Performance Index and Economic Efficiency of SASSO C44 Broilers Fed Diets Containing Graded Levels of Dried Blood-Rumen Content Mixture to Replace Roasted Soybean Meal

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Abstract

This experiment was carried out to evaluate performance index and economic efficiency of broiler chicks fed diets containing dried blood rumen content mixtures (DBRCM) as a replacement for roasted soybean meal (RSBM). A total of 225 unsexed day-old broiler chicks (SASSO C44) were randomly allocated to five dietary treatments in a completely randomized design. Each treatment was replicated thrice with 15 birds per replicate. The experimental diets were formulated to contain 100% RSBM+0%DBRCM (T1), 80%RSBM+ 20% DBRCM (T2), 60% RSBM + 40% DBRCM (T3), 40% RSBM + 60% DBRCM(T4) and 20% RSBM+ 80% DBRCM (T5) based on a control ration contained 30% roasted soybean meal. The result showed that there was no statistical difference ($P \geq 0.05$) in performance index during the experimental period. The mean mortality was not influenced ($P \geq 0.05$) across the treatment groups. Birds fed T1 had the highest ($P<0.05$) and T5 the lowest ($P<0.05$) feed cost per kilogram feed. Feed cost per unit gain (Kg) was the highest ($P<0.05$) for T1 and the lowest ($P<0.05$) for T4 and T5. Total feed cost of the birds fed T1 was higher than those of the birds fed T5 diet. The highest ($P<0.05$) economic efficiency was observed for birds fed on T4 and T5. Based on this result, it could be concluded that 80% DBRCM can replace roasted soybean meal to achieve the highest economic efficiency, without affecting the performance index of broiler chicken.

Keywords: DBRCM, Economic efficiency, Performance index, Roasted soybean meal

Introduction

In developing countries, labour is cheap, climatic conditions require simple and poultry housing is inexpensive but feed cost is the most important component accounting for 70-85% of total production cost of poultry (Opara, 1996). The bulk of the feed cost arises from protein concentrates such as groundnut cake, fishmeal and soybean meal. Thus, there is the need to look for locally available and cheap sources of feed ingredients particularly those that do not attract competition in consumption between humans and livestock. One possible cheap source of protein is the Dried Blood Rumen Content Mixture (DBRCM) obtained from backyard slaughtering system, slaughtering slabs, slaughtering house and abattoirs.

According to the CSA (2013a) the cattle population in Ethiopia is 53.99 million. By considering an off-take rate of 7% for cattle (Bisrat, 2013), around 3.8 million cattle are slaughtered annually, and a recovery rate of 2.7-3.5 kg (DM basis) of ruminal contents (Dominguez *et al.*, 1994) and 3-4% of its body weight blood per head of a slaughtered animal are produced (Liu, 2009), where approximately about 133,000 quintals of DM rumen content and 38 million litres of blood per annum can be produced. According to Downes *et al.* (1987), in the separation of blood into plasma and blood cell fractions, 60% plasma with a solids content of 8%, and 40% corpuscles with a solids content of 38% are obtained. Therefore, from 100 kg of blood, 4.8 kg of plasma powder and 15.2 kg corpuscle powder would be produced. Based on this calculation from 38 million litres of blood, 76,000 quintals of blood meal can be produced in Ethiopia annually. If a quintal of dried rumen content and blood meal might be sold at 300 and 800 Ethiopian Birr, respectively, 39.9 million Birr from dried rumen content and 60.8 million Birr from blood meal can be obtained. Therefore, no use of these wastes would mean, Ethiopia would lose 100.7 million Birr annually. Similarly, in Debre Markos, around 5,000 cattle are slaughtered formally in a municipal slaughter house per annum. Accordingly, an estimated 17,500 kg DM of rumen content and 50,000 liters of blood (10,000 kg blood meal) can be produced annually (calculated by considering 250 kg body weight per slaughtered bovine).

