# Effects of Heat-Treated Bovine Blood Meal on Growth Performances and Carcass Characteristics of Broiler Chickens

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**Abstract:** A total of 180 one-day-old unsexed Cobb 500 broiler chicks were randomly distributed to four experimental diets and three replications per treatment, with each pen with 15 chicks per replicate arranged in a completely randomized design to evaluate the effects of partial substitution of soybean meal with blood meal on performances and carcass characteristics. The treatments were: T1 (0% blood meal), T2 (9% blood meal), T3 (18% blood meal), and T4 (27% blood meal). The rations were prepared in an isocaloric and isonitrogenous manner and the experiment was lasted for 49 days. Dry matter (DM) intake was not significant ($P>0.05$) between T2 and control (T1) during the starter, finisher, and entire period. But DM intake was significant ($P<0.05$) in T2 compared to T3 and T4 during the starter, finisher, and entire period. There was a significant difference ($P<0.05$) in body weight (BW) gain and feed conversion ratio (FCR) in birds fed diet T2 as compared to T1, T3, and T4 during the finisher phase. In addition, the finding showed that significant ($P<0.05$) drumstick, thigh, and abdominal fat weight were recorded in T2 compared to the control (T1), T3, and T4. However, there was no significant difference ($P>0.05$) in breast weight, wing weight, and dressing weight between the control and T2. Therefore, dried bovine blood meal can be incorporated at a 9% level as a soybean replacement without affecting the chickens' performance.

**Keywords:** *Blood meal, Body weight gain, Broilers, Carcass characteristics, Dry matter intake*

## Introduction

Poultry farming is important for family nutrition in developing countries (Fulas *et al*., 2018). Among these, broiler production entails raising heavy meat breed chickens to provide high-quality meat products (Agbede and Aletor, 2007). However, their productivity has been hampered by the lack of conventional feed resources and the accompanying high prices (EIAR, 2016). Feed accounts for 75-80% of total poultry production costs, owing partly to the high cost of conventional feedstuffs resulting directly from their high demand as a human staple meal (FAO, 2011). Furthermore, protein sources constrain poultry feed production, particularly in the tropics (Atawodi *et al*., 2008). As a result, there is a need to look for non-conventional options that are inexpensive, widely available, and effective and can be used as alternative sources of protein in broiler ration.

Bovine blood is one such inordinately high protein-containing animal by-product. Blood is a by-product of slaughterhouses that is used as a protein source in broiler diets (Brookes, 2002), and it is one of the richest sources of lysine, arginine, methionine, cystine and leucine at proportion of 7.05, 3.63, 0.55, 0.52 and 10.53%, respectively (NRC, 1994). It has about 89% DM, 86% CP, 1.1% EE, 1.2% CF, 5.96% NFE, 4% Ash, 0.5% Ca, and 0.4% P (FAO, 2010). It also boosts the performance, growth rate, and feed intake of different broiler outputs (Fombad *et al*., 2004). At a slaughterhouse, wasted blood generates scents that cause social difficulties like negative consequences on the health for people and pollute the environment (Yunta *et al*., 2013).

As a result, replacing expensive conventional feed ingredients with cheap and readily available non-convectional protein sources of slaughterhouse by-products such as bovine blood represents an appropriate strategy for lowering feed costs, minimizing pollution associated with bovine blood, and encouraging broiler production. Therefore, this study aims to assess the effect of replacing soybean meal with blood meal on broiler chicken performance and carcass characteristics.

## Materials and Methods

### *Description of the Study Area*

The experiment was conducted in Dinkula town, which is located in Endegagn *woreda*, Gurage Zone, in southern Ethiopia. The area is situated 230 km south west of Addis Ababa with a latitude and longitude of 7º 45' east and 37º 36' west, respectively. Its altitude ranges from 2200 to 2400 meters above sea level (masl). The mean minimum and maximum annual temperature ranges from 15ºC to 25ºC, and annual rainfall ranges between 1200 and 1400 mm (AGPII, 2017).

