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Growth performance of broiler chicken fed diet with single cell protein

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ABSTRACT

The present study was designed to study the effect of single cell protein (SCP) on growth performances in broiler chicken. Day old chicks (600) were distributed in six groups and each group was consisting of four replicates with 25 birds in each. Soybean meal was replaced by SCP at the level of 0 (control), 2% (T_1), 4% (T_2), 6% (T_3), 8% (T_4) and 10% (T_5). Total duration of the trial was 42 days. There was decrease in body weight, feed intake, performance index and increase in FCR with higher inclusion level but at the 2% level, the results were comparable with control. Dressing%, breast yield% and abdominal fat% decreased as the replacement of the soybean meal increased. However, hot carcass weight%, neck%, wing%, drumstick%, thigh%, back% showed no difference. Hemoglobin, total protein, albumin, globulin, glucose, ALT and AST level decreased significantly as the inclusion level increases but the level of uric acid increased. It can be concluded that SCP with 2% replacement of the soybean meal can be included in the commercial broiler ration without any adverse effect.

Keywords: Biochemical, Body weight, Broiler, Carcass, Dressing, Single cell protein

In poultry industry, feed resource is the major constraint as it is the 60-70% of total cost of production of broiler chicken. Modern fast growing broiler chicken require high amount of protein with balanced amino acid content. Among the vegetable protein, soybean meal is mostly preferred due to its high protein as well as balanced amino acid content (Hombegowda *et al.* 2021). Recently, due to huge fluctuation in price, availability and due to presence of hulls and antinutritional factor (Erdaw *et al*. 2018), sometimes its use in broiler production is limited. Among the animal protein source, fish meal, meat meal, bone meal, blood meal and hydrolyzed feather meal are available. But their usage is limited due to quality variation and presence of pathogenic microorganism. In view of the above facts, there is continuous search for alternative high quality proetin feedstuff that can improve broiler production performance. One of the possible alternative protein sources is single cell protein (SCP). The SCP consists of protein rich microorganisms such as filamentous fungi, yeast, algae, and bacteria. It is a very fast way of producing protein compared to the production of protein through cultivation of agricultural crops or animal farming (Pourelmi *et al.* 2018). Various studies reported that SCP can be incorporated up to 5% level or to meet 30-40% of total CP in broiler diets with improved weight gain, feed conversion ratio (FCR) and economic efficiency (Zhang *et al*. 2013). In the present experiment, broiler chickens were supplemented with a SCP by replacing soybean meal on iso-nitrogenous basis. Hence, the aim of this investigation was to evaluate the effect of SCP on growth performance, carcass traits and serum biochemistry of broiler chickens.

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MATERIALS AND METHODS

The experiment was conducted in a commercial poultry farm (S.S.K. Feed Product Farm, 24 Paraganas (S), West Bengal, India). Day-old Cobb-400 commercial broiler chicks (600) were procured from the local market which were weighed and randomly distributed into the six groups (Control, T_1, T_2, T_3, T_4 and T_5) with 4 replicates (25 chicks in each replicate). This study was performed as per approval of Institutional Ethics Committee. The birds in each replicate were placed in pen with litter composed of wood savings, dry rice husk and lime. The birds were vaccinated against Ranikhet disease (F_1 strain) on 7th day, Infectious Bursal Disease on 14th day and Ranikhet disease (La Sota strain) on 21th day. The birds were fed a measured quantity of feed at 08.00 h and 16.00 h every day. The total duration of experiment was 42 days. The experiment was conducted in April and May. In West Bengal, it was summer season with the temperature around 40°C. This high temperature might cause heat stress in the birds. In order to prevent the heat stress, some managemental procedures were taken. Soybean meal from the control diet was replaced by SCP at the level of 2, 4, 6, 8 and 10% level. SCP was supplied by CJ Corporation Bio Business Unit, Seoul, Korea. The control diet was made with basal diet without fortification with SCP. The experimental diets were formulated to meet

the BIS (2007) nutritional requirement of broiler chicken. Ingredients and chemical composition of starter and finisher diets are presented in Supplementary Table 1 and Supplementary Table 2. Feed intake was recorded daily. The total body weight was measured at weekly intervals. The ratio of weekly body weight gain and FCR were calculated as a measure of the performance index (PI) of the birds.

