

Carcass Characteristics of Broiler Birds Fed Graded Levels of Garlic (*Allium sativum L.*) in Semi-arid Sokoto, Nigeria

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ABSTRACT: The experiment was conducted at the Poultry Production Unit of the Department of Animal Science, Usmanu Danfodiyo University, Teaching and Research Farm situated at the Veterinary Clinic, Aliyu Jodi road in sokoto metropolis. The study aimed at evaluating the performance and carcass characteristics of broiler birds fed graded levels of garlic. Diet was formulated into four treatments groups. Treatment 1, 2, 3 and 4 with 300, 400, 600 and 0g of garlic added over the top to each treatment respectively. Two hundred (200) Day old broiler chicks were laid in a completely randomized design (CRD) with fifty birds per treatment replicated five times. All managements practice was observed throughout the seven (7) weeks of the experiment. Data was collected at the end of starter and finisher phase on carcass characteristics performance such as primal cuts and organs/offals. Some absolute weight (Total organs weight), primal cut (Drumstick) organs (Liver, gizzard, lungs, heart and abdominal fat) and percentages (thigh %, wing % and neck %) showed a significant difference ($P>0.05$) as a result of garlic inclusion while other parameters varied numerically. It was therefore concluded that T2 (450g garlic) performed better than other treatments in terms of performance.

Keywords: Broiler birds, garlic, semi-arid, Sokoto State

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INTRODUCTION

Garlic (*Allium sativum*) has been called the wonder drug of the herbal world due to its multi-functional benefits. Garlic possesses at least 33 sulphur containing compounds, several enzymes, amino acid and minerals (Newallet *et al.*, 1996). The major active ingredients in garlic are allicin, ajoene, dialkylpolysulphides, s-allylcysteine etc. which may be responsible for the various properties of garlic (Canogullari *et al.*, 2010). In vitro studies have shown that garlic possess antibacterial, antifungal, anti-parasitic, antiviral (Ankri and Mirelman, 1999) and antioxidant (Prasad *et al.*, 2009) properties. Suriya *et al.* (2012) suggested that inclusion of garlic may have the potential to be an alternative to antibiotic growth promoter for broiler chicken. Asgarlic contains a sulfur volatile active component that has antibacterial, anti-inflammatory and antioxidant biological properties

(Wilson and Demming-Adams, 2007), it has been explored as a potential alternative to antibiotics in poultry production. Apart from its volatile compounds, garlic is also highly rich in vitamins (especially vitamin B complex and vitamin C), antioxidants, flavonoids, minerals (especially P, K and Se) (Pekowska and Skupień, 2009), being even considered a rich source of other non-volatile phytonutrients with important medicinal and therapeutic properties, from which a particular emphasis is given to flavonoids, saponins and saponogenins, phenolic compounds, nitrogen oxides and amides and proteins (Lanzotti *et al.*, 2014).

Problem statement

The use of antibiotic growth promoters has resulted in the

development of drug resistant bacteria (Alexander *et al.*, 2008). However, the use of antibiotics has multiple effects on animal including appetite stimulator, enhance digestive secretion, immuno-stimulant, bactericidal, antiviral, antioxidants and are termed as phytochemicals (Hashemi and Davoodi, 2011). For long time feed additives have been widely used to increase animals' performance and lately it is used in poultry industry to enhance growth, feed efficiency and layers performance (Collington *et al.*, 1990; Khan *et al.*, 2007). The use of antibiotics growth promoters is restricted in many countries around the world (Thakar *et al.* 2004). Antibiotic growth promoter has the benefit of improving weight gain and feed efficiency of broiler chicken (Feighner and Dashkevich, 1987; Jukes and Williams, 1953; Butaye *et al.*, 2003). However, the use of antibiotic growth promoter can result in the development of drug-resistant bacteria (Alexander *et al.*, 2008). Those resistant bacteria may infect humans via the food chain and thus it is a public health concern (Torres *et al.*, 2010; Bekele and Ashenafi, 2010).

