The Effect of Replacing Meat and Bone Meal with Soybean Meal on the Performance and Economic Returns of Broiler Chickens

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Abstract

The experiment was carried out to determine the effects of replacing meat and bone meal (MBM) with soybean meal (SBM) in starter and finisher diets on daily feed intake, body weight gain, food conversion ratio, water consumption, economic efficiency and carcass characteristics. A total of 306 day old broiler chickens were divided into six diet groups (each group with three replicates). Each replicate had 17 birds. Diet 1 was a commercial diet; diet 2 had 26% MBM; diet 3 had 6.5% SBM and 19.5% MBM; diet 4 had 13% SBM and 13% MBM; diet 5 had 19.5% SBM and 6.5% MBM and diet 6 had 26% SBM. At the end of the experiment (seven weeks), one male and female broilers were slaughtered from each replicate to evaluate the carcass development and abdominal fat. Feed intake and body weight gain of the birds were significantly ($p<0.05$) higher for diet 1 for the entire period of feeding, while both traits were inferior for diet 2. The highest feed conversion ratio was recorded for diet 2 ($p<0.05$). The rate of survival was not significantly different among treatments ($p>0.05$). The lowest abdominal fat percentage was observed for diet 1 and diet 6. Diet 1 comprised the highest eviscerated and breast weight percentage ($p<0.05$). The results of this study showed that using MBM beyond 6.5% significantly depressed the body weight gain, feed consumption, feed conversion ratio and increased cost of production.

Keywords: *Broiler; Meat and Bone Meal; Soybean Meal; Starter and Finisher*

Introduction

The fastest way of meeting the growing demand for protein of animal origin is through increasing the productivity of livestock and poultry and by lowering the cost of production to bring animal protein within the reach of more people that badly needs it. High feed cost is the single most important constraint to the expansion of animal production, which account for about 70% of the total production costs of broiler meat (Teguia and Beynen, 2005). Thus, exploring of full potential of all feed resources is a necessity for a successful poultry production.

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The other reason for seeking alternative protein source is the occurrence of Bovine Spongiform Encephalopathy (BSE) in the world in the last few years, which has raised a great concern on risks for human health (CEC, 2000). The disease was being transmitted to animals by the use of concentrate feed incorporating meat and bone meal (MBM) from infected animals (Speedy, 2004). As a preventative measure designed to stop the spread of the disease and minimize the potential risks to humans, the use of animal byproducts in manufacturing of animal feeds was prohibited (CEC, 2000). Authorities from countries such as Saudi Arabia, a major broiler chicken importer, also adopted this policy.

In the past, meat and bone meal was a primary protein source in animal diets in many areas in the world, but now a days due to its price and disease risk, broilers are fed diets exclusively formulated with plant-based ingredients Soybean meal is the preferred protein source in animal feed due to its relatively high protein content and a balanced amino acid composition (Brookes, 2000). It has also a high content of potassium, which is an electrolyte known to induce water consumption. The abundant availability of competitively priced soybeans on world markets today should be able to replace the protein material formerly derived from meat (Brookes, 2001).

The knowledge of the nutritional characteristics of Ethiopian soybean and its optimal levels of inclusion in poultry ration is very crucial to the sector especially at this time when animal feeds originating from meat are becoming expensive and risky. Therefore, the objective of this study was, to determine the effect of partial and full replacement of meat and bone meal (MBM) by soybean meal (SBM) on performance, carcass characteristics and economic advantage on broilers.

Materials and Methods

Study site

The study was conducted at the Debre Zeit Agricultural Research Center, located at 47 km South of Addis Ababa at an altitude of 1900m .a. s. l., latitude of 8° 44`N and longitude of 38° 57`E. The average (25 years) annual rainfall is 851mm with an average minimum and maximum temperature of 8.9°C and 26°C, respectively. The average relative humidity is 58.6 percent (DZARC, 2002).

Study animals

Cobb 500 strain of broiler chickens represents the study animals. It was the cross of Cornish and the Barred Plymouth Rock that gave rise to the first of the modern, commercial breeds, the Cobb. Cobb 500 is developed for intensive, indoor production; it is certainly a fast grower compared to Ross birds and has been known to grow too quickly for its legs to cope with its weight. It has proven ability to perform well in a wide range of environments, satisfying demand for maximum meat output. It has an excellent feed conversion ratio. Now a days, Cobb 500 strain is widely used in and around Debre Zeit.

