# Comparative Effects of Garlic or Ginger in the Diets of Broiler Chickens Subjected to Different Feeding Manipulations

**Akinbami O. Ismail,**
Department of Agricultural Science Education,
Lagos State University of Education,
KM 30, Lagos-Badagry,
Ijanikin with campus @Odo-Noforija Epe Lagos, Nigeria

**Balogun Daud Ishola***
Faculty of Business and Management
Universiti Sultan Zainal Abidin,
Kampung Gong Badak, 21300, Terengganu, Malaysia
Corresponding author Email: si4240@putra.unisza.edu.my

**Abdurauf I.A**
Department of Agricultural Science Education,
Lagos State University of Education,
KM 30, Lagos-Badagry,
Ijanikin with campus @Odo-Noforija Epe Lagos, Nigeria

**Hussain L A**
Department of Agricultural Science Education,
Lagos State University of Education,
KM 30, Lagos-Badagry,
Ijanikin with campus @Odo-Noforija Epe Lagos, Nigeria

**Bamgbowu .S**
Department of Agricultural Science Education,
Lagos State University of Education,
KM 30, Lagos-Badagry,
Ijanikin with campus @Odo-Noforija Epe Lagos, Nigeria

**Ibironke**
Department of Agricultural Science Education,
Lagos State University of Education,
KM 30, Lagos-Badagry,
Ijanikin with campus @Odo-Noforija Epe Lagos, Nigeria

**Balogun Adekunle Daoud**
Department of Political Science,
Fountain University,
Opp. Olomola Hospital, Along Agric Settlement Road,
Oke-Osun, Osogbo, Nigeria
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***Abstract***

*The major objective of poultry enterprise is to produce proteins of high quality at minimum cost in the shortest possible time. It is believed that 70 to 75% of total cost on broiler production is incurred on feed. This study composed of two experiments. Experiment investigated the effect of garlic or ginger inclusion in the diets of broiler chickens subjected to different feed access times. A total of 384 unsexed day-old Cobb strain of broiler chickens were used for experiment. The result obtained showed that the main effects of phytobiotics and levels of phytobiotics had a significant ($p < 0.05$) effect on feed conversion ratio: less feed intake resulted in high body weight gain on the growth performance of the broiler chickens. Inclusion of phytobiotics at 2.5% increased the lymphocytes of the broiler chickens. Low density lipoprotein was significantly ($p < 0.05$) influenced by the interactive effect of phytobiotics and feed access time in experiment. Increasing its value. Total cholesterol was also increased and significantly ($p < 0.05$) influenced by inclusion levels of phytobiotics and feed access time in the experiment with birds fed diet containing garlic combined with feed access time of 8 hrs and 12 hrs having the least. Breast percentage of the broiler chickens were significantly ($p < 0.05$) increased by the inclusion of phytobiotics at 2.5% in the experiment. The study concluded that the inclusion of phytobiotics at 2.5% in restricted birds reduce stress and improved breast meat percentage in carcass of broilers chickens.*

***Keywords: phytobiotics; broiler chickens; feeding manipulations; growth performance***

## 1.0 INTRODUCTION

The major objective of poultry enterprise is to produce proteins of high quality at minimum cost in the shortest possible time. It is believed that 70 to 75% of total cost on broiler production is incurred on feed. But it has been noted that most of the feed components e.g. maize, sorghum, millet, etc. consumed by man form major sources of energy to broiler chickens. This has adversely affected the poultry industry since man compete with these poultry birds for feed thereby soaring cost (Anaeto *et al.*, 2009). There is a need to identify methods of reducing cost (Khetani *et al*., 2009). According to Adeyemi *et al.,* (2013), the ability to judiciously manipulate feed to maximize productivity is central to the profitability of a stable poultry production enterprise.

Feed restriction, which is denying birds, particularly the fast-growing broiler chickens, a full access to nutrients that are required for their normal growth and development, is categorized into quantitative and qualitative feed restrictions (Giachetto *et al.*, 2003). Feed restriction is used to modify the growth pattern of the fast-growing broiler chickens, especially in alternative production systems where long growth periods are required (Nielsen *et al.,* 2003).

Excessive fat deposition is one of the main problems faced by the broiler chicken industry which can be addressed by restriction feeding since it does not only reduce carcass yield and feed efficiency but also cause rejection of the meat by consumers and causes difficulties in processing. Earlier reports on feed restriction during the growing period in broiler chickens indicate that restricting feed intake lowers body weight and carcass fat and improves feed efficiency with compensatory growth during re-feeding (Plavnik *et al.*, 1986; Fantanna *et al.*, 1992).

Feeding time and feed access time are also very important feeding manipulation techniques. Feeding time refers to the actual time the birds are fed. Ambient temperature plays important role in this regard. The feeding time manipulation technique is particularly important because depressed growth rate and decreased feed consumption of broiler raised in higher temperature environments have been reported (Daghir, 1995) On the other hand, feed access time is the period or duration the birds were allowed to feed. Feed additives are groups of nutrient and non-nutrient compounds which help in improving the efficiency of feed utilization and general well-being of the animal especially during stress thus reducing the high cost of feed. Inclusion of natural growth promoters such as prebiotics, probiotics, phytobiotics, enzymes, plant extracts, etc., can be used as additives in broiler chickens' diets (Borazjanizadeh *et al*., 2011). Garlic and ginger are natural growth promoters that are used to realise feed efficient utilization and general well-being of broiler chickens.

Ginger and Garlic supplements in broiler chickens have been recognized for their strong stimulating effect on the immune and digestive systems in the birds. The use of these phyto-biotics along with practical feed manipulation strategy is expected to result in some positive contributions. Therefore, this study examined the influence of feed access time and feeding time on the performance, carcass characteristics and blood profile of broiler chickens fed diets containing ginger and garlic.

## 2.0 LITERATURE REVIEW

### 2.1 Feed Manipulation

Feed manipulation is a general term for all efforts made to improve efficiency of feed and profitability derivable from feeding. It involves such efforts as feed restriction and feeding time to take advantage of weather conditions, different access durations to feed, frequencies of feeding and the use of additives that could be beneficial to the consuming livestock by stimulating feed intake, improving digestion etc.

### 2.2 Feed Restrictions

Broiler chickens are raised on concentrated energy diets to maximize growth rate and reduce the total number of days needed to reach market weight. Plavnik *et al.*, (1986) reported that the increase in growth rate of modern broiler chickens has been associated with increased fat deposition. This problem most commonly occurs in broiler chickens that are fed *ad libitum* (Pastemark and Shalev, 1983). The accelerated growth rate causes stress on the birds and can result in metabolic diseases and skeletal disorders that lead to economic losses due to reduced animal performance, high mortality rates and carcass condemnation at slaughterhouses (Cuddington, 2004). The phenomenon of compensatory growth has long been recognized as having the potential to have profound effects on the rate of growth and body composition of most animals.

Feed restricted birds are hyperactive, and they show increased pacing before the expected feeding time and increase drinking and pecking at non-food objects afterwards, compared with *ad libitum* fed birds (Kostal *et al.*, 1992; Savory *et al.*, 1992). The expression of these activities is often stereotyped in nature, characteristic of frustration of feeding motivation (Duncan and Wood-Gush, 1972) and is positively correlated with the level of feed restriction imposed (Savory and Maros, 1993). Also, feed restricted males are more aggressive than *ad libitum* fed males (Mench, 1988). Savory *et al.* (1993) concluded that restricted-fed broiler breeders are “chronically hungry, frustrated and stressed” and that the first of the ‘Five Freedoms’ is being contravened (Savory *et al.*, 1993).

### 2.2.1 Methods of Feed Restriction

Various methods of under-nutrition have been used to retard or even strop growth during the restriction period. These methods include physical feed restriction, limiting the level of consumption of food in time (skip-a-day feeding) or reducing the hours of illumination of feeding (Religious *et al*., 2001), diet dilution, chemical methods of feed restriction and use of low protein or low energy diets (Zubair and Lesson, 1996).

#### 2.2.1.1 Physical Feed Restriction

Physical feed restriction provides a calculated quantity of feed per bird, which is often just enough to meet maintenance requirements (Plavnik and Hurwitz, 1989). However, it has a constraint due to the need to weigh feed daily. In addition to this, it is necessary to provide sufficient feeder space to avoid competition among the restricted birds and to prevent unequal growth of birds within a flock. Quantitative feed restriction has been observed to reduce mortality and culling (Fontana *et al*., 1992; Robinson *et al*., 1992), improve feed conversion ratio (Fontana *et al*., 1992; Deaton, 1995; Plavnik and Hurwitz, 1988; Lee and Lesson, 2001) and allow a complete recovery of body weight if the degree of restriction was not too severe and slaughter ages were extended beyond 6 weeks (Deaton, 1995; Plavnik and Hurwitz, 1988). Dozier *et al*. (2002) referred to feed restriction programs of yielding inconsistent results in the literature and that variation may be partially attributed to differences in bird’s management, lighting, strain and ventilation. Plavnik and Hurwitz (1988) reported complete compensatory gain with males but not females after early feed restriction. From their findings, it can be deducted that with females, feed restriction should be initiated from 5 to 7 days of age and the duration should not exceed 5 days to achieve complete recovery of final body weight and optimum feed efficiency.

Although the level of early feed restriction is an important factor influencing the broiler chicken response, early feed restriction at 30% of *ad libitum* intake was not able to influence broiler chicken performance parameters at market age of 49 days (Giachetto *et al*., 2003). In the same study, broiler chicken’s carcass protein, total fat and abdominal fat pad were not affected by the treatment. Benyi and Habi (1998) reported that with a 30% food restriction, less abdominal fat deposition than when there was a 15% food reduction, reduction of feeding time by 2 days per week or *ad libitum* feeding. Tumova *et al*. (2002) reported an accelerated growth rate on the previously restricted birds at the age of 21 days resulting in a similar daily weight gain with full-fed cockerel, and from the age of 35 days daily weight gain of the previously restricted birds was higher with about 15% than full-fed broiler chickens. Lippens *et al.* (2000) working with Ross and Hybro broiler chickens, indicated that moderate early-life feed restriction programmes did not always guarantee sufficient 'catch-up' growth to obtain a similar slaughter weight at the same age as the *ad libitum* birds. No significant differences were observed regarding feed conversion ratio and total carcass fat, although the restricted birds showed a tendency towards higher abdominal fat content. Rosebrough and McMurty (1993) suggested that even feed-restricted broiler chickens were still overeating and that the level of feed intake may control the invivo lipogenesis.

A controversial aspect of feed restriction programs has been the inconsistent carcass fat deposition. Summers *et al*. (1990) and Jones and Farrel (1992) did not find changes in carcass composition of birds after feed restriction conditions. However, Plavnik and Hurwitz (1985; 1989) and Plavnik *et al*. (1986) reported a decrease in fat pad of broiler chickens restricted from 6 to 12 days of age, without adverse effects on growth. Lee and Leeson (2001), Leeson *et al*. (1991), Saleh *et al* (2004; 2005) and Urdaneta and Leeson (2002) were not able to show a clear effect of the effect of feed restriction on fat pads of broiler.

**2.2.1.2 Skip-A-Day Feeding**

Skip-a-day feed removal is a technique for limiting early growth and has not been extensively examined for broiler chickens (Dozier *et al*., 2002). Skip-a-day feeding programs providing limited allotments are widely used in broiler breeder's growth restriction programs. Removing feed for 24-hour periods during the starter period reduces early rapid growth and meat yield in broiler chickens. Skip-a-day feed removal has been reported in other studies to decrease early growth and reduce the incident of ascites without affecting final body weight (Arce *et al*., 1992; Ballay *et al.*, 1992). Oyedeji *et al*. (2003), Oyedeji and Atteh (2005) reported reduction in feed intake after subjecting the birds to fasting on every other day. Oyedeji and Atteh (2005) concluded that skip-a-day feeding for 3 weeks starting at day-old would improve carcass quality and reduce sudden death syndrome which is often associated with birds that are on *ad libitum* feeding.

**2.2.1.3 Lighting**

Lighting is a powerful exogenous factor in control of many physiological and behavioural processes (Manser, 1996). Birds are very sensitive to light. Light allows the birds to establish rhythm and synchronize many essential functions, including body temperature and various metabolic steps that facilitate feeding and digestion (Olanrewaju *et al.*, 2006). Light intensity, colour, and the photoperiodic regime can affect the physical activity of broiler chickens (Lewis and Morris, 1998). Broiler chickens normally do not eat during darkness, if this period does not extend for more than 12 hours (Savory, 1979). As a normal practice, modern broiler chickens are grown under 23 hours of light per day. It is known that by altering lighting schedules by either reducing the hours of light or developing intermittent schedules, feed utilization is improved (Blair *et al*., 1993; Wilson *et al*, 1984). Light manipulation is used in broiler chicken production to control growth, improve feed efficiency, minimize mortality and reduce electricity costs.

Broiler chickens under different reduced light programmes, therefore, will have reduced feed intake. However, broiler chickens do learn to eat during darkness when hours of light are low (Morris, 1986). It is hypothesized that short photoperiods early in life will reduce feed intake and limit growth (Olanrewaju *et al*., 2006). Classen (2004) comparing 12 light-hours versus 12 dark-hours, 16 light-hours versus 8 dark-hours and 20 light-hours versus 4 dark-hours demonstrated clearly that longer periods of darkness prevent regular access to feed and consequently reduce feed intake and limit growth. Chickens can learn to eat in the dark (Perry, 1981), but their feed intake in the dark is much reduced (Buyse and Decuypere, 1988). They can also learn to increase feed intake during the light period in anticipation of the dark period but are limited by their crop size (Perry, 1981).

**2.2.1.4 Diet Dilution**

Many workers have used diet dilution as an alternative method offered restriction because of the advantage of attaining a more consistent growth pattern within a flock. Leeson *et al*. (1991) and Jones and Farrel (1992), using 50 to 65% diet dilution with rice hulls to retard early growth, reported that even though the birds ate more feed, the adjustment was insufficient to normalise nutrient intake and so growth rate was reduced.