Justification

Horton and Prasad (1991) reported that garlic as a feed additive, improved broiler growth, feed conversion ratio (FCR) and decreased mortality rate. Similarly, Demir *et al.*, (2003) reported that garlic may be used as an alternative to antibiotic growth promoters in broiler production. (Javandel *et al.*, 2008) also reported that the use of natural feed additives like garlic has made it possible for one to avoid the harmful effects of synthetic antibiotics. Demir *et al.*, (2003) reported that garlic may be used as an alternative antibiotic growth promoter in broiler production. Javandel *et al.*, (2008) also reported that the use of natural feed additives like garlic has made it possible for one to avoid the harmful effects of synthetic antibiotics.

Objectives of the study

The aim of the study is to examine the effect of graded level of garlic on carcass characteristics of broiler birds.

MATERIALS AND METHODS

Study area

The study was conducted at the Poultry Production Unit of the Teaching and Research farm of Animal Science Department, Faculty of Agriculture, Usmanu Danfodiyo University Sokoto located at Veterinary Clinic, Aliyu Jedo road, Sokoto. Sokoto state is located in the Sudano-sahelian savanna ecological belt of Nigeria with Longitude 11° 3' to 13° 50' E and Latitude 4° to 6° 40' N

(Tsoho and Salau, 2012). It encompasses wide-ranging tracts of almost flat to slightly rolling landscape (Ologe, 2002). Rainfall in Sokoto State as in other parts of Nigeria is dominantly controlled by the movement and pulsation of the Inter-Tropical Discontinuity (ITD) (Ilesanmi, 1971). The wet season lasts from May/June to September (Ojo, 1991).

Experimental design

A total of 200 day-old chicks were used for this experiment. Using a completely randomized design (CRD), the day-old chicks were divided into four treatments consisting of fifty chicks per treatment. Each treatment was replicated five times with 10 birds per replicate. Garlic powder was added to treatment 1, 2 and 3 at 300g, 450g and 600g graded levels to every 100kg of the feed respectively, over the top, while treatment 4 served as control with 0g garlic.

Housing preparation

Tropical open-sided type of poultry house covered with wire mesh and concrete floor was being used for the experiment. Before the commencement of the experiment, the house was swept clean, washed, thoroughly and sprayed with disinfectant. Litter materials were spread on the floor, chick drinkers and feeding trays were used for the starter phase while round metal conical feeders and big drinkers were used in the finisher phase.

Sourcing of the experimental birds

The day-old chicks for the study were purchased from Agrited Farm Ltd in Ibadan, Oyo state, Nigeria. The birds were transported to Sokoto under the cool hours of the evening through the night and arrived Sokoto early in the cool morning hours of the next day.

Management of experimental broiler birds

The birds were brooded using 200-watt electric bulbs as source of heat and light for each pento ensure adequate and uniform distribution of heat and light. The birds were routinely vaccinated. Strict bio-security measures were followed throughout the experimental period. Feeding troughs and drinkers were cleaned regularly. Sick birds were isolated and in the event of mortality, the dead birds were disposed properly. Experimental diet and cool, clean and fresh water were given to the birds at free choice (*ad-libitum*).

Sourcing and processing of feed ingredients

Feed ingredients like maize, bone meal, limestone, wheat

Table 1: Gross and calculated chemical composition of the starter diets.

Ingredients	Treatment 1 (300g Garlic)	Treatment 2 (450g Garlic)	Treatment 3 (600g Garlic)	Treatment 4 (0g Garlic)
Maize	49	49	49	49
Soya bean meal	22	22	22	22
Groundnut cake	12	12	12	12
Wheat offal	13	13	13	13
Limestone	0.5	0.5	0.5	0.5
Bone meal	2.5	2.5	2.5	2.5
Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated Chemical Composition				
Energy (KcalKgME)	3000	3000	3000	3000
Protein (%)	22	22	22	22
Lysine (%)	1.1	1.1	1.1	1.1
Methionine (%)	0.6	0.6	0.6	0.6
Calcium (%)	0.9	0.9	0.9	0.9
Phosphorus (%)	0.6	0.6	0.6	0.6
Fibre (CF) (%)	5.4	5.4	5.4	5.4