These massive amounts of rumen content and blood are not utilized for animal feeding, but simply released into the environment. The existing system of disposing abattoir wastes results in pollution not only causing problems related to odour, flies and hygiene, but surface and ground water can also be polluted with pathogens and undesirable chemical compounds. Efforts have not been made yet in Ethiopia in general and in Debre-Markos in particular to utilize these waste products as an alternative feed ingredient in broiler rations. The need to maximize the economic benefits and minimize the disposal problems, this study was conducted to evaluate the performance index and economic efficiency of Sasso C44 broilers fed diets containing graded levels of dried blood-rumen content mixture as replacement for roasted soybean meal.

Materials and methods

The study area

This study was conducted in Debre-Markos, East Gojjam Zone which is located at 300 km from Addis Ababa in Northwest of the country and 265 km Southeast of Bahir Dar town, capital of Amhara Region. The geographical coordinate of the town is $10^{0}21^{1}$ latitude North and $37^{0}43^{1}$ longitudes East. The total area of the town is about 6160 hectares and located at 2420 meters above sea level. The mean annual rainfall and temperature is 1308 mm and 160C, respectively.

Collecting and processing of blood

Fresh blood was collected immediately after cattle were slaughtered. The blood was boiled at $100^{O}C$ for 45 minutes in the barrel order to let water evaporate and destroy potential pathogenic organisms (Tabinda *et al.,* 2007). After boiling the coagulant was spread on a clean plastic sheet over the spreading table to avoid any contamination on the ground. The drying period lasted from three to five days depending on weather condition, the amount of the materials spread and frequency of turning. Oversized dried blood was ground using a hand mortar to pass through 3 mm sieve size, which was similar to the size of the commercial broiler ration (Addo *et al.,* 2012).

Collecting and processing of rumen content

Fresh rumen content was collected from freshly eviscerated cattle in Debre-Markos municipality slaughter house. The metal vat containing the rumen content was placed on burning firewood and boiled for 2 hours with intermittent stirring to prevent burning until the mixture was almost free of steam (Adeniji and Jimoh, 2007). This was done to reduce the microbial load of the rumen content. The boiled rumen content was then spread on a clean plastic sheet for sun drying. The drying period lasted from three to four days. To uniform the particle size, oversized dried rumen content was ground using a hand mortar to pass through 3 mm sieve size, which was similar to the size of commercial broiler ration (Addo *et al*., 2012)

Mixing of dried blood and rumen content

The dried blood and dried rumen contents were mixed at 1:1 ratio to produce dried blood-rumen content mixture that was used to replace roasted soybean meal at varied levels in rations of starter and finisher phases of growth.

Preparation of roasted soybean meal

Sufficient amount of full fat soybean was purchased from Debre Markos local market. All impurities were purified by hand picking and shaking in wind. It was rinsed in water to clean up. The full fat soybean was roasted using metal plate for 15 minutes by continuous stirring until it turned in to golden brownish colour to destroy the anti-nutritional components (trypsin inhibitor) (Dave, 2007). A great precaution was given to avoid under and overheating. The roasted soybean was ground by milling machine which passed a 3mm sieve size and the meal was then used for feed formulation

Experimental birds and their management

Two hundred and twenty-five-day old unsexed SASSO C44 broiler chicks were purchased from Ethiochick PLC. All chicks were individually weighed and randomly allocated to the pens, using a Completely Randomized Design (CRD). The experimental house was divided into fifteen separate pens of 1.8m^2 (with 0.12m^2/bird) using timber and mesh wire. Before placing the experimental birds into the pens, the whole unit was cleaned, disinfected with 37% formalin two weeks prior to the introduction of chicks, allowed to dry and littered with properly dried teff *(Eragrostis teff)* straw at a depth of 8 cm before the arrival of the chicks. The house was electrically heated using 200 watt bulbs per pen. The brooder temperature was maintained at about 35-32°C for the first 7 days of age. After 7 days the temperature was gradually reduced by 2 °C every week up to the end of the experiment. Windows were opened adequately to provide natural ventilation.