Griffiths *et al*. (1977) lowered the energy of a broiler chicken diet to 2233 kcal ME/kg DM from 3087 kcal ME/kg DM of feed by substitution ground yellow corn with oatmeal as the main ingredient. Chickens fed the low energy diet consumed significantly more feed than those fed the high energy diet. When fed the low energy diet from 0 to 3 weeks of age, the chicks were not significantly different in body weight or in abdominal fat pad development from the *ad libitum* birds at 4 weeks of age. Leeson *et al*. (1991) offered broiler chickens a conventional finisher diet diluted up to 50% with a 50:50 mixture of sand: oat hulls from 35 to 49days of age and showed no significant difference in body weight at 49day or breast weight at 42 or 49days of age. Cabel and Waldroup (1990) observed that diluting the starter diet with sand from 5 to 11 days of age moderately restricted growth, which was completely recovered by 49 days of age.

**2.2.1.5 Chemical Method**

The use of chemical is another means of achieving reduced growth rate. It has an advantage of evenly distributing the feed among birds and so reducing the variations in growth than can occur with physical feed restriction. Restriction of feed intake of broiler chickens by chemical means was suggested by Pinchasov and Jensen (1989). They supplemented broiler chickens and fed them for 7 to 14 days and reported that diets with 1.5 and 3.0% glycolic acid intake was depressed by 17 and 45%, respectively, resulting in growth retardation during the under-nutrition period of about 71 and 41%, relative to the growth of control birds. Body weight of the chemically restricted male broiler chickens was similar to those fed *ad libitum* at 49 days of age. Oyawoye and Krueger (1990) showed that 400/mg and 300/mg of phenyl propanolamine hydrochloride or monensin sodium per kg diet, respectively, significantly depressed body weight of the broiler chickens at 4 weeks of age. Pinchasov and Elmaliah (1994) included 1 or 3% of acetic and propionic acids in the diet and found that weight gains of chemical restricted birds were close to the birds who were obtaining under a recommended program of quantitative feed restriction for female broiler breeders between 2 to 6 weeks of age.

### 2.2.1.6 Use of Low Protein or Low Energy Diets

Energy in broiler chickens is needed for maintenance and growth of body tissues, vital metabolic activities and maintenance of normal body temperature. Energy concentration of the diet is also of primary importance in determining the amount of feed ingested by the broiler chicken. Broiler chickens eat primarily to satisfy their energy requirements (Reddy, 2000). When this requirement is satisfied, the chicken stops eating. Therefore, diets with higher energy concentration will have low intake and those with lower energy concentration will have higher feed intake (Macleod, 1991). Holsheimer and Veerkamp (1992) reported that high energy diets significantly increased carcass weight and yield of abdominal fat; however, carcass part weights were not influenced by dietary energy. Also, relative abdominal fat weight increased linearly with increments in dietary energy.

The use of low protein or low energy diets has an advantage in that it does not require any additional labour to weigh feed. Broiler chickens require 220, 200 and 180 g/kg dietary crude protein during the starting, growing and finishing periods, respectively, for optimal growth (NRC, 1994). Fisher (1984) reported that broiler chickens tend to increase their feed intake to make up for deficiencies when fed diets that are marginally deficient in crude protein. Leeson *et al*. (1991) reported that diluting commercial broiler chicken diets from 35 to 49 days of age with oat hulls and sand, which led to the diets deficient in energy content, caused significant reduction in body weight at 42 days of age, although the growth was compensated thereafter. Birds seemed to maintain energy intake, therefore there was increased feed intake with energy deficient diet. Coon *et al*. (1981) comparing the performance of male and female broiler chickens fed low or high energy rations for 56 days, found a significant improvement in the feed conversion ratio using a diet with high energy level. Zorrila *et al*. (1993), observed a linear increase in body weight gain when dietary energy levels were increased.

On the other hands, a linear decrease in carcass weight and breast meat yield was observed with birds fed both protein and energy deficient diets. These results suggested that birds can grow quite well on low energy diet, but a period of 7 days is necessary to adjust their feed intake (Leeson *et al*., 1991). Babu *et al*. (1986) reported comparable feed intake, weight gain and feed: gain ratio for broiler chickens subjected to low crude protein diets compared with those on higher crude protein diets. In contrast, Plavnik and Hurwitz (1990) reported that broiler chickens fed low crude protein diets gained the least body weight and did not recover the body weight as measured at 56 days of age. Morris (1971) also reported 25% growth retardation by feeding low crude protein diets. Sizemore and Siegel (1993) tested the effects of early energy restriction, while keeping protein and other nutrients constant, on different female broiler chickens to energy crosses. The authors observed significant differences in the response of female broiler chickens to energy restriction. They concluded that the reason the results on early feed restriction are often contradictory is that the make-up of the broiler chickens may interact with their response to the nutritive content of the diet and change the result.

### 2.2.1.7 Feed Textures

Feed forms and particles size also influences broiler growth and development (Reece *et al*, 1986; Jones *et al.*, 1995). Broilers fed crumble-pellet diets show improved weight gain, feed intake and feed conversion ratio compared to birds fed mash (Calet, 1965). Birds offered mash spend more time consuming their feed compared to birds fed pellets (Savory, 1974) and therefore, expend more energy in this process. Rews (1991) suggested that the improvement in growth rate due to eating pellets is related to some extent to the increase in bulk density of pellets which in some situations increase nutrients intake.

Nir *et al*. (1995) fed male and female broiler to 49 days with mash or crumble diets during the starter and grower periods and mash or pellets for the finisher period. Males shows a significant increase in body weight and improved feed conversion when fed pelleted compared to mash diets. On the other hand, the improvement in performance was not evident for females, which shows no significant difference either in body weight or feed conversion ratio at 49 days of age. Mortality was higher in birds fed pelleted diets. These results agree with those of Jones *et al*. (1995) and Hamilton and Proudfoot (1995), where an improved weight gain and feed conversion at 6 weeks of age were obtained in birds fed pelleted compared to mash diets. The improvement in broiler performance with pelleted diets may be attributable to a greater digestibility of carbohydrates together with increased daily nutrient intake (Hamilton and Proud foot, 1995), better nutrient availability (Nir *et al*., 1995) and/or less feed wastage (Calet 1965, Savory, 1974). Because chicks fed pelleted diets spend less time and energy feeding, they were less active than mash-fed birds (Nir *et al*., 1995) and so spend less energy for maintenance.

## 2.3 Effect of Early Feed Restriction on Market Age of Broiler Chicks

Accelerated growth that occurred in broiler chicks several weeks after a severe feed restriction at the age of one week was responsible for almost complete recovery of body weight at market age (Plavnik and Hurwitz, 1985). This resulted in improved feed efficiency at 6-8 weeks of age, even when compared on body weight basis (Plavnik *et al*. 1986). Also, in carcass fat reduction at 6 weeks after restriction resulted in inhibition of adipocytes proliferation. In another report, Hannagan and Wills (1973) in analysis, the effect with Berge and Bearse (1961), Benyi *et al.* (1980) stated that body weight decrease depending on the level of feed restriction. Plavnik and Hurwitz (1985) further discovered that there was weight loss with female chicks when fed restricted diet for more than 7 days regardless of age of restricted birds. According to them, growth rate was similar for the control and restricted birds during the first 3 weeks, but the restricted ones tended to exceed that of the controls after 5 weeks. However, the efficiency of feed utilization as a function of weight gain proved similar for all groups. Plavnik and Hurwitz (1989) concluded that mixed populations chicks restricted early in life (3 or 5 days) should be preferred to late ages. In addition, severe restriction should be maximally 5 days. For broilers with short growing period, their response of accelerated growth to feed restriction is delayed. If marketed earlier than 49 days, market weight would not be attained. Hence, the need to give critical appraisal of the evolution of feed efficiency and probably also the effect on carcass fat. Auckland and Morris (1971) and Moran (1981) have proved that energy restriction differs from protein restriction on the growth of chicks and turkeys under stress conditions. The coefficient for maintenance was weight per day at lowered to 1.5 kcal/g per day in anticipation of the reduced needs of energy restriction. Reduction in energy requirement may result to decrease of both basal metabolic rate and specific dynamic action. This agrees with observation as recorded by Nir *et al*. (1987) in man and animal.

### 2.4 Effect of Feed Restriction on Size of Organ

Chickens develop morphological, anatomical, physiological and behaviour characteristics that are population dependent in response to different feeding regimen such as *ad libitum*, intermittent and force feeding (Pinchasov *et al.*, 1985). These feeding regimens allow for varying proportional differences in availability of energy. Evidence indicates that such differences in response are partly due to variation between population in the allocation of resources for supply (e.g. gastrointestinal tract) and demand (e.g. muscle) at various stages of growth (Katanbaf *et al*., 1988). These observations suggest that development patterns may vary among and within populations reared under different feeding regimens.

### 2.5 Blood Haematological Profile

Haematological profiles both in human and animal sciences are important indices of the physiological state of the individual (Khan and Zafar, 2005). Haemato-biochemical indices are of immense importance in poultry production. The blood in the body (Ahmad *et al*., 2003) mainly maintains physiological equilibrium but many physiological conditions may alter this equilibrium. Hence, the haematological values during different physiological situations could be used for diagnosis of various pathological and metabolic disorders, which can adversely affect the productive and reproductive performance of animals (Ahmad *et al*., 2003). The ability to interpret the state of blood profile in normal and diseased condition is among many primary objectives of haematological studies. Haematological and serum biochemical parameters have been reported to provide valuable information on the immune status of animals (Kral and Suchy, 2000). Research (Siegel, 1968; Khan *et al*., 1987) has proven that definite changes occur in the profile of blood cell throughout life. Haematological and biochemical indices can be affected by nutrition, age, sex, genetics, physiological status, housing, starvation, environmental factors, stress, disease and transportation (Opara *et al*., 2006). Incidence of disease and malnutrition are diagnosed by the deviation from the normal reference values of the various serum biochemical and haematological parameters measured depending on the case being investigated. Evaluation and interpretation of the results obtained are dependent on the reference value for each animal species, in those regions under existing environmental conditions (Otto *et al*., 2000).

## 3.0 METHODOLOGY

### 3.1 Experimental Birds and Management

A total of 384 unsexed day-old Cobb broiler chicks were obtained from a commercial hatchery in Abeokuta and were floor brooded for two weeks before the commencement of the experiment. The brooder house as well as all the equipment were thoroughly disinfected before the arrival of the chicks. During brooding and rearing, the chicks were given all recommended vaccination and medication viz; Newcastle disease vaccine, Anti-stress, Infectious Bursal disease, and anti-coccidial treatment. Three hundred and eighty-four (384) chicks bought were selected after brooding and used for the experiment.

### 3.2 Experimental Layout

The experimental arrangement was a 2 x 2 x 4 factorial layout in a Complete Randomized Design. The 384 selected birds were weighed and distributed into two phyto-groups (Garlic and Ginger) of one hundred and ninety-two (192) birds each. Each group was further divided into two phyto-levels (0% and 2.5%) each with 96 birds. Each phyto-level was further divided into four feed access times (4 hrs (7am-11am), 8 hrs (7am-3pm), 12hrs (7am-7pm) and 16hours (7am-11pm)). Each feed access time had three replicates containing 8 birds each. The birds were distributed into different groups, sub-groups and replicates on weight equalization basis. The birds were exposed to the experimental diets and feed access time for 21days after which they were allowed realimentation for 28 days during which they had unrestricted access to feed. The total duration of the experiment was 49 days (7weeks).

### 3.3 Experimental Diets

The experimental diet that was used was a straight diet with 21% CP and 2746.5 Kcal/kg ME energy. Garlic and Ginger were included at the rate of 0 and 2.5% each, to form three different diets that were used in this experiment, i.e. Control diet, Garlic containing diet and Ginger containing diet. The composition of the diet is given in Table 1.

**Table 1: Composition (%) of experimental feed**

| Ingredient | Control | Garlic | Ginger |
|---|---|---|---|
| Maize | 500 | 500 | 500 |
| Fishmeal (72% crude protein) | 20 | 20.00 | 20.00 |
| Soya meal | 200 | 210.00 | 210.00 |
| GNC | 100 | 100.00 | 100.00 |
| Wheat offal | 130 | 100.00 | 100.00 |
| Bone meal | 30 | 25.00 | 25.00 |
| Limestone | 10 | 10.00 | 10.00 |
| Lysine | 2.5 | 2.50 | 2.50 |
| Methionine | 2.5 | 2.50 | 2.50 |
| Premix | 2.5 | 2.50 | 2.50 |
| Salt (NaCl) | 2.5 | 2.50 | 2.50 |
| Garlic | - | 25.00 | - |
| Ginger | - | - | 25.00 |
| | 1000.00 | 1000.00 | 1000.00 |
| ME | 2746.50 | 2716.00 | 2716.00 |
| Methionine | 0.58 | 0.57 | 0.57 |
| Lysine | 1.27 | 1.29 | 1.29 |
| Protein | 21.13 | 21.07 | 21.07 |
| Fibre | 3.63 | 3.42 | 3.42 |
| Fat | 3.86 | 3.78 | 3.78 |

| | | | |
|---|---|---|---|
| Ca | 1.25 | 1.12 | 1.12 |
| Av. Phos | 0.55 | 0.49 | 0.49 |

Calculated nutrient value.

## 3.4 Data Collection

### 3.4.1 Growth Performance

Data were collected on initial weight, feed intake, weekly body weight, body weight gain and feed conversion ratio (FCR) were calculated. Performance data were collected all through the experimental period.

#### 3.4.1.1 Feed Intake

A measured quantity of feed was offered to the birds daily and the leftover was weighed to determine the daily feed intake and subsequently the weekly feed intake. The feed intake was calculated as follows:

Feed intake(g) = Feed supplied(g) – left over(g)

$$\text{Average feed intake} = \frac{\text{Feed intake(g/bird)}}{\text{No of birds per replicate.}}$$

#### 3.4.1.2 Body Weight and Weight Gain

The birds were weighed on replicate basis at the commencement of the experiment and subsequently on weekly basis.

$$\text{Average body weight (g)} = \frac{\text{Total weight of birds (g)}}{\text{Total no of birds per replicate}}$$

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

#### 3.4.1.3 Average Daily Weight Gain

$$\text{Average daily weight gain} = \frac{\text{(Final weight – Initial weight)}}{\text{Number of days}}$$

#### 3.4.1.4 Feed Conversion Ratio

This is the proportion of feed converted into flesh by the birds.

