricus, liver, heart and pancrease. Gizzard in Treatment 4 recorded the lowest and T1 and T5 recorded the highest and similar values. However, Treatment 4 recorded the highest and T1, T2, T3 and T5 recorded similar values. At finisher phase, chicken fed fenugreek seeds-based diets had their Proventiculus, liver, heart and kidney were significantly ($p< 0.05$) affected while gizzard, spleen, lungs, pancrease and bursal of fabricus were not significantly ($p>0.05$) affected. Proventiculus recorded the highest value in Treatment 1 and Treatment 2 (T1 and T2), statistically similar to treatment 4 and 5, while the lowest value was recorded from Treatment 3 (T3). Liver recorded the lowest in Treatment 4 (T4) and highest in Treatment 2 (T2). Treatment 2 (T2) recorded the highest though statistically ($P>0.05$) similar to T1 and T3, while Treatment 1, Treatment 3, Treatment 4 and Treatment 5 (T1, T3, T4 and T5) recorded similar values in the heart. However, kidney recorded the highest in Treatment 3 (T3) and the lowest in Treatment 1 (T1).

Table 4*:* Effect of Fenugreek (*Trigonella foenum - graecum*) seeds on relative organ characteristics of broiler chicken at starter and finisher phase.

	Starter Phase						*Finisher Phase*					
Parameters (%)	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**
Proventicus	0.72	0.10	0.75	0.95	0.79	0.05	0.65^{a}	0.63^{a}	0.47^{b}	0.50^{ab}	0.53^{ab}	0.02
Gizzard	2.95^{a}	2.70^{ab}	2.58^{ab}	2.22^{b}	2.96^{a}	0.09	2.30	1.98	2.05	2.03	2.23	0.11
Bursa of fabricius	0.06	0.06	0.06	0.06	0.06	0.00	0.15	0.13	0.12	0.08	0.08	0.01
Liver	2.57	2.89	2.70	3.00	2.55	0.07	2.66^{ab}	2.99^{a}	2.65^{ab}	2.49^{b}	2.49^{b}	0.01
Lungs	0.75^{b}	0.75^{b}	0.84^{b}	1.02^{a}	0.86^{ab}	0.03	0.73	0.65	0.81	0.78	0.70	0.03
Heart	0.72	0.72	0.75	0.71	0.69	0.02	0.50^{b}	0.65^{a}	0.53^{b}	0.51^{b}	0.53^{b}	0.02
Pancrease	0.30	0.38	0.35	0.40	0.32	0.01	0.23	0.26	0.28	0.24	0.29	0.01

^{ab}= Means on the same row bearing the different superscript are significantly different ($p<0.05$) SEM = Standard Error of Means.

Table 5: showed the haematological indices of broiler chicken fed diets with varying levels of fenugreek (*Trigonella foenum graecum*) seed. Significant ($p<0.05$) differences were observed in packed cell volume (PCV), hemoglobin (Hb), white blood cell (WBC), red blood cell (RBC), platelet (at finisher phase), lymphocytes, neutrophil, monocytes (at starter phase), mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration. Fenugreek seeds supplementation lowered ($p<0.5$) the PCV, Hb and WBC of the broiler starter chicken though it did not follow any regular pattern. Meanwhile, they were less affected at finisher phase. However, RBC and neutrophil were significantly increased ($p<0.5$) as a result of fenugreek seeds supplementation in the starter phase. However, no significant differences ($p>0.5$) were observed in platelet and eosinophil across the treatments. At the finisher phase, higher values of PCV, Hb and WBC was recorded in birds fed fenugreek seeds except for Treatment 3 (birds fed 15g/kg feed of fenugreek seeds) which recorded a similar ($p>0.5$) value compared to those fed control diets. Treatment 4 (20g/kg feed) recorded the highest value for PCV, RBC, WBC and blood platelets. However, no significant differences ($p>0.5$) were observed in monocyte (MON) and eosinophil (EOS) across the treatments.

Table 5*:* Effect of fenugreek (*Trigonella foenum - graecum*) seeds on haematological profile of broiler chicken at starter and finisher phase.