### *Experimental feed Preparation and Treatments*

Fresh blood was collected in a plastic container immediately after the cattle were slaughtered in

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Endegagn *woreda* municipal abattoir. The blood was boiled to 100ºC for 45 minutes to let the water evaporate and destroy potential pathogenic organisms (Khawaja *et al*., 2007). Then it was spread on a clean plastic sheet over a spreading concrete floor to avoid any contamination on the ground and then sun-dried for three days. Similarly, stirring and turning were undertaken four times daily to facilitate even drying. The dried blood particle size was then manually grounded using a manual mortar and pestle to pass through a 3 mm sieve (Addo *et al*., 2012).

The feed ingredients used in this experiment were corn grain (maize), wheat middlings, noug (*Guizotia abyssinica*) seed cake, soybean meal, blood meal, vitamin premix-for broiler, methionine, lysine, salt, and limestone. The coarse feed ingredients were milled in a sieve size of 3 mm. The ration formulation was done based on the feed ingredient's nutrient composition and balanced with the nutrient requirement of broiler chicken as shown in Table 1. Four starter and finisher broiler treatment rations containing blood meal were prepared at the level of 0% (T1), 9% (T2), 18% (T3), and 27% (T4), replacing soybean meal. The rations were formulated to be nearly isocaloric and isonitrogenous with metabolizable energy (ME) content of 3000 kcal/kg dry matter (DM) and crude protein (CP) content of 22% during the starter phase 1-21 days and ME of 3200 kcal/kg DM and CP content of 20% during the finisher phase of 22-49 days of age to meet the nutrient requirements of the broiler chicken (Table 2) (NRC, 1994).

Table 1. The chemical composition of feed ingredients on DM basis (%).

| Ingredients | DM | Ash | CF | CP | EE | NFE | Ca | P | ME(Kcal/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Maize | 90.29 | 3.18 | 3.10 | 8.20 | 4.67 | 71.14 | 0.22 | 0.38 | 3500 |
| Soya bean meal | 96.32 | 7.45 | 8.58 | 44.5 | 1.80 | 29.99 | 0.55 | 0.80 | 2850 |
| Wheat middling | 90.93 | 3.62 | 6.58 | 12.6 | 1.96 | 66.17 | 0.27 | 0.85 | 3326 |
| Noug cake | 93.62 | 13.89 | 22.98 | 28.8 | 11.91 | 16.13 | 0.91 | 0.67 | 1955 |
| Blood meal | 93.85 | 4.98 | 2.89 | 83.5 | 0.07 | 2.41 | 0.70 | 0.52 | 3495 |
| Sorghum | 85.30 | 8.55 | 7.40 | 7.80 | 2.01 | 59.54 | 0.04 | 0.32 | 3055 |

*DM=Dry matter; CF=Crude fiber; CP=Crude protein; EE=Ether extract; NFE= Nitrogen free extract; Ca=Calcium; P=Phosphorus; ME=Metabolizable energy.*

Table 2. The proportion of ingredients used in the starter and finisher rations.

| Ingredients (%) | Starter phase | | | | Finisher phase | | | |
|---|---|---|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| Maize | 45.5 | 45.6 | 46 | 47.3 | 49.5 | 50.8 | 51.9 | 53 |
| Soya bean meal | 30 | 27.3 | 24.6 | 21.9 | 28 | 25.5 | 23 | 20.5 |
| Wheat middlings | 7.5 | 6.8 | 5.5 | 4.7 | 6.9 | 5.3 | 4.4 | 2.6 |
| Noug cake | 11.4 | 11.1 | 10.4 | 9.3 | 8.8 | 8.2 | 7.3 | 7 |
| Sorghum | 3 | 3.9 | 5.5 | 6.1 | 4.2 | 5.1 | 5.8 | 6.8 |
| Blood meal | 0 | 2.7 | 5.4 | 8.1 | 0 | 2.5 | 5 | 7.5 |
| Limestone | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Salt | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Vitamin premix* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Methionine | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Lysine | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| ME (kcal/kg) | 3002.3 | 3087.8 | 3021.3 | 3127.1 | 3162.5 | 3189.1 | 3237.3 | 3249 |
| DM | 92.6 | 92.3 | 91.9 | 91.8 | 92.1 | 92 | 91.8 | 91.6 |
| CP | 22.3 | 22.4 | 22.4 | 22.2 | 19.6 | 20.3 | 20.3 | 20.4 |
| CF | 4.8 | 4.7 | 4.4 | 4.2 | 5.5 | 5.3 | 4.8 | 4.6 |
| EE | 4.4 | 4 | 3.5 | 3.3 | 3.7 | 3.6 | 3.3 | 3.3 |
| Ash | 12.6 | 12.1 | 15.6 | 14.4 | 12.3 | 11.9 | 11.5 | 11.6 |
| NFE | 45.7 | 47.2 | 44.8 | 47.2 | 51 | 50.9 | 51.9 | 51.3 |
| Ca | 0.97 | 0.94 | 0.91 | 0.89 | 0.90 | 0.89 | 0.88 | 0.87 |
| P | 0.66 | 0.64 | 0.62 | 0.60 | 0.63 | 0.61 | 0.60 | 0.57 |