Table 2: Gross and calculated chemical composition of the finisher diets

Ingredients	Treatment 1 (300g Garlic)	Treatment 2 (450g Garlic)	Treatment 3 (600g Garlic)	Treatment 4 (0g Garlic)
Maize	50	50	50	50
Soya bean meal	18	18	18	18
Groundnut cake	20	20	20	20
Wheat offal	8	8	8	8
Limestone	1.5	1.5	1.5	1.5
Bone meal	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated Chemical Composition				
Energy (KcalKgME)	2800	2800	2800	2800
Protein (%)	23	23	23	23
Lysine (%)	0.9	0.9	0.9	0.9
Methionine (%)	0.6	0.6	0.6	0.6
Calcium (%)	1.0	1.0	1.0	1.0
Phosphorus (%)	0.5	0.5	0.5	0.5
Fibre (CF) (%)	6.0	6.0	6.0	6.0

offal, and salt was purchased from Sokoto Central Market. Groundnut cake, soybean meal and micro ingredient such as premix, methionine, and lysine were sourced from a vendor in Sokoto. The garlic used in the experiment was purchased from Sokoto Central Market. The dried garlic purchased was ground using mortar and pestle into fine powder and stored in airtight bags until required for the formulation of the experimental diets.

Experimental diet formulation

Using a computer software, a starter diet targeting

29000Kcal/KgME and 22% crude protein was formulated for the starter phase, while a finisher diet targeting 28000Kcal/KgME and % crude protein was formulated for the starter phase (Tables 1 and 2).

Experimental diet compounding/ mixing

The selected ingredients were weighed according to bulk, spread on a clean, plain floor, heaped and level. Ingredients of little quantities such as lysine, methionine, salt and garlic were weight and mix along with a portion of the feed. Limestone and bone meal was also mixed

and spread. After this, the heap was mixed severally; turning and heaping to another side until a thorough and uniform mixture was obtained. The feed mash was then packed into empty sacks for feeding the experimental birds

Data collection

Carcass characteristics

Data was collected on Carcass Characteristics of the Experimental Birds such as primal cuts, offals/organs and weights and percentages..

Sample and sampling procedure

At the end of the experiment, three birds were randomly selected from each replicate to give a fair representation of all the body size. Thus, a total number of 60 birds were used for carcass analysis.

Primal cuts

Such as: thigh, breast, drumstick, back, wing and neck. All were weighed in absolute terms

Organs: liver, gizzard, intestine, head and feet. All were weighed in absolute terms.

Organs/offals

Internal organs include: intestines, abdominal fat, liver, lungs, spleen, crop and gizzard, each of them was weight and expressed in percentage of live weight as well as the carcass weight using formula described by (Hann and splinder, 2002; Etalem, (2013).

Weights and percentages

- >Live weight (LW)(g) = weight before slaughter.
- >Killed weight (KW) (g) = weight before slaughter.
- >Plucked weight (PW)/Carcass weight (g) = Weight after removal of feathers (Scalding)
- >Dressed weight (DW) (g) = Weight after evisceration.
- >Killed weight (KW) as percent of live weight (LW)
- >Dressed weight (DW) as percent of live weight (LW)

$$>\text{Dressing (\%)} = \frac{\text{carcass weight}}{\text{live weight}} \times 100$$

- >Primal cuts as percent of DW
- >Total organs as percent DW

Data analysis

The data was analyzed using General linear model (GLM) procedure of statistical analysis system (SAS)

package Version 9.2 software (SAS, 2007) and the P-value was set at 0.05 level of significance. Where differences exist, least significant Difference (LSD) was used to separate the means.

RESULTS

Carcass characteristics

Primal cuts

Breast (B) (g)

The results in (Table 3) show that there is no significant difference ($P>0.05$) between the breast means of all the four treatments. The highest breast mean value (254.32) was recorded in T4 (control) while the lowest (229.96) was recorded in T3 which has the highest inclusion level (600g) of garlic. There was fluctuation in the breast means as garlic level increases in treatments. For example, from T1 (300g) to T2 (450g) there is increase in the value for breast weight which declined between T2 (450g) (242.73) to T3 (600g) (229.96). Supplementation of garlic as reported had no significant effect ($P>0.05$) on the breast weight of broiler birds. This is in contradiction of Ehebha et al. (2018) who documented that ginger supplementation had effect on breast weight. While breast weight of the current study ranged between 200-250g that of Ehebha et al. (2018) ranged between 700-1000g. Abubakar, (2020) have reported breast weights range (403.96-475.42) higher in the study area as a result of administering oxytetracycline on carcass characteristics.