	Starter Phase						*Finisher Phase*					
Parameters (%)	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5 (25g)**	**SEM +/-**	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM +/-**
PCV (%)	36.50^{a}	31.00^{b}	30.33^{b}	30.67^{b}	30.50^{b}	0.48	26.50^{b}	31.50^{a}	26.00^{b}	32.00^{a}	31.00^{a}	0.69
Hemoglobin (g/dl)	11.80^{a}	10.10^{b}	9.90^{b}	10.07^{b}	9.95^{b}	0.15	8.70^{b}	10.45^{a}	8.70^{b}	10.10^{a}	10.05^{a}	0.10
RBC ($x10^{6}$iu/L)	3.64^{b}	3.35^{a}	3.17^{a}	3.19^{a}	3.34^{a}	0.04	2.82^{a}	2.78^{b}	2.81^{b}	3.41^{a}	3.03^{b}	0.88

WBC (x10^{3}iu/L)	190.00^{a}	151.33^{c}	157.67^{bc}	160.33^{bc}	161.67^{b}	225.73	125.00^{b}	163.00^{a}	135.00^{b}	165.00^{a}	155.00^{a}	434.75
Platelet (UL)	1370.00	1396.67	1308.33	1386.67	1425.00	2273.55	1230.00^{bc}	1405.00^{ab}	1110.00^{c}	1570.00^{a}	1305.00^{bc}	1305.00
Lymphocyte (%)	68.50^{a}	61.67^{b}	61.83^{b}	61.83^{b}	63.00^{b}	0.59	55.00^{c}	66.00^{a}	54.50^{c}	60.50^{b}	62.50^{ab}	1.22
Neutrophil (%)	24.00^{b}	31.17^{a}	30.50^{a}	31.50^{a}	30.67^{a}	0.59	38.50^{a}	27.00^{c}	39.00^{a}	33.00^{b}	30.00^{bc}	1.26
Monocyte (%)	4.00^{a}	3.67^{a}	2.50^{b}	2.83^{b}	2.50^{b}	0.14	2.00	2.50	3.50	2.50	3.50	0.25
Eosinophil (%)	3.50	3.17	4.00	3.83	3.83	0.21	4.50	3.00	3.00	4.00	3.50	0.29
MCV (g/dL)	100.03^{a}	92.24^{ab}	97.28^{a}	93.91^{ab}	84.60^{b}	1.77	94.70^{b}	116.91^{a}	92.67^{b}	93.84^{b}	102.56^{ab}	2.98
MCH (g/dL)	32.42^{a}	29.99^{a}	32.05^{a}	30.64^{a}	27.03^{b}	0.56	31.11^{b}	38.86^{a}	31.04^{b}	29.63^{b}	33.26^{ab}	1.07
MCHC (g/dL)	32.33^{ab}	32.51^{ab}	32.94^{a}	32.63^{ab}	32.05^{b}	0.11	32.83^{a}	33.18^{a}	33.51^{a}	31.57^{b}	32.42^{ab}	0.21

^{ab}= Means on the same row bearing the different superscript are significantly different ($p<0.05$).

Table 6: shows the effects on serum characteristics of broiler starter chicken fed diets supplemented with varying levels of fenugreek seed at starter and finisher phase. The impact of dietary fenugreek seeds supplementation significantly ($p<0.05$) affected albumin, total protein, glucose, urea, creatinine, aspartate aminotransferase, alanine transaminase and globulin. The glucose value at starter phase is higher in chicken fed diets supplemented with 10g, 15g and 25g of fenugreek seeds (T2, T3 and T5) and T4 is lower in chicken fed with fenugreek seeds of 20g while the chicken fed with no supplement of fenugreek seeds has the lowest value in broiler chicken fed control diet. Glucose (mg/d) value at finisher phase