Cleaned and disinfected feeders and waterers were provided in each pen. The feeders were filled with the measured amounts of feed and offered twice a day at 7:30-8:30 AM in the morning and 5:30-6:30 PM in the afternoon. The waterers were washed every day and filled with fresh and clean tap water as *ad libitum.* Experimental chickens were vaccinated for NCD; using HB1 at 7th day and Lasota at 21 and 45 days with drinking water and for Gumboro at day 14, 28 and 42 with drinking water. At 49 days the birds were vaccinated against fowl thyphoid. Amprolium was used as a prophylactic treatment for coccidiosis for three times (at a time 30 g/100 litters of water for 5 days) during the experimental period.

Treatments and experimental rations

The feed ingredients used for this study were maize (*Zea mays*), wheat middling, noug (*Guizotia abyssinica*) seedcake, roasted soybean (*Glysine max*), a 1:1 ratio of dried blood rumen content mixture (DBRCM), vitamin premix, lysine, methionine, salt and limestone. The ingredients were milled to a sieve size of 3 mm and stored until required for the formulation of experimental rations.

The test diets for the starter phase (1-28 days) were formulated to be isocaloric and isonitrogenous containing 3000 kcal ME /kg DM and 23% CP and the finisher phase (29-56 days) contain 3200 kcal ME/kg and 20 % CP to meet the requirements of starter and finisher phases of broiler (NRC,1994). Rations were formulated based on the results of the chemical analysis of the feed ingredients, and the control diet was formulated to contain about 30% roasted soybean meals from the total ration. Therefore, based on 30% roasted soybean meal, the treatments contained in T1 (100% RSBM+0%DBRCM), T2 (80% RSBM+20% DBRCM), T3 (60% RSBM+40% DBRCM), T4 (40% RSBM+60% DBRCM) and T5 (20% RSBM+80% DBRCM). The experimental ration, containing graded levels of dried blood rumen content mixture as replacement of roasted soybean meal was formulated and fed for 56 days of experimental period.

Measurements

Feed offered and refusals were weighed and recorded every day throughout the experimental period to estimate the feed intake for each replicate and treatment. Feed intake was determined by difference from the quantity offered and refused daily. Dry matter intake was calculated by difference between offered and refusals on dry matter basis. The body weight of birds was weighed individually from each replicate at the beginning of the experiment and weekly till the end of the experiment. The total body weight gain was calculated by subtracting the initial body weight from the final weight of birds. Average daily weight gain (ADG) was calculated as body weight change divided by the number of experimental days. Feed conversion ratio (FCR) was calculated as unit weight of feed consumed per unit body weight change. Performance index (PI) was computed by dividing the mean body weight of broiler chicks to feed conversion ratio and multiplied by 100 (PI= (Body weight/FCR) *100) (North, 1981). The mortality of birds was recorded throughout the experimental period, and mortality percentage was calculated by the number of chicks' dead from the total chicks entered in each treatment* 100.

Chemical analysis of feed ingredients

The representative samples were collected from each feed ingredient and taken to animal nutrition laboratory of the National Veterinary Institute (NVI) at Bishofitu, Ethiopia for chemical analysis before formulating the actual dietary treatments. In the same way, samples were taken from each treatment diet at each mixing for analysis. Also, samples were taken from refusals every day and kept in paper bags, and finally taken for chemical analysis. All samples were analysed for dry matter (DM), ether extract (EE), crude fiber (CF) and ash contents (A.O.A.C., 2000). Nitrogen was determined by Kjeldhal procedure and crude protein (CP) was calculated by multiplying N content by 6.25. The calcium content was determined by atomic absorption spectrometer after dry ashing. The metabolizable energy (ME) levels of feed ingredients was calculated using the formula,

ME (kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 Ash (Wiseman, 1987).

Economic efficiency analysis

Feed cost per unit gain was computed using the cost of feed consumed to attain a kilogram (kg) of body weight gain. The feed cost was calculated based on the cost of one kg commercial ration and DBRCM on the market. The cost of the control diet was calculated by the cost of one kg commercial ration in the available market by the total feed consumed. The cost of other treatments was calculated using cost proportions of a commercial ration and DBRCM percentage in the diet and multiplied by the total feed consumed during the experimental period. The feed cost per unit gain was considered in order to evaluate the effect of a new feed inclusion on net revenue of chicken sales.