Three hundred and six day old Cobb 500 broiler chicks received from Alema farm (local poultry company) located at Debre Zeit was used for the experiment and the chicks were randomly allotted to six dietary treatments replicated three times. Each replica has seventeen (17) birds and subjected in a completely randomized design (CRD).

Diet preparation and experimental design

Birds were provided daily with a known amount of feed and water *ad libitum*. Feed and water were weighed every morning and offered to the respective groups. The chickens were allocated to six diet groups where the MBM is progressively replaced by SBM from 0% to 100%. The diet groups were diet 1 which was a commercial ration, diet 2 with 26% MBM, diet 3 with 19.5% MBM and 6.5% SBM, diet 4 with 13% MBM and 13% SBM, diet 5 with 6.5% MBM and19.5% SBM and diet 6 with 26% SBM. The ration contains around 22% and 20% crude protein and 3000kcal/kg and 3200kcal/kg of metabolizable energy for starter and finisher broiler chicks, respectively. The nutrient composition of the soybean meal and meat and bone meal used for the study is presented in Table 1, whereas the ingredients and nutrient composition of starter and finisher diets are indicated in Tables 3 and 4.

Table 1. Proximate compositions of soybean meal and meat and bone meal used for the trial

Feed stuff	DM (%)	CP (%)	CF (%)	FE (%)	NFE (%)	MM (%)	Ca (%)	P (%)
MBM	97.69	42.90	0.00	18.74	4.09	34.27	12.70	0.97
SBM	95.14	44.31	7.89	9.86	31.45	6.50	0.29	0.60

DM=Dry matter; CP= Crude protein; CF= Crude fiber; FE=Fat extract; NFE= Nitrogen free extract; MM= Mineral matter; Ca= Calcium; P= Phosphorus.

Table 2. Ingredients and nutrient composition of starter diets

----------Diets ----------						
Feed stuff (kg/100kg)	1	2	3	4	5	6
Maize	-	58.00	57.50	57.75	57.50	57.00
MBM	-	26.00	19.50	13.00	6.50	-
SBM Eth.	-	-	6. 50	13.00	19.50	26.00
Noug cake	-	12.50	13.00	12.75	13.00	13.50
Broiler premix1	-	1.00	1.00	1.00	1.00	1.00
Salt	-	0.50	0.50	0.50	0.50	0.50
Soybean oil	-	2.00	2.00	2.00	2.00	2.00
Total	-	100.00	100.00	100.00	100.00	100.00

----------Diets ----------						
Feed stuff (kg/100kg)	1	2	3	4	5	6
Composition result after proximate analysis						
DM (%)	90.57	93.93	93.60	92.31	92.45	92.36
CF (%)	5.79	6.15	5.87	6.73	9.04	6.52
CP (%)	22.27	21.14	23.56	22.30	23.19	22.55
FE (EE) (%)	6.21	10.41	14.00	9.49	9.69	9.80
NFE (%)	60.39	48.06	43.87	51.63	49.98	54.76
MM (%)	5.70	14.25	12.71	9.85	8.11	6.38
Ca++ (%)	1.19	4.00	3.17	2.18	1.46	0.88
P (%)	0.47	0.78	0.74	0.61	0.36	0.33
ME (Kcal/kg DM)	3542.89	3389.82	3675.15	3467.42	3345.60	3647.43

1 Broiler premix 1% per kg contains: Vitamins: Vitamin A,1000000IU; VitaminD3, 200000IU;Vitamin E, 1000mg; Vitamin K, 225mg; vitamin B1, 125mg; vitamin B2, 500mg; vitamin B3, 1375mg; vitamin B6, 125mg; vitamin B12, 1mg; vitamin PP,4000mg; folic acid, 100mg; Choline Chloride, 37500mg; Biotin, 0mg. Trace elements: Iron, 0.45%; Copper,0.05%; Manganese, 0.6%; Cobalt, 0.01%; Zinc,0.7%; Iodium, 0.01%; Selinium, 0.04%; Minerals: Calcium, 29.7%. Other Additives: Anti—oxidant (BHT) 0.05%.