*ME= Metabolizable energy; DM= Dry matter; CP= Crude protein; CF= Crude fiber; EE= Ether extract; NFE=Nitrogen free extract; Ca= Calcium; P= Phosphorus; T1= 0% blood meal; T2= 9% blood meal; T3= 18% blood meal; T4= 27% blood meal as a replacement of soybean meal; Vitamin premix* 50 kg contains, Vit A= 2000000iu, Vit D3= 400000 iu, Vit E= 10000 mg, Vit K3= 300 mg, Vit B1= 150 mg, Vit B2= 1000 mg, Vit B3= 2000 mg, Vit B6= 500 mg, Vit B12= 4 mg, Vitpp= 60000 mg, Folic acid= 160 mg, Choline chloride= 30000 mg, Anti-oxidant= 500 gm, Manganese= 10000 mg, Zinc= 14000 mg, Iron= 9000 mg, Copper= 1000 mg, Iodium= 200 mg, Selenium= 80 mg, Calcium= 28.2%.*

***Management of Birds and Experimental Design***

A total of 180 Cobb-500 one-day-old broiler chicks were purchased. The experimental house and pens were cleaned, disinfected, and treated with anti-parasite spray (37% formalin) 14 days before the chicks arrived. After arriving, the chicks with a mean initial body weight of 45.7±0.3 gram (Mean± SD) were randomly divided into four treatments and three replications per treatment, with each pen containing 15 chicks per duplicate and placed in an experimental pen partitioned with a plastic sheet. Sawdust was spread to a depth of 7cm on the floor as litter material. The animals were given *ad libitum* food and water access throughout the trial. The chicks were brooded using 200-watt electric infrared lamps that were gradually adjusted in height. Birds were vaccinated against Newcastle disease (HB1 at day 7 and Lasota a booster dose at day 21) and infectious bursal disease (Gumboro disease) at the age of 14 days.

***Measurements and Data Collection***

The feed offered (in gram) and refusals were collected and weighed every morning after visual inspection and handpicking to remove external contaminants. The DM intake was calculated by multiplying the daily and total feed consumption by their respective DM content. The birds were weighed weekly, and the average was derived by dividing the total weight by the number of birds. The difference between the final and beginning body weights was used to calculate body weight change (BW). The average daily gain (ADG) was estimated by dividing the BW change by the number of trial days. The feed conversion ratio (FCR) was calculated as the daily dry matter intake ratio to ADG (Koch *et al.*, 1963).

At the end of the experiment, two broiler chickens were chosen randomly from each replication. The broiler birds were starved for 12 hours before being weighed and slaughtered by severing the jugular vein. Following the blood and feather removal, the dressed carcass weight was measured. Dressing percentage was computed by multiplying the proportion of dressed carcass weight to slaughter weight by 100. After removing the lower leg (shank), head, kidney, lung, pancreas, crop, proventriculus, small intestine, large intestine, ceca, and urogenital tracts from the dressed carcass, the eviscerated carcass weight was measured (Kubena *et al.*, 1974). The eviscerated carcass, including the breast, wings, thighs, drumsticks, and back was consumed. The eviscerated corpse was separated and weighed, including the breast, wings, thighs, drumsticks, and back. The dressing % was obtained by dividing each carcass component weight by the slaughter weight and multiplying the result by 100. Fat from the proventriculus, gizzard, and abdominal wall was collected and weighed. Fat percentage was estimated by multiplying the proportion of slaughter weight by 100.