In order to examine the economic advantage of replacing roasted soybean meal with dried blood rumen content mixture, economic efficiency (EE) was calculated as the ratio between income (price of weight gain) and the cost of feed consumed (Waheed and Eltaieb, 2005). The data were calculated that the price of one kg body weight of bird on selling time and the cost of feed used according to the prices available in local markets during the experimental period. The economic efficiency was calculated based on Waheed and Eltaieb (2005) formula as follows,

Price of total feed consumption (Birr) = Total feed consumption (kg) per bird X price/kg feed

Total revenue (Birr) = Total gain (kg) X price of one kg body weight on selling (Birr)

Net revenue (NR) (Birr) = Total revenue (Birr) from this gain–total feed cost for this gain

Economic efficiency (EE) =Net revenue /total feed cost

Relative economic efficiency (REE) = Economic efficiency /control economic efficiency

Statistical analysis

All collected data during the feeding trial were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure by Statistical Analysis Systems software (SAS, 2008) Version 9.2. When treatment effects were found to be significant ($P<0.05$), mean separation was undertaken using Tukey HSD test. All values were calculated on a pen average basis.

Results

The chemical composition of feed ingredients used for experimental diets is presented in Table 1.

Table 1. Chemical composition of feed ingredients used for preparing experimental diets as DM basis

No	Feed type	DM	MM	CF	CP	EE	Ca	NFE	kcal ME/kg DM
1	DBRCM	93.3	7.5	15.75	36.93	1.48	1.43	31.64	2328.487
2	Noug sees cake	94.6	8.88	23.35	38.46	7.27	2.47	16.64	1913.039
3	White Maize	90.7	0.63	1.65	7.45	4.98	1.29	75.99	4049.853
4	Soybean/Roasted/	96.8	5.65	14.77	32.17	13.29	2.07	30.92	3133.357
5	Wheat Middling	90.3	3.06	6.53	17.72	4.21	1.66	58.78	3475.965

NOTE: DBRCM- Dried Blood Rumen Content Mixture; NSC- Noug Seed Cake; DM -Dry Matter; CP-Crude Protein; ME-Metabolizable Energy; CF-Crude Fiber; EE-Ether Extract; MM-Mineral Matter NFE-Nitrogen Free Extract; Ca-Calcium. kg-kilogram

Feed ingredients of starter and finisher ration

The feed ingredients and chemical composition of the five dietary treatment groups of starter and finisher ration is present in Table 2.

Table 2. Proportion of ingredients used in formulating broiler starter and finisher rations, and chemical composition of the treatment groups

Ingredients %	**Starter ration**					**Finisher ration**				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
RSBM	30	24	18	12	6	30	24	18	12	6
DBRCM	0	6	12	18	24	0	6	12	18	24
Maize	34.2	36.6	35.2	36.1	36.2	40.7	42.2	43.2	45.5	46.0
NSC	24.4	24.7	21.8	21.5	20.6	13.8	12.5	12.4	11.7	9.9
Wheat middling	8.8	6.1	10.4	9.8	10.6	12.7	12.7	11.8	10.2	11.5
Limestone	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Vitamin premix	0.5	0.5	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	0.5	0.5
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
CP (% DM)	23.1	23.2	23.1	23.2	23.3	20.2	20.1	20.3	20.2	20.1
ME (kcal/Kg DM)	3097.7	3058.5	3047.5	3009.1	2975.4	3293.7	3281.3	3240.3	3216.2	3198.9
CF (% DM)	5.2	5.1	5.4	5.3	5.1	6.4	6.2	6.1	6.3	6.2
MM (% DM)	8.5	8.6	8.4	8.3	8.5	9.3	9.6	9.5	9.3	9.4
EE (% DM)	5.4	5.2	5.3	5.1	5.4	5.6	5.5	5.4	5.3	5.2
NFE (% DM)	57.8	57.9	57.8	58.1	57.7	58.5	58.6	58.7	58.9	59.1
Ca (% DM)	1.2	1.1	1.3	1.4	1.2	0.84	0.82	0.86	0.85	0.81