Table 3. Ingredient and nutrient composition of finisher diets

----------Diets---------						
Feed stuffs (kg/100kg)	1	2	3	4	5	6
Maize	-	60.00	60.00	60.00	60.00	60.00
MBM	-	26.00	19.50	13.00	6.50	-
SBM Eth.	-	-	6.50	13.00	19.50	26.00
Sorghum	-	8.50	8.50	8.50	8.50	8.50
Noug cake	-	2.00	2.00	2.00	2.00	2.00
Premix general1	-	1.00	1.00	1.00	1.00	1.00
Salt	-	0.50	0.50	0.50	0.50	0.50
Soybean oil	-	2.00	2.00	2.00	2.00	2.00
Total	-	100.00	100.00	100.00	100.00	100.00
Laboratory result composition after chemical analysis						
DM%	90.97	92.63	92.44	92.37	91.77	91.77
CF%	6.34	3.87	3.26	4.93	4.70	4.66
CP%	19.82	16.57	17.92	18.46	17.52	18.32
FE (EE)%	6.46	11.44	8.26	7.17	8.90	8.35
NFE%	61.96	56.13	60.36	59.12	61.98	61.96
MM%	5.42	11.99	10.20	10.32	6.90	6.71
Ca++%	1.17	0.89	0.92	0.89	0.87	0.85
P%	0.62	0.79	0.81	0.79	0.65	0.64
ME Kcal/kg DM	3518.93	3740.87	3695.02	3482.70	3736.75	3718.13

[1] Broiler premix 1% per kg contains: **Vitamins**: Vitamin A,1000000IU; VitaminD3, 200000IU;Vitamin E, 1000mg; Vitamin K, 225mg; vi- tamin B1, 125mg; vitamin B2, 500mg; vitamin B3, 1375mg; vitamin B6, 125mg; vitamin B12, 1mg; vitamin PP,4000mg; folic acid, 100mg; Choline Chloride, 37500mg; Biotin, 0mg. **Trace elements:** Iron, 0.45%; Copper,0.05%; Manganese, 0.6%; Cobalt, 0.01%; Zinc,0.7%; Iodium, 0.01%; Selenium, 0.04%; **Minerals:** Calcium, 29.7%. **Other Additives:** Anti—oxidant (BHT) 0.05%.

Housing and management

Litter system housing, which is partitioned into 18 equal-sized pens, was used. Before placing the experimental birds into the pens, the whole unit was cleaned, disinfected and littered with properly dried tef *(Eragrostis tef)* straw. Subsequently, the necessary sanitary precautions were observed. The house was electrically heated using 250 watt bulbs two per pen. Experimental chickens were vaccinated for NCD; using HB1 at 2nd day and Lasota at day 23 through ocular routes and Gumboro at day 7 and 21 with drinking water.

Data collected and performance parameters considered

The body weights of birds were taken as a group using sensitive balance weekly until the end of the study period (seventh week). Feed and water offered to the chicken were measured every morning and refusals were recorded the next morning and the difference between offers and refusals were calculated. Then mean weekly feed consumption was calculated for each replicate for seven weeks. Body weight gain and feed conversion ratios were calculated based on the mean weekly body weight and feed consumption.

The price of feed and mortality were recorded. Feed intake per bird and price of feed per kilogram were used to calculate the cost of feed consumed by a bird for the period. The cost per kilogram of weight gain was calculated according to the procedures of Sonaiya *et al.* (1986) and Ukachukwu and Anugwa (1995), which involves taking the product of price per kilogram of feed and feed-to-gain ratio of birds consuming such diets. The economic benefit was estimated by considering partial budget analysis assumptions, according to the principles developed by Upton (1979). The prices of the different diets (prices/kg) at the starter, finisher and entire period of feeding were noted.

At the end of the study, two broilers (one male and one female) per replicate were randomly removed and starved over night. They were then weighed and slaughtered by cervical dislocation as described by Oluyemi and Roberts (2000). The slaughtered birds were plucked manually after scalding in hot water. Eviscerated percentage was calculated by removing the viscera, head, shank, lungs and heart but with liver, gizzard and neck. The abdominal fat, drumstick and thigh together, liver and gizzard were measured and expressed as percent of live weight.

Laboratory analysis of feed samples

Representative samples of all the feed ingredients used in the study were sent to National Veterinary Institute for chemical analysis by proximate principles. The dry matter (DM %), crude protein (CP %), mineral mater (MM %), crude fiber (CF %), fat extract (%), nitrogen free extract (%), Ca (%) and P (%) composition of the experimental diets (formulated feed) and the test materials (MBM and SBM) were analyzed using the method of A.O.A.C. (1990). ME was estimated by employing the formula proposed by Wiseman (1987), ME (Kcal/kg DM) = 3951+ 54.4EE - 88.7CF – 40.8Ash.

