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Effect of Cotton Seed Meal on the Performance Traits and Meat Composition in Commercial Broilers

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Authors' contributions

This work was carried out in collaboration between all authors. Author SI designed the study, wrote the protocol and performed the experiment. Author AKMAK performed the statistical analysis. Authors SI and MNI managed the literature searches and wrote the first draft of the manuscript. Author MNI will give the financial support for publication charges. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the effect of different levels of cotton seed meal (CSM) on performance traits and meat composition in commercial broilers.
Place and Duration of the Study: The experiment was carried out at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during the period from 26 February, 2018 to 10 April, 2018.
Study Design and Methodology: Two hundred fifty two Cobb-500 day-old broiler chicks with good health were randomly allotted to six dietary treatments in three replications with fourteen birds per replication in a complete randomized design for 35 days period. The dietary treatments were: T0, soyabean meal (SBM) based diet; T1, 10% CSM protein with 90% SBM protein; T2, 20% CSM protein with 80% SBM protein; T3, 30% CSM protein with 70% SBM protein; T4, 40% CSM protein with 60% SBM protein and T5, 50% CSM protein with 50% SBM protein. The mash feed was supplied *ad libitum* basis.

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Results: Average feed intake (g/d) was increased (P=0.001) in higher amount of CSM group. Dressing percentage was tended to higher (*P = 0.089*) in T0 and lower value was showed in T5. Crude protein (CP) content of breast meat significantly (*P < 0.01*) affected among the treatments. The highest CP content was observed in T5 (22.57%) and lowest CP content was in T1 (21.12%). Crude fibre (CF) content was significantly increased (*P < 0.01*) in the diet contained higher amount of CSM (0.35%, 0.32%, 0.31%, 0.22%, 0.13% for T5, T4, T3, T2 and T1; respectively) and the lowest CF was observed for T0 (0.11%). Ether extract (EE) of breast muscle was also significantly increased (*P < 0.01*) in the diet contained higher amount of CSM (1.27%, 1.15%, 1.12%, 1.09%, 1.05% for T5, T4, T3, T2 and T1; respectively) and lower EE was observed in T0 group (1.01%). Ash content was higher (*P < 0.05*) in T0 (1.49%), T2 (1.48%) and T3 (1.45%) group compare to others. The second higher value was observed for T1 (1.4%) diet and the lowest ash content was observed in T4 (1.25%) and T5 (1.32%).
Conclusion: It would be concluded that CSM can be a substitute of soyabean meal in broiler ration and up to 40% CSM protein can be incorporated in broiler chicken diet without any adverse effects.

Keywords: Cotton seed meal; soyabean meal; broiler; carcass weight; dressing percentage; breast muscle.

1. INTRODUCTION

Broilers play an important role in human nutrition, employment and income generation. As an important sub-sector of livestock production, the poultry industry in Bangladesh plays a vital role in economic growth and simultaneously creates numerous employment opportunities. Poultry industry is a fundamental part of animal production, is committed to the nation for supplying a cheap source of good quality nutritious animal protein in terms of meat and eggs [1]. It was recorded that poultry meat alone contributes 37% of the total meat production in Bangladesh [2]. Poultry contributes about 22-27% of the total animal protein supply in the country. So, to cope with market demand for animal meat protein, modern broilers are reaching market age sooner each year. Therefore, advances in nutrition will be the fundamental for securing this rapid growth achievement and maintaining sustainable broiler production. Soyabean meal is generally recognized as an effective and high-quality vegetable protein feed-stuff [3,4]. Recently in Bangladesh, high demand of soyabean meal has been observed but its availability is not sufficient round the year and the prices are also higher in off-season. Therefore, it is very important to improve the scientific knowledge for utilizing low cost locally available agro-industrial by-products in broiler feed in order to reduce the feed cost and to substitute as an effective protein source. Cottonseed meal is one of them. Cotton seed meal is a by-product of cotton seed that is used for animal feeding because it is rich in oil and protein [5]. CSM is a fairly good source of protein (222.0 to 560.2 g per kg); [6,7] and metabolizable energy (7.4 to 11.99MJ per kg); [7]. Another researcher reported that cottonseed cake has been used as a cheaper alternative to soybean cake in livestock feeding and a good source of dietary protein [8]. So, CSM is very useful in livestock feeding in the cotton growing areas. Although CSM is an inexpensive source of protein with high protein content [9], it's nutrient bioavailability in poultry diets is low due to the presence of anti-nutritional factors, such as free gossypol, Cycloproponoic fatty acids and crude fibre [10], which may cause negative effects on growth, reproductive performance and organ abnormalities [9,11]. But cottonseed products offer a safe alternative feed when fed at recommended levels [12-14]. If carefully incorporated, cotton seed meal can reduce feed cost while maintaining or increasing the level of bird's performance. In Bangladesh context, there is very little research work on inclusion of CSM as an alternative protein source in broiler diets. Therefore, the purpose of this study was to evaluate the effect of different levels of cotton seed meal on performance traits and meat composition in commercial broilers.