***Chemical Analysis***

Samples of feed ingredients and feed offered and refused from the respective treatments were analyzed for dry matter (DM), crude fiber (CF), ether extract (E.E.), crude protein (C.P.), Ash, Ca and P using the proximate analysis method of the Association of Official Analytical Chemists (AOAC, 2000). Nitrogen was determined by Kjeldhal procedure and CP=N x 6.25. The metabolizable energy (M.E.) levels of feed ingredients were calculated using the formula, M.E. (kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 Ash (Wiseman, 1987).

***Partial Budget Analysis***

The partial budget analysis was done according to Upton (1979) to determine the economic benefit of blood meal as a replacement of soybean. The cost of feed was considered as total variable cost (TVC). The cost of the feed was computed by multiplying the actual feed intake for the whole feeding period with the prevailing market price of the formulated treatment ration, whereas day-old-chicks, labor, vaccination, house rent, electric cost, and cost of equipment were assumed to similar for all the treatments as fixed costs. The total return (TR) obtained from the selling price of the carcass at the supermarket. The net return (NR) was expressed by subtracting total variable cost (TVC) from total return (TR).

$$NR=TR-TVC$$

The change in net return (ΔNR) expressed as the difference between the change in total return (ΔTR) and total variable cost (ΔTVC).

$$\Delta NR = \Delta TR - \Delta TVC$$

The marginal rate of return (MRR) measures the increase in net return (ΔNR) related to each additional unit of expenditure (Δ TVC) and expressed in the percentage.

$$MRR= \Delta NR / \Delta TVC$$

***Data Analysis***

The collected data were subjected to analysis of variance (ANOVA) using the Statistical Analysis software System version 9.2 following the general linear model (GLM) procedure (SAS, 2008). The mean for treatments showing a significant difference was compared using the Tukey's test.

## Results and Discussion

***Dry Matter Intake***

The dry matter intake of broiler birds fed on different levels of blood meal (BM) is presented in Table 3 below. There were highly significant differences ($P<0.001$) among the treatment on daily and total DM intake during the starter, entire period, and during the finisher phase. The birds fed T2 diets (9% BM) had no significant difference ($P>0.05$) in daily and total DMI compared with the control group (T1). Birds in T2 (9% BM) had no significant difference ($P>0.05$) in total DM intake and daily DM intake compared with T3 (18% BM) during the starter phase. However, it had significant effect (P<0.05) on daily DMI and total DMI compared to T3 (18% BM) and T4 (27%BM) group birds during starter finisher, and entire period. The total DM and daily DM intake birds fed T2 diet were higher by 2.6%, 2.5% and 4.9%, 4.8% than T3 and T4 during finisher phase and higher by 2.3%, 2.3% and 5.4%, 5.3% during the entire experimental period, respectively. The present study was similar to the findings of Mojahed (2005), who reported that the inclusion of blood meal in the broiler diet at lower level of 4% caused no effect in feed intake. However, the results of the current study were inconsistent with the result of Castello *et al.* (2004) who reported that supplementation of broiler chicken diet with more than 3% blood meal had a negative effect on feed intake. This difference might be due to variation in blood meal processing condition.

A lower DM intake was recorded from T4 diets (27 % BM) group birds compared to the control and treatment group birds. The total DM and daily DM intake of birds fed T4 diet were lower than the control group by 4.9% and 4.8% during the finisher phase and lower than the control group by 5.4% and 5.3% during entire experimental period, respectively. This result agreed with the findings of Ndelekwute *et al.* (2008), who reported that there was a significant reduction (P<0.05) in feed intake with an increase in the levels of a blood meal. This indicates that the substitution or inclusion level of blood meal increases, the feed intake of the bird decreases. This is may be due to increased ash content of blood meal and amino acid imbalance of the blood meal.