Statistical analysis

Variance between treatments was analyzed using the General Linear Model (GLM) procedures of the Statistical Analysis Systems using SPSS (release 15.0, 2006) software. When the analysis of variance revealed the existence of significant differences among treatment means, then Duncan Multiple Range Test (Duncan, 1955) was used to locate treatment means that were significantly different from one another. Before analysis, mortality count data were transformed using the square root transformation.

Results

Feed intake

The mean daily feed consumptions during the starter phase are given in Table 4. Mean total feed intake was significantly higher ($P<0.05$) in the starter phase for the groups fed on diet 1 (48.64g/bird) followed by those under diet 5 (41.16g/bird) and diet 4 (41.11g/bird). The least mean daily feed intake was observed for diet 2 (29.91g/bird). Chicks kept on MBM and SBM-containing treatments were inferior ($p<0.05$) in terms of finisher feed intake when compared to those on diet 1(Table 5). Chicks on diet 5 and diet 6 had the next highest intake. The level of MBM in the diet groups was inversely related to feed intake.

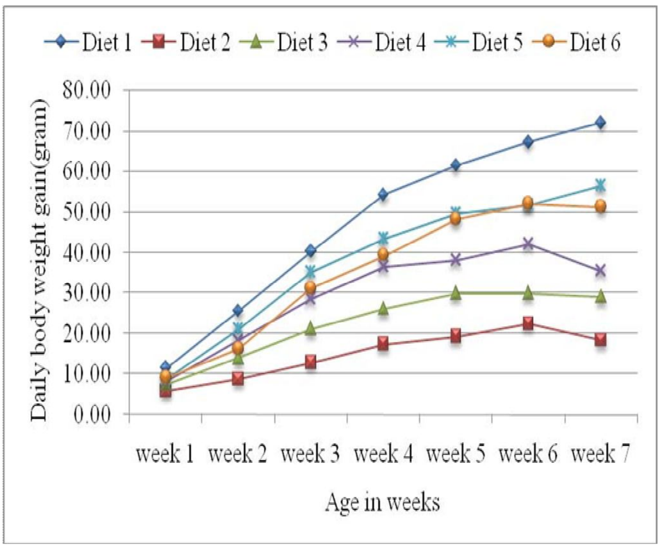

Figure 1. Average weekly feed intake during the study period in the different experimental groups

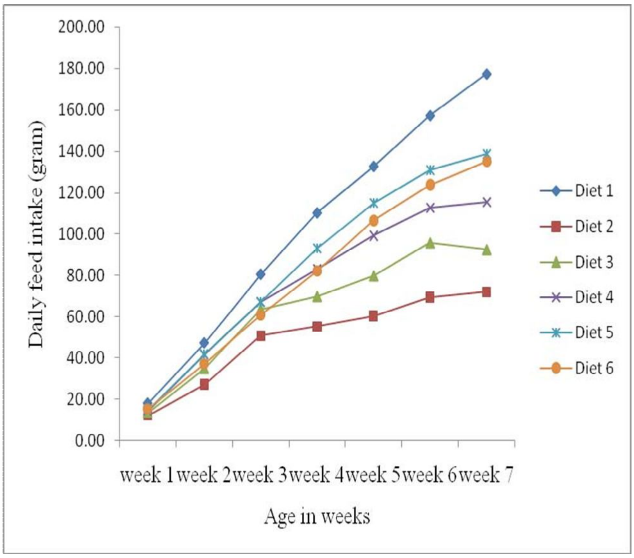

Figure 2. Daily body weight gain in the different treatment groups in the respective weeks during the study period

Body weight gain

In the starter phase, the mean daily body weight gain of the group assigned to the commercial ration (diet 1) was significantly higher (25.74g), followed by that of the groups fed on diet 5 (21.70g). As the level of MBM increased from 6.5% to 26% in the treatment groups, the body weight gain decreased significantly ($P<0.05$). Similar results were found in the finisher phase too. The highest daily weight gain was recorded for chicken kept on diet 1 (66.02g) (Table 5). Those chickens on diet 5 (52.17g) and diet 6 (49.36g) showed the next higher weight gain. The least daily weight gain was recorded for diet 2 (20.05g/day).

Feed conversion ratio

Feed conversion ratio of the experimental chicks in the starter and finisher phases are shown in Table 4 and 5. The least amount of feed required for a unit of weight gain was observed in chicks kept in diet 1 (1.81) and diet 5 (1.85) ($p<0.05$). The highest feed required for a unit of weight gain was observed for diet 2. Similar to weight gain, as the level of MBM was beyond 6.5% the feed required for a unit of gain also increased significantly in all phases of feeding ($p<0.05$).