Thigh (T)(g)

The result shows that there was no significant difference ($P>0.05$) between the thigh means of all the four treatments. The highest thigh mean value (113.40) was recorded in T1 that has the lowest inclusion level (300g) while the lowest (98.22) was recorded in T2 (450g). The mean does not follow any regular pattern. There was a fluctuation in the thigh means as garlic level increases. For example, T1 (300g) to T2 (450g) there was decrease. An increase was observed in the means from T2 (450g) to T3 (600g). Varying only numerically, thigh weight fluctuated as garlic inclusion level increased from T1 (300g) to T3 (600g). Indicating that addition of garlic in the diet of broiler chickens did not influence thigh weight across the treatments. In a confirmatory report Ehebha et al. (2018) also reported no significant difference ($P>0.05$) with values ranging between 300-400g as against those of the present study 90-120g. Abubakar, (2020) reported thigh weights range (167.42-205.30) higher in the study area as a result of administering oxytetracycline on

Table 3: Primal cuts performance of experimental broiler chickens fed graded levels of Garlic in the finisher phase (5-8 weeks).

Parameter	Treatment 1 (300g Garlic)	Treatment 2 (450g Garlic)	Treatment 3 (600g Garlic)	Treatment 4 (0g Garlic)	SEM
Breast (g)	242.31	242.73	229.96	254.32	7.234
Thigh (g)	113.40	98.22	99.83	107.10	3.145
Drumstick (g)	100.57 ^{ab}	103.13 ^a	85.23 ^b	101.26 ^{ab}	2.964
Back (g)	83.94	100.87	83.29	106.00	5.107
Wings (g)	81.06	92.22	83.01	81.89	3.056
Neck (g)	43.44	41.60	44.17	43.49	1.467

^{a-b} Means within the same row with different superscripts are significantly different at $P < 0.05$.

SEM= Standard Error of Mean

carcass characteristics.

Drumstick (D) (g)

The result on Drumstick weight indicates a significant difference ($P < 0.05$) between the Drumstick means of all the treatments with the highest mean (103.13) recorded in T2 and the lowest (85.23) recorded in T3 that has the highest garlic inclusion level (600g). Treatments 1, and 4 (control) are seen to be similar ($P > 0.05$) statistically while T4 (0g) is also the same ($P > 0.05$) with T2 (450g) and T3 (600g). Garlic supplementation on drumstick weight showed a significant difference ($P < 0.05$) on drumstick weight. Drumstick weight values between 300-400g were reported by Zhang *et al.*, (2002). With no significant difference as against 80-110g reported in this study.

Back (BK)(g)

The result on Back weight means shows no significant difference ($P > 0.05$) between the Back weight means of the experimental birds all treatments. The highest Back mean value (106.00) was recorded in T4 (control) while the lowest (83.29) was recorded in T3 with the highest inclusion level (600g). A fluctuation as the level of garlic inclusion increased from T1 (300g) to T3 (600g) was observed in the result. There was no significant difference ($P > 0.05$) in back weight among treatments. Back weight values ranges between 80-110g in disagreement with the values of Ehebha *et al.* (2018) who fed ginger root meal and found a significant difference ($P < 0.05$) unlike in the case of this study.

Wings (W)(g)

The result on Wings weight shows no significant difference ($P > 0.05$) between the wings weight means in all the four treatments. The highest wings weight mean value (92.22) was recorded in T2 while T1 with the lowest garlic inclusion level (150g) recorded the lowest (81.06) mean value for wing weight performance. It is also indicated by the result that there is fluctuation in the Wings means value as inclusion level of garlic increases. For example, from T1 (300g) to T2 (450g) there is an increase while a decrease was observed in T2 (450g) to

T3 (600g). Although no significant. Wing weight was reported to fluctuate with garlic inclusion level from T1 (300g) to T3 (600g). This contradicts Oluwafemi and Bamigboye, (2020) who reported significant difference ($P < 0.05$) in wing weight when broiler chickens were fed diet supplemented with garlic oil. Bilyaminu, (2012) reported wings weights range (85.00-128.00g) higher in the study area as a result of feeding graded levels of parboiled bambara groundnut meal carcass characteristics.