Note:RSBM=Roasted Soybean Meal; DBRCM=Dried Blood Rumen Content Mixture;NSC = Noug Seed Cake; T1=0%DBRCM +100%RSBM, T2=20%DBRCM +80%RSBM; T3=40 %DBRCM+60%RSBM;T4=60%DBRCM+40%RSBM;T5=80%DBRCM +20%RSBM; DM =Dry Matter; CP=Crude Protein; ME=Metabolizable Energy; CF=Crude Fiber; EE=Ether Extract; NFE=Nitrogen Free Extract; Ca=Calcium. Vitamin premix = 25 kg Broiler premix contains, Vitamin A 1000 000 IU, Vitamin D3 200 000 IU. Vitamin E 1000 mg, Vitamin K3 225 mg, Vitamin B1 125 mg, Vitamin B2 500 mg, Vitamin B3 1375 mg, Vitamin B6 125mg, Vitamin B12 2 mg, Vitamin PP (niacin) 4, 000 mg, Folic Acid, 100 mg, choline chloride 37,500 mg, Calcium 29.7 %, Iron 0.4 %, Copper 0.05 %,Manganese 0.6 %, Zinc 0.7%, Iodine 0.01 % Selenium 0.004 %

Dry matter intake, body weight change, feed conversion ratio of SASSO C44 broiler chicks

Dry matter intake, body weight change, feed conversion ratio of SASSO C44 broiler chicks fed a diet containing graded levels of dried blood rumen content mixture as a replacement of roasted soybean meal is presented in Table 3. When birds fed a diet containing DBRCM had no a significant difference ($P \geq 0.05$) in daily DM intake compared with the control group during the starter phase. However, the lowest ($P<0.05$) DM intake was observed birds fed on 80% DBRCM (T5) compared with other treatment groups in finisher and the whole growth period. The lowest ($P<0.05$) body weight gain was observed when birds fed a diet containing 80% DBRCM in starter phase. Statistically there was no a significant difference (P≥0.05) in body weight gain among dietary treatment groups in both finisher and the entire experimental period. There was no any significant difference (P≥0.05) in FCR through starter, finisher and entire experimental period among the treatment groups.

Table 3. Dry matter intake, body weight change, feed conversion ratio and mortality rate of SASSO C44 broiler chicks during starter phase (1-28 days), finisher phase (29-56days) and enter experiment (1-56days)