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

## 3.5 Haematological and Biochemical Components Determination

On the 49th day of the study, after re-alimentation, two birds were slaughtered per replicate and blood samples collected for haematological and serum parameters. Blood (2.5 ml) was collected from each bird into sample bottles containing ethylene diamine tetra acetic acid (EDTA). This was used to determine the haematological parameters viz: packed cell volume (PCV), haemoglobin concentration (HB), white blood cell (WBC) and red blood cell (RBC), following standard procedure described by Baker and Silverton (1985). Another 2.5ml of blood was collected into sample bottle without anticoagulant for the determination of serum metabolites (total serum protein (TP), albumin, globulin and cholesterol).

### 3.6 Carcass characteristics

At the end of the 7$^{th}$ week of the study, after re-alimentation, two birds per replicate with weight closed to their group average were selected and used for carcass evaluation. The birds were deprived of feed for 12 hours to empty their gut content, but with adequate provision of water and then slaughtered by throat slitting. Complete bleeding was ensured, and the feathers were plucked after scalding. After defeathering, the birds were weighed and eviscerated, the abdominal fat pads were weighed along-side the internal organs (heart, lungs, liver, gizzard, etc.) The carcass was cut into retail cut parts (breast, wing, thigh, back, drumstick, neck and weighted). All measurements were expressed as a percentage of live weight (Aderibigbe et al., 2013).

### 3.7 Statistical Analysis

Data collected were subjected to one way Analysis of variance for Complete Randomized Design in a 2 x 2 x 4 factorial arrangement. Significant ($p<0.05$) differences among means were separated using Tukey Krammer mean separation technique as contained in the Minitab® 17.1.0 (Minitab, 2013).

## 4.0 RESULTS

### 4.1 Main effect of phytobiotics level and feed access times on growth Performance and cost benefits of broiler chickens

The main effects of phytobiotics, level and feed access times on growth performance and cost benefits of broiler chickens are shown in Table 2.

The final weight gain, daily feed intake, daily weight gain and feed conversion ratio was significantly ($p<0.05$) affected by the level of photobiotic and feed access time while other parameters measured were not significantly ($p>0.05$) influenced by restriction period. The highest final weight (978.10g) and feed intake (88.65g) was observed at 16 hours feed access time, while the highest daily weight gain (41.71) was recorded at 8 hours feed access time. The best feed conversion ratio (2.19) was observed at 8 hours feed access time. Cost of feed consumed and cost of gain per kg were significantly ($p>0.5$) influenced by the level of photobiotic and feed access time. The highest cost of feed consumed (₦380.60) and cost of gain/kg (₦979.0) was recorded at 24 hours feed access time.

However, during realimentation, all parameters measured were not significantly (p>0.05) affected except the cost of feed consumed and cost of gain/kg that were significantly (p<0.05) affected by the level of phytobiotics and feed access time. During realimentation, the highest cost of feed consumed (530.70) was observed at 16 hours feed access time while 4 hours feed access time recorded the highest cost of gain/kg (287.90).

| | Phytobiotics | | | Level | | | Feed Access Time | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ginger** | **Garlic** | **P-Value** | **0** | **2.5** | **P-Value** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| **Restriction Period (21 days)** | | | | | | | | | | | | |
| Initial weight(g) | 191.77 | 196.53 | 0.34 | 199.03 | 184.27 | 0.06 | 198.52 | 193.15 | 186.02 | 198.91 | 0.23 | 2.49 |
| Final weight(g) | 889.50 | 900.70 | 0.54 | 930.10[a] | 860.10[b] | 0.03 | 852.20[b] | 895.80[b] | 854.20[b] | 978.10[a] | 0.02 | 16.00 |
| Feed intake/day(g) | 74.25 | 73.18 | 0.15 | 74.46[a] | 72.96[b] | 0.05 | 67.58[b] | 69.17[b] | 69.44[b] | 88.65[a] | 0.03 | 1.32 |
| weight gain/day(g) | 31.73 | 31.71 | 0.98 | 32.90[a] | 30.54[b] | 0.03 | 28.48[c] | 41.71[a] | 31.51[b] | 34.80[b] | 0.02 | 0.57 |
| Feed conversion ratio | 2.38 | 2.32 | 0.39 | 2.27[b] | 2.42[a] | 0.03 | 2.41[ab] | 2.19[b] | 2.21[b] | 2.56[a] | 0.04 | 0.46 |
| Cost of feed/kg(₦) | 190.00 | 193.00 | | 182.00 | 201.00 | | 191.50 | 191.80 | 191.50 | 191.50 | - | - |
| Cost of feed consumed(₦) | 310.90 | 312.90 | 0.79 | 300.70[b] | 323.20[a] | 0.04 | 291.90[b] | 293.30[b] | 282.10[b] | 380.60[a] | 0.03 | 5.33 |
| Cost of gain/kg(₦) | 747.20 | 730.30 | 0.65 | 688.90[b] | 788.60[a] | 0.01 | 706.90[b] | 654.40[b] | 632.70[b] | 979.00[a] | 0.03 | 37.20 |
| **Realimentation Period(28 days)** | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial weight(g) | 889.50 | 900.70 | 0.54 | $930.10^{a}$ | $860.10^{b}$ | 0.03 | $852.20^{b}$ | $895.80^{b}$ | $854.20^{b}$ | $978.10^{a}$ | 0.23 | 10.50 |
| Final weight (g) | 1407.40 | 1432.50 | 0.53 | 1412.90 | 1427.00 | 0.75 | 1396.90 | 1334.80 | 1497.70 | 1450.40 | 0.11 | 24.60 |
| Feed intake/day(g) | 95.45 | 94.54 | 0.47 | 93.92 | 96.08 | 0.14 | 98.18 | 91.08 | 92.95 | 97.78 | 0.21 | 0.83 |
| Weight gain/day(g) | 24.37 | 25.93 | 0.34 | 25.33 | 24.97 | 0.85 | 22.62 | 21.78 | 29.23 | 26.97 | 0.21 | 0.99 |
| Feed conversion ratio | 4.22 | 3.91 | 0.31 | 3.91 | 4.07 | 0.98 | 4.76 | 4.42 | 3.39 | 3.70 | 0.12 | 0.18 |
| Cost of feed/kg (₦) | 190.30 | 193.30 | | 182.00 | 201.00 | | 191.50 | 191.50 | 191.50 | 191.50 | - | - |
| Cost of feed consumed (₦) | 508.40 | 510.60 | 0.35 | $480.70^{b}$ | $538.30^{a}$ | 0.02 | $524.90^{b}$ | $485.90^{b}$ | $496.60^{b}$ | $530.70^{a}$ | 0.02 | 4.73 |
| Cost of gain/kg (₦) | 2148.90 | 1994.0 | 0.35 | 19557.0 | 2186.30 | 0.17 | $2497.0^{a}$ | $2161.0^{b}$ | $1696.0^{b}$ | $1948.0^{b}$ | 0.01 | 11.40 |

**Table 2: Main effect of phytobiotics type, level and feed access on growth performance and cost benefits of broiler chickens**

### 4.2 Interactive effect of phytobiotics and levels on growths performance and cost benefits of broiler chickens

Interactive effects of phytobiotics and levels on growth performance and cost benefits of broiler chickens during feed restriction and realimentation are shown in Table 3. All the parameters measured during restriction and realimentation period were not significantly ($p>0.05$) affected. During restriction the highest cost of feed consumed for ginger (₦323.80) and garlic (₦322.70) was observed at 2.5 level. The same trends for the two parameters were also observed during realimentation period.

**Table 3: Interactive effect of Phytobiotics type and Level used on growth performance and cost benefits of broiler chickens**

| | **Ginger** | | **Garlic** | | | |
|---|---|---|---|---|---|---|
| | **0** | **2.5** | **0** | **2.5** | **P-Value** | **SEM** |
| **Restriction Period (21 days)** | | | | | | |
| Initial weight (g) | 195.09 | 188.45 | 202.96 | 190.09 | 0.53 | 2.49 |
| Final weight (g) | 912.40 | 866.50 | 802.96 | 790.09 | 0.23 | 16.00 |
| Feed intake/day (g) | 75.28 | 73.21 | 73.65 | 72.70 | 0.46 | 1.32 |
| Weight gain/day (g) | 32.90 | 30.56 | 32.90 | 30.52 | 0.98 | 0.57 |
| Feed conversio ratio | 2.30 | 2.46 | 2.24 | 2.39 | 0.92 | 0.46 |
| Cost of feed/kg (₦) | 182.00 | 198.00 | 182.00 | 204.00 | - | - |
| Cost of feed consumed (₦) | 298.20 | 323.80 | 303.30 | 322.70 | 0.13 | 5.33 |
| Cost of gain/kg (₦) | 689.80 | 804.70 | 687.90 | 772.60 | 0.13 | 5.62 |
| **Realimentation Period(28 days)** | | | | | | |
| Initial weight (g) | 912.40 | 866.50 | 802.96 | 790.09 | 0.52 | 10.50 |
| Final weight (g) | 1412.90 | 1401.90 | 1412.90 | 1452.10 | 0.52 | 24.60 |
| Feed intake/day (g) | 94.06 | 96.84 | 93.77 | 95.32 | 0.63 | 0.83 |
| Weight gain/day (g) | 25.33 | 23.41 | 25.33 | 26.84 | 0.34 | 0.99 |
| Feed conversion ratio | 4.08 | 4.36 | 4.07 | 3.76 | 0.34 | 0.18 |
| Cost of feed/kg (₦) | 182.00 | 198.00 | 182.00 | 204.00 | 0.39 | 11.40 |
| Cost of feed consumed (₦) | 481.50 | 535.40 | 497.90 | 541.20 | 039 | 11.40 |
| Cost of gain/kg (₦) | 196.40 | 233.30 | 195.00 | 203.90 | 0.39 | 11.40 |

## 4.3 Interactive effect of phytobiotics type and feed access time on growth Performance and cost benefits of broiler chickens

The interactive effect of phytobiotics type and access time on growth performance and cost benefits of Broiler chickens is shown in Table 4. All parameters measured were not significantly p>0.05) affected. During restriction the highest cost of feed consumed and cost of gain per kg was seen at 16 hours feed access time for both ginger and garlic. While the lowest cost of feed consumed (₦218.70) was observed at 8 hours feed access time of ginger. Lowest cost of feed consumed (₦276.20) for birds on garlic was observed at 12 hours feed access time. During realimentation period, ginger at 4 hours feed access time recorded the highest cost of feed consumed and highest cost of gain per kg.

**Table 4: Interactive effect of phytobiotics type and feed access time on growth performance and cost benefits of broiler chickens**

| | Ginger | | | | Garlic | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | P-Value | SEM |
| **Restriction Period (21 days)** | | | | | | | | | | |
| Initial weight (g) | 193.33 | 189.44 | 187.84 | 192.27 | 203.70 | 196.85 | 185.00 | 200.56 | 0.83 | 2.49 |
| Final weight (g) | 817.60 | 883.50 | 881.70 | 975.00 | 886.80 | 908.10 | 826.70 | 981.10 | 0.29 | 16.00 |
| Feed intake/day (g) | 67.30 | 69.92 | 70.87 | 88.89 | 67.86 | 68.41 | 68.02 | 88.41 | 0.63 | 1.32 |
| Weight gain/day (g) | 28.18 | 31.91 | 32.46 | 34.37 | 29.52 | 31.51 | 30.56 | 35.23 | 0.30 | 0.57 |
| Feed conversion ratio | 2.50 | 2.21 | 2.20 | 2.60 | 2.34 | 2.12 | 2.23 | 2.52 | 0.78 | 0.46 |
| Cost of feed/kg (₦) | 190.00 | 190.00 | 190.00 | 190.00 | 193.00 | 193.00 | 193.00 | 193.00 | - | - |
| Cost of feed consumed (₦) | 283.10 | 281.10 | 288.00 | 383.70 | 300.70$^{b}$ | 297.40$^{b}$ | 276.20$^{b}$ | 377.50$^{a}$ | 0.03 | 5.30 |
| Cost of gain/Kg (₦) | 712.40 | 640.00 | 631.00 | 1005.00 | 701.50 | 650.80 | 616.50 | 952.30 | 0.90 | 37.20 |
| **Realimentation Period (28 days)** | | | | | | | | | | |
| Initial weight (g) | 817.60 | 883.50 | 881.70 | 975.00 | 886.80 | 908.10 | 826.70 | 981.10 | 0.73 | 10.50 |
| Final weight (g) | 1422.20 | 1311.30 | 1474.50 | 1421.60 | 1371.50 | 1358.40 | 1521.00 | 1479.10 | 0.73 | 24.60 |
| Feed intake/day (g) | 100.24 | 91.18 | 91.81 | 98.58 | 96.12 | 90.98 | 94.09 | 96.98 | 0.34 | 0.83 |
| Weight gain/day (g) | 22.87 | 20.69 | 28.54 | 25.37 | 22.37 | 22.88 | 29.91 | 28.57 | 0.87 | 0.99 |
| Feed conversion ratio | 4.80 | 4.73 | 3.38 | 3.97 | 4.72 | 4.11 | 3.40 | 3.43 | 0.83 | 0.18 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of feed/kg (₦) | 190.00 | 190.00 | 190.00 | 190.00 | 193.00 | 193.00 | 193.00 | 193.00 | - | - |
| Cost of Feed Consumed (₦) | 530.90 | 482.90 | 487.50 | 530.60 | 513.00 | 488.90 | 505.60 | 530.77 | 0.40 | 4.73 |
| Cost of gain/kg (₦) | 252.80 | 230.60 | 165.90 | 210.00 | 243.10 | 201.70 | 173.40 | 197.77 | 0.80 | 11.40 |

SEM = Standard error of mean

### 4.4 Interactive effect between levels of phytobiotics and feed access time on growth

The interactive effect of level used and feed access time on growth performance of broiler chickens during restriction and realimentation period is shown in Table 5. All parameters measured were significantly ($p<0.05$) affected both at restriction and realimentation period except ($p>0.5$) the cost parameter during the restriction period.