Mortality

The mortality of chicks during the starter phases ranged from 0% in chicks kept under diet 1and 5 to 5.9% in those kept under diet 2 and 3. In the finisher phase, mortality ranged from 0% in diet group 1 to 5.9% in diet group 5 (Table 4 and 5). However, there was no significant difference (P>0.05) among the different diet groups in both the starter and finisher phases.

Economic efficiency

Diet 2 incurred the highest cost per unit of body weight gain both in the starter (9.29 Birr) and finisher (9.64 Birr) phases followed by diet 1 and diet 3 (Table 4 and 5). The least costs per unit of body weight gain was found in chicks under diet 5 and diet 6 in both the starter and finisher phases (p<0.05). These two diet combinations (groups) were economically feasible than the use of commercial diet or higher levels of MBM. Level of inclusion of MBM seems to have shown strong negative correlation with cost of feed consumed per kg live weight gain. Moreover, uniformity of birds' and size was negatively affected by higher level of MBM in the diet.

The economic return in terms of partial budget analysis from broilers raised under different treatment feed costs are presented in Table 7. In this experiment, the highest net profit of 23.70 Birr per bird was obtained from the sale of processed broiler carcass reared under the feeding regimen of commercial diet followed by diet 6 (19.84 Birr) and diet 5 (19.73 Birr). The least profit was earned from diet 2 (2.40 Birr).

Mean eviscerated and organ weight

The highest eviscerated yield (%) was achieved by chickens on diet 1 (73.80%) followed by those on diet 6 (70.54%) and diet 5 (69.21%), while the lowest yield (%) was observed in groups on diet 2 (66.17%) (Table 8). However, the value for chickens on diet 2 were not statistically different from those on diet 3 (66.93%), and diet 4 (68.57%). The eviscerated parts included were carcass parts, liver, gizzard and neck. Mean abdominal fat percent was highest for chickens on diet 3, 4 and 2. The least abdominal fat proportion was recorded for diet 1 and 6. The result from this experiment showed that there seems to be a positive correlation between the level of inclusion of MBM and an abdominal fat content. Chicken kept in diet 1 again yielded the highest proportion of breast meat cut (30.44%) followed by diet 6 (26.43%), 5 (26.27%), 4 (25.49%) and 3 (24.35%). The least percent was recorded for diet 2. Thigh and drumstick portions were not statistically significant (p>0.05) among each feeding groups. In contrary, the liver and gizzard weight proportions were higher for diet 2but it was not significantly different (p>0.05) from diet 3, 4 and 5 (Table 8).

Table 4. Response of broiler chicks to different dietary combinations of MBM in starter diets by SBM (0-21 days)

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Initial body weight (g/bird)	35.64±0.09	35.78±0.07	35.77±0.18	35.78±0.09	35.59±0.09	35.78±0.18
Mean daily weight gain(g/ bird)	25.74 ±0.32^{a}	9.17 ±0.57^{e}	14.13 ±0.80^{d}	18.34 ±0.57^{c}	21.70 ±0.49^{b}	18.81 ±0.90^{c}
Final body weight (g/bird)	576.26±6.65^{a}	228.36 ±11.85^{e}	332.49 ±16.61^{d}	421.27±11.80^{c}	491.28 ±10.23^{b}	430.82 ±18.91^{c}
Mean daily feed intake(g/ bird)	48.64 ±0.41^{a}	29.91 ±1.17^{d}	37.94 ±2.07^{bc}	41.11 ±0.51^{b}	41.16 ±0.78^{b}	36.79±1.09^{c}
Mean total feed intake (g/ bird)	1021.39 ±8.51^{a}	628.03±24.62^{d}	796.81 ±43.53^{bc}	863.24 ±10.72^{b}	864.31 ±16.35^{b}	772.49 ±22.96^{c}
FCR (feed : gain)	1.81 ±0.01^{d}	3.04 ± 0.08^{a}	2.50 ±0.08^{b}	2.14±0.10^{c}	1.85 ±0.01^{d}	1.92 ±0.04^{d}
Mortality*	0.00±0.00	1.00±0.00	0.58 ±0.58	0.67±0.33	0.00 ±0.00	0.33±0.33
Cost per kg of starter diet (Birr)	3.51	2.84	2.90	2.96	3.02	3.07
Feed cost/kg of gain	6.63±0.05^{b}	9.29±0.22^{d}	7.80±0.23^{c}	6.65±0.30^{b}	5.73±0.03^{a}	6.01±0.12^{a}
Cost/total feed consumed	3.59±0.03^{a}	1.78±0.07^{e}	2.31±0.13^{d}	2.56±0.03^{bc}	2.61±0.05^{b}	2.37±0.07^{cd}