was significantly higher in T1 (the control diet) and T5 (25g/kg diet of fenugreek seeds). The albumin is highest in T1and T2 with the values of 1.11 and 1.26 while T3, T4 and T5 are between the same range. Albumin (g/dL) was highly significant at T2 (10g/kg) diets supplemented with fenugreek seeds followed by T3 (15g/kg) diets of fenugreek and T1(0g/kg) diet of fenugreek seeds shows the lowest value. Cholesterol is highest in T1and T3. T2 and T4 are between the same range while T5 has the lowest value of the chicken fed with fenugreek seed at starter phase. Cholesterol (mg/dL) at finisher phase of T5 (25g/kg) and T3 (15g/kg) fed diets of fenugreek seeds was highly significant followed by T4(20 g/kg) and T2 (10g/kg) whereby T1 showed the lowest value. Aspartate aminotransferase at starter phase is highest in T1, T2, T3 and T5 while lower in T4. Aspartate aminotransferase at finisher phase [i.u/L] was significantly higher in T3 and has the lowest value in T4. Alanine transaminase value at starter is highest in T5 while T3 and T4 are lower but are under the same range followed by T1 while T2 is the lowest of all. Alanine transaminase [i.u/l] at finisher phase was significantly affected it was significantly higher in T3 fed 15g/kg diet of fenugreek seeds which is also similar with T2 fed 10g/kg diet of fenugreek seeds while T1 has the lowest value. Total protein value is highest in chicken fed with diets supplemented with fenugreek seeds in T2 while T1, T3, T4 and T5 are within the same range of values at starter phase. Total protein (g/dL) was significantly affected, T1 fed 0g/kg diet of fenugreek seed is the highest which is also similar with T2, T3 and T4. Urea value is highest in T3 while it is lowest in T5 at starter phase. Urea at finisher phase (g/dL) was significantly higher in T4 fed 20g/kg diet of fenugreek seed, T1 fed 0g/kg diet of fenugreek seed shows the lowest value. Creatinine value at starter phase is highest in T3 and lowest in T5. Creatinine value at finisher phase was significantly higher in T5 fed 25g/kg diet of fenugreek seeds, followed by T3, T4 and T2, T1 shows the lowest value. Cholesterol value was found to be highest in T3 followed by T1, T4 and T2 while T5 has the lowest value at starter phase. Cholesterol value at finisher phase was significantly higher in broiler chicken fed control diets(85.72mg/dL) while broiler chicken fed diet containing 25g/kg of fenugreek seeds had the least shows the lowest value (70.34mg/dL). Globulin was only significantly higher in T1 fed 0g/kg diet of fenugreek seeds, followed by T4, T3 and T2 fed 3,2 and 1g/kg diet of fenugreek seed and T5 has the lowest value. Globulin was not significantly ($p<0.05$) affected at starter phase.

Table 6: Effect of fenugreek (*Trigonella foenum - graecum*) seeds of serum characteristics of broiler chicken at starter and finisher phase.

	Starter Phase						***Finisher Phase***					
Parameters	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**	**T1(0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**
Albumin(g/dL)	1.11^{b}	1.26^{a}	1.06^{b}	1.01^{b}	1.05^{b}	0.03	1.04^{c}	1.25^{a}	1.18^{ab}	1.13^{abc}	1.06^{bc}	0.11
Globulin(g/dL)	1.65	1.77	1.39	1.81	1.42	0.08	1.79^{a}	1.45^{b}	1.46^{b}	$1,46^{b}$	1.01^{c}	0.31
Total protein(g/dL)	2.76^{ab}	3.03^{a}	2.46^{b}	2.82^{ab}	2.46^{b}	0.84	2.82^{a}	2.70^{a}	2.64^{a}	2.59^{a}	2.07^{b}	0.34
Glucose(mg/dL)	116.33^{c}	192.10^{a}	195.39^{a}	180.52^{b}	197.63^{a}	7.13	199.03^{a}	176.29^{bc}	179.03^{b}	169.19^{c}	192.74^{a}	12.11
Urea(mg/dL)	6.99^{d}	8.18^{b}	9.06^{a}	7.38^{c}	6.21^{e}	0.23	4.92^{c}	6.32^{b}	5.15^{c}	8.12^{a}	6.35^{b}	1.19
Creatinine(mg/dL)	1.15^{b}	0.97^{c}	1.30^{a}	1.00^{c}	1.02^{c}	0.03	0.60^{c}	0.90^{b}	1.00^{b}	0.95^{b}	1.15^{a}	0.20
Cholesterol(mg/dL)	122.57^{a}	116.02^{a}	123.08a	119.91^{a}	94.34^{b}	3.34	85.72^{a}	77.62^{ab}	82.49^{a}	77.96^{ab}	70.34^{c}	12.45
High density lipoprotein (mg/dL)	35.43^{b}	39.99^{ab}	43.91^{a}	34.99^{b}	38.69^{ab}	1.06	23.74^{c}	26.46^{b}	30.69^{a}	27.80^{b}	31.35^{a}	3.15
Aspartate amino transferase(iu/L)	95.25^{a}	101.48^{a}	97.59^{a}	81.23^{b}	104.18^{a}	2.15	92.82^{b}	95.75^{ab}	107.03^{a}	50.70^{c}	92.21^{ab}	21.03
Alanine transaminase (iu/L)	9.44^{bc}	7.92^{d}	11.56^{bc}	12.64^{b}	17.94^{a}	0.84	5.51^{b}	12.36^{a}	13.10^{a}	6.40^{b}	6.80^{b}	3.53