Parameters	Experimental Diets						
	T1	T2	T3	T4	T5	SEM	P-value
Starter Phase							
Mean daily DM intake (g/bird)	40.4	39.9	40.3	38.6	38.5	0.282	0.051
Mean total DM intake (g/bird)	1130.9^{a}	1117.6^{ab}	1128.6^{ab}	1081.5^{ab}	1076.6^{b}	7.907	0.047
Initial bodyweight(g)	41.5^{a}	41.2^{a}	41.3^{a}	41.0^{a}	41.3^{a}	0.406	0.998
Mean final body weight(g)	772.4^{a}	768.8^{ab}	729.4^{ab}	753.8^{ab}	696.3^{b}	10.451	0.034
Mean daily weight gain(g/bird)	26.1^{a}	26.0^{ab}	24.6^{ab}	25.5^{ab}	23.4^{b}	0.374	0.033
Mean total gain(g)	730.9^{a}	727.7 ^{ab}	688.1 ^{ab}	712.8 ^{ab}	655.1 ^{b}	10.474	0.033
FCR (g DMI I/g gain)	1.5^{a}	1.5^{a}	1.6^{a}	1.5^{a}	1.6^{a}	0.020	0.153
Finisher phase							
Mean daily DM intake (g/bird)	116.2^{a}	116.4 ^{a}	119.1 ^{a}	116.9 ^{a}	111.8^{b}	0.680	0.001
Mean total DM intake (g/bird)	3253.4 ^{a}	3259.6 ^{a}	3333.7 ^{a}	3272.6 ^{a}	3130.7^{b}	19.093	0.001
Initial bodyweight(g)	772.4^{a}	768.8^{ab}	729.4^{ab}	753.8^{ab}	696.3^{b}	10.451	0.034
Mean final body weight(g)	1713.4^{a}	1783.1^{a}	1811.3^{a}	1773.7^{a}	1521.1^{a}	41.612	0.203
Mean daily weight gain(g/bird)	33.6^{a}	36.2^{a}	38.6^{a}	36.4^{a}	29.5^{a}	1.414	0.363
Mean total gain(g)	941.0^{a}	1014.3^{a}	1081.9^{a}	1019.9^{a}	824.8^{a}	39.604	0.360
FCR (g DM I/g gain)	3.5^{a}	3.4^{a}	3.1^{a}	3.2^{a}	3.8^{a}	0.125	0.513
Entire Experimental Period							
Mean daily DM intake (g/bird)	79.0^{a}	78.9 ^{a}	80.4 ^{a}	78.5 ^{ab}	75.8^{b}	0.443	0.004
Mean total DM intake (g/bird)	4424.6 ^{a}	4417.1 ^{a}	4502.5 ^{a}	4392.7 ^{ab}	4245.8^{b}	24.780	0.005
Initial bodyweight(g)	41.5^{a}	41.2 ^{a}	41.3 ^{a}	41.0 ^{a}	41.3 ^{a}	0.407	0.998
Mean final body weight(g)	1713.4 ^{a}	1783.1 ^{a}	1811.3 ^{a}	1773.7 ^{a}	1521.1 ^{a}	41.613	0.203
Mean daily weight gain(g/bird)	29.9 ^{a}	31.1 ^{a}	31.6 ^{a}	31.0 ^{a}	26.4 ^{a}	0.745	0.203
Mean total gain(g)	1671.9 ^{a}	1741.9 ^{a}	1770.0 ^{a}	1732.6 ^{a}	1479.9 ^{a}	41.741	0.205
FCR(gDMI I/g gain)	2.7 ^{a}	2.6 ^{a}	2.6 ^{a}	2.5 ^{a}	2.9 ^{a}	0.058	0.465

Means with a different superscript in a row are significantly different (P< 0.05);DMI-Dry Matter Intake; g- gram; FCR-Feed Conversion Ratio; SEM-Standard Error of the Mean;T1-0%DBRCM+100%RSBM; T2-20% DBRCM +80%RSBM; T3 40% DBRCM +60%RSBM ; T4-60% DBRCM + 40% RSBM; T5-80% DBRCM+20%RSBM

Performance index

The performance index of broilers fed diets containing graded levels of DBRCM as replacement for roasted soybean meal is presented in Table 4. There was no statistical difference (P≥0.05) in performance index during the starter phase, finisher phase and the entire experimental period. The mean mortality was not influenced (P≥0.05) across the treatment groups.

Table 4. Performance index of broilers fed diets containing graded levels of DBRCM during starter phase (1-28 days), finisher phase (29-56 days) and the enter experimental period (1-56 days)

Performance index	Experimental diets						
	T1	T2	T3	T4	T5	SEM	P
Starter phase	50.12	50.11	44.50	49.79	42.40	1.328	0.181
Finisher phase	49.78	57.05	58.50	55.33	40.12	3.311	0.419
Entire experiment	64.83	70.50	70.92	70.31	53.24	3.136	0.358
Number of mortality	2	0	1	2	3	≈	≈
Mean mortality	0.7	0.0	0.3	0.7	1.0	0.133	0.212
Mortality %	4.44	0.0	2.22	4.44	6.66	≈	≈
Survival %	95.56	100	97.78	95.56	93.34	≈	≈

Note: T1=0%DBRCM +100%RSBM; T2=20% DBRCM +80%RSBM; T3=40% DBRCM +60% RSBM; T4=60% DBRCM + 40% RSBM; T5=80% DBRCM+20%RSBM; SEM-Standard Error of the Mean

Performance index (PI)= (Body Weight in kg /FCR) *100

Economic efficiency (EE)