On 42nd day, two birds from each replicate were slaughtered and weight of different body parts viz., breast, thigh, back, drumstick and giblets (gizzard, liver, lungs and heart) were recorded. Blood (5 ml) was collected at the end of the trial. Serum was separated and stored at -20°C for further analysis of different blood parameters. Proximate principles in feed samples were analyzed as per methods described in AOAC (2005). The data were analyzed by the general linear model of the SPSS (10.0) and the results were expressed as mean and pooled standard error of mean (SEM).

RESULTS AND DISCUSSION

The mean body weight of broiler was significantly (P<0.001) reduced with higher doses (Table 1). The highest body weight was achieved by control and 2% SCP group, and lowest body weight in 10% SCP group. Feed intake was significantly (P<0.05) reduced from 2nd week to end of the study in 4, 6, 8 and 10% SCP diet (Table 2). Lowest feed intake was found in 10% supplemented group and highest feed intake was found in control and 2% SCP diet. Compared to control group, cumulative feed intake was also significantly (P<0.001) reduced in 4, 6, 8, and 10% SCP supplemented groups (Supplementary Table 3). Up to 6th week, cumulative feed intake of control and 2% SCP fed birds was highest and lowest in 10% SCP diet group. From the 2nd week to the end of the experiment, there was a significant (P<0.001) decline in FCR with the increase in the inclusion level (Table 3). The performance index in control and 2% SCP diet was similar but in other supplemented groups in different weeks showed significantly (P<0.001) decline trend (Supplementary Table 4).

This result corroborated with the findings of An *et al*. (2018), Hombegowda *et al*. (2021). Pourelmi *et al*. (2018) also reported that inclusion of 10% and 15% bacterial cell protein (replacing soybean meal) in broiler diets resulted

Table 1. Effect of feeding of SCP on body weight (g/bird) of broiler chicken

Attribute	Diet						SEM	P value
	C	T_1	T_2	T_3	T_4	T_5		
Day 0	40.21	40.39	40.25	40.2	40.11	40.19	0.210	0.958
Wk1	112.33	113.19	111.35	114.05	110.78	111.06	2.200	0.874
Wk2	253.16^{a}	253.37^{a}	246.11^{a}	241.18^{a}	220.26^{b}	202.35^{b}	5.993	0.000
Wk3	576.08^{a}	580.44^{a}	566.06^{a}	559.85^{a}	521.79^{b}	502.08^{b}	8.340	0.000
Wk4	975.70^{a}	975.72^{a}	908.43^{bc}	900.49^{bc}	857.16c^{d}	818.64^{d}	20.708	0.001
Wk5	1423.74^{a}	1420.29^{a}	1344.61^{ab}	1293.15^{b}	1209.05^{c}	1134.35^{c}	24.994	0.000
Wk6	1946.15^{a}	1946.90^{a}	1816.22^{b}	1765.50^{bc}	1692.00^{cd}	1614.45^{d}	30.942	0.000

^{a,b,c,d}Means followed by different letters in a row differ significantly at P<0.05. SEM, standard error of mean; Wk, week.