^{abc} means within the same row bearing different subscripts differs significantly ($p<0.5$) SEM: Standard Error of means

Table 7: showed the nutrient digestibility of broiler chicken fed diets supplemented with varying level of fenugreek seed at starter phase and finisher phase. Significant difference was ($p<0.05$) observed in the crude protein, crude fibre, ash, nitrogen free extract and dry matter of broilers fed diets supplemented with varying levels of fenugreek seed while ether extract was not significantly ($p>0.05$) affected. Chicken on control diet (T1) had significantly ($p<0.05$) higher value for all proximate composition analyzed compared to other dietary treatment. At the finisher phase, birds fed 10g/kg feed of fenugreek seeds has the highest ($p<0.5$) values for crude protein, ether extract, nitrogen free extract and dry matter content. It was observed from the results that the significant differences in nutrient digestibility between broiler finisher diets supplemented with fenugreek seed, particularly the higher values in crude protein, nitrogen free extract, ash and dry matter at a supplementation level of 10g/kg suggest that fenugreek seed powder positively influences nutrient utilization in broiler chicken.

Table 7: Effect of Fenugreek (*Trigonella foenum - graecum*) seeds on nutrient digestibility of broiler chicken at starter and finisher phase.

	Starter Phase						***Finisher Phase***					
Parameters (%)	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5 (25g)**	**SEM**	**T1 (0g)**	**T2(10g)**	**T3(15g)**	**T4(20g)**	**T5(25g)**	**SEM**
Dry matter	62.60^{a}	52.53^{b}	57.56^{ab}	53.56^{a}	56.73^{ab}	1.28	59.63^{a}	74.23^{a}	60.22^{a}	40.72^{b}	64.36^{a}	3.46
Crude protein	63.37^{a}	59.82^{a}	53.91^{b}	50.72^{b}	59.88^{a}	1.21	79.02^{ab}	85.25^{a}	78.98^{ab}	70.13^{b}	82.16^{a}	1.65
Crude fiber	62.19^{a}	59.26^{ab}	58.32^{ab}	51.62^{b}	55.65	1.33	52.45	54.93	53.42	50.42	46.79	1.28
Ether Extract	58.08	55.66	51.66	51.94	55.92	1.05	54.97^{b}	71.40^{a}	51.42^{b}	54.45^{b}	57.12^{b}	1.93
Ash	64.83^{a}	57.51^{b}	51.89^{bc}	546.05^{c}	51.68^{bc}	1.69	91.13	76.49	75.95	85.41	73.81	1.52
Nitrogen free extract	64.97^{a}	56.27^{b}	52.37^{b}	55.10^{b}	52.85^{b}	1.18	156.84^{a}	72.45^{a}	57.53^{a}	34.96^{b}	61.09^{a}	3.88

^{ab}= Means on the same row bearing the different superscript are significantly different ($p<0.05$)SEM= Standard error of mean