2. MATERIALS AND METHODS

2.1 Animal, Experimental Design and Management

The experiment was carried out at Bangabandhu Sheikh Mujibur Rahman Agricultural University Poultry Farm, Salna, Gazipur, Bangladesh. Two hundred fifty two (252) healthy day-old Cobb-500 broiler chicks were weighed and randomly allocated to six dietary treatments replicated three times with fourteen birds per replicate in a

Complete Randomized Design (CRD).The dietary treatments were: T0, SBM based diet; T1, 10% CSM protein with 90% SBM protein; T2, 20% CSM protein with 80% SBM protein; T3, 30% CSM protein with 70% SBM protein; T4, 40% CSM protein with 60% SBM protein and T5, 50% CSM protein with 50% SBM protein. A strict bio-security program was maintained inside and outside of the research shed. The birds were vaccinated against Infectious Bursal Disease (IBD) and Newcastle Disease (ND). The management practices were identical for all dietary groups. Electric light was provided for 23.5 hours and the brooding temperature was almost maintained at 33±2°C for first week. In course of the trial, the temperature was gradually reduced to 25±2°C at the end of the experiment. Fresh and dried saw dust was used at a depth of about 3 cm for bedding material. The birds were critically observed twice a day for clinical sign if any (slow movement, infrequent sitting, lack of appetite, significant changes of feathering, paralysis etc.) and for monitoring other activities. Feeders were cleaned in each week and drinkers were washed twice daily.

2.2 Preparation of Experimental Diet and Feeding

The experimental diets were formulated by replacing soyabean meal with CSM according to the recommendation of NRC [15] in three phases namely starter (1 to 14 days), grower (15 to 28 days) and finisher (29 to 35 days). All feed ingredients were weighed separately and soyabean oil was incorporated into soyabean meal first and then mixed thoroughly with other macro ingredients. Micro ingredients were mixed thoroughly with the ground maize and then mixed with the other macro ingredients. Diet for each treatment was prepared properly as per recommendation. The ingredients and nutritional composition of different diets (starter, grower and finisher) are presented in Table 1, Table 2 and Table 3; respectively. All diets were free from antibiotics. The broiler mash feed was supplied three times daily on an ad libitum basis.

Table 1. Ingredients composition and nutrient content of broiler starter diet

Items	Treatments					
	T0	**T1**	**T2**	**T3**	**T4**	**T5**
Ingredients (% as fed basis)						
Corn	54.73	51.38	47.88	44.28	40.53	36.35
Cotton seed meal	0	5.13	10.5	16.04	21.75	28.19
Soyabean meal	29	26.7	24.29	21.8	19.25	16.34
Soyabean oil	1.25	1.77	2.31	2.86	3.45	4.1
Distillers Dried Grains with Solubles (DDGs)	6	6	6	6	6	6
Protein concentrate	6	6	6	6	6	6
Lime stone	1.4	1.4	1.4	1.4	1.4	1.4
Di calcium phosphate	0.6	0.6	0.6	0.6	0.6	0.6
[a]Vitamin–Mineral Premix	0.25	0.25	0.25	0.25	0.25	0.25
Threonine	0.05	0.05	0.05	0.05	0.05	0.05
L- Lysine	0.1	0.1	0.1	0.1	0.1	0.1
DL-Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Enzyme	0.04	0.04	0.04	0.04	0.04	0.04
Phytase	0.01	0.01	0.01	0.01	0.01	0.01
Anti-Oxidant	0.02	0.02	0.02	0.02	0.02	0.02
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated nutrient analysis						
ME (Kcal/Kg)	2951.08	2951.17	2951.04	2951.14	2951.17	2951.31
Crude Protein (%)	23.02	23.02	23.02	23.02	23.03	23.02
Linoleic acid (%)	1.15	1.08	1.00	0.93	0.84	0.75
Ca (%)	1.12	1.13	1.14	1.15	1.15	1.16
P (Total) (%)	0.68	0.69	0.70	0.70	0.71	0.72
P (non-phy) (%)	0.47	0.47	0.47	0.46	0.46	0.46
Na (%)	0.16	0.16	0.15	0.15	0.15	0.14
Cl (%)	0.22	0.21	0.21	0.21	0.21	0.20
K (%)	1.76	1.69	1.62	1.54	1.46	1.36