Table 3. Feed intake, weight gain and feed conversion ratio of Cobb 500 broilers fed with different levels of a blood meal.

| Parameter | Phase | Dietary treatments | | | | | P-value |
|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 | SEM | |
| DM intake (g/bird) | Starter | 952.8$^{a}$ | 955.1$^{a}$ | 944.4$^{a}$ | 885$^{b}$ | 6.07 | <.001 |
| | Finisher | 3522.6$^{a}$ | 3531.9$^{a}$ | 3439.1$^{b}$ | 3350.6$^{c}$ | 32.80 | .002 |
| | Entire Period | 4475.5$^{a}$ | 4487$^{a}$ | 4383.6$^{b}$ | 4235.6$^{c}$ | 30.48 | <.001 |
| DM intake | Starter | 45.3$^{a}$ | 45.4$^{a}$ | 44.9$^{a}$ | 42$^{b}$ | .28 | <.001 |
| (g/bird/day) | Finisher | 125.7$^{a}$ | 126$^{a}$ | 122.8$^{b}$ | 119.6$^{c}$ | 1.17 | .002 |
| | Entire period | 91.3$^{a}$ | 91.5$^{a}$ | 89.4$^{b}$ | 86.4$^{c}$ | .63 | <.001 |
| IBW(g/bird) | | 45.8 | 45.6 | 45.9 | 45.5 | .25 | .473 |
| FBW(g/bird) | Starter | 690$^{a}$ | 701.9$^{a}$ | 627.2$^{b}$ | 600.9$^{c}$ | 7.80 | <.001 |
| | Finisher | 2430.3$^{b}$ | 2505.3$^{a}$ | 2222.5$^{c}$ | 1805.7$^{d}$ | 24.45 | <.001 |
| BWG(g/bird) | Starter | 644.2$^{a}$ | 656.3$^{a}$ | 581.3$^{b}$ | 555.4$^{c}$ | 7.98 | <.001 |
| | Finisher | 1740.3$^{b}$ | 1803.4$^{a}$ | 1595.3$^{c}$ | 1204.8$^{d}$ | 22.63 | <.001 |
| | Entire Period | 2384$^{b}$ | 2459.7$^{a}$ | 2176.6$^{c}$ | 1760.2$^{d}$ | 24.15 | <.001 |
| ADG(g/bird/day) | Starter | 30.7$^{a}$ | 31.2$^{a}$ | 27.7$^{b}$ | 26.4$^{c}$ | .37 | <.001 |
| | Finisher | 62.1$^{b}$ | 64.4$^{a}$ | 56.9$^{c}$ | 43$^{d}$ | .82 | <.001 |
| | Entire Period | 48.6$^{b}$ | 50.2$^{a}$ | 44.4$^{c}$ | 35.9$^{d}$ | .51 | <.001 |
| FCR | Starter | 1.4$^{c}$ | 1.4$^{c}$ | 1.5$^{b}$ | 1.6$^{a}$ | .05 | .004 |
| | Finisher | 2$^{c}$ | 1.9$^{d}$ | 2.1$^{b}$ | 2.7$^{a}$ | .05 | <.001 |
| | Entire Period | 1.80$^{c}$ | 1.80$^{c}$ | 2.00$^{b}$ | 2.30$^{a}$ | .03 | <.001 |
| | Starter | 1 | 0 | 1 | 0 | - | - |
| Mortality | Finisher | | 0 | 0 | 0 | - | - |
| | Entire period | 1 | 0 | 1 | 0 | - | - |

*Means within a row with different superscripts differ significantly (P<0.05); T1= 0% blood meal; T2= 9% blood meal; T3= 18% blood meal; T4= 27% blood meal; SEM= Standard error of the mean; IBW= Initial body weight gain; FBW= Final body weight gain; BWG= Body weight gain; ADG= Average daily gain; FCR= Feed conversion ratio.*