The highest final weight (987.50g), daily weight gain (34.84g) and best feed conversion ratio was observed at 4 hours feed access time. Also, the highest cost of gain per kg was seen at 2.5% level of use 16 hours feed access time. During re alimentation period, the highest final weight (1587.80) and daily weight (33.63) were recorded at 12 hours feed access time, 0% level of used. The highest feed consumed was recorded at 0% of use 16 hours feed access time, while the highest cost of gain per kg (₦282.00) was seen at 0% level of use and 4 hours feed access time. The cost of gain per kg was found to be significantly ($p<0.05$) affected due to the interactive effect of level and feed access time.

**Table 5: Interactive effect of phytobiotic level used and feed access time on growth performance and cost benefits of broiler chickens**

| | **0%** | | | | **2.5%** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| **Restriction Period (21 days)** | | | | | | | | | | |
| Initial weight (g) | 212.41 | 192.96 | 186.67 | 204.07 | 184.63 | 193.33 | 185.37 | 193.75 | 0.18 | 2.49 |
| Final weight (g) | 987.50$^{a}$ | 938.10$^{abc}$ | 820.00$^{cd}$ | 974.60$^{ab}$ | 716.90$^{d}$ | 853.50$^{bc}$ | 888.30$^{abc}$ | 981.50$^{ab}$ | 0.02 | 16.00 |
| Feed intake/day (g) | 69.92$^{bc}$ | 69.52$^{bc}$ | 68.57$^{bc}$ | 89.84$^{a}$ | 65.24$^{c}$ | 68.81$^{bc}$ | 70.32 | 87.46$^{b}$ | 0.03 | 1.32 |
| Weight gain/day (g) | 33.65$^{a}$ | 33.02$^{a}$ | 30.16$^{b}$ | 34.76$^{b}$ | 24.05$^{b}$ | 30.40$^{b}$ | 32.86$^{a}$ | 34.84$^{a}$ | 0.01 | 0.57 |
| Feed conversion ratio | 2.08$^{c}$ | 2.11$^{c}$ | 2.28$^{bc}$ | 2.61$^{ab}$ | 2.75$^{a}$ | 2.28$^{c}$ | 2.15$^{c}$ | 2.52$^{bc}$ | 0.03 | 0.46 |
| Cost of feed/kg (₦) | 182.00 | 182.00 | 182.00 | 180.20 | 201.00 | 201.00 | 201.00 | 201.00 | - | - |
| Cost of feed consumed (₦) | 293.20 | 205.10 | 262.10 | 362.40 | 290.60 | 301.40 | 302.20 | 398.80 | 0.50 | 5.33 |
| Cost of gain/kg (₦) | 610.10 | 601.00 | 598.10 | 946.20 | 803.80 | 689.70 | 649.40 | 1011.70 | 0.50 | 5.60 |
| **Realimentation Period(28 days)** | | | | | | | | | | |
| Initial weight (g) | 212.41 | 192.96 | 186.67 | 204.07 | 184.63 | 193.33 | 185.37 | 193.75 | 0.52 | 10.50 |
| Final weight (g) | 1214.00$^{c}$ | 1344.10$^{abc}$ | 1587.80$^{a}$ | 1505.70$^{ab}$ | 1579.70$^{ab}$ | 1325.60$^{bc}$ | 1407.70$^{abc}$ | 1395.00$^{abc}$ | 0.01 | 24.60 |
| Feed intake/day (g) | 93.15$^{abc}$ | 90.21$^{c}$ | 92.67$^{bc}$ | 99.62$^{ab}$ | 103.20$^{a}$ | 91.94$^{bc}$ | 93.23$^{abc}$ | 95.93$^{abc}$ | 0.02 | 0.83 |
| Weight gain/day (g) | 16.13$^{c}$ | 22.39$^{bc}$ | 33.63$^{a}$ | 29.15$^{ab}$ | 29.11$^{abc}$ | 21.18$^{bc}$ | 24.82$^{abc}$ | 24.87$^{abc}$ | 0.01 | 0.99 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Feed conversion ratio | 5.82[a] | 4.17[ab] | 2.82[b] | 3.49[ab] | 3.70[ab] | 4.68[ab] | 3.96[ab] | 3.91[ab] | 0.04 | 0.18 |
| Cost of feed/kg (₦) | 182.00 | 182.00 | 182.00 | 182.00 | 201.00 | 201.10 | 201.10 | 201.10 | - | - |
| Cost of feed consume (₦) | 480.70 | 459.70 | 466.90 | 575.70 | 569.10 | 572.10 | 526.40 | 545.70 | 0.30 | 9.46 |
| Cost of gain/kg (₦) | 282.00[a] | 191.30[abc] | 132.40[c] | 177.10[bc] | 213.90[bc] | 240.90[ab] | 206.80[abc] | 212.60[abc] | 0.02 | 22.8 |

### 4.5 Interactive effect of Phytobiotics type, level used, and access time on growth performance and cost benefits of broiler chickens

The Interactive effect of Phytobiotics type, level used, and access time on growth performance and cost benefits of broiler chickens is presented in Table 6. All parameters measured during restriction and realimentation period were not significantly (p>0.05) affected. During restriction, the highest final weight (1010.20g) was obtained in garlic at 0% level of used and 4 hours feed access. However, the highest daily weight gain (34.67g) was seen at 16 hours feed access time of ginger at 0% level of used as well as at 12 feed ccess time 2.5% level of use and garlic at 16 hours feed access time 0% level.

The cost of feed consumed (413.0) and cost of gain per kg (1083.30) were found to be the highest at ginger 24 hours feed access time and 2.5% level. During re alimentation period, the highest final weight (1630.40g) was observed at ginger 4 hours Feed Access Time and 2.5% level of used. On the other hand, the highest weight gain (33.63g) was seen in both ginger and garlic at 12 hours feed access time and 0% level. The highest cost of feed consumed (₦584.80) was recorded in ginger at 4 hours feed access time, 0% level of used. While the highest cost of gain per kg (₦282.00) was seen at ginger and garlic at 4 hours feed access time, 0%.

**Table 6: Interactive effect of phytobiotics type, level used, and access time on growth performance and cost benefits of broiler chickens**

| | **Ginger** | | | | | | | | **Garlic** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0** | | | | **2.5** | | | | **0** | | | | **2.5** | | | | | |
| | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| **Restriction** Period (21days) | | | | | | | | | | | | | | | | | | |
| Initial weight (g) | 207.41 | 185.93 | 186.67 | 200.37 | 179.26 | 192.96 | 187.41 | 194.17 | 217.41 | 200.00 | 186.67 | 207.78 | 190.00 | 193.70 | 183.33 | 193.33 | 0.96 | 2.49 |
| Final weight (g) | 954.80 | 905.90 | 820.67 | 958.90 | 670.40 | 861.10 | 943.10 | 861.10 | 1010.20 | 970.40 | 820.00 | 990.40 | 763.30 | 845.90 | 833.30 | 971.90 | 0.54 | 16.00 |
| Feed intake/day (g) | 69.37 | 70.48 | 71.43 | 89.64 | 65.24 | 69.37 | 70.32 | 87.94 | 70.48 | 68.57 | 65.71 | 89.84 | 65.29 | 68.25 | 70.32 | 86.98 | 0.33 | 1.32 |
| Weight gain/day (g) | 33.65 | 33.02 | 30.16 | 34.76 | 22.30 | 30.79 | 34.76 | 33.97 | 33.65 | 33.02 | 30.16 | 34.76 | 25.40 | 30.09 | 30.95 | 35.71 | 0.30 | 0.57 |
| FCR | 2.06 | 2.14 | 2.37 | 2.61 | 2.94 | 2.27 | 2.03 | 2.60 | 2.10 | 2.08 | 2.18 | 2.61 | 2.57 | 2.28 | 2.27 | 2.44 | 0.20 | 0.46 |
| Cost of feed/kg (₦) | 182.00 | 182.00 | 182.00 | 182.00 | 198.00 | 198.00 | 198.00 | 198.00 | 182.00 | 182.00 | 182.00 | 182.00 | 204.00 | 204.00 | 204.00 | 204.00 | - | - |
| Cost of feed consumed (₦) | 284.50 | 279.00 | 273.00 | 356.20 | 281.60 | 299.30 | 303.10 | 413.0 | 301.90 | 291.20 | 251.20 | 368.70 | 299.60 | 303.60 | 301.20 | 386.20 | 0.18 | 15.1 |
| Cost of gain/kg | 587.70 | 595.80 | 647.70 | 928.00 | 837.00 | 68420 | 614.30 | 1083.30 | 632.5 | 606.30 | 578.50 | 964.40 | 770.50 | 695.30 | 684.50 | 940.20 | 0.3 | 14.40 |
| **Realimentation** Period (28day) | | | | | | | | | | | | | | | | | | |
| Initial weight | 207.41 | 185.93 | 186.67 | 200.37 | 179.26 | 192.96 | 187.41 | 194.17 | 217.41 | 200.00 | 186.67 | 207.78 | 190.00 | 193.70 | 183.33 | 193.33 | 0.92 | 10.50 |
| Final weight | 1214.00 | 1344.10 | 1587.80 | 1505.70 | 1630.40 | 1278.60 | 1361.10 | 1337.50 | 1214.00 | 1344.10 | 1587.80 | 1505.70 | 1529.10 | 1372.60 | 1454.30 | 1452.50 | 0.73 | 24.60 |
| Feed intake/day | 91.15 | 90.87 | 92.06 | 99.62 | 107.32 | 91.48 | 91.01 | 97.53 | 93.15 | 89.56 | 92.75 | 99.62 | 99.08 | 92.41 | 95.45 | 94.33 | 0.29 | 0.83 |
| Weight gain/day | 16.13 | 22.39 | 33.63 | 29.15 | 29.61 | 19.00 | 23.45 | 21.58 | 16.13 | 22.39 | 33.63 | 29.15 | 28.61 | 23.36 | 26.19 | 27.89 | 0.87 | 0.99 |
| FCR | 5.82 | 4.19 | 2.82 | 3.49 | 3.78 | 5.27 | 3.94 | 4.46 | 5.82 | 4.14 | 2.82 | 3.49 | 3.62 | 4.09 | 3.98 | 3.36 | 0.86 | 0.18 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cost of feed/kg (₦) | 182.00 | 182.00 | 182.00 | 182.00 | 198.00 | 198.00 | 198.00 | 198.00 | 182.00 | 182.00 | 182.00 | 182.00 | 204.00 | 204.00 | 204.00 | 204.00 | - | - |
| Cost of feed consumed (₦) | 480.00 | 463.00 | 466.60 | 575.70 | 584.80 | 502.80 | 508.50 | 545.50 | 480.60 | 456.30 | 467.20 | 515.70 | 553.40 | 521.40 | 544.00 | 545.80 | 0.32 | 13.40 |
| Cost of gain/kg | 282.00 | 194.20 | 132.30 | 177.10 | 223.60 | 267.00 | 199.50 | 243.00 | 282.00 | 188.50 | 132.60 | 177.10 | 204.10 | 214.90 | 214.90 | 182.30 | 0.85 | 3.23 |

### 4.6 Main effects of phytobiotics type, levels of inclusion, and feed access time on haematological parameters on growth performance and cost benefits of broiler chickens

The main effects of phytobiotic type, levels of inclusion, and feed access time, on haematological parameters of broiler chickens are shown in Table 7. Heterophils and lymphocytes of the birds were significant ($p<0.05$) influenced by level of inclusion of phytobiotics. Other parameters were not significantly ($p>0.05$) influenced. Birds fed diet without phytobiotics (0%) had higher value (30.21%) of heterophilis while those fed diets containing 2.5% of the phytobiotics had higher Lymphocytes value (69.17%). Other parameters were not influenced by level of inclusion of phytobiotics. Phytobiotic type and feed access time did not have any significant ($p>0.05$) effect on all parameter measure.

**Table 7: Main effects of phytobiotics type, levels of inclusion, and feed access time on haematological parameters of broiler chickens**

| | Phytobiotic type | | | Levels of inclusion, % | | | Feed access time, Hr | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ginger | Garlic | P-Value | 0 | 2.5 | P-Value | 4 | 8 | 12 | 16 | P-Value | SEM |
| PCV (%) | 31.35 | 32.21 | 0.33 | 31.60 | 31.96 | 0.69 | 33.17 | 30.38 | 32.58 | 32.00 | 0.10 | 0.43 |
| Hb (g/dl) | 10.81 | 11.05 | 0.45 | 10.96 | 10.88 | 0.78 | 11.33 | 11.02 | 10.81 | 10.76 | 0.42 | 0.15 |
| RBC ($\times 10^6$ /mm$^3$) | 2.81 | 2.90 | 0.51 | 2.88 | 2.83 | 0.68 | 2.90 | 2.87 | 2.94 | 2.71 | 0.61 | 0.05 |
| WBC (%) | 13.91 | 13.79 | 0.82 | 13.73 | 14.05 | 0.64 | 13.83 | 13.69 | 14.05 | 13.83 | 0.97 | 0.22 |
| HET (%) | 29.29 | 29.33 | 0.95 | 30.21$^a$ | 28.42$^b$ | 0.01 | 30.33 | 29.08 | 29.00 | 28.83 | 0.37 | 0.35 |
| LYM (%) | 68.20 | 68.33 | 0.88 | 67.38$^b$ | 69.17$^a$ | 0.03 | 67.33 | 68.67 | 68.33 | 68.75 | 0.58 | 0.41 |
| EOS (%) | 0.96 | 1.04 | 0.69 | 0.88 | 1.13 | 0.24 | 0.75 | 1.17 | 1.00 | 1.08 | 0.53 | 0.09 |
| BAS (%) | 0.88 | 0.79 | 0.64 | 0.88 | 0.79 | 0.64 | 0.92 | 0.75 | 0.92 | 0.75 | 0.83 | 0.00 |
| MCV (FL) | 114.26 | 112.28 | 0.67 | 111.45 | 115.09 | 0.44 | 114.36 | 108.30 | 113.52 | 116.01 | 0.70 | 2.08 |
| MCH (pg) | 39.13 | 38.65 | 0.08 | 38.40 | 0.80 | 0.61 | 39.26 | 38.86 | 37.68 | 39.76 | 0.89 | 0.83 |
| MCHC (g/dl) | 34.13 | 34.38 | 0.87 | 34.47 | 34.18 | 0.68 | 34.19 | 35.64 | 33.28 | 34.18 | 0.68 | 0.35 |
| MONO (%) | 0.88 | 0.79 | 0.64 | 0.88 | 0.79 | 0.64 | 0.92 | 0.75 | 0.92 | 0.75 | 0.83 | 0.08 |

SEM = Standard error of mean

PCV = Packed Cell Volume, HB = Haemoglobin concentration, RBC=Red Blood Cell, WBC = White Blood Cell, HET = Heterophils, LYM= Lymphocytes, EOS = Eosinophils, BAS = Basophils, MONO = monocytes, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration.

