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Effects of Partial Substitution of Soybean Meal with Heat Treated Bovine Blood Meal on the Performances and Carcass Characteristics of Broiler Chickens

Mesele Kebede
Gurage Zone Livestock and Fishery Resource Office, Gurage,Ethiopia

Abstract

A total of 180 day-old unsexed Cobb 500 broilers chickswere randomly distributed to four experimental diets and three replications per treatment with each pen 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. Treatments to replace soybean meal with blood meal were T1 (0% blood meal), T2 (9% blood meal), T3 (18% blood meal), and T4 (27% blood meal). Isocaloric and isonitrogenous starter and finisher rations were prepared and used for 49 days of experimental period at Dinkulatown of EdegagnWoreda. At the end of the experimental period, two chicks from each replication were randomly selected and slaughtered to evaluate the effect of blood meal on carcass characteristics. DM intake was not significant (P>0.05) between T2 and control (T1) during the starter, finisher, and entire period. But DM intake was highly significant (P<0.05) in T2 compared to T3 and T4 during the starter, finisher, and entire period. This resulted in significant (P<0.05) increase of BW gain and better FCR (P<0.05) in birds fed diet T2 as compared to T1, T3, & T4 during the finisher phase. In addition, finding showed that Significant (P<0.05) slaughter weight and eviscerated carcass weight were recorded in T1 & T2 as compared to T3 & T4. Therefore, dried bovine blood meal can be incorporated 9% substitution level of soybean without affecting the performance of the chickens.

Keywords: Blood meal, Dry matter, weight gain, Carcass

Introduction

Poultry production has an important economic, social and cultural and plays a significant role in family nutrition in developing countries (Fulas*et al.*, 2018). Of all poultry businesses, broiler production is a growing agricultural business in the developing countries. Broiler production involves the keeping of chickens of heavy meat breeds to get good quality meat products usually sold live or processed at ten to twelve weeks of age (Agbede and Aletor, 2007). However, the productivity of poultry has been limited by the scarcity and subsequent high prices of conventional protein and energy sources (EIAR, 2016). Feed accounts for 75-80% of the total cost of poultry production and this is largely due to the cost of conventional feedstuffs stemming directly from their high demands as a staple food by a human (FAO, 2011). Protein sources are limiting factors in poultry feed production especially in the tropics(Atawodi*et al.*, 2008). Therefore, there is a need to search for the use of non-conventional, cheap, and readily available local feed ingredients resources, which can be alternative sources of protein for use as a broiler feed.. One of such non-conventional high protein-containing animal by-product is bovine blood. Blood is a by-product of slaughterhouses and used as a protein source in the broiler diet (Brookes, 2002) and it is considered one of the richest sources of lysine and a very good source of arginine, methionine, cystine, and leucine; however, it contains less glycine and very much less isoleucine (NRC, 1994). Blood meal contains 89% DM, 86% CP, 1.1% EE, 1.2% CF, 5.96% NFE, 4% Ash, 0.5% Ca, and 0.4% P (FAO, 2010).

Blood meal improves performance, growth rate, and feed intake of various broiler productions (Fombad *et al*., 2004). The utilization of blood is not that many so more blood are discarded and at a slaughterhouse, blood rot cause odors that cause social problems and pollute the environment (Yunta*et al*., 2013). So that the substitution of expensive conventional feed ingredients with cheap and readily available non-convectional protein sources of slaughterhouse byproduct (bovine blood) represents a suitable strategy to reduce feed cost, minimize the disposal problems associated with bovine blood and encouraging broiler production. Therefore, this study was aimed at to evaluate the effect of substituting soybean meal with blood meal on performance, carcass characteristics, and profitability.

Materials and Methods

Description of study area

The experiment was conducted in the poultry house in Dinkula town of Endegagn, which is located in Endegagn, Gurage zone, in Southern Ethiopia. The area is located 230 km Southwest of Addis Ababa with a latitude and longitude of 7º 45' East and 37º 36' West, respectively. Its altitude range of 2200-2400 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 from Endegagnworeda municipal abattoir. The blood was boiled to 100ºC for 45 minutes (Khawaja*et al.*, 2007) and the coagulant was spread on a clean plastic sheet over the spreading concrete floor to sun-dried for eight hours for 3 days depending on weather conditions. The dried blood particle size then was manually grounded using a manual mortar and pestle to pass through a 3 mm sieve size (Addo*et al.*, 2012).