^{abcdef} Means within a row followed by different superscripts are significantly different ($p<0.05$);

* Mortality count data were transformed by square root method; Values are means ± standard errors

Feed cost/kg gain=FCR X kg feed cost; Cost/ total feed consumed= FCR X kg feed cost X total weight gained; Values are means ± standard errors

Table 5. Effect of replacement of MBM in broiler finisher diets (22-49 days) by SBM

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Initial body weight (g/ bird)	576.26±6.65^{a}	228.36 ±11.85^{e}	332.49 ±16.61^{d}	421.27±11.80^{c}	491.28 ±10.23^{b}	430.82 ±18.91^{c}
Mean daily weight gain(g/ bird)	66.02± 0.36^{a}	20.05±0.39^{e}	29.69±1.31^{d}	39.47±1.64^{c}	52.17±1.79^{b}	49.36±1.53^{b}
Total body weight gain (g/bird)	1782.56±9.61^{a}	541.29±10.60^{e}	801.76±35.25^{d}	1065.79±44.22^{c}	1408.58±48.33^{b}	1332.78±41.40^{b}
Final body weight (g/bird)	2358.82±10.51^{a}	769.66±3.19^{f}	1134.25±50.18^{e}	1487.06±47.52^{d}	1899.86±56.43^{b}	1763.61±50.55^{c}
Mean daily feed intake(g/ bird)	149.75±1.34^{a}	66.62±2.47^{e}	87.47±3.99^{d}	106.40±3.59^{c}	123.80±1.80^{b}	116.04±2.93^{b}
Mean total feed intake (g/bird)	4043.07±36.19^{a}	1798.64±66.72^{e}	2361.68±107.78^{d}	2872.80±96.85^{c}	3342.72±48.68^{b}	3133.02±79.20^{b}
FCR (feed : gain)	2.26±0.02^{a}	3.33±0.14^{c}	2.95±0.05^{b}	2.71±0.04^{b}	2.38±0.08^{a}	2.35±0.04^{a}
Mortality*	0.00±0.00	0.33±0.33	0.33±0 .33	0.33±0.33	0.80±0.42	0.33±0.33
Cost per kg of finisher diet (birr)	4.04	2.90	2.96	3.01	3.07	3.13
Feed cost/ kg of gain	9.16±0.10^{cd}	9.64±0.40^{d}	8.72±0.15^{bc}	8.12±0.11^{b}	7.30±0.24^{a}	7.36±0.14^{a}
Cost/total feed consumed	16.33±0.15^{a}	5.22±0.19^{e}	6.99±0.32^{d}	8.65±0.29^{c}	10.26±0.15^{b}	9.81±0.25^{b}

^{abcdef} Means within a row followed by different superscripts are significantly different ($p<0.05$);

* Mortality count data were transformed by square root method; Values are means ± standard errors.

Feed cost/kg gain=FCR X kg feed cost; Cost/ total feed consumed= FCR X kg feed cost X total weight gained; Values are means ± standard errors

Table 6. Response of replacing MBM in broiler diets (0-49 days) by SBM

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Initial body weight (g/bird)	35.64±0.09	35.78±0.07	35.77±0.18	35.78±0.09	35.59±0.09	35.78±0.18
Mean daily weight gain(g/bird)	48.39±0.22[a]	15.29±0.07[f]	22.89±1.05[e]	30.23±0.99[d]	38.84±1.18[b]	35.99±1.05[c]
Total body weight gain (g/bird)	2323.18±10.48[a]	733.88±3.21[f]	1098.49±50.33[e]	1450.92±47.58[d]	1864.36±56.52[b]	1727.82±50.48[c]
Final body weight (g/bird)	2358.82±10.51[a]	769.66±3.19[f]	1134.25±50.18[e]	1487.06±47.52[d]	1899.86±56.43[b]	1763.61±50.55[c]
Mean daily feed intake(g/bird)	105.51±.59[a]	50.56±1.53[e]	65.80±3.11[d]	77.83±1.99[c]	87.65±1.34[b]	81.36±2.09[c]
Mean total feed intake (g/bird)	5064.5±28.25[a]	2426.7±73.38[e]	3158.5±149.03[d]	3736.0±95.43[c]	4207.0±64.39[b]	3905.5±100.16[c]
FCR (feed : gain)	2.18±0.02[a]	3.30±0.09[d]	2.88±0.06[c]	2.58±0.02[b]	2.26±0.06[a]	2.26±0.02[a]
Mortality*	0.00±0.00	1.14±0.14	0.91±0.50	0.80±0.42	0.80±0.42	0.47±0.47
Feed cost/ kg of gain(1-49th day)	8.57±0.08[c]	9.53±0.25[d]	8.47±0.18[c]	7.72±0.06[b]	6.91±0.18[a]	7.05±0.08[a]
Total feed Cost (1-49th day)	19.92±0.12[a]	7.00±0.21[e]	9.30±0.44[d]	11.20±0.29[c]	12.87±0.20[b]	12.18±0.31[b]