Table 2. Effect of feeding of SCP on feed intake (g/bird) of broiler chicken

Attribute	Diet						SEM	P value
	C	T_1	T_2	T_3	T_4	T_5		
Wk1	126.66^{ab}	128.69^{ab}	124.37^{ab}	131.49^{a}	122.63^{ab}	119.39^{c}	3.179	0.174
Wk2	247.57^{a}	245.54^{a}	240.85^{a}	228.10^{ab}	220.98^{ab}	201.94^{c}	9.231	0.032
Wk3	687.55^{ab}	693.78^{a}	684.82^{ab}	675.01^{ab}	644.66^{bc}	631.39^{c}	13.312	0.030
Wk4	724.79^{a}	717.56^{a}	652.36^{ab}	645.71^{ab}	614.67^{b}	582.85^{b}	24.740	0.010
Wk5	865.92^{a}	866.11^{a}	810.68^{ab}	772.80^{ab}	768.06^{b}	740.87^{b}	28.821	0.039
Wk6	1119.21^{a}	1119.47^{a}	1052.17^{ab}	1039.05^{ab}	1004.59^{b}	995.95^{b}	29.898	0.043

^{a,b,c,}Means followed by different letters in a row differ significantly at P<0.05. SEM, standard error of mean; Wk, week.

Table 3. Effect of feeding of SCP on feed conversion ratio of broiler chicken

Attribute	Diet						SEM	P value
	C	T_1	T_2	T_3	T_4	T_5		
Wk1	1.127	1.129	1.117	1.153	1.107	1.075	0.034	0.705
Wk2	1.478^{b}	1.477^{b}	1.484^{b}	1.491^{b}	1.560^{a}	1.588^{a}	0.012	0.000
Wk3	1.843^{b}	1.840^{b}	1.855^{b}	1.848^{b}	1.894^{a}	1.895^{a}	0.005	0.000
Wk4	1.831^{b}	1.830^{b}	1.874^{a}	1.866^{a}	1.870^{a}	1.876^{a}	0.006	0.000
Wk5	1.863^{c}	1.867^{c}	1.869^{c}	1.897^{c}	1.961^{b}	2.007^{a}	0.012	0.000
Wk6	1.938^{d}	1.937^{d}	1.963^{cd}	1.978^{bc}	1.995^{b}	2.027^{a}	0.009	0.000

^{a,b,c,d}Means followed by different letters in a row differ significantly at P<0.05. SEM, standard error of mean; Wk, week.

Table 4. Effect of feeding of SCP on carcass traits of broiler chicken

Attribute	Diet						SEM	P value
	C	T_1	T_2	T_3	T_4	T_5		
Hot carcass wt. (%)	77.14[a]	77.93[a]	76.88[ab]	76.53[ab]	75.88[b]	76.84[ab]	0.511	0.196
Dressing percentage	65.29[a]	65.25[a]	63.70[ab]	62.51[bc]	61.45[c]	60.77[c]	0.591	0.005
Breast (%)	22.41[a]	22.42[a]	21.81[b]	21.49[b]	20.54[c]	20.15[d]	0.124	0.000
Back (%)	14.22	13.92	14.28	13.42	13.49	13.81	0.389	0.541
Thigh (%)	10.62	10.60	10.57	10.54	10.63	10.62	0.118	0.993
Drumstick (%)	9.62	9.76	9.57	9.54	9.63	9.62	0.091	0.632
Neck (%)	2.91	2.82	2.80	2.64	2.61	2.65	0.133	0.55
Wings (%)	6.27	6.29	6.28	6.29	6.24	6.26	0.02	0.518
Liver (%)	3.56	3.65	3.62	3.52	3.47	3.57	0.09	0.728
Giblet (%)	5.95	6.00	6.10	5.96	6.05	6.03	0.083	0.796
Abdominal fat (%)	3.16[a]	3.00[b]	2.87[c]	2.77[d]	2.64[e]	2.54[f]	0.012	0.000

[a,b,c,d,e,f]Means followed by different letters in a row differ significantly at P<0.05. SEM, standard error of mean.