The feed ingredients used in this experiment were corn grain (maize), wheat middlings, noug seedcake (*Guizotiaabyssinica*), soybean meal, blood meal, vitamin premix for broiler, methionine, lysine, salt, and limestone were milled a sieve size of 3 mm (Table 1). Treatment rations containing blood meal were prepared at the level of 0% (T1), 9% (T2), 18% (T3), and 27% (T4) replacing soybean meal. The four treatment rations were formulated to be nearly isocaloric and isonitrogenous with metabolizable energy (ME) content of 3000 kcal/kg DM and 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 (NRC, 1994) (Table 2).

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

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

Note: 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

	Starter phase				Finisher phase			
Ingredients (%)	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
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

Management of birds and experimental design

A total of 180 day-old Cobb 500 broiler chickens were purchased from Alema farm, Bishoftu. The experimental house and pens were cleaned, disinfected, and sprayed against external parasites 14 days before the arrival of the chicks. Watering and feeding troughs were thoroughly cleaned 24 hours before the arrival of the chicks. After arrived, the chicks with a mean initial body weight of 45.7 ± 0.3 gram (Mean ± SD) were randomly divided into 4 dietary treatments and three replications per treatment with each pen 15 chicks per replicate arranged in a completely randomized design (CRD) and placed in an experimental pen with aplastic sheet partitioned.The floor was covered with sawdust to 5cm depth as litter material. Feed and water were provided *ad libitum* throughout the experimental period. The chicks were brooded using 100watt electric bulbs adjusted at gradual height. The chicks were given commercial anti-stress (vita-chicks) in fresh clean drinking water to overcome stress due to transportation. 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

A weighed amount of feed was offered daily in the morning and afternoon and refusals were collected and weighed the next morning after removing external contaminants by visual inspection and handpicking. The DM intake was computed by multiplying the daily as well as the total feed consumption by DM content. Birds were weighed weekly in a group per pen and their average was calculated as total weight divided by the number of birds. Bodyweight change was calculated as the difference between the final and initial bodyweight (BW). Average daily gain (ADG) was calculated as BW change was divided by the number of experimental days. Feed conversion ratio (FCR) was computed as the ratio of daily dry matter (DM) intake per ADG (Koch *et al*., 1963). Mortality was registered as it occurred. .

At the end of the experiment period, two broiler birds were randomly picked from each replication. The broiler birds were starved for 12 hours, weighed, and killed by severing the jugular vein. The feather was removed by hand and dressed carcass weight was measured after removing the blood and feather. Dressing percentage was calculated as the proportion of dressed carcass weight to slaughter weight multiplied by100. Eviscerated carcass weight was determined after removing lower leg (shank), head, kidney, lung, pancreas, crop, proventriculus, small intestine, large intestine, ceca, and urogenital tracts from the dressed carcass (Kubena*et al*., 1974). Fat around the proventriculus, gizzard, against the abdominal wall and the cloacae were collected and weighed. The edible organ parts, heart, gizzard, and liver were also weighed and expressed in percentage, in relation to slaughter weight.

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 (EE), Crude protein (CP), Ash, Ca and P using the proximate analysis method of the (AOAC, 2000). Nitrogen was determined by Kjeldhal procedure and CP=N x 6.25. The metabolizable energy (ME) levels of feed ingredients were calculated using the formula, ME (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.

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 Turkey test.

Results and Discussion

Dry matter intake

The dry matter intake of broiler birds fed on different levels of BM is presented in Table 3 below. There were highly significant difference (P<0.001) among the treatment on daily and total DM intake during the starter, entire period, and during the finisher phase (P=0.002). The birds fed T2 diets (9% BM) had no significant difference (P>0.05) in daily and total DMI compared with control groups (T1). 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 highly significant (P<0.05) in daily DMI and total DMI compared to T3 (18% BM) and T4 (27% BM) group birds during starter finisher, and entire period. The present study was similar to the findings of Mojahed (2005) 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 is may 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. 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 (g/bird/day)	Starter	45.3^{a}	45.4^{a}	44.9^{a}	42^{b}	.28	<.001
	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	1.8^{c}	1.8^{c}	2^{b}	2.3^{a}	.03	<.001

Note; ^{a,b,c,d}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; 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 high significant difference (*P*<0.001) among the treatment on FBW, BWG, and ADG during the starter, finisher, and entire periods. Birds fed T2 diets (9% BM) had highly significant (*P*<0.05) in FBW, BWG, and ADG compared to the control groups and other treatment groups during the finisher phase and entire period. The FBW, BWG, and ADG of birds fed T2 diet were higher than the control group by 3.1%, 3.6%, and 3.7% during the finisher phase and BWG and ADG during the entire experimental period was higher by 3.6% and 3.3% respectively. However, T2 had no significant difference (*P*>0.05) with control (T1) in FBW, BWG, and ADG in the starter phase. The current finding showed that better FBW, BWG, and ADG were observed with birds fed T2 diets (9% blood meal) compared to control (T1), T3, and T4. This result was in line with Khawaja*et al. (*2007) who reported that broiler chickens fed a diet containing at lower level of 3% 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) reported that the blood meal enhanced the growth performance of the broiler chicks. The current result contradicted with the finding of Hassan and Ansari, (2007) 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.