[abcdef] Means within a row followed by different superscripts are significantly different ($p<0.05$); Values are means ± standard errors;

* Mortality count data were transformed by square root.

Feed cost/kg gain=FCR X kg feed cost; Cost/ total feed consumed= FCR X kg feed cost X total weight gained; Values are means ± standard errors

Table 7. Average production cost and returns fed different treatment rations

Partial production costs	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Day old chick cost	8.00	8.00	8.00	8.00	8.00	8.00
Feed cost (Birr)	19.92	7.00	9.30	11.20	12.87	12.18
Total cost	27.92	15	17.3	19.2	20.87	20.18
Average carcass weight (kg)	1.78	0.60	0.90	1.20	1.40	1.38
Price/kg of carcass (supermarket)	29.00	29.00	29.00	29.00	29.00	29.00
Total carcass Sale (Birr)	51.62	17.40	26.10	34.8	40.60	40.02
Net profit	23.70	2.40	8.80	15.60	19.73	19.84

Table 8. Effect of treatment diets on carcass and organs weight and abdominal fat deposition and their share in live weight (%) at 49 days of age

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Live weight(g)	2423.48±146.94[a]	907.92±101.14[d]	1342.42±44.16[c]	1750.68±86.87[b]	2014.43±155.06[b]	1951.50±81.77[b]
Eviscerated wt (PLWT)*	73.80±0.35[a]	66.17±0.94[d]	66.93±1.01[cd]	68.57±0.67[bcd]	69.21±1.04[bc]	70.54±0.59[b]
Breast (PLWT)	30.44±0.79[a]	22.14±1.53[c]	24.35±0.95[bc]	25.49±0.74[b]	26.27±0.99[b]	26.43±0.52[b]
Thigh + drumstick (PLWT)	22.72±0.24[a]	21.51±0.38[ab]	20.89±0.31[b]	21.53±0.49[ab]	20.99±0.96[b]	22.29±0.53[ab]
Liver (PLWT)	1.88±0.09[c]	2.38±0.06[a]	2.11±0.14[abc]	2.09±0.12[abc]	2.20±0.10[ab]	2.03±0.09[bc]
Gizzard (PLWT)	1.51±0.06[b]	1.87±0.15[a]	1.51±0.10[b]	1.42±0.07[b]	1.28±0.06[b]	1.51±0.07[b]
Abdominal fat (PLWT)	1.75±0.14[d]	3.75±0.43[ab]	4.01±0.38[a]	3.35±0.32[ab]	2.88±0.25[bc]	2.23±0.38[cd]

[abcd] Means within a row followed by different superscripts are significantly different ($p<0.05$); Values are means ± standard errors; PLWT = percent live weight proportion of the organ; *Eviscerated weight includes the edible carcass, neck of the bird, Gizzard and liver.

Discussion

The feed intake and body weight gain of broilers were higher for commercial diet both in the starter and finisher phases. On the contrary, reduced feed intakes as well as body weight gain were observed for diet 2 (diet containing 26% of MBM). This is due to the increased level of MBM, which depresses intake. This finding is in agreement with other previous reports on different species of animals. Liu (2000) indicated that 10 or 15% inclusion of MBM depressed broiler chick performance as compared to a soybean meal diet. Salmon (1977) reported reduced weight gains as MBM increased from 7.5 to 15% in turkey diets. Amino acid deficiency especially of lysine is the main factor to be considered in the low chick performance when using high levels of MBM in the diet (Liu, 2000). In addition to that there was limitation in its use in poultry rations due to variability in protein quality of MBM (Bozkurt *et al.,* 2004).