***Body Weight Gain and FCR***

The effect of substitution of dried blood meal at different levels on the FBW, BW gain, ADG, and FCR of broiler birds are shown in Table 3 above. There was significant difference (*P*<0.05) among the treatment on FBW and BWG during the starter, finisher, and entire periods. Birds fed T2 diets (9% BM) had significantly higher (*P*<0.05) FBW and BW gain compared to the control groups and other treatment groups during the finisher phase and entire period. The FBW and BWG of birds fed T2 diet were higher than the control group by 3.1% and 3.6% during the finisher phase respectively and BWG during the entire experimental period was higher by 3.6%. However, T2 had no significant difference (*P*>0.05) with control (T1) in BW and BW gain in the starter phase. In the current study, better body weight and body weight gain were found in birds fed T2 diets (9% blood meal) than other groups. This result is in line with Khawaja *et al.* (2007) who reported that broiler chickens fed a diet containing lower level (3%) of blood meal showed best growth performance than other chickens fed 4, 5, 6% of the blood meal. The result was also consistent with the result of Gous and Morris (2005), who reported that blood meal enhanced the growth performance of the broiler chicks. The current result contradicted with the finding of Hassan and Ansari (2007), who reported that diets containing more than 3% blood meal unfavorably influenced body weight gain of broiler chickens. The increase in body weight gain may be due to the combination of blood meal with soybean meal result balanced amino acids which improve body weight gain (Onwudike, 1981).

However, lower FBW and BW gain were recorded with birds consumed T4 diets (27% blood meal). The FBW and BWG of birds fed T4 diet were lower than the control group by 25.7% and 30.8% during the finisher phase, respectively and lower than the control by 26.2% during the entire experimental period. The current result was consistent with the result of Ndelekwute *et al.* (2008), who recorded that body weight and body weight gain were decreased with an increase in the level of the blood meal. Also, this result agreed with the findings of Naji *et al.* (2003) who reported that an increase in inclusion level of blood meal resulted in reduced feed intake and as results reduced BW gain. Weight gain can be reduced with higher levels of blood meal and this might be due to low levels of the sulfur-containing amino acids and isoleucine, which is responsible for poor utilization of blood meal (Onwudike, 1981).

There was high significant difference ($P$<0.001) among the treatment on ADG during the starter, finisher, and entire periods. T2 birds had no significant difference ($P$>0.05) with control (T1) on ADG in the starter phase. However, birds fed T2 diets (9% BM) had significantly better ($P$<0.05) ADG compared to the control groups and other treatment groups during the finisher phase and entire period. The ADG of birds fed T2 diet were higher than control group by 3.7% and 3.3% during finisher and entire experimental period, respectively. The current result is contradicted with the finding of Onu *et al.* (2011), who reported that broiler chickens fed different inclusion levels of blood meal (0%, 2.2%, 3.6%, 5%) had no significant difference on ADG among the treatment groups during the finisher phase. However, lower ($P$<0.05) ADG was recorded in T4 birds (27% blood meal). The ADG of birds fed T4 diet were lower than control group by 30.8% and 26.1% during the finisher and entire experimental period, respectively. The current result was consistent with the result of Ufele (2015), who reported that ration with too much blood meal (i.e. 300g of blood meal mixed with 500g of chick mash) was unpalatable for broilers and resulted in low ADG. This may be due to decreased feed intake and poor feed conversion efficiency.

There was high significant difference ($P$<0.001) among the treatment groups on FCR during the finisher and entire period. Birds fed T1 and T2 diets had significantly better ($P$<0.05) FCR compared to T3 and T4 during the starter and entire period. However, birds fed T2 diets (9% BM) had significantly best ($P$<0.05) FCR compared to the control group and other treatment groups during the finisher phase. The current result is consistent with the finding of Khawaja *et al.* (2007), who reported that broiler chickens fed a diet containing 3% blood meal showed better feed conversion efficiency than other chickens fed on 4, 5, 6% blood meal. Significantly poor (P<0.05) FCR was recorded in bird fed T4 diet (27%). This result agrees with the finding of Ndelekwute *et al.* (2008), who reported that feed conversion ratio decreased with increase in blood meal. This may be due to decreased feed intake as result of increased blood meal level.

Mortality was recorded in the experimental period and only two birds were died one each from T1 and T3 due to stress. However, the substitution of different levels of blood meal did not affect all treatment groups.