Table 5. Effect of feeding of SCP on blood biochemical characteristics of broiler chicken

Attribute	Diet						SEM	P value
	C	T_1	T_2	T_3	T_4	T_5		
Hemoglobin (mg/dL)	9.32[a]	9.33[a]	8.68[b]	8.52[c]	8.35[d]	8.15[e]	0.050	0.000
Glucose (mg/dL)	225.30[a]	217.77[b]	212.10[bc]	207.04[c]	198.67[d]	194.84[d]	1.865	0.004
Total protein (mg/dL)	6.86[a]	6.78[ab]	6.63[b]	6.35[c]	6.36[c]	6.31[c]	0.057	0.000
Albumin (mg/dL)	2.77[a]	2.72[a]	2.74[a]	2.62[b]	2.55[b]	2.43[c]	0.025	0.000
Globulin (mg/dL)	3.24[a]	3.17[a]	3.14[a]	3.21[a]	3.07[a]	2.85[b]	0.62	0.010
Aspartate amino transferase (U/L)	178.34[a]	167.01[b]	158.02[b]	151.42[c]	147.77[c]	132.73[d]	3.211	0.000
Alanine amino transferase (U/L)	22.36[a]	22.10[ab]	21.74[bc]	21.45[c]	20.53[d]	20.14[d]	0.142	0.000
Uric acid (U/L)	303.55[c]	316.82[bc]	322.98[b]	333.40[ab]	342.13[a]	347.75[a]	5.493	0.001
Triglyceride (mg/dL)	125.07[b]	133.79[a]	124.99[b]	128.62[ab]	122.06[b]	124.25[b]	2.611	0.085
Cholesterol (mg/dL)	157.77	153.98	156.32	154.43	156.71	156.71	2.908	0.435

[a,b,c,d]Means followed by different letters in a row differ significantly at P<0.05. SEM, standard error of mean.

in significantly decreased body weight gain compared to control and 5% bacterial cell protein diet groups. In the present experiment, reduced feed intake may be due to decreased palatability with increasing SCP associated with the greater proportions of free amino acids and resulted in decreased performance of birds (Overland *et al*. 2010). In the present study, PI was decreasing because the body weight was decreasing and FCR was increasing with the increase in the inclusion level.

There was no statistically significant (P>0.05) difference in hot carcass weight, back, thigh, drumstick, neck, wing, liver and giblet percentage but there was a significant difference (P<0.05) in dressing percentage, breast yield and abdominal fat percentage among different dietary treatment groups (Table 4). There was no difference between control and 2% SCP diet in hot carcass weight, dressing percentage, breast percentage and abdominal fat percentage. So, to meet the first growth rate, broiler birds draw up nutrients from the reserve mainly from breast and abdominal fat pad. As the feed intake was lower in experimental birds, so to fulfill the high demand of energy, carbohydrate and fat reserves were mobilized. This may be the reason behind the less deposition of the fat. During very high demand of energy after exhaustion of fat and carbohydrate, birds draw up protein to meet the calorific demand. All these factors resulted in less breast muscle yield and dressing percentage in the present study. Schoyen *et al*. (2007) suggested that abdominal fat deposition tend to decrease in broiler with increasing level of SCP. These findings are in contrast with Overland *et al*. (2010), Najib (2014) and Hombegowda *et al*. (2021).

Blood hemoglobin, glucose, total protein, albumin, globulin, AST and ALT level decreased significantly (P<0.05) whereas uric acid increased (P<0.001). But there was no influence (P>0.05) on serum triglyceride and cholesterol level (Table 5). Reduction in hemoglobin, total protein, albumin, globulin and glucose values is an indication of malnutrition which is reflected in significant difference in feed intake (P<0.05) of experimental birds with increased level of SCP. Our result is in accordance with the findings of Aderolu *et al*. (2007) and Rameshwari *et al.* (2005). In the present study, hyper uricemia occured which may be due to starvation followed by massive tissue destruction and renal disease (Chandra *et al.* 1983).

From the present investigations, it is recommended that SCP can be included up to 2% in broiler chicken as a protein source replacing soybean meal without any adverse effect on overall growth performance.

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