### 4.7 Effects of interaction between phytobiotics type and level of inclusion on haematological parameters of broiler chickens

Table 8 shows the effects of interaction between phytobiotics type and level of inclusion on haematological parameters of broiler chickens. None of the parameters measured was significantly ($p>0.05$) affected by the interactive effects of phytobiotic type and level of inclusion.

**Table 8: Effects of interaction between phytobiotics iype and levels of inclusion on haematological parameters of broiler chickens**

| Phytobiotic type | Ginger | | Garlic | | | |
|---|---|---|---|---|---|---|
| **Levels of inclusion, %** | **0** | **2.5** | **0** | **2.5** | **P-Value** | **SEM** |
| PCV (%) | 30.71 | 32.00 | 35.50 | 31.92 | 0.29 | 0.43 |
| Hb (g/dl) | 10.84 | 10.76 | 11.10 | 10.99 | 0.98 | 0.15 |
| RBC ($\times 10^6$ /mm$^3$) | 2.84 | 2.78 | 2.93 | 2.88 | 0.98 | 0.05 |
| WBC (%) | 13.80 | 14.02 | 13.66 | 13.93 | 0.96 | 0.22 |
| HET (%) | 30.33 | 28.25 | 30.08 | 28.58 | 0.66 | 0.35 |
| LYM (%) | 67.33 | 69.08 | 67.42 | 69.25 | 0.96 | 0.41 |
| EOS (%) | 0.83 | 0.21 | 0.92 | 1.17 | 1.00 | 0.09 |
| BAS (%) | 0.75 | 1.00 | 1.00 | 0.58 | 0.07 | 0.00 |
| MCV (FL) | 110.91 | 117.62 | 122.00 | 112.56 | 0.57 | 2.08 |
| MCH (pg) | 38.52 | 39.74 | 32.28 | 29.02 | 0.90 | 0.83 |
| MCHC (g/dl) | 34.74 | 33.79 | 34.20 | 34.56 | 0.36 | 0.35 |
| MONO (%) | 0.75 | 1.00 | 1.00 | 0.58 | 0.07 | 0.08 |

SEM = Standard error of mean
PCV = Packed Cell Volume, HB = Haemoglobin concentration, RBC = Red Blood Cell, WBC = White Blood Cell, HET = Heterophils, EOS = Eosinophils, ELYM = Lymphocytes, BAS = Basophils, MONO = monocytes, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration.

### 4.8 Effects of interaction between phytobiotic type and feed access time on haematological parameters of broiler chickens

The effects of interaction between phytobiotic type and feed access time on haematological parameters of broiler chickens are presented in Table 9. All parameters measured were not significantly (p>0.05) influenced by the type and level of inclusion of phytobiotic.

**Table 9: Effects of interaction between phytobiotic type and feed access time on haematological parameters of broiler Chicken**

| Phytobiotic type | Ginger | | | | Garlic | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Feed access time, hr** | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| PCV (%) | 33.00 | 29.58 | 32.00 | 30.83 | 33.33 | 31.17 | 33.17 | 31.17 | 0.29 | 0.43 |
| Hb (g/dl) | 11.06 | 10.92 | 10.90 | 10.35 | 11.58 | 11.12 | 10.73 | 10.77 | 0.89 | 0.15 |
| RBC ($\times 10^6$ /mm$^3$) | 2.93 | 2.75 | 2.97 | 2.60 | 2.88 | 2.98 | 2.92 | 2.82 | 0.78 | 0.05 |
| WBC (%) | 14.20 | 13.53 | 13.93 | 13.97 | 13.47 | 13.85 | 14.17 | 13.68 | 0.88 | 0.22 |
| HET (%) | 31.17 | 19.33 | 28.67 | 28.00 | 29.50 | 28.83 | 29.33 | 29.67 | 0.33 | 0.35 |
| LYM (%) | 65.83 | 68.17 | 68.83 | 70.00 | 68.83 | 69.17 | 67.83 | 67.50 | 0.09 | 0.41 |
| EOS (%) | 0.83 | 1.17 | 0.83 | 1.00 | 0.67 | 1.17 | 1.17 | 1.17 | 0.85 | 0.09 |
| BAS (%) | 0.86 | 0.75 | 0.82 | 0.73 | 0.90 | 0.70 | 0.91 | 0.72 | 0.80 | 0.00 |
| MCV (FL) | 1.17 | 0.83 | 1.00 | 0.50 | 0.67 | 0.67 | 0.83 | 1.00 | 0.26 | 0.08 |
| MCH (pg) | 113.32 | 111.69 | 111.10 | 120.94 | 114.12 | 105.91 | 115.94 | 111.08 | 0.64 | 2.08 |
| MCHC (g/dl) | 37.99 | 39.82 | 37.60 | 41.11 | 40.53 | 37.89 | 37.76 | 38.41 | 0.77 | 0.83 |
| MONO (%) | 33.59 | 35.61 | 34.08 | 33.78 | 34.79 | 35.68 | 32.48 | 34.58 | 0.51 | 0.35 |

SEM = Standard error of mean

PCV = Packed Cell Volume, HB = Haemoglobin concentration, RBC = Red Blood Cell, WBC = White Blood Cell, HET = Heterophils, LYM = Lymphocytes, EOS = Eosinophils, BAS = Basophils, MONO = Monocytes, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration

### 4.9 Effects of interaction between levels of inclusion and feed access time on haematological parameters of broiler chickens

The effect of interaction between levels and feed access time on haematological parameters of broiler chickens is presented in Table 10. There were no significant (p>0.05) differences in all the parameters measured because of the interaction between level of inclusion and type of phytobiotic.

**Table 10: Effects of interaction between levels of inclusion and feed access time on haematological parameters of broiler chickens**

| Levels of inclusion, % | **0%** | | | | **2.5%** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Feed access time, Hr | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| PCV (%) | 32.67 | 30.75 | 32.83 | 30.17 | 33.67 | 30.00 | 32.33 | 31.83 | 0.72 | 0.43 |
| Hb (g/dl) | 11.20 | 11.17 | 11.10 | 10.43 | 11.45 | 10.87 | 10.53 | 10.68 | 0.76 | 0.15 |
| RBC ($\times 10^6$ /mm$^3$) | 2.28 | 2.97 | 2.97 | 2.72 | 2.93 | 2.77 | 2.92 | 2.70 | 0.92 | 0.50 |
| WBC (%) | 13.82 | 13.30 | 14.22 | 13.58 | 13.85 | 14.08 | 13.88 | 14.07 | 0.87 | 0.22 |
| HET (%) | 30.69 | 29.33 | 30.83 | 30.00 | 30.00 | 28.83 | 27.17 | 27.67 | 0.29 | 0.35 |
| LYM (%) | 67.00 | 68.50 | 66.50 | 67.50 | 67.67 | 68.83 | 70.17 | 70.00 | 0.41 | 0.41 |
| EOS (%) | 0.67 | 1.00 | 1.00 | 0.83 | 0.83 | 1.33 | 1.00 | 1.33 | 0.85 | 0.09 |
| BAS (%) | 0.84 | 0.73 | 0.80 | 0.71 | 0.88 | 0.78 | 0.89 | 0.70 | 0.78 | 0.83 |
| MCV (FL) | 0.83 | 1.00 | 0.83 | 0.83 | 1.00 | 0.59 | 1.00 | 0.68 | 0.05 | 0.08 |
| MCH (pg) | 114.12 | 107.91 | 112.29 | 111.50 | 111.39 | 109.69 | 11.75 | 120.51 | 0.93 | 2.08 |
| MCHC (g/dl) | 39.11 | 37.93 | 37.92 | 38.64 | 39.42 | 39.78 | 37.44 | 40.88 | 0.95 | 0.83 |
| MONO (%) | 34.28 | 35.10 | 33.84 | 34.66 | 34.10 | 36.18 | 32.32 | 33.70 | 0.67 | 0.35 |

SEM = Standard error of means
PCV = Packed Cell Volume, HB = Haemoglobin concentration, RBC = Red Blood Cell, WBC = White Blood Cell, HET = Heterophils, LYM = Lymphocytes, EOS = Eosinophils, BAS = Basophils, MONO = monocytes, MCV=Mean Corpuscular Volume, MCH=Mean Corpuscular Haemoglobin, MCHC=Mean Corpuscular Haemoglobin Concentration.

## 4.10 Effects of interaction among phytobiotic type, levels of inclusion and feed access time on haematological parameters of broiler chickens

The interaction effects of phytobiotic type, levels of inclusion and feed access time on haematological parameters of broiler chickens are shown in Table 11. The interaction among phytobiotic type, levels of inclusion, and feed access time had no significant ($p>0.05$) effect on all parameters measured.

**Table 11: Effects of interaction among phytobiotic type, levels of inclusion and feed access time on haematological parameters of broiler chickens**

| Phytobiotic type | **Ginger** | | | | | | | | **Garlic** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Levels of inclusion, % | **0** | | | | **2.5** | | | | **0** | | | | **2.5** | | | | | |
| Feed access time, Hr | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| PCV (%) | 33.33 | 29.50 | 31.00 | 29.00 | 32.67 | 29.67 | 33.00 | 32.67 | 32.00 | 32.00 | 34.67 | 31.33 | 34.67 | 30.33 | 31.67 | 31.00 | 0.33 | 0.43 |
| Hb (g/dl) | 11.17 | 11.27 | 10.60 | 10.33 | 10.97 | 10.57 | 11.20 | 10.37 | 11.23 | 11.07 | 11.60 | 10.53 | 11.93 | 11.17 | 9.87 | 11.00 | 0.27 | 0.15 |
| RBC ($\times 10^6$/$mm^3$) | 3.07 | 2.80 | 2.87 | 2.63 | 2.80 | 2.70 | 3.07 | 2.57 | 2.70 | 3.13 | 3.07 | 2.80 | 3.07 | 2.83 | 2.77 | 2.83 | 0.48 | 0.05 |
| WBC (%) | 14.57 | 13.47 | 13.33 | 13.87 | 13.83 | 18.63 | 14.53 | 14.07 | 13.07 | 13.17 | 15.10 | 13.30 | 13.87 | 14.53 | 13.23 | 14.07 | 0.34 | 0.22 |
| HET (%) | 32.33 | 29.67 | 30.33 | 29.00 | 30.00 | 29.00 | 27.00 | 27.00 | 29.00 | 29.00 | 31.33 | 31.00 | 30.00 | 28.67 | 27.33 | 28.33 | 0.67 | 0.35 |
| LYM (%) | 64.67 | 68.33 | 67.33 | 69.00 | 67.00 | 68.00 | 70.33 | 71.00 | 69.33 | 69.67 | 65.67 | 66.00 | 68.33 | 69.67 | 70.00 | 69.00 | 0.67 | 0.41 |
| EOS (%) | 0.67 | 0.67 | 1.00 | 1.00 | 1.00 | 1.67 | 0.67 | 1.00 | 0.67 | 1.33 | 1.00 | 0.67 | 0.67 | 1.00 | 1.33 | 1.67 | 0.21 | 0.09 |
| BAS (%) | 0.84 | 0.73 | 0.80 | 0.71 | 0.88 | 0.78 | 0.89 | 0.70 | 0.82 | 0.72 | 0.81 | 0.73 | 0.75 | 0.83 | 0.91 | 0.90 | 0.78 | 0.00 |
| MCV (FL) | 1.00 | 1.00 | 0.67 | 0.33 | 1.33 | 0.67 | 1.33 | 0.67 | 0.67 | 1.00 | 1.00 | 1.33 | 0.63 | 0.33 | 0.67 | 0.67 | 0.83 | 0.08 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MCH (pg) | 109.67 | 113.02 | 109.72 | 111.21 | 116.97 | 110.97 | 111.48 | 130.66 | 118.57 | 102.79 | 114.86 | 11.79 | 113.81 | 109.03 | 117.02 | 110.36 | 0.69 | 2.08 |
| MCHC (g/dl) | 36.65 | 40.30 | 37.44 | 39.69 | 39.34 | 39.33 | 37.76 | 42.53 | 41.57 | 35.56 | 38.40 | 37.59 | 39.49 | 40.23 | 37.12 | 39.24 | 0.81 | 0.83 |
| MONO (%) | 33.48 | 35.63 | 34.18 | 35.65 | 33.69 | 35.58 | 33.89 | 31.92 | 35.68 | 34.57 | 33.49 | 33.68 | 34.50 | 36.78 | 31.47 | 35.49 | 0.26 | 0.35 |

SEM = Standard error of mean
PCV = Packed Cell Volume, HB = Haemoglobin, RBC = Red Blood Cell, WBC = White Blood Cell, HET = Heterophils, LYM = Lymphocytes, EOS = Eosinophils, BAS = Basophils, MONO = Monocytes, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration.

### 4.11 Main effects of phytobiotic type, levels of inclusion, and feed access time on serum biochemical indices of broiler chickens

The main effects of phytobiotic type, levels of inclusion, and feed access time on serum biochemical indices of broiler chickens are shown in Table 12. Total protein was found to be significantly different ($p<0.05$) because of phytobiotic type (ginger and garlic). Furthermore, high density lipoprotein, low density lipoprotein and total cholestrol were found to be significantly ($p<0.05$) different because of the effect of feed access time (at 4, 8, 12, and 16 hr, respectively).