### *Carcass Characteristics of Broilers*

The carcass characteristics of broiler birds fed on different levels of BM diets are presented in Table 4 below. Highly significant differences ($P$<0.001) were recorded between treatments on slaughter weight and eviscerated carcass weight. The current result indicated that highly significant ($P$<0.001) slaughter weight and eviscerated carcass weight were obtained in T1 and T2 birds than other treatment groups. The current study showed that there was a significant difference in carcass yield. This result is not consistent with the finding of Ndelekwute *et al.* (2016), who reported that there was no significant difference ($P$>0.05) in carcass yield of birds fed on diet containing fish meal: blood mixture of 3:0, 2:1, 1:2, and 0:3 in starter phase and 2:0, 1:1, 0.5:1.5, and 0:2 in finisher phase. The lower slaughter weight and eviscerated carcass weight was obtained for birds that consumed T4 diet. Previous study showed that an increase in inclusion level of blood meal resulted in reduced feed intake, which might be due to low levels of the sulfur-containing amino acids and isoleucine (Naji *et al*., 2003).

There was a significant difference ($P$<0.05) among the treatment groups on breast weight. The current finding indicated that significant ($P$<0.05) breast weight was obtained in birds fed T1 and T2 diets than other treatment groups (T3 and T4). This result is not consistent with the findings of Olajide *et al*. (2012), who reported that breast weight was not affected ($P$>0.05) by dietary treatment of cassava leaf: blood meal mix containing proportion of 0:0, 12.5:12.5, 25:25, 37.5:37.5, and 50:50 as a replacement for soybean meal. There were high significant differences ($P$<0.001) between treatments on drumstick and thigh weight. The current result indicated that significantly higher ($P$<0.05) drumstick and thigh weight was obtained in birds consumed T2 diets than other treatment groups. This result is inconsistent with the finding of Salih (2008), who reported that blood meal: feather mixture containing proportion of 0:0, 1:0, 0:1, 5:3, and 5:5 as a replacement of soybean meal had no significant effect on drumstick and thigh weigh in the treatment groups.

The current result showed no significant difference ($P$>0.05) in dressing percentage and abdominal fat percentage between the treatment groups, which agree with the finding of Esonu *et al.* (2011), who reported that there were no differences in the abdominal fat percentage of birds fed on different levels of fermented bovine blood rumen digesta mixture at proportion of 0:0, 2.5:2.5, 5:5, 7.5:7.5, and 10:10.

Table 4. Carcass characteristics of broilers fed with different levels of blood meal.

| Parameter | Dietary treatments | | | | | P-value |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | SEM | |
| Slaughter weight(g) | 2351.8[a] | 2486[a] | 2101.8[b] | 1767[c] | 41.340 | <.001 |
| Dressed weight(g) | 2117.1[a] | 2248.5[a] | 1900.5[b] | 1579[c] | 41.156 | <.001 |
| Dressed% | 70.8 | 72.6 | 70.4 | 69.3 | .914 | .658 |
| Eviscerated carcass weight(g) | 1354.5[a] | 1505.9[a] | 1160.3[b] | 949.5[c] | 41.785 | <.001 |
| Eviscerated carcass weight% | 57.6[ab] | 60.6[a] | 55.2[b] | 53.6[b] | 1.257 | .003 |
| Thigh weight(g) | 265.2[b] | 318.5[a] | 227.8[c] | 199.4[c] | 16.225 | <.001 |
| Thigh% | 11.1[b] | 13.1[a] | 10.8[b] | 11.2[b] | .600 | .021 |
| Drumstick weight(g) | 229.3[b] | 280.3[a] | 212[b] | 162[c] | 10.034 | <.001 |
| Drumstick% | 9.7[b] | 11.2[a] | 10.1[ab] | 9.1[b] | .436 | .007 |
| Breast weight(g) | 641.8[a] | 63.9[a] | 496.5[bc] | 384[c] | 40.891 | .001 |
| Breast% | 27.2[a] | 25.7[ab] | 23.6[ab] | 21.6[b] | 1.684 | .046 |
| Back weight(g) | 150.2[ab] | 161[a] | 139.8[bc] | 125.6[c] | 4.957 | .001 |
| Back% | 6.4[b] | 6.4[b] | 6.6[ab] | 7[a] | .152 | .008 |
| Wing weight (g) | 92.5[a] | 90.9[ab] | 83.6[bc] | 77.5[c] | 2.548 | .001 |
| Wing% | 3.9[b] | 3.6[c] | 3.9[b] | 4.4[a] | .081 | <.001 |
| Abdominal fat weight(g) | 34.6[b] | 44.1[a] | 29.2[bc] | 23[c] | 2.286 | <.001 |
| Abdominal fat% | 1.4 | 1.7 | 1.3 | 1.3 | .158 | .101 |
| Gizzard weight(g) | 42.5[a] | 43.1[a] | 39.7[b] | 38[b] | 1.023 | .003 |
| Gizzard% | 1.8[a] | 1.7[b] | 1.9[a] | 1.9[a] | .062 | <.001 |
| Liver weight(g) | 57.2 | 57.7 | 56.7 | 58.5 | 3.763 | .963 |
| Liver% | 2.4[c] | 2.3[c] | 2.7[b] | 3.3[a] | 0.159 | .001 |
| Heart weight(g) | 20.9 | 21 | 18.6 | 18.5 | 1.182 | .110 |
| Heart% | 0.9[ab] | 0.8[b] | 0.8[b] | 1[a] | .062 | .035 |