Neck (N) (g)

The result shows no significant difference ($P > 0.05$) in Neck weight means between the four treatments. The highest neck weight mean value (44.17) was recorded in T3 with the highest inclusion level (600g) while the lowest (41.60) was recorded in T2 (450g). There was a fluctuation in the mean values for neck weight across the treatments. A decrease was observed from T1 (300g) to T2 (450g) after which the value increased slightly at T3 (600g). Significant difference ($P < 0.05$) was not observed among the neck weight of the experimental birds between the four treatments. This contradicts the earlier report of Fauzziyya, (2018) who reported a significant difference ($P < 0.05$) in the neck weight with values between 70-81g when graded levels of choline chloride was fed to broiler chickens in semi-arid sokoto. The difference might be due to different test ingredient used in the experiments.

Organs/Offals

Liver (L) (g)

The result indicates a significant difference ($P < 0.05$) in Liver weight means between the broilers the four treatments. The result shows that the liver weight mean value was recorded as highest (25.50) in T1 with the lowest inclusion level (300g) and was lowest (21.27) recorded in T2. T1 (300g), T3 (600g) and T4 (control) are seen to be statistically ($P > 0.05$) similar. Liver weight declined between T1 (300g) and T2 (450g) before increasing with increase with garlic inclusion at T3 (600g) (Table 4). Liver weight showed a significant difference

Table 4: Organs/offals performance of experimental broiler chickens fed graded levels of Garlic in the finisher phase (5-8 weeks).

Parameter	Treatment 1 (300g Garlic)	Treatment 2 (450g Garlic)	Treatment 3 (600g Garlic)	Treatment 4 (0g Garlic)	SEM
Liver (g)	25.50 ^a	21.27 ^b	25.23 ^a	25.35 ^a	0.716
Gizzard (g)	26.57 ^b	21.86 ^c	25.65 ^{bc}	36.64 ^a	1.411
Feet (g)	41.12	40.60	37.62	36.60	1.244
Intestine (g)	73.64	59.05	67.62	63.68	2.697
Head (g)	41.53	42.22	32.24	32.34	2.424
Abdomin Fat (g)	4.82 ^a	3.89 ^a	5.49 ^a	1.68 ^b	0.460
Heart (g)	4.62 ^{ab}	5.30 ^a	4.09 ^b	4.92 ^a	0.149

^{a-b} Means within the same row with different superscripts are significantly different at $P < 0.05$. SEM= Standard Error of Mean

($P < 0.05$). Although a significant was observed in liver weight, the weight decreased at a point. In a different study Samuel, (2019) reported no significant difference ($P > 0.05$) in liver weight when varying levels of protein where fed to ascertain the performance and carcass characteristics of broiler birds. Abubakar, (2020) reported liver weights range (46.45-74.92g) higher in the study area as a result of administering oxytetracycline on carcass characteristics.

Gizzard (G) (g)

The result shows a significant difference ($P < 0.05$) in the Gizzard weight means of all birds in the four treatments. The highest gizzard weight mean value (36.64) was recorded in T4 (control) while the lowest (21.86) was seen in T2. There was fluctuation in Gizzard weight means for example, from T1 (300g) to T2 (450g) gizzard weight decreased before increasing at T3 (600g). Treatments 1, 2 and 3 are observed from the result to be statistically ($P > 0.05$) similar. SEM recorded for this parameter was 1.411. Significant difference was reported to exist between the treatments as a result of feeding graded level of garlic. This could mean that feeding garlic result in reduction of gizzard weight since the control T4 (0g) was found to have the highest (36.64g) gizzard weight. This study is in line with Shittu *et al.*, (2020) who reported a significant difference ($P > 0.05$) in gizzard weight when varying levels of protein to broiler chickens (Table 4).

Feet (F) (g)

Result shows no significant difference ($P > 0.05$) between the Feet weight means of the experimental birds in all four treatments. The highest feet mean value (41.12) was recorded in T1 (150g) with the lowest garlic inclusion and the lowest (37.62) value recorded in T3 with the highest inclusion level (600g). Therefore, Feet weight decreased as the level of garlic increases across the treatments. The SEM recorded for the Feet parameter is 1.224. Feet weight showed no significant difference ($P > 0.05$). Although no significant was observed in feet weight, the

weight decreased as the inclusion level of garlic increases. In a different study of Fauziyya, (2018). Who reports a significant difference ($P < 0.05$) in feet weight when varying levels of choline chloride was fed. Abubakar, (2020) reported thigh weights range (59.25-66.75g) higher in the study area as a result of administering oxytetracycline on carcass characteristics (Table 4).