However, lower FBW,BWG, and ADG were recorded with birds consumed T4 diets (27% blood meal). The FBW, BWG, and ADG of birds fed T4 diet were lower than the control group by 25.7%, 30.8%, and 30.8% during the finisher phase and BWG and ADG lower than the control by 26.2% and 26.1% during the entire experimental period respectively. The current result was consistent with the result of Ndelekwute*et al.* (2008), who observed that final body weight, body weight gain, and average daily 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.

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 groups and other treatment groups during the finisher phase. The current result consistent with the finding of Khawaja *et al. (*2007), who reported that broiler chickens fed a diet containing 3% blood meal showed better FCR than other chickens fed 4, 5, 6% of the blood meal. Significantly poor FCR was recorded in bird fed T4 diet (27%). This result was agreed with the result of Ndelekwute *et al.* (2008) 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 entire experimental period. Only 2 birds were died in T1and T3 during the starter phase of the experimental period due to stress. However, the substitutionof 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 BM are presented in Table 4 below. There were high significant differences (*P*<0.001) between treatments on slaughter weight and eviscerated carcass weight. The current result indicated that highly significant (*P*<0.05) slaughter weight, eviscerated carcass weight, and breast weight were obtained in birds consumed T1 and T2 diet than other treatment groups (T3 and T4). The current study showed that there was a significant difference in carcass yield. This result was not agreed with the finding of Ndelekwute *et al*. (2016), who reported that there was no significant difference (*P*>0.05) in carcass yield fed 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 consumed T4 diet. This is may be due to poor feed intake and weight gain.

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 %	90	90.4	90.4	89.3	.914	.658
Eviscerated carcass weight(g)	1354.5[a]	1505.9[a]	1160.3[b]	949.5[c]	41.785	<.001
Thigh weight(g)	265.2[b]	318.5[a]	227.8[c]	199.4[c]	16.225	<.001
Drumstick weight(g)	229.3[b]	280.3[a]	212[b]	162[c]	10.034	<.001
Breast weight(g)	641.8[a]	639[a]	496.5[bc]	384[c]	40.891	.001
Back weight(g)	150.2[ab]	161[a]	139.8[bc]	125.6[c]	4.957	.001
Wing weight (g)	92.5[a]	90.9[ab]	83.6[bc]	77.5[c]	2.548	.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
Liver weight(g)	57.2	57.7	56.7	58.5	3.763	.963
Heart weight(g)	20.9	21	18.6	18.5	1.182	.110

Note; [a,b,c]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

There were high significant differences (*P*<0.001) between treatments on drumstick and thigh weight. The current result indicated that high (*P*<0.05) drumstick and thigh weight was obtained in birds consumed T2 diets than control (T1) and other treatment groups (T3 and T4). This result was 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 that no significant difference (*P*>0.05) in dressing percentage and abdominal fat percentage between the treatment groups, which was agreed with 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 of proportion of 0:0, 2.5:2.5, 5:5, 7.5:7.5, and 10:10.

Partial Budget Analysis

The partial budget analysis of broiler birds fed on different levels of BM as a substitution of soybean meal is presented in Table 5 below. The result indicated that higher net return was obtained from birds fed T2 (9% blood meal) diet while the least profit was earned from T4 (27% blood meal). The higher economic profit found in birds fed T2 diets (9% blood meal) is due to higher body weight gain and the lower economic profit in the birds fed T4 diet is due to lower feed intake which result lower body weight gain.

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

	Dietary treatment			
Parameter	T1	T2	T3	T4
Day old chick cost (birr)	33	33	33	33
Per unit feed cost(birr)	15.6	15.1	14.5	14.1
Total feed cost(total variable cost, birr/bird)	69.8	67.8	63.7	59.6
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
Net return (birr)	48.4	67.2	33.2	12.7

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

Conclusion and Recommendations

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

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