Discussion

It was observed from the experiment that fenugreek (*Trigonella foenum-graecum*) seeds supplementation reduced the final live weight (FLW) and weight gain (WG) of broiler starter phase. These results contradict the finding (Hassan *et al*., 2004 and Hermes *et al.,* 2009) that fenugreek seeds supplementation in the broiler chicken diet increased growth performance. However, no effects were observed on the FLW and WG at the finisher phase. In line with these results reprinted the reduction in overall growth performance of broiler with inclusion of fenugreek seeds in the diets. The decrease in the BWG might be driven by the reduced feed intake during starter phase. It might also be associated with the reduced acceptability and lower feed utilization of the diets during the adaptation period of broiler chicken. Volatile oil and alkaloids (Ahmad *et al*., 2016) has two main constituents of fenugreek seeds that cause an acceptability of the feed. However, the body weight gain and feed intake were not affected during the finisher phase. Duru *et al.* (2013) also reported the unchanged body weight gain and feed intake from 22 to 42 days of age including 5, 10, 20 and 40g/kg fenugreek. Therefore, it appears that that younger broilers are more sensitive to fenugreek possibly due to being more responsive to factors affecting palatability and responsive to factors affecting the gastrointestinal system. Also, this present study has shown that the inclusion of fenugreek seeds in the diet helps to improve growth performance of broiler chicken which has been reported by Olayeni *et al*. (2024) that the inclusion of fenugreek powder help to improve the growth performance since it has been reported that fenugreek contained some phytochemicals like Tannin which functions is to improve digestibility, palatability of feeds and also serves as natural growth promoters which has been proving in the study. The results showed that the dressing percentage, neck, breast, thigh, drumstick, and wings were not significantly affected ($p > 0.05$) and were similar to the result of Abass and Hamed (2010). The improvement in the body weight is due to the presence of the fatty acids or due to stimulating effect on the digestive system of broiler (Hermadez *et al*., 2004). These findings were in disagreement with those of (Azoua *et al.,* 2001) who noted that adding fenugreek to broiler diets resulted in an increased body weight. Also, weight of T1 groups were significantly higher than T2, T3 and T4. The results were different with Elusbushra (2012) who showed

that weekly gain in body weight of broiler chicks receiving 1.5 percent of fenugreek seed was significantly ($p<0.05$) higher than control group. The present study is in concomitance with those reported by (El- Husseiny *et al*., 2002) that there was notable improvement in overall carcass yield and carcass quality parameters on dietary addition of herbal liver tonics (Liv- 52) containing fenugreek seeds. There was a linear disease in the relative weight of back up to 1g/kg diet supplementation level and is in line with the report of Alloui *et al*. (2012) found that addition of fenugreek significantly decreased the back yield of broiler than those fed control diets. The results of some of the relative organs (proventiculus, liver, heart and kidney) of broiler chicken were significantly ($p<0.05$) affected among the different treatment groups. Yesuf *et al*. (2017) and Medina *et al.* (2020) and also found significant ($p<0.05$) influence on some organs of broiler chicken fed diets containing fenugreek seeds because it has been reported that phytochemical which will help to improve organ functions in the body. The packed cell volume, hemoglobin and mean corpuscular hemoglobin are major indices for evaluating circulatory

erythrocytes and are significant in the diagnosis of anemia. A PCV value more than 56% is an indication of dehydration in birds, no PCV value was above 37% and the values obtained were within the reference ranges for broiler of 22-35 percent and 25-45 percent as reported by (Aikipitanyi and Egweh, 2020).

Hemoglobin result ranges from 9.90 to 11.80 (g/dL) agreed with the result of (Adeyemo and Sani, 2013) and (Najib and Al-Aquil,2015) that reported lower hemoglobin values. The hemoglobin values were within the normal hemoglobin range of 7.00 to 13.00 (g/dL) as reported by (Banerjee, 2005) for chickens since hemoglobin is responsible for cellular respiration which is important in metabolic reactions (McDonald *et al.,* 1995), a decrease in hemoglobin is an important determinant of anaemia which probably led to reduction in the oxygen carrying capacity of blood. The WBC is slightly lower at T2 and higher at T1. Fenugreek seeds contain alkanoid which fight any foreign body or help to build immune system which has been shown in the study that inclusion of fenugreek seed in the diets helps suppress the multiplication of bacteria in the body. The result agrees with the results obtained by (Herms *et al*., 2010) who reported increase in value with no statistical difference. Thus, birds with low white blood cells are exposed to high risk of disease infection, while those with moderate counts are capable of generating antibodies in the process of phagocytosis and have a high degree of resistance to diseases (Soetan and Ajibade, 2013). However, results obtained here are within normal values. Decrease in the values of WBC counts of the starter chicken could be related to levels of supplementation. PCV result ranged from 26.00 to 32.00%. Birds on T4 had the highest PCV value, followed byT2, while the least PCV value was recorded in T3. The PCV result agreed with the range reported by (Banerjee,2005; and Adeyemo and Sani 2013), which also disagreed with the report of Najib and Al-Aqil (2015) that gave a lower PCV value. The differences observed could be due to breed. HB result ranges from 8.70 to 10.45 (g/dL). Birds on T2 gave the highest value, followed by T4 while T1 gave the least HB value. The findings disagreed with the result of Adeyemo and Sani (2013) and Najib and Al-Aqil (2015) that reported a lower HB value. Also, the result is lower than the range reported by (Iheukwumere *et al*., 2008). These values were within the normal HB range of 7.00 to 13.00 (g/dL) as reported by Banerjee (2005) for chickens since haemoglobin is responsible for cellular respiration which is important in metabolic reactions McDonald *et al.* (1995), a decrease in hemoglobin is an important determinant of anaemia which may probably lead to reduction in the oxygen carrying capacity of blood. RBC results from 2.78 to 3.41($x10^{12}$/L). birds on T4 gave the highest value, followed by T5, while T2 gave the least RBC value. The findings agreed with that of Ladokun *et al*. (2008) and Adeyemo and Sani (2013) that showed significant ($p<0.05$) differences.