**Table 12: Main effects of Phytobiotic Type, levels of inclusion and feed access time on serum biochemical indices of broiler Chickens**

| | Phytobiotic type | | | Levels of inclusion, % | | | Feed access time, hr | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ginger | Garlic | P-Value | 0 | 2.5 | P-Value | 4 | 8 | 12 | 16 | P-Value | SEM |
| Total protein (g/dl) | 6.75[b] | 7.00[a] | 0.03 | 6.92 | 6.82 | 0.40 | 6.90 | 6.72 | 7.06 | 6.81 | 0.26 | 0.06 |
| Albumin (g/dl) | 3.81 | 3.92 | 0.24 | 3.87 | 3.87 | 1.00 | 3.98 | 3.81 | 3.83 | 3.84 | 0.59 | 0.04 |
| Globulin (g/dl) | 2.93 | 3.08 | 0.36 | 3.06 | 2.95 | 0.51 | 2.92 | 2.90 | 3.23 | 2.98 | 0.46 | 0.07 |
| Triglyceride (g/dl) | 97.20 | 113.40 | 0.49 | 118.40 | 92.30 | 0.27 | 115.00 | 136.10 | 95.70 | 74.60 | 0.29 | 11.00 |
| HDL (g/dl) | 61.64 | 66.90 | 0.44 | 64.97 | 63.57 | 0.83 | 60.67[ab] | 82.02[a] | 61.54[ab] | 52.85[b] | 0.03 | 3.62 |
| VLDL (g/dl) | 19.44 | 22.68 | 0.49 | 23.67 | 27.21 | 0.23 | 22.99 | 27.21 | 19.14 | 14.91 | 0.29 | 2.20 |
| LDL (g/dl) | 31.22 | 38.99 | 0.08 | 35.64 | 34.57 | 0.80 | 35.15[ab] | 46.71[a] | 31.08[ab] | 27.48[b] | 0.02 | 3.30 |
| Total Cholesterol (g/dl) | 111.80 | 128.57 | 0.08 | 124.28 | 116.09 | 0.38 | 118.81[b] | 152.94[a] | 111.77[b] | 95.23[b] | 0.01 | 6.59 |

SEM = Standard error of mean
HDL = High density lipoprotein, VLDL = Very low-density lipoprotein, LDL = Low density lipoprotein,

### 4.12 The effects of interaction between phytobiotic type and levels of inclusion on serum biochemical indices of broiler chickens

The effects of interaction between phytobiotic type and levels of inclusion on serum biochemical indices of broiler chickens are presented in Table 13. Significant ($p<0.5$) variation was recorded in total protein as a result of interaction between phytobiotic types and level of inclusion. The total protein values were different only between birds fed diet containing 2.5 ginger and those fed diets containing 2.5% garlic.

**Table 13: Effects of interaction between phtyobiotics type and levels of inclusion on serum biochemical indices of broiler chickens**

| | Ginger | | Garlic | | | |
|---|---|---|---|---|---|---|
| | 0 | 2.5 | 0 | 2.5 | P-Value | SEM |
| Total protein (g/dl) | 6.94$^{ab}$ | 6.57$^{b}$ | 6.93$^{ab}$ | 7.08$^{a}$ | 0.04 | 0.06 |
| Albumin (g/dl) | 3.87 | 3.76 | 3.87 | 3.98 | 0.24 | 0.04 |
| Globulin (g/dl) | 3.06 | 2.81 | 3.06 | 3.10 | 0.36 | 0.07 |
| Triglyceride (g/dl) | 118.40 | 76.10 | 118.40 | 108.50 | 0.49 | 11.00 |
| HDL (g/dl) | 64.97 | 58.31 | 64.97 | 68.82 | 0.44 | 3.62 |
| VLDL (g/dl) | 23.67 | 15.22 | 23.67 | 21.70 | 0.49 | 2.20 |
| LDL (g/dl) | 35.64 | 26.80 | 35.64 | 42.33 | 0.08 | 3.30 |
| Total Cholesterol (g/dl) | 124.28 | 99.33 | 124.28 | 132.86 | 0.08 | 6.59 |

$^{a,b}$Means on the same row having different superscript are significantly ($p<0.05$) difference
SEM = Standard error of mean
HDL = High density lipoprotein, VLDL = Very low density lipoprotein, LDL = Low density lipoprotein

### 4.13 Effects of interaction between phytobiotic type and feed access time on

**serum biochemical indices of broiler chickens**

The effects of interaction between phytobiotic type and feed access time on serum biochemical indices of broiler chickens is shown on Table 14. Low density lipoprotein and total cholesterol values were found to be significantly different ($p<0.05$) as a result of interactions between the phytobiotic type and feed access time. Value recorded for other parameters measured were not significant ($p>0.05$) different

**Table 14: Effects of interaction between phytobiotic type and feed access time on serum biochemical indices of broiler chicken**

| | Ginger | | | | Garlic | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | P-Value | SEM |
| Total protein (g/dl) | 6.70 | 6.68 | 6.93 | 6.67 | 7.10 | 6.75 | 7.18 | 6.97 | 0.81 | 0.06 |
| Albumin (g/dl) | 3.85 | 3.68 | 3.82 | 3.90 | 4.10 | 3.95 | 3.95 | 3.85 | 0.39 | 0.04 |
| Globulin (g/dl) | 2.85 | 3.00 | 3.12 | 2.77 | 3.00 | 2.80 | 3.33 | 3.18 | 0.58 | 0.07 |
| Triglyceride (g/dl) | 120.10 | 119.20 | 82.30 | 65.30 | 109.90 | 152.90 | 107.20 | 83.80 | 0.92 | 11.00 |
| HDL (g/dl) | 67.98 | 70.97 | 54.27 | 53.35 | 53.35 | 93.08 | 68.82 | 52.35 | 0.23 | 3.62 |
| VLDL (g/dl) | 24.02 | 23.83 | 16.85 | 13.07 | 21.97 | 30.58 | 21.43 | 16.75 | 0.92 | 2.20 |
| LDL (g/dl) | $39.78^{ab}$ | $27.70^{b}$ | $31.37^{b}$ | $26.03^{c}$ | $30.52^{b}$ | $65.72^{a}$ | $30.80^{b}$ | $28.92^{b}$ | 0.03 | 3.30 |
| Total cholesterol (g/dl) | $131.80^{ab}$ | $120.50^{b}$ | $102.50^{b}$ | $92.50^{b}$ | $105.80^{b}$ | $189.40^{a}$ | $121.10^{b}$ | $98.00^{b}$ | 0.03 | 6.59 |

$^{abc}$Means on the same row having different superscript are significantly ($p<0.05$)
SEM = Standard error of means
LDL = Low density lipoprotein, VLDL = very low-density lipoprotein, HDL=High density lipoprotein.

### 4.1.4 Effects of interaction between level of inclusion on feed access time on serum biochemical indices of broiler chicken

The interactive effects of levels of inclusion and feed access time on serum biochemical indices of broiler chickens are presented in Table 15. Among all the parameters measured, only Low Density Lipoprotein (LDL) was found to be significantly influenced by ($p<0.05$) the interaction between phytobiotic inclusion level and feed access time.

**Table 15: Effects of interaction between levels of inclusion and feed access time on serum biochemical indices of broiler chickens**

| | **0** | | | | **2.5** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **4** | **8** | **12** | **16** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| Total protein (g/dl) | 6.97 | 6.73 | 6.97 | 7.03 | 6.83 | 6.70 | 7.15 | 6.60 | 0.35 | 0.06 |
| Albumin (g/dl) | 3.83 | 3.87 | 3.90 | 3.87 | 4.12 | 3.77 | 3.77 | 3.82 | 0.36 | 0.04 |
| Globulin (g/dl) | 3.13 | 2.87 | 3.07 | 3.17 | 2.72 | 2.93 | 3.38 | 2.78 | 0.29 | 0.07 |
| Triglyceride (g/dl) | 148.20 | 167.90 | 72.90 | 84.50 | 81.80 | 104.20 | 118.60 | 64.70 | 0.29 | 11.00 |
| HDL (g/dl) | 63.27 | 78.27 | 70.37 | 48.00 | 58.07 | 85.78 | 52.72 | 57.70 | 0.45 | 3.62 |
| VLDL (g/dl) | 29.63 | 33.57 | 14.57 | 16.90 | 16.35 | 20.85 | 23.72 | 12.92 | 0.29 | 2.20 |
| LDL (g/dl) | $37.73^{a}$ | $29.73^{b}$ | $43.40^{a}$ | $31.70^{b}$ | $32.57^{b}$ | $63.68^{a}$ | $18.77^{b}$ | $23.25^{b}$ | 0.00 | 3.30 |
| Total cholesterol (g/dl) | 130.60 | 141.60 | 128.30 | 96.60 | 107.00 | 168.30 | 95.20 | 93.90 | 0.13 | 6.59 |

$^{a,b}$Means on the same row having different superscript are significantly (p<0.05)
SEM = Standard error of mean
HDL = High density lipoprotein, VLDL = Very low density lipoprotein, LDL = Low density lipoprotein,

## 4.15 Effects of interaction between phytobiotic type, levels of inclusion and feed access time on serum biochemical indices of broiler chickens

The effects of interaction between phytobiotic type, levels of inclusion and feed access time on serum biochemical indices of broiler chickens is presented on Table 16. The interaction had significant effect (p<0.05) on Low density lipoprtain and Cholestrol while other parameters were not significantly affected. The highest total protein value recorded 7.40 (g/dl) was from birds on 2.5% level of used (garlic) at 12hrs feed access time, and the lowest value 6.30 (g/dl) recorded was from the birds on 2.5% levels of inclusion at 16 hrs feed access time.

The highest Albumin value 4.03 (g/dl) recorded at 2.5% level of used (garlic) at 8hrs feed access time, while the highest Globulin value 3.60 (g/dl) is at 12hrs feed access time, 2.5% level (garlic).

**Table 16: Effects of interaction between photobiotic type, levels of inclusion and feed access time on serum biochemical indices of broiler chickens**

| | Ginger | | | | | | | | Garlic | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | 2.5 | | | | 0 | | | | 2.5 | | | | | |
| | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | P-Value | SEM |
| Total protein (g/dl) | 6.97 | 6.73 | 6.97 | 7.03 | 6.43 | 6.63 | 6.90 | 6.30 | 6.97 | 6.73 | 6.97 | 7.03 | 7.23 | 6.77 | 7.40 | 7.03 | 0.81 | 0.06 |
| Albumin (g/dl) | 3.83 | 3.87 | 3.90 | 3.87 | 3.87 | 3.50 | 3.73 | 3.93 | 3.83 | 3.87 | 3.90 | 3.87 | 4.37 | 4.03 | 3.80 | 3.70 | 0.39 | 0.04 |
| Globulin (g/dl) | 3.13 | 2.87 | 3.07 | 3.17 | 2.57 | 3.13 | 2.57 | 2.37 | 3.13 | 2.87 | 3.07 | 3.17 | 2.87 | 2.73 | 3.60 | 3.20 | 0.58 | 0.07 |
| Triglyceride (g/dl) | 148.20 | 167.90 | 72.90 | 84.50 | 92.00 | 70.50 | 95.80 | 46.20 | 148.20 | 167.90 | 72.90 | 84.50 | 71.50 | 137.90 | 141.40 | 83.10 | 0.92 | 11.00 |
| HDL (g/dl) | 63.30 | 78.30 | 70.40 | 48.00 | 72.70 | 63.70 | 38.20 | 58.70 | 63.30 | 78.30 | 70.40 | 48.00 | 43.30 | 107.90 | 67.30 | 56.70 | 0.23 | 3.62 |
| VLDL (g/dl) | 29.63 | 33.57 | 14.57 | 16.90 | 18.40 | 14.10 | 19.13 | 9.23 | 29.63 | 33.57 | 14.57 | 16.90 | 14.30 | 27.60 | 28.30 | 16.60 | 0.92 | 2.20 |
| LDL (g/dl) | $37.73^{b}$ | $29.73^{b}$ | $43.40^{b}$ | $31.70^{b}$ | $41.83^{a}$ | $25.67^{b}$ | $19.33^{b}$ | $20.30^{ab}$ | $37.73^{b}$ | $29.73^{b}$ | $43.40^{a}$ | $31.70^{b}$ | $23.30^{b}$ | $101.70^{a}$ | $18.20^{b}$ | $26.13^{b}$ | 0.003 | 3.30 |
| Cholesterol (g/dl) | $130.60^{b}$ | $141.60^{ab}$ | $128.50^{a}$ | $96.60^{b}$ | $132.90^{b}$ | $99.40^{b}$ | $76.60^{b}$ | $88.30^{b}$ | $130.60^{b}$ | $141.60^{ab}$ | $128.30^{b}$ | $96.60^{b}$ | $81.00^{b}$ | $237.20^{a}$ | $113.80^{b}$ | $99.40^{b}$ | 0.01 | 6.59 |

$^{abc}$Means on the same row having different superscript are significantly (p<0.05) difference
SEM = Standard error of mean
HDL=High density lipoprotein, VLDL=very low-density lipoprotein, LDL = low density lipoprotein

## 4.16 Main effect of phytobiotic type, levels of inclusion, and feed access time on carcass characteristics of broiler chickens

The main effect of phytobiotic type, levels of inclusion and feed access time on carcass characteristics of broiler chickens is shown in Table 17.

The live weight was found to be significantly different ($p<0.05$) because of feed access time, higher live weight value was recorded for birds given 16 hours of feed access time than others allowed lower feed access time while the wing was also significant ($p<0.05$) due to the effect of phytobiotic type and levels of inclusion. The relative weight of wing was signifantly ($p<0.05$) influenced by phytogenic type and inclusion level. Birds that received dietary inclusion of garlic had lower relative wing weight than those that were fed diet containing ginger. Also, inclusion of 2.5% phytobiotic gave higher relative weight of wing in birds. On the other hand, the main effect of phytobiotic type, levels of inclusion, and feed access time had a significant difference ($p<0.05$) on the breast and lung. The proventriculus was also significant ($p<0.05$) due to the effect of phytobiotic type and levels of inclusion only. The wing, shank, liver and intestine were significantly ($p>0.05$) influence by effect of feed access time.

