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Proximate composition and fatty acid profile of breast meat in commercial broilers fed with black soldier fly larvae meal

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Abstract

Replacing soya with several other plants sources such as canola, sunflower, cotton seed, field beans and peas, but results have indicated negative impact on growth performance in broilers. Insects could be considered as a potential and sustainable cheaper alternative source of protein to replace soyabean partially in livestock feed, especially poultry. An attempt was made to incorporate and evaluate the effect of inclusion of black Soldier fly larvae meal in broiler diet on proximate composition and Fatty acid composition of breast meat of commercial broilers. Birds up to 6 weeks were fed diet with 5, 10 and 15 percent of black soldier fly larvae meal and all the diets will be formulated to meet isocaloric and nitrogenous by manipulating the diet inclusion level in the basal diet. At the end of the 6th week, birds were slaughtered and evaluated for proximate composition and Fatty acid profile of breast meat of commercial broilers. The findings of the present study indicated no significant difference in proximate composition (moisture, protein, fat, ash and gross energy) between the different treatment