The present study on serum is in agreement with the results of Azouz (2001) found that protein and globulin of increased significantly by feeding Hubbard broiler chicks on diets supplemented with fenugreek seeds. Similarly, Khard and Abdel-Fattah (2007) concluded that supplementation of broiler diet with 1% fenugreek modulated cholesterol profile in the serum may be reflected in the meat and benefits human diets. Weerasingh and Atapattu (2013) and Mamoun *et al*. (2014) reported that serum cholesterol levels were reduced when fenugreek was added in diet of broilers and increasing the triglyceride levels reduced when fenugreek was added in diet of broilers and increasing triglyceride level in broilers. Duru *et al.* (2013) also reported the same findings and stated that if the level of fenugreek seed increased above 20g/kg Broiler diet causes decreased triglyceride and cholesterol levels but increased the LDL cholesterol and glucose. Nevertheless, the decrease in serum cholesterol levels may be due to the presence of saponins and resins in fenugreek seed (such as hemicelluloses, mucilage, tannin and pectin) inhibit bile acid ,help lower LDL-cholesterol and inhibit

intestinal cholesterol absorptions; thereby reducing blood cholesterol levels (Petit *et al*.,1995 and Mukhtar *et al*., 1995). Serum biochemical indicators can reflect the body's metabolism and some disease states as an effective indicator for checking the health of animal's body, the concentration of the total cholesterol and triglycerides in serum can be used as indicators of lipid metabolism. Under normal conditions, serum triglycerides maintain dynamic balance. Both are related to atherosclerosis and cardiovascular disease.

The former (LDL-C) is positively correlated with the occurrence of the diseases, and the latter (HDL-C) is negatively correlated with the occurrence of the disease. Fenugreek seed can control blood lipids and lower serum total cholesterol since it contains saponin which helps to reduce cholesterol content in the body. In the present research, the result showed that all the serum biochemical indices were significantly affected ($P<0.05$). The result of this study agreed in the cholesterol and the glucose value with the study conducted by Huang *et al*. (2022) where the results of the two indices (cholesterol and glucose) were significantly affected ($P<0.05$), however, on the other hand was in disagreement with the values of Albumin, HDL, ALT, TP, Globulin, Urea and Creatinine because they were significantly affected in the present study and not in the study conducted by Huang *et al*.(2022).

Studies had shown that fenugreek supplementation can enhance nutrient digestibility and absorption in poultry diet (Rajput *et al*., 2013; Al-Yousef *et al*., 2017). The greatest value of crude protein digestibility was recorded for birds fed diets containing 10g/kg of fenugreek seeds. Result obtained by Magda (2012) showed that inclusion of 20g of fenugreek seeds in broiler diet was useful for improving protein efficiency ratio. Improving the digestibility of Crude protein for birds fed diets supplemented with fenugreek seeds can result in long contact between the digesta and mucosal epithelium due to its positive impact on intestinal morphology which may be more effective for digestion and absorption of nutrients (Bogulslawska- Tryk*et al*., 2012). Furthermore, fenugreek contain high quality proteins, reduce availability of energy, glucose level and necessary fatty acids, as well as tannin and phenol steroid saponins which stimulate digestive system, increase feed intake and activate the hypothalamus gland (Toaha *et al*., 2016; Covarrubias *et al*., 2018).

Conclusion and Recommendation

This study concluded that the inclusion of fenugreek seed in the diets of broiler chicken had positive effect on growth performance, carcass yield, haematology and serum biochemistry and nutrient digestibility. It is therefore recommended that feeding broiler birds with a diet that contains 20g/kg of fenugreek seed will improve overall performance and health status of broiler chicken.

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