The economic efficiency of the experimental ration is presented in Table 5. There was a difference ($P<0.05$) in a kilogram of feed cost among treatment rations. T1 had the highest ($P<0.05$) and T5 the lowest ($P<0.05$) cost per kilogram feed. Feed cost per kilogram gain was the highest ($P<0.05$) for T1 and the lowest ($P<0.05$) for T4 and T5. Significant difference ($P<0.05$) was observed among treatment groups in the cost of total feed consumed. Birds in T1 had the highest ($P<0.05$) and those in T5 the lowest ($P<0.05$) cost of total feed consumed. The highest ($P<0.05$) economic efficiency was observed for birds fed on T4 and T5 and the lowest economic efficiency for birds on T1. The highest relative economic efficiency was observed for birds in T4 and T5.

Table 5. Economic efficiency of diets containing graded levels of DBRCM as a replacement for roasted soybean meal

Parameters	Experimental Diets						
	T1	T2	T3	T4	T5	SEM	P
Mean final body weight (kg)	1.71^{a}	1.78^{a}	1.81^{a}	1.77^{a}	1.52^{a}	41.613	0.203
Feed cost/kg	6.54^{a}	6.04^{b}	5.60^{c}	5.10^{d}	4.64^{e}	0.179	0.009
Total feed consumed/as feed basis/	4.86^{a}	4.87^{a}	4.91^{a}	4.83^{a}	4.64^{b}	0.027	0.001
Feed cost/ Kg gain)	19.09^{a}	17.14^{ab}	15.59^{ab}	14.24^{b}	14.58^{b}	0.569	0.021
Total feed cost (ETH Birr/bird)	31.82^{a}	29.44^{b}	27.52^{c}	24.63^{d}	21.56^{e}	0.964	0.001
Total Revenue (ETH Birr)	100.31	104.52	106.20	103.96	88.79	2.504	0.164
Net Revenue (ETH Birr)	68.50	75.08	78.68	79.33	67.24	2.314	0.340

Economic efficiency	2.16[b]	2.55[ab]	2.86[ab]	3.22[a]	3.12[a]	0.124	0.010
Relative economic efficiency	1	1.18	1.32	1.49	1.44	≈	≈

Note: Means with a different superscript in a row are significantly different (P< 0.05); T1=0% DBRCM +100%RSBM; T2=20% DBRCM +80%RSBM; T3= 40% DBRCM +60%RSBM; T4=60% DBRCM + 40% RSBM; T5=80% DBRCM + 20%RSBM; SEM-Standard Error of the Mean; kg-kilogram; 1Birr =0.045USD

Total revenue (Birr) =Total gain (Kg) X price of one kg body weight on selling (60 ETB Birr)

Net revenue= Total revenue from the gain – total feed cost (Birr)

Economic efficiency =Net Revenue /total feed cost

Relative economic efficiency=Economic efficiency/control economic efficiency

Discussions

The results related to DMI of Sasso C44 broiler chicks were in line with the report of Adenui and Balogun (2003), a non-significant difference in dry matter intake by pullets on a 10% bovine blood rumen content mixture (BBRCM) diet and those on a control diet without BBRCM. The results of the current study disagreed with the report of Olukayode *et al.* (2008) who noted a higher feed intake for chicks fed a diet containing 10% sun dried rumen content blood meal than chicks fed a diet containing 15% sun dried rumen content blood meal (SDRBM). Shim *et al.* (1989) and Pond (1989) reported that feed intake to be higher on fibrous diets, which substantiated the higher feed intake of pullets on 20% BBRCM diet. However, when the inclusion level was increased to 80% DBRCM, the DMI was reduced, probably due to increasing fibrousness of the diets as the inclusion level of DBRCM was increased. Bolarinwa (1998) reported that the increased inclusion level of SDRBM increases the fiber content, which limited feed utilization in poultry production. Other than the fiber content, Onu *et al.* (2011) reported that the reduced intake of the birds on high inclusion level of BBRCM in diets could also be attributed to depressed appetite resulting from the unpleasant smell of the diets. Odunsi (2003) also reported that the high-level inclusion of blood meal and / or rumen content would result in unpleasant odour and make it less palatable to birds causing a depression in consumption. The same author stated that, the diets became darker in colour and the odor more bring out with an increase in BBRDM. The combination of these two factors will negatively influence palatability resulting in low consumption.