**Table 17: Main effect of phytobiotics type, levels of inclusion, and feed access time on carcass characteristics of broiler chickens**

| | Phytobiotic type | | | Inclusion level | | | Feed access time | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ginger** | **Garlic** | **P-Value** | **0** | **2.5** | **P-Value** | **4** | **8** | **12** | **16** | **P-Value** | **SEM** |
| Live Weight (g) | 1433.30 | 1491.70 | 0.38 | 1475.00 | 1450.00 | 0.71 | 1408.30$^{b}$ | 1366.70$^{b}$ | 1408.30$^{b}$ | 1666.70$^{a}$ | 0.01 | 33.60 |
| Dress Weight (g) | 72.60 | 68.82 | 0.06 | 69.12 | 72.31 | 0.11 | 70.19 | 69.36 | 70.33 | 72.23 | 0.76 | 1.06 |
| Eviscrated Weight (g) | 60.46 | 58.11 | 0.57 | 60.14 | 58.44 | 0.68 | 50.97 | 60.50 | 61.28 | 64.41 | 0.13 | 2.03 |
| Pluck Weight (g) | 84.55 | 83.24 | 0.76 | 80.19 | 87.60 | 0.09 | 87.52 | 76.67 | 85.17 | 85.64 | 0.28 | 2.18 |
| Neck (%) | 4.41 | 4.39 | 0.94 | 4.44 | 4.35 | 0.76 | 4.29 | 4.56 | 4.21 | 4.51 | 0.76 | 0.12 |
| Wing (%) | 8.07$^{a}$ | 7.39$^{b}$ | 0.02 | 7.43$^{b}$ | 8.03$^{a}$ | 0.04 | 8.04$^{a}$ | 7.90$^{b}$ | 7.96$^{b}$ | 7.02$^{c}$ | 0.03 | 0.16 |
| Thigh (%) | 9.88$^{a}$ | 9.3$^{b}$ | 0.02 | 9.23$^{b}$ | 10.03$^{a}$ | 0.02 | 9.83 | 9.39 | 9.46 | 9.85 | 0.57 | 0.17 |
| Head (%) | 2.76 | 2.66 | 0.33 | 2.67 | 2.75 | 0.38 | 2.78 | 2.67 | 2.87 | 2.51 | 0.07 | 0.51 |
| Shank (%) | 4.12 | 3.92 | 0.47 | 4.02 | 4.02 | 1.00 | 4.25$^{b}$ | 3.98$^{c}$ | 4.50$^{a}$ | 3.35$^{bc}$ | 0.03 | 0.14 |
| Drum Stick (%) | 10.49 | 10.07 | 0.14 | 10.14 | 10.42 | 0.34 | 10.31 | 9.97 | 10.45 | 10.39 | 0.63 | 0.15 |
| Breast (%) | 18.92$^{a}$ | 17.37$^{b}$ | 0.02 | 17.37$^{b}$ | 17.37$^{b}$ | 0.03 | 17.28$^{b}$ | 17.53$^{b}$ | 17.58$^{b}$ | 20.21$^{a}$ | 0.01 | 0.39 |
| Back (%) | 12.38 | 12.50 | 0.79 | 12.27 | 12.62 | 0.43 | 12.84 | 12.33 | 11.95 | 12.66 | 0.50 | 0.20 |
| Liver (%) | 1.90 | 1.83 | 0.23 | 1.84 | 1.90 | 0.43 | 2.10$^{a}$ | 1.90$^{ab}$ | 1.81$^{bc}$ | 1.61$^{c}$ | 0.03 | 0.49 |
| Heart (%) | 0.42 | 0.43 | 0.72 | 0.40 | 0.45 | 0.14 | 0.45 | 0.41 | 0.42 | 0.41 | 0.69 | 0.13 |
| Spleen (%) | 0.07 | 0.08 | 0.12 | 0.08 | 0.82 | 0.45 | 0.08 | 0.08 | 0.08 | 0.07 | 0.85 | 0.003 |
| Intestine (%) | 6.60 | 7.19 | 0.12 | 7.14 | 6.66 | 0.20 | 7.49$^{a}$ | 6.66$^{c}$ | 7.36$^{b}$ | 6.08$^{bc}$ | 0.04 | 0.20 |
| Proventriculus (%) | 0.23$^{b}$ | 0.56$^{a}$ | 0.00 | 0.52$^{a}$ | 0.28$^{b}$ | 0.02 | 0.42 | 0.40 | 0.41 | 0.37 | 0.36 | 0.04 |
| Gizzard (%) | 3.19 | 3.11 | 0.68 | 3.17 | 3.13 | 0.85 | 3.26 | 3.02 | 3.28 | 3.04 | 0.63 | 0.08 |
| Lungs (%) | 0.26$^{b}$ | 0.50$^{a}$ | 0.00 | 0.51$^{a}$ | 0.26$^{b}$ | 0.00 | 0.41$^{ab}$ | 0.44$^{a}$ | 0.39$^{ab}$ | 0.29$^{b}$ | 0.02 | 0.37 |

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

### 4.17 The effects of interaction between phytobiotic type and levels of inclusion on carcass characteristics of broiler chickens

The effects of interaction between phytobiotic type and levels of inclusion on carcass characteristics of broiler chickens is presented in Table 18. The interactive effects of phytobiotic type and level of inclusion had significant ($p<0.05$) effect on the thigh, intestine, gizzard and lung, while other parameters measured were not significantly difference. The highest value (1500g) of live weight recorded was at 2.5% level of used (garlic) while the lowest value (1400g) was recorded at 2.5% level of used (ginger).

**Table 18: Effects of interaction between phytobiotic type and levels of inclusion on carcass characteristics of broiler chickens**

| | **Ginger** | | **Garlic** | | | |
|---|---|---|---|---|---|---|
| | **0** | **2.5** | **0** | **2.5** | **P-Value** | **SEM** |
| Live Weight (g) | 1466.70 | 1400.00 | 1483.30 | 1500.00 | 0.53 | 33.60 |
| Dress Weight (%) | 69.08 | 76.12 | 69.15 | 68.49 | 0.06 | 1.06 |
| Eviscrated Weight (%) | 62.15 | 58.28 | 53.13 | 58.10 | 0.68 | 2.18 |
| Pluck Weight (%) | 76.75 | 92.36 | 83.64 | 82.82 | 0.06 | 2.03 |
| Neck (%) | 4.47 | 4.34 | 4.41 | 4.36 | 0.88 | 0.12 |
| Wing (%) | 7.73 | 8.41 | 7.14 | 7.65 | 0.75 | 0.16 |
| Thigh (%) | $9.00^{b}$ | $10.77^{a}$ | $9.46^{b}$ | $9.30^{b}$ | 0.01 | 0.17 |
| Head (%) | 2.68 | 2.84 | 2.66 | 2.67 | 0.40 | 0.05 |
| Shank (%) | 4.13 | 4.10 | 3.91 | 3.93 | 0.93 | 0.14 |
| Drum Stick %) | 10.18 | 10.80 | 10.10 | 10.03 | 0.23 | 0.15 |
| Breast (%) | 12.00 | 12.77 | 12.53 | 12.47 | 0.34 | 0.20 |
| Back (%) | 1.84 | 2.00 | 1.84 | 1.81 | 0.21 | 0.49 |
| Liver (%) | 0.39 | 0.45 | 0.42 | 0.44 | 0.56 | 0.12 |
| Heart (%) | 0.06 | 0.08 | 0.09 | 0.08 | 0.40 | 0.003 |
| Spleen (%) | 7.04 | 6.16 | 7.24 | 7.15 | 0.29 | 0.20 |
| Intestine (%) | $0.47^{b}$ | $0.45^{c}$ | $0.57^{a}$ | $0.56^{a}$ | 0.02 | 0.35 |
| Proventriculus (%) | 3.22 | 3.15 | 3.11 | 3.14 | 0.63 | 0.08 |
| Gizzard (%) | $0.52^{a}$ | $0.50^{b}$ | $0.49^{a}$ | $0.51^{b}$ | 0.01 | 0.03 |
| Lungs (%) | $17.29^{b}$ | $20.56^{a}$ | $17.55^{b}$ | $17.19^{b}$ | 0.01 | 0.39 |

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

### 4.18 Effects of interaction between phytobiotic type and feed access time on carcass characteristics of broiler chickens

The effects of interaction between phytobiotic type and feed access time on carcass characteristics of broiler chickens is shown in Table 19. Among all the parameters measured, only the gizzard was significantly ($p<0.05$) affected by the interaction between phytobiotic type and feed access time. Birds fed diets containing garlic and allowed 4, 8, or 12 hours of feed access had higher gizzard value than birds in other treatment groups.

**Table 19: Effects of interaction between phytobiotic type and feed access time on carcass characteristic of broiler chicken**

| | Ginger | | | | Garlic | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | P-Value | SEM |
| Live weight (g) | 1350.00 | 1300.00 | 1416.70 | 1666.70 | 1466.70 | 1433.30 | 1400.00 | 1666.70 | 0.79 | 33.60 |
| Dress weight (%) | 72.19 | 71.51 | 72.88 | 73.81 | 69.63 | 67.21 | 67.78 | 70.65 | 0.97 | 1.06 |
| Eviscrated weight (%) | 43.58 | 64.42 | 66.47 | 67.38 | 58.35 | 56.58 | 56.08 | 61.44 | 0.13 | 2.18 |
| Pluck weight (%) | 90.57 | 72.46 | 88.52 | 86.72 | 84.52 | 80.87 | 83.02 | 84.55 | 0.60 | 2.03 |
| Neck (%) | 4.16 | 4.75 | 4.53 | 4.18 | 4.42 | 4.38 | 3.90 | 4.84 | 0.34 | 0.12 |
| Wing (%) | 8.01 | 8.20 | 8.26 | 7.79 | 8.07 | 7.60 | 7.66 | 6.24 | 0.23 | 0.16 |
| Thigh (%) | 9.82 | 9.72 | 9.92 | 10.07 | 9.83 | 9.06 | 9.01 | 9.62 | 0.72 | 0.17 |
| Head (%) | 2.88 | 2.79 | 2.86 | 2.51 | 2.68 | 2.61 | 2.87 | 2.50 | 0.81 | 0.05 |
| Shank (%) | 4.21 | 4.05 | 4.32 | 3.87 | 4.28 | 3.90 | 4.68 | 2.82 | 0.73 | 0.14 |
| Drum Stick (%) | 10.28 | 10.28 | 10.85 | 10.54 | 10.34 | 9.66 | 10.04 | 10.24 | 0.70 | 0.15 |
| Breast (%) | 18.02 | 17.82 | 18.42 | 21.42 | 16.53 | 17.25 | 16.71 | 18.99 | 0.77 | 0.39 |
| Back (%) | 12.95 | 12.45 | 11.76 | 12.39 | 12.73 | 12.21 | 12.14 | 12.93 | 0.88 | 0.20 |
| Liver (%) | 2.07 | 2.12 | 1.85 | 1.62 | 2.13 | 1.80 | 1.77 | 1.60 | 0.33 | 0.49 |
| Heart (%) | 0.06 | 0.08 | 0.07 | 0.08 | 0.09 | 0.08 | 0.10 | 0.07 | 0.27 | 0.003 |
| Spleen (%) | 7.56 | 6.60 | 6.82 | 5.42 | 7.42 | 6.71 | 7.90 | 6.74 | 0.44 | 0.20 |
| Intestine (%) | 0.23 | 0.25 | 0.24 | 0.21 | 0.61 | 0.55 | 0.57 | 0.58 | 0.57 | 0.35 |
| Proventriculus (%) | 3.27 | 3.24 | 3.32 | 2.92 | 3.24 | 2.81 | 3.24 | 3.16 | 0.62 | 0.08 |
| Gizzard (%) | $0.24^{b}$ | $0.28^{b}$ | $0.25^{b}$ | $0.27^{b}$ | $0.58^{a}$ | $0.59^{a}$ | $0.53^{a}$ | $0.31^{b}$ | 0.01 | 0.03 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lungs (%) | 0.46 | 0.42 | 0.40 | 0.40 | 0.44 | 0.40 | 0.44 | 0.43 | 0.71 | 0.12 |

[a,b]Means on the same row having different superscript are significantly ($p<0.05$) different
SEM = Standard error of mean

### 4.19 Effects of interaction between levels of inclusion and feed access time on carcass characteristics of broiler chickens

The effects of interaction between levels of inclusion and feed access time on carcass characteristics of broiler chickens is presented in Table 20. Only the liver was significantly ($p<0.05$) different because of the interaction while other parameters measured were not significant.

**Table 20: Effects of interaction between phytobiotic levels of inclusion and feed access time on carcass characteristics of broiler Chickens**

| | 0 | | | | 2.5 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | P-Value | SEM |
| Live weight (g) | 1450.00 | 1366.70 | 1450.00 | 1633.40 | 1366.70 | 1366.70 | 1366.70 | 1700.00 | 0.82 | 33.60 |
| Dress weight (%) | 65.12 | 69.09 | 70.44 | 71.81 | 76.71 | 69.63 | 70.22 | 72.66 | 0.12 | 1.06 |
| Eviscrated weight (%) | 55.58 | 60.05 | 61.66 | 63.27 | 46.35 | 60.95 | 60.89 | 65.56 | 0.75 | 2.03 |
| Pluck weight (%) | 79.93 | 69.47 | 85.16 | 86.21 | 95.10 | 83.86 | 86.38 | 85.06 | 0.39 | 2.18 |
| Neck (%) | 7.51 | 7.92 | 7.95 | 6.34 | 8.57 | 7.88 | 7.97 | 7.89 | 0.18 | 0.16 |
| Wing (%) | 4.33 | 4.43 | 4.26 | 4.74 | 4.26 | 4.70 | 4.17 | 4.29 | 0.83 | 0.12 |
| Thigh (%) | 8.82 | 9.14 | 9.14 | 9.82 | 10.83 | 9.64 | 9.79 | 9.88 | 0.12 | 0.17 |
| Head (%) | 2.54 | 2.74 | 2.89 | 3.01 | 3.01 | 2.65 | 2.85 | 2.51 | 0.16 | 0.51 |
| Shank (%) | 4.00 | 4.05 | 4.61 | 3.41 | 4.49 | 3.90 | 4.39 | 3.29 | 0.77 | 0.14 |
| Drum stick (%) | 9.54 | 10.06 | 10.56 | 10.40 | 11.08 | 9.88 | 10.33 | 10.37 | 0.09 | 0.15 |
| Breast (%) | 0.42 | 0.39 | 0.42 | 0.40 | 0.49 | 0.44 | 0.43 | 0.43 | 0.87 | 0.13 |
| Back (%) | 12.15 | 12.43 | 11.84 | 12.64 | 3.52 | 12.22 | 12.06 | 12.67 | 0.59 | 0.20 |
| Liver (%) | $1.92^{abc}$ | $2.03^{ab}$ | $1.73^{abc}$ | $1.69^{bc}$ | $2.29^{a}$ | $1.89^{abc}$ | $1.89^{abc}$ | $1.53^{c}$ | 0.03 | 0.49 |
| Heart (%) | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.09 | 0.08 | 0.07 | 0.57 | 0.003 |
| Spleen (%) | 7.59 | 6.74 | 7.49 | 6.73 | 7.38 | 6.57 | 7.33 | 5.43 | 0.66 | 0.20 |
| Intestine (%) | 0.54 | 0.53 | 0.53 | 0.48 | 0.31 | 0.28 | 0.28 | 0.25 | 0.98 | 0.04 |
| Proventriculus (%) | 3.04 | 3.19 | 3.28 | 3.16 | 3.47 | 2.86 | 3.28 | 2.92 | 0.45 | 0.08 |
| Gizzard (%) | 0.53 | 0.58 | 0.58 | 0.40 | 0.29 | 0.30 | 0.27 | 0.18 | 0.92 | 0.37 |

$^{a,bc}$Means on the same row having different superscript are significantly ($p<0.05$) different
SEM = Standard error of mean.

