Original Research Article

Effect of cotton seed meal on the performance traits and meat composition in commercial broilers

ABSTRACT (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

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 based diet; T1, 10% CSM protein with 90% soyabean meal protein; T2, 20% CSM protein with 80% soyabean meal protein; T3, 30% CSM protein with 70% soyabean meal protein; T4, 40% CSM protein with 60% soyabean meal protein and T5, 50% CSM protein with 50% soyabean meal protein. The mash feed was supplied *ad libitum* basis.

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. 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%). 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%). 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 can be concluded that CSM would 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, national income, employment and income generation in Bangladesh. 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 (SBM) is generally recognizes 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 (CSM) is one of them. Cotton seed meal (CSM) 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, Cyclopropononic 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, 13, 14]. If carefully incorporated, cotton seed meal can reduce feed costs while maintaining or increasing the level of bird's performance. Besides, there is a very few research on CSM 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. MATERIAL 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) good and healthy day-oldCobb-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, soyabean meal based diet; T1, 10% CSM protein with 90% soyabean meal protein; T2, 20% CSM protein with 80% soyabean meal protein; T3, 30% CSM protein with 70% soyabean meal protein; T4, 40% CSM protein with 60% soyabean meal protein and T5, 50% CSM protein with 50% soyabean meal 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 24 hours and the brooding temperature was almost maintained at 33±2 ºC for first week. In course of the trial, the temperature was gradually reduced to 25±2 ºC 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. Feeder was cleaned in each week and waterer was 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 [15] recommendation in the 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 form antibiotics. The broiler mash feed was supplied three times daily on an ad libitum basis. Fresh clean and safe water was made available at all the times.

2.3 Slaughtering and sample collection of broilers

After 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 Calculation

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 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 dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE) and total ash were determined 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.

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

Items	Treatments					
	T0	T1	T2	T3	T4	T5
Ingredients (Required amount per 100 kg) , % 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
Nutrient composition (Calculated value)						
ME (Kcal/Kg)	2951.08	2951.17	2951.04	2950.54	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
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

aVitamin –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

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

Items	**Treatment**					
	T0	**T1**	**T2**	**T3**	**T4**	**T5**
Ingredients (Required amount per 100 kg) , % 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
Nutrient composition (Calculated value)						
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*

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

Items	**Treatment**					
	T0	**T1**	**T2**	**T3**	**T4**	**T5**
Ingredients (Required amount per 100 kg) , % 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
Nutrient composition (Calculated value)						
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*

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 incorporation levels, 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 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. Supplementation of lysine can help to alleviate the negative effects of cottonseed meal [20, 21, 22]. Decreased efficiency of CSM utilization was also observed when the level of CSM was increased in the diet [23, 24]. However, another research [25] disagreed with the previous results on live weight and feed conversion ratio and reported that no adverse effect of CSM at the level of 30%. In this study the results was also fully agreed with the findings of [25]. 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 research [17, 26] reported that feed cost was numerically decreased with increasing levels of CSM in the diet. In this work also similar trend was 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 intake. According as, cost for per kg live weight gain was similar to all diets. The substitution of soyabean meal with CSM might have lowered the actual energy content [27] and digestible lysine content [28, 29, 14] of the diets. But in this study, 100g L-lysine was added to all of the diets which did not prove beneficial in counteracting the negative effect of gossypol in broilers because average growth rate was similar in all of the treatments.

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 (%)	67.12b	66.74ab	66.03ab	64.41a	65.18ab	64.43a	0.49	0.089
Feed cost/kg live weight gain (BDT)	72.29	71.46	69.91	72.75	72.21	72.51	0.450	0.698

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 19.7±1.88 for day 45 Cobb broiler chickens [31]. In this study, the observation was made for 35 days old Cobb broiler chickens and the similar value was also found. 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±0.39 [31] which value was higher compared 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 showed 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±0.14) 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.

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

4. CONCLUSION

From the results of this study, it can be concluded that CSM would 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.

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