Next to commercial ration a better feed intake and weight gain was recorded for the diet containing 19.5%SBM and 6.5%MBM in the starter phase. This could possibly be due to the synergetic effect of two or more protein sources in the diet, which encourages more feed intake than feeding SBM or MBM separately. This result is in agreement with those of Sibbald (1975) and McDonald *et al.* (1995) who reported that a combination of different protein source has associative effect in amino acid complementarity that satisfy requirements of the broilers better and improve performance. Similarly, the weight gain of diet 5 and diet 6 were not significant ($p>0.05$) in week 1, 4, 5, 6, and 7. This indicates that a full SBM diet could practically substitute fully MBM in the above specified weeks mainly in the finisher phase and totally substitute the higher inclusion levels of MBM in all weeks. This result is in agreement with that of Arafa *et al.* (2001) who reported that the effect of feeding diets containing all-vegetable protein versus mixture of vegetable and animal protein sources on feed consumption, live body weight gain and feed conversion ratio of broiler chicks were not significantly different from those of the fish meal diet. The increased levels of MBM incorporated in poultry diets might reduce costs partially as cheaper protein, calcium and phosphorus source than those conventional feedstuffs (Waldroup, 2002). However, the inclusion did not exceed 10% in poultry rations, due to variability in protein quality of MBM (Bozkurt *et al.,* 2004).

The economic results of broiler production are highly dependent on the efficiency of conversion of feed to product (Washburn, 1980). In this study, the FCR values of chickens on diet 1, 5 and 6 were not different for the whole period of growth. This indicates that both diets could possibly interchangeably used for broiler ration with lower production costs. The increased level of MBM had negative effect on FCR, and this is attributed to lower protein quality and nutrient digestibility of MBM. This was demonstrated in some reports (Bozkurt *et al.,* 2004; Johnson and Parsons, 1997; Wang and Parsons, 1998) that low quality MBM supplementation to broiler chick diets had detrimental effects on bird performance. The feed efficiency declined in all treatments as the birds grew up. This finding is in agreement with that of Milton (2003) and MAFRA (2008). This is mainly because heavy birds use increasing quantities of feed to maintain their body mass, and less is used for growth.

The final judge in any feeding program is the economics of the operation; reduction in feed cost is basic for profitability of broiler operations. The economic analysis results indicated that both practices, feeding diets with lower level of MBM and without MBM, provided positive net benefits at all levels per kg of body weight gain. The highest body weight gain with lower feed cost in starter and finisher phases was obtained from diets 5 and 6 without a significant difference between them. However, the highest net benefit was obtained from diet 1 (23.70 Birr).

Higher relative proportion of abdominal fat was observed for the diets containing MBM beyond 6.5% (diets 2, 3 and 4) in the ration. This might be due to the higher energy-protein ratio in the diets. It was reported previously that the smaller the energy-protein ratio, the less fat will be deposited (Rezaei et al., 2004; Farrel, 1974; Bartov et al., 1974; Lesson et al., 1988; Yashamita et al., 1975). The other reason for high fat deposition might be the low lysine level in high level of MBM in the experimental diets (Leeson and Summers 2001). Rezaei et al. (2004) reported a trend of reduction in fat pad percentage due to increased Lysine level. The highest breast meat was observed in diet 1 followed by diet 4, 5 and 6. This could be due to the fact that the commercial diet might had synthetic amino acid like lysine, whereas the lower level of MBM and a full soybean meal diet may also fulfill these amino acids for the birds. Increasing Lysine level in diet increased breast meat percentage significantly as shown in other research reports (Bilgili et al., 1992; Gorman and Balnave, 1995; Han and Baker, 1994; Kidd et al., 1998).

Conclusion

The result of this experiment clearly showed that in terms of biological efficiency and economic response, the commercial diet purchased from local producer showed superior performance over the other treatments during the starter and finisher phase. From the MBM and SBM combination diets, 6.5% MBM and 19.5% SBM in both parameters showed a better efficiency for the first 3 weeks of age; Similarly, in the finisher phase MBM could safely and economically be substituted with total SBM both in their feed efficiency and economic return. On the other hand, abdominal fat deposition increases as the level of MBM increased. Economically a better profit was gained from SBM diet than MBM diets. The nutrient content of seeds vary depending on the type of climate and soil, and therefore evaluation of the amino acid profile and nutrient content of Ethiopian SBM is required. To completely replace animal origin protein sources and improve amino acid balance in the diet, other plant source protein should be investigated; The level of MBM included in this experiment perform better at 6.5%, but the higher levels significantly depressed growth performance. This suggests that MBM should not be used at a higher level than 6.5% of the diet.

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