## 4.20 Effects of interaction between phytobiotics type levels of inclusion and feed access time on carcass characteristics of broiler chickens

The effects of interaction between phytobiotics type levels of inclusion and feed access time on carcass characteristics of broiler chickens are shown in Table 21. The interaction did not have significant ($p>0.05$) effect on any of the parameters measured.

**Table 21: Effects of interaction between Phytobiotic type, Levels of inclusion, and Feed access time on Carcass characteristics of broiler chickens**

| | Ginger | | | | | | | | Garlic | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | 2.5 | | | | 0 | | | | 2.5 | | | |
| | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 | 4 | 8 | 12 | 16 |
| Live weight (g) | 1433.0 | 1300.0 | 1500.0 | 1633.0 | 1267.0 | 1300.0 | 1333.0 | 1700.0 | 1467.0 | 1433.0 | 1400.0 | 1633.0 | 1467.0 | 1433.0 | 1400.0 | 1700.0 |
| Dressed weight (%) | 60.60 | 70.98 | 73.10 | 71.63 | 83.79 | 72.05 | 72.67 | 75.99 | 69.63 | 67.21 | 67.78 | 71.98 | 69.63 | 70.98 | 67.78 | 69.33 |
| Eviscrated weight (%) | 52.32 | 63.52 | 67.24 | 65.02 | 34.34 | 65.31 | 66.71 | 69.74 | 58.35 | 56.58 | 56.08 | 61.51 | 58.35 | 56.58 | 56.08 | 61.37 |
| Pluck weight (%) | 75.34 | 58.25 | 87.30 | 86.28 | 105.68 | 86.85 | 89.74 | 87.17 | 84.52 | 80.87 | 83.02 | 86.14 | 84.52 | 80.87 | 83.02 | 82.96 |
| Neck (%) | 4.21 | 4.48 | 4.61 | 4.55 | 4.09 | 4.02 | 4.44 | 3.82 | 4.42 | 4.38 | 3.90 | 4.93 | 4.42 | 4.38 | 3.90 | 4.76 |
| Wing (%) | 6.95 | 8.24 | 8.25 | 7.46 | 9.07 | 8.14 | 8.28 | 8.13 | 8.07 | 7.60 | 7.66 | 5.23 | 8.07 | 7.60 | 7.66 | 7.26 |
| Thigh (%) | 2.81 | 9.21 | 9.27 | 9.71 | 11.83 | 10.22 | 10.57 | 10.44 | 9.83 | 9.06 | 9.01 | 9.93 | 9.83 | 9.06 | 9.01 | 9.32 |
| Head (%) | 2.41 | 2.88 | 2.91 | 2.52 | 3.35 | 2.70 | 2.82 | 2.51 | 2.68 | 2.61 | 2.87 | 2.49 | 2.68 | 2.61 | 2.87 | 2.51 |
| Shank (%) | 3.73 | 4.20 | 4.54 | 4.04 | 4.70 | 3.91 | 4.11 | 3.71 | 4.28 | 3.90 | 4.68 | 2.77 | 4.28 | 3.90 | 4.68 | 2.87 |
| Drum stick (%) | 0.39 | 0.37 | 0.39 | 0.41 | 0.53 | 0.47 | 0.41 | 0.38 | 0.44 | 0.39 | 0.44 | 0.38 | 0.44 | 0.40 | 0.44 | 0.48 |
| Breast (%) | 8.74 | 10.47 | 11.09 | 10.43 | 11.82 | 10.10 | 10.62 | 10.65 | 10.34 | 9.66 | 10.04 | 10.38 | 10.34 | 9.66 | 10.04 | 10.09 |
| Back (%) | 14.55 | 16.96 | 18.07 | 19.55 | 21.48 | 18.68 | 18.77 | 23.29 | 16.53 | 17.25 | 16.71 | 19.70 | 16.53 | 17.25 | 16.71 | 19.70 |
| Liver (%) | 11.58 | 12.65 | 11.55 | 12.22 | 14.32 | 12.24 | 11.97 | 12.55 | 12.73 | 12.21 | 12.14 | 13.06 | 12.21 | 12.14 | 12.79 | 0.62 |
| Heart (%) | 1.70 | 2.26 | 1.69 | 1.71 | 2.45 | 1.99 | 2.02 | 1.52 | 2.13 | 1.80 | 1.77 | 1.67 | 2.13 | 1.80 | 1.77 | 1.53 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spleen (%) | 0.05 | 0.07 | 0.07 | 0.09 | 0.08 | 0.10 | 0.07 | 0.02 | 0.09 | 0.08 | 0.10 | 0.07 | 0.09 | 0.08 | 0.10 | 0.07 |
| Intestine (%) | 7.77 | 6.78 | 7.07 | 6.54 | 7.35 | 6.43 | 6.57 | 4.29 | 7.42 | 6.71 | 7.90 | 6.92 | 7.42 | 6.71 | 7.90 | 6.57 |
| Proventriculus (%) | 0.46 | 0.49 | 0.48 | 0.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 | 0.55 | 0.57 | 0.53 | 0.61 | 0.55 | 0.75 | 0.50 |
| Gizzard (%) | 2.84 | 3.56 | 3.32 | 3.17 | 3.70 | 2.91 | 3.32 | 2.66 | 3.24 | 2.81 | 3.24 | 3.15 | 3.24 | 2.81 | 3.24 | 3.17 |
| Lungs (%) | 0.49 | 0.57 | 0.50 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.59 | 0.53 | 0.26 | 0.57 | 0.59 | 0.53 | 0.36 |

SEM = Standard error of mean

## 5.1 DISCUSSION

In this experiment, results obtained showed varying levels of use of phytobiotics had significant effect on the growth performance indices of the broiler chickens with reduced feed intake, final weight and weight gain as a result of used phytobiotics. This is inconsistent with the findings of Toghyani *et al*. (2011) who found that birds administered probiotics experienced greater body weight increase. However, the effectiveness of probiotics, prebiotics, and plant extracts for broiler growth performance has produced inconsistent results in literature. By adding probiotics, prebiotics, plant extracts, and essential oils to broiler diets, Botsoglou *et al*. (2002) found no discernible difference in body weight gain and feed conversion. This might be caused by variations in management techniques, environmental factors, bird age, and bird sex. Feed restriction is a feeding technique in which the amount, timing, and length of feed are regulated. It affects whether a bird can reach the same body weight as unrestrained birds (Ballay *et al*., 1992). The findings also revealed that during re-alimentation as opposed to restriction, birds' body weight and weight gain were higher. Lower body weight was the result of the feed limitation being more severe. This outcome is consistent with Mohebodini *et al*. (2009) and Vargas *et al*. (1999) studies, which showed that body weight and weight gain decreased with increasing feed limitation. According to Santoso (2002), the degree of feed limitation had a substantial impact on body weight. This result is also in agreement with Jalal and Zakaria (2012) research, which indicated that birds fed *ad libitum* displayed higher body weights and gained more weight than the restricted groups. El-Moniary *et al*. (2010) had various outcomes. At every feed access time, feed intake during limitation was shown to be significantly impacted. The findings of this study concur with those of Leeson *et al*. (1999) and Santoso (2002). However, they differ from those of Leeson *et al*. (1991) and Mahmood and Mehmood (2007), who claimed that restricted birds take more feed than full-fed birds.

The main effect of phytobiotic type inclusion level and feed access time significantly affect the cost of feed consumed and the cost of gain per kilogram at both restriction and re-alimentation period. The highest cost of feed was obtained at 2.5% level of inclusion during both restriction and re-alimentation period.

Blood is a vital instrument in the diagnosis and monitoring of diseases since it serves as a pathological mirror of an animal's health in relation to exposure to toxins and other situations (Olafedeha *et al*., 2010). (Merck Manual, 2012). Results obtained in this study revealed that heterophils and lymphocytes were affected by the varying levels of phytobiotics. The Lymphocytes were the most numerous and frequent White blood cell (WBC) type followed by heterophils, eosinophils and the monocytes. Bounous *et al*. (2000) observed the same trend and described the Lymphocytes as the most numerous White blood cell (WBC) in chickens. Islam *et al*. (2004) reported 70.4 to 72.1% lymphocytes and 2.92 to 3.92% monocytes for local chicken of Bangladesh. Monocytes of 10.85 to 10.90% were obtained for normal native chickens of Kashmir (Pampori and Iqbal, 2007). Lymphocytes secrete antibodies that bind to foreign microorganisms in body tissues and mediate their destruction (Britannica, 2013).

Monocytes are efficient in eliminating pathogens directly and removing cellular waste from infection areas. The Heterophils and Lymphocytes values were however lower than the values of 1.0 to 5.0% reported by Simaraks *et al*. (2004). Serum biochemical indices are important indicators for detecting organ diseases in domestic animals (Malik *et al*., 2013) and the amount of available protein in the diets. There were significant differences observed in the main effect of phytobiotics on total protein and on Higher density lipoprotein (HDL), low density lipoprotein (LDL), and total cholesterol (CHDL) at all the feed access time respectfully. The result obtained is in agreement with the findings of Syed *et al*. (2018), who reported that adding phytobiotics including green tea leaves, peppermint, and Tumeric to broiler diets decreased serum levels of cholesterol, triglycerides, and low-density lipoprotein (LDL) while increasing serum levels of HDL. This according to these authors may be attributed to the unique properties of phytobiotics, such as anti-atherosclerotic, antimicrobial, and immune modulatory potential (Sharifi *et al*., 2014).

Cholesterol is originated from two sources which are from feed (exogenous cholesterol) and endogenous cholesterol produced by body itself (endogen cholesterol). Cholesterol originated from feed play an important role since it is a main sterol in the body, cell surface component, and intracellular membrane (Figueiredo *et al*., 2008). Highest and lowest total cholesterol was obtained in birds fed garlic with 16hrs and 8 feed access time, respectively. The significant reductions observed in total cholesterol concentrations in this study are probably since garlic increases excretion of bile acids and depressed the hepatic activities of lipogenic and cholesterogenic enzymes such as malic enzyme, fatty acid synthase, glucose-6-phosphate de-hydrogenase and 3-hydroxy-3-methyl-glutary-CoA (HMG CoA) reductase 40. Also, Chi *et al*. (1982) reported that garlic increased the excretion of cholesterol, as manifested by enhanced excretion of acidic and neutral steroids in both 16 and10 weeks old rats after feeding rats with 2 and 4% lyophilised garlic diets. In the present study, dietary inclusion of phytobiotics had no effect on dressing percentage and the relative weight of internal organs. In agreement with the findings of this study, Najafi and Torki (2010), Onu (2010), Rahimi *et al*. (2011), Habibi *et al*. (2014) noted that supplemental ginger in feed or drinking water for broilers chicken had no significant effect on dressing percentage and the relative weight of liver, heart and gizzard.

### 5.2 Conclusion

From this study, it can be concluded that:

i. Main effect of phytobiotics had significant effect on growth performance of broiler chickens and cost benefits.

ii. Growth performance of broiler chickens was significantly influenced by the main effect of levels of phtyobiotics (final weight gain, feed intake, daily weight gain and feed conversion ratio).

iii. The effects of interaction between phytobiotics type and inclusion level did not affect growth performance of broiler chickens.

iv. Growth performance of broiler chickens was not influenced by the interaction between phytobiotics and feed access time.

v. Interaction between phytobiotic levels and feed access time had significant effect on growth performance of broiler chickens.

vi. Interaction between phytobiotics type, levels of inclusion and feed access time did not affect growth performance of broiler chickens.

vii. Ginger diet was cheaper than diet containing garlic.

viii. Garlic was consumed more than ginger.

ix. Inclusion of phytobiotics at 2.5% increased the lymphocytes of the broiler chickens while it reduced the heterophils.

x. Most haematological parameters and serum biochemical indices of the birds were not affected by the main and effects of interaction between phytobiotics, levels and feed access time.

xi. Inclusion of ginger combined with feed access time of 16hrs reduced LDL in the broiler chickens.

xii. Inclusion of garlic combined with feed access time of 16hrs reduced Total cholesterol in the broiler chickens.

xiii. Mean effect of phytobiotics had significant effect on the carcass traits of the broiler chickens.

xiv. Inclusion of phytobiotics at 2.5% inclusion level increased the relative weight of the thigh, wing, and breast percentage of broiler chickens.

## 5.3 Recommendations

i. Dietary inclusion of phytobiotics at 2.5% is recommended to increase the lymphocytes of the broiler chickens.

ii. Inclusion of ginger combined with feed access time of 4hrs is recommended to reduce LDL in the broiler chickens.

iii. Inclusion of phytobiotics at 2.5% inclusion level increased the breast percentage of the broiler chickens hence, recommended. Addition of phytobiotic reduced heterophils in restricted birds thereby reduce stress

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