*Means within a row with different superscripts differ (P<0.05); T1= 0% blood meal; T2= 9% blood meal; T3= 18% blood meal; T4= 27% blood meal; SEM= Standard error of the mean.*

***Partial Budget Analysis***

The partial budget analysis of broiler birds fed different levels of BM as a replacement of soybean meal is presented in Table 5. The result indicated that higher net return was obtained from birds fed T2 diet while the least profit was earned from T4. The reduction of feed cost (Birr/kg) with the increasing level of blood meal was the result of the cost difference between a blood meal and a soybean meal. This result agrees with the observation of Khawaja *et al*. (2007), who reported that low prices of blood meal, better feed efficiency, and weight gain with 3% blood meal were responsible for better net profit.

Table 5. Partial budget analysis of diet containing different levels of blood meal.

| Parameter | Dietary treatment | | | |
|---|---|---|---|---|
| | T1 | T2 | T3 | T4 |
| Day old chick cost (birr/kg) | 33 | 33 | 33 | 33 |
| Per unit feed cost (birr/kg) | 15.6 | 15.1 | 14.5 | 14.1 |
| Total feed cost (total variable cost, birr/bird) | 69.8 | 67.8 | 63.7 | 59.6 |
| Change in total variable cost (ΔTVC) (birr) | 0 | -2 | -6.1 | -10.2 |
| Average carcass weight (kg) | 1.35 | 1.50 | 1.16 | 0.94 |
| Price per kg of carcass (supermarket) | 112 | 112 | 112 | 112 |
| Total return(birr) | 118.2 | 135 | 96.9 | 72.3 |
| Change in total return (ΔTR) | 0 | 16.8 | -21.3 | -45.9 |
| Net return(birr) | 48.4 | 67.2 | 33.2 | 12.7 |
| Change in net return (ΔNR) | 0 | 18.8 | -15.2 | -35.7 |
| Marginal return rate (MRR) | 0 | -9.4 | 2.5 | 3.5 |

*T1= 0% blood meal; T2= 9% blood meal; T3= 18% blood meal; T4= 27% blood meal.*

When substitution of blood meal increased in the diet of birds, feed cost per kg was decreased. As a result, the lower total feed cost and feed cost per kg was found in birds consumed T4 diet (27% blood meal) and the higher total feed cost and feed cost per kg was observed in birds fed T1 diet (control) compared to other treatment groups. Lower net return and higher net return were obtained in T4 (27% blood meal) and T2 (9% blood meal), respectively. The lower economic profit in the birds fed T4 diet (27% blood meal) is due to lower weight gain. Higher economic profit was found in birds fed T2 diets (9% blood meal) when compared with the remaining treatment birds. This is due to higher body weight gain in T2.

## Conclusion

Substitution of soybean meal with blood meal as a protein source of up to 9% had a better performance on feed intake, weight gain, and carcass characteristics and was more profitable and cost-saving. The utilization of this feedstuff by poultry producers should be encouraged to be profitable by reducing production costs. Further research should be conducted to investigate the physiological, biochemical, and microbial load effects of substitution /inclusion levels of blood meal in other classes of birds.

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## Conflict of Interests

The authors declare that they have no competing interests.

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