Items	Treatments					
	T0	T1	T2	T3	T4	T5
Lysine (%)	1.24	1.22	1.21	1.20	1.18	1.17
Methionine (%)	0.64	0.64	0.65	0.65	0.65	0.65
Cystine (%)	0.31	0.32	0.32	0.32	0.32	0.32
Methionine +cystine (%)	0.96	0.96	0.96	0.97	0.97	0.97
Threonine (%)	0.72	0.72	0.71	0.71	0.70	0.69
Tryptophan (%)	0.28	0.28	0.27	0.27	0.26	0.26
Feed cost/kg (Tk.)	37.61	37.45	37.27	37.09	36.92	36.71

[a]*Vitamin–Mineral Premix provided the following per kilo gram of diet: Vitamin A, 5.0 MU; Vitamin D, 1.0 MU; Vitamin E, 10.0 g; Vitamin K, 1.6 g; Vitamin B1, 0.6 g; Vitamin B2, 2.0 g; Vitamin B6, 1.6 g; Vitamin B12, 4.0 mg; Biotin, 20.0 mg; Pantothenic Acid, 4.0 g; Folic Acid, 0.2 g; Nicotinic Acid, 12.0 g; Copper, 2.4 g; Iron, 9.6 g; Zinc, 160 g; Manganese, 19.2 g; Selenium, 0.05 g; Cobalt, 0.12 g; Iodine, 0.24 g*

Table 2. Ingredients composition and nutrient content of broiler grower diet

Items	Treatment					
	T0	T1	T2	T3	T4	T5
Ingredients (% as fed basis)						
Corn	54.48	51.14	47.64	44.05	40.29	36.11
Cotton seed meal	0	5.13	10.5	16.03	21.78	28.19
Soyabean meal	29.01	26.7	24.29	21.8	19.22	16.34
Soyabean oil	3.8	4.32	4.86	5.41	6	6.65
Distillers Dried Grains with Solubles (DDGs)	6	6	6	6	6	6
Protein concentrate	3.7	3.7	3.7	3.7	3.7	3.7
Lime stone	1.4	1.4	1.4	1.4	1.4	1.4
Di calcium phosphate	0.6	0.6	0.6	0.6	0.6	0.6
[a]Vitamin –Mineral Premix	0.25	0.25	0.25	0.25	0.25	0.25
Threonine	0.05	0.05	0.05	0.05	0.05	0.05
L- Lysine	0.1	0.1	0.1	0.1	0.1	0.1
DL-Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Enzyme	0.04	0.04	0.04	0.04	0.04	0.04
Phytase	0.01	0.01	0.01	0.01	0.01	0.01
Anti-Oxidant	0.015	0.015	0.015	0.015	0.015	0.015
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated nutrient analysis						
ME (Kcal/Kg)	3101.42	3101.59	3101.46	3101.05	3101.56	3101.73
Crude Protein (%)	21.55	21.55	21.55	21.55	21.55	21.55
Linoleic acid (%)	1.15	1.07	1.00	0.92	0.84	0.75
Ca (%)	0.98	0.98	0.99	1.00	1.01	1.01
P (Total) (%)	0.61	0.61	0.62	0.63	0.64	0.64
P (non-phy) (%)	0.39	0.39	0.39	0.39	0.39	0.38
Na (%)	0.16	0.16	0.15	0.15	0.15	0.14
Cl (%)	0.22	0.21	0.21	0.21	0.21	0.20
K (%)	1.76	1.69	1.61	1.54	1.45	1.36
Lysine (%)	1.15	1.13	1.12	1.11	1.09	1.08
Methionine (%)	0.60	0.60	0.60	0.60	0.61	0.61
Cystine (%)	0.28	0.28	0.29	0.29	0.29	0.29
Met+cys (%)	0.88	0.88	0.89	0.89	0.90	0.90
Threonine (%)	0.72	0.72	0.71	0.71	0.70	0.69
Tryptophan (%)	0.27	0.27	0.26	0.26	0.25	0.25
Feed cost/kg (Tk.)	37.17	37.01	36.83	36.65	36.47	36.27