The result of the current study using DBRCM for Sasso C44 broilers confirmed the report of Olukayode *et al.* (2008) who noted that final body weight and body weight gain were superior for birds fed 10% SDRBM compared with all other diets in both the finisher phase and the entire period. Similar results were observed by Esonu *et al.* (2011), who reported that the body weight gain of the birds was numerically increased linearly up to 10% inclusion level of FBBRCM and then decreasing trend was observed. The results were in disagreement with the finding of Onu *et al.* (2011) who noted a linearly increased body weight gain with increasing level of bovine blood rumen content meal of broilers.

The improved weight gain of birds fed BBRCM diets could be attributed to a higher protein content of the diets which were efficiently metabolized for growth (Onu *et al.,* 2011). According to Esonu *et al.* (2004), chicks have difficulties to utilize high fibre diets when the inclusion level is increased and adult birds utilize high fibre materials than chicks. So that the finisher birds could tolerate DBRCM diets better than the starter chicks in the current study, because at this stage, they have a more developed gastro intestinal tract to handle the fibre contents of the diets (Esonu *et al.,* 2004). Due to this reason, a similar final body weight and body weight gain was observed in finisher and the entire experimental period up to 80% DBRCM inclusion level.

The inclusion of DBRCM up to 80% for the replacement of RSBM didn't affect the feed conversion ratio in both growth phases. This was in conformity with the report of Esonu *et al.* (2011) who noted no differences among the groups, fed diets containing different levels of fermented bovine blood rumen digesta (FBBRD). However, the contradictory results were reported by Onu *et al.* (2011), where improvement in feed conversion ratio of birds was achieved as the level of BBRCM inclusion in the diets increased in finisher phases. Similarly, the opposite results were observed in the report of Adeniji and Balogun (2002) and Odunsi (2003), where a significant difference in FCR of birds fed different levels of blood rumen content mixtures was observed. Pond *et al.,* (1989) reported that the lowest feed conversion ratio of broiler chicks fed a diet containing 6% of BBRCM inclusion in both growth periods might be related with a high fiber content of the diets since diets with high fibre contents reduce FCR. The performance index was not influenced by the inclusion of dried blood rumen content mixture as replacement of roasted soybean meal though out the experimental period in both growth phases.

The results related to EE agrees with the report of Onu *et al.* (2011), the reduction in the cost of diets containing higher levels of bovine blood rumen content mixture (BBRCM) was observed, because the cost per kilogram of processed BBRCM was by far cheaper than soybean meal. The same results were reported by Olukayode *et al.* (2008), who indicated that feed cost per unit weight gain was lower for all SDRBM diets than the SDRBM-free diet. The results were also in agreement with Esonu *et al.* (2011), who reported that the dietary inclusion of fermented bovine blood rumen digesta (FBBRD) reduced cost of producing a kilogram of feed which is reflected in the cost of a kg of meat produced. Adenui and Balogun (2003) reported that for pullets fed different levels of BBRCM, a reduction in the price of feed was observed with the increase in the levels of BBRCM in the test diets. The reduction in the price of feed with increase in the level of BBRCM in the diet was a result of the cheap price per kg of the BBRCM. The BBRCM can still be far cheaper compared with prices of most conventional protein supplements available.

Conclusions

Dried blood rumen content mixture didn't affect the-health of Sasso C44 broiler chicks during the starter and finisher phases. Hence, it could safely replace roasted soybean meal up to 60% for starter and up to 80% for finisher phases of broiler feeding to maximize the economic efficiency of the production without affecting the body weight gain, feed conversion ratio and performance index of birds. As a result, dried blood and rumen content mixture could be considered as an important and cheap non-conventional feed ingredient for economical feeding of chickens in general and Sasso C44 broilers in particular without affecting their performance index.

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