Intestine (I) (g)

The result shows no significant difference ($P > 0.05$) in Intestine weight means between the four treatments. The lowest Intestine means value (59.05) was recorded in T2 and the highest (73.64) was recorded in T1 with the lowest garlic inclusion level (300g). The weight of the Intestine weight showed a decrease with increase in garlic level between T1 (300g) and T2 (450g) and later increased in T3 (600g). The SEM recorded for the intestine parameter is 2.697. Although not significant. Intestine weight was reported to fluctuate with garlic inclusion level from T1 (300g) to T3 (600g). This in line with the results of Christopher 2015, who reported no significant difference ($P > 0.05$) in intestine weight when broiler chickens where fed diet supplemented with garlic meal as ingredient in the diet. Abubakar, (2020) reported thigh weights range (115.37-149.75g) higher in the study area as a result of administering oxytetracycline on carcass characteristics (Table 4).

Head (H) (g)

Result obtained on Head weight showed no significant difference ($P > 0.05$) between the head means of the experimental broiler birds in all the treatments. The highest Head mean value (42.22) was recorded in T2 (450g) and the lowest (32.24) mean value was observed in T3 with the highest garlic level (600g). The result showed that the mean value for head weight increases with increase in garlic level from T1 (300g) to T2 (450g) and later decreased at T3 (600g). No significant difference ($P > 0.05$) was reported to exist between the treatments as a results of feeding graded level of garlic.

This study is in line with Ehebha et al.(2018) who also reported no significant difference ($P>0.05$) in head weight when graded levels of ginger root meal were fed to the broiler chickens.

Abdominal Fat (AF) (g)

The result shows a significant difference ($P<0.05$) in Abdominal Fat weight means between the four treatments. It was observed that abdominal fat mean value was highest (5.49) in T3 with the highest inclusion level (600g) and lowest (1.68) in T4 (control). Treatments 1, 2 and 3 with graded levels of garlic are seen to be statistically ($P>0.05$) similar. Abdominal fat weight decreases with increase in garlic level between T1 (300g) and T2 (450g) before increasing to the highest at T3 (450g). SEM recorded for abdominal fat weight is 0.460. Significant difference ($P<0.05$) was observed among the abdominal fat weight of the experimental birds between the four treatments. This contradicts the earlier report of Taufik and Manuddin (2019) who reported no significant difference ($P>0.05$) in the abdominal fat weight when garlic was fed supplemented to broiler chickens diet to determine the effect on performance, carcass weight and abdominal fat (Table 4).

Heart (Ht) (g)

The result showed a significant difference ($P<0.05$) in Heart weight means between the experimental broiler chickens in all the four treatments. The highest Heart weight mean value (5.30) was recorded in T2 (450g) and the lowest (4.09) value seen in T3 with the highest inclusion level (600g). Treatment 1, 2 and 4 (Control) are statistically similar ($P>0.05$) and T1 is also observed to be the same statistically ($P>0.05$) to T3. There was fluctuation in the heart weigh means as garlic level increases in the treatments. For example, there was an increase in the means as the level of garlic increases from T1 (300g) to T2 before declining in T3 (600g). SEM recorded for this parameter is 0.149. Garlic supplementation on heart weight showed no significant difference ($P>0.05$). Heart weight values between 0.50-0.52g were reported by Rinkesh *et al.*, (2009). With a significant difference as against 4.00-5.35g reported in this study.

Conclusion

It is concluded from the research that garlic inclusion made performance better with regards to Total body weight, Total body weight gain, and feed conversion ratio. After carcass evaluation it is also concluded that birds fed diet with inclusion level of garlic performed better in most

of the carcass cuts.

Recommendation

The following recommendations are made from the result of this study;

1. Broiler diet could be supplemented with 450g of garlic for better performance.
2. The research should be tried during the cool months of the study area.
3. According to my results it should not exceed 450g.
4. More research should be performed on layers to determine the egg production.

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