[a]*Vitamin–Mineral Premix provided the following per kilo gram of diet: Vitamin A, 5.0 MU; Vitamin D, 1.0 MU; Vitamin E, 10.0 g; Vitamin K, 1.6 g; Vitamin B1, 0.6 g; Vitamin B2, 2.0 g; Vitamin B6, 1.6 g; Vitamin B12, 4.0 mg; Biotin, 20.0 mg; Pantothenic Acid, 4.0 g; Folic Acid, 0.2 g; Nicotinic Acid, 12.0 g; Copper, 2.4 g; Iron, 9.6 g; Zinc, 160 g; Manganese, 19.2g; Selenium, 0.05 g; Cobalt, 0.12 g; Iodine, 0.24 g*

2.3 Slaughtering and Sample Collection of Broilers

At the 35th day of the experiment, three (3) birds from each replicate were randomly selected from each pen and each broiler chicken was weighed. Birds were sacrificed and hanged until complete bleeding. After complete bleeding the birds feathers were removed by hand and pining was done manually. Viscera and giblet were removed from the carcass. Legs, head, neck and shank were separated from the body parts. Live bird, slaughtered bird (after complete bleeding), skin, viscera, giblet, legs, head, neck, shank and carcass were weighed individually. Breast muscles were collected randomly from each replicate.

2.4 Parameters Measured

The feed intake of each replication was determined by subtracting the amount of left over from the amount of supplied feed on the previous day. Live weight of each bird was recorded as

Table 3. Ingredients composition and nutrient content of broiler finisher diet

Items	Treatment					
	T0	T1	T2	T3	T4	T5
Ingredients (% as fed basis)						
Corn	64.08	62.32	60.7	58.62	56.67	54.44
Cotton seed meal	0	2.7	5.2	8.4	11.4	14.8
Soyabean meal	16.01	14.8	13.67	12.23	10.88	9.36
Soyabean oil	2.5	2.77	3.02	3.34	3.64	3.99
Distillers Dried Grains with Solubles (DDGs)	5	5	5	5	5	5
Protein concentrate	9.5	9.5	9.5	9.5	9.5	9.5
Lime stone	1.3	1.3	1.3	1.3	1.3	1.3
Di calcium phosphate	0.6	0.6	0.6	0.6	0.6	0.6
[a]Vitamin-Mineral Premix	0.25	0.25	0.25	0.25	0.25	0.25
Threonine	0.05	0.05	0.05	0.05	0.05	0.05
L- Lysine	0.1	0.1	0.1	0.1	0.1	0.1
DL-Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Enzyme	0.04	0.04	0.04	0.04	0.04	0.04
Phytase	0.01	0.01	0.01	0.01	0.01	0.01
Anti-Oxidant	0.015	0.015	0.015	0.015	0.015	0.015
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated nutrient analysis						
ME (Kcal/Kg)	3121.64	3121.48	3121.41	3121.27	3121.13	3121.45
C.Protein (%)	20.05	20.05	20.05	20.05	20.05	20.05
Linoleic acid (%)	1.28	1.24	1.20	1.16	1.12	1.07
Ca (%)	1.28	1.28	1.28	1.29	1.29	1.30
P (Total) (%)	0.73	0.73	0.74	0.74	0.74	0.75
P (non-phy) (%)	0.55	0.55	0.55	0.55	0.55	0.55
Na (%)	0.16	0.16	0.15	0.15	0.15	0.15
Cl (%)	0.21	0.21	0.21	0.21	0.21	0.21
K (%)	1.46	1.42	1.39	1.34	1.30	1.25
Lysine (%)	1.03	1.03	1.02	1.01	1.01	1.00
Methionine (%)	0.64	0.64	0.64	0.65	0.65	0.65
Cystine (%)	0.29	0.29	0.29	0.29	0.29	0.29
Met+cys (%)	0.93	0.93	0.93	0.93	0.94	0.94
Threonine (%)	0.53	0.53	0.53	0.52	0.52	0.52
Tryptophan (%)	0.21	0.21	0.21	0.20	0.20	0.20
Feed cost/kg (Tk.)	39.33	39.24	39.16	39.05	38.95	38.85

[a]Vitamin–Mineral Premix provided the following per kilo gram of diet: Vitamin A, 5.0 MU; Vitamin D, 1.0 MU; Vitamin E, 10.0 g; Vitamin K, 1.6 g; Vitamin B1, 0.6 g; Vitamin B2, 2.0 g; Vitamin B6, 1.6 g; Vitamin B12, 4.0 mg; Biotin, 20.0 mg; Pantothenic Acid, 4.0 g; Folic Acid, 0.2 g; Nicotinic Acid, 12.0 g; Copper, 2.4 g; Iron, 9.6 g; Zinc, 160 g; Manganese, 19.2g; Selenium, 0.05 g; Cobalt, 0.12 g; Iodine, 0.24 g

the average weight of all birds of each replicate. Carcass weight and dressing percent were calculated accordingly by considering the live weight of broilers for each replication.

2.5 Chemical Analysis

Samples of breast meat were analyzed to determine the dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE) and total ash according to the methods of Association of Official Analytical Chemists [16].

2.6 Statistical Analysis

The data were analyzed by using the statistical program (SPSS 16.0) to compute analysis of variance (ANOVA) for a completely randomized design (CRD) and Duncan's multiple range test (DMRT) was done to differentiate among the treatment means at 5% level of significant.

3. RESULTS AND DISCUSSION

3.1 Performance Traits

Performance traits of broilers fed different experimental diets are presented in Table 4. Average feed intake was significantly higher ($P < 0.01$) in the diets containing higher amount of CSM. This result is consistent with the observation of other researchers [17,8] who reported that CSM influence higher feed intake and at moderate levels (20-30%) of CSM incorporation feed intake can be increased, which impairs feed efficiency [18]. In this study, there was no significant difference ($P > 0.05$) for average live weight gain when broilers fed different levels of CSM, which were also consistent with the findings of previous studies [10,19,9]. Although, the birds fed on diet T2, T3 and T4 had their weights numerically tended to improved, but the birds with diet T2 showed superiority in weights over other diets. These results showed consonance with earlier researcher report [17], who concluded that feeding cotton seed cake up to 50% had no significant effect on performance of broiler chickens. However, decreased efficiency of CSM utilization was also observed when the level of CSM was increased in the diet [20,21]. On the other hand, another researchers [22] finding were disagreed with the previous results on live weight and feed conversion ratio and reported that, there were no adverse effect of CSM at the level of 30%. Similar results were also observed in this study which was the fully agreed above statement. Live weight and carcass weight did not show any significant difference among the treatments. But dressing percentage was tended to significant ($P = 0.089$) among the treatments. The higher value was observed in control (0% CSM) group and the lower value was for T5 group where broilers received 50% CSM protein. However, after receiving of CSM diet (up to 15%) dressing percentage value were 64.8 to 66.8% [14], which was more or less similar to the present observations. No significant difference was observed in feed cost per kg live weight gain. However, some researchers [17,23] reported that feed cost was numerically decreased with increasing levels of CSM in the diet. In this study similar trend was also observed because CSM is relatively cheaper compared to soyabean meal in the market. But higher percent of CSM level influence the higher amount of feed

Table 4. Performance traits of broilers fed different experimental diets

Parameters	Dietary treatment						SEM	P-value
	T0	T1	T2	T3	T4	T5		
Average feed intake (g)	91.99^{a}	91.46^{a}	93.37^{b}	94.65^{b}	94.16^{b}	93.51^{b}	1.24	0.001
Average live weight gain (g/d)	48.59	48.61	50.45	48.99	48.85	48.17	0.79	0.616
Carcass traits								
Live weight (g)	1876.22	1950.67	1851.00	1896.00	1916.11	1830.89	15.39	0.737
Carcass weight (g)	1259.84	1304.22	1223.12	1222.76	1250.56	1179.47	13.19	0.525
Dressing percentage (%)	67.12^{b}	66.74^{ab}	66.03^{ab}	64.41^{a}	65.18^{ab}	64.43^{a}	0.49	0.089
Feed cost/kg live weight gain (Tk.)	72.29	71.46	69.91	72.75	72.21	72.51	0.450	0.698

^{a,b}Means with different letters in rows differ significantly ($P \leq 0.05$)

Table 5. Nutrient composition of breast meat for different experimental diets

Parameters	Dietary treatment						SEM	P-value
	T0	T1	T2	T3	T4	T5		
DM%	24.82	23.78	25.09	25.25	24.41	25.59	1.00	0.688
Nutrient composition (%, DM basis)								
CP%	22.11^{c}	21.12^{a}	22.22^{c}	22.18^{c}	21.61^{b}	22.57^{d}	0.84	0.000
CF%	0.11^{a}	0.13^{a}	0.22^{b}	0.31^{c}	0.32^{cd}	0.35^{d}	0.10	0.000
EE%	1.01^{a}	1.05^{ab}	1.09^{abc}	1.12^{bc}	1.15^{c}	1.27^{d}	0.10	0.001
Ash%	1.49^{c}	1.4^{bc}	1.48^{c}	1.45^{c}	1.25^{a}	1.32^{ab}	0.10	0.002

^{a,b,c}Means with different letters in rows differ significantly (P ≤ 0.01)

intake. Accordingly, the cost per kg live weight gain was similar to all diets. The substitution of soyabean meal with CSM might have lowered the actual energy content [24] and digestible lysine content [25,26,14] of the diets. Supplementation of lysine can help to alleviate the negative effects of cottonseed meal [27-29]. In this study, 100 g L-lysine was added to all of the diets. Due to addition of same amount of lysine in all treatments, the beneficial effect of lysine supplementation on free gossypol was not prominent in this study. As a result the average growth rate was more or less similar in all of the treatments.

3.2 Nutrient Composition of Meat

Nutrient compositions of breast meat of broilers of different treatments are shown in the Table 5. No significant difference was found for the DM content of broilers breast meat ranged due to the treatments. CP content of breast meat was significantly ($P < 0.01$) differed among the treatments. The highest CP content was observed in T5 and the lowest CP content was in T1. Second lowest value was showed by T4. However, T0, T2 and T3 did not show significant difference among them. Little information is available about the effects of CSM on the meat compositions of broiler chickens. It was reported that the CP content of breast muscle was 22.57 to 23.08% for day 42 and day 52 Cobb broiler chickens [30] and was 19.7% for day 45 Cobb broiler chickens [31]. In this study, similar values were also found for the CP content of breast muscle of Cobb-500 broiler chickens at 35th day. Higher level of CSM influenced the higher fibre content in breast meat. The CF content of breast muscle was significantly ($P < 0.01$) higher in T5 diet and significantly lower value was observed in T0 and T1 diets. The CF content of breast muscle was increased with increasing the CSM in diets. Higher amount of CSM may influence the higher amount of CF in breast muscle. Cotton seed meal contained higher amount of EE compared to soyabean meal which may influenced ($P < 0.01$) the higher intramuscular EE content of breast muscle in higher CSM receiving groups (T5) compared to small amount of CSM contained diets receiving group (T1) and the lower EE value was observed for control group (T0). The increased EE in breast muscle were observed when broiler fed higher percentage of CSM containing diets, which might be attributed to the enhanced anabolism of intramuscular fat [9]. However, others observed that the EE content of breast muscle was 2.22 to 2.55% [30] and 3.6% [31] which value was higher with compare to this research. Ash content was higher ($P < 0.05$) in T0, T2 and T3 diets compare to the other treatment diets. But T0, T2 and T3 diets did not show any significant difference among the diets. The second higher value was observed for T1 diet but T0, T1, T2 and T3 did not show any significant difference among the treatments. However, the lowest ash content was observed in T4 but T4 and T5 did not differ significantly between the diets for the ash content of breast muscle. This observation was more or less similar (1.13% to 1.17% and 1.4%) with the result that was reported by others [30,31] for meat composition of Cobb broilers. Mortality was only 0.5% and no health problems were detected, need for prolonged feeding trial to assess safety and productivity of the use of CSM is clear warranted.

4. CONCLUSION

From the results of this study it would be concluded that, CSM protein can be incorporated (up to 40%) in broiler chicken diet without any adverse effects on feed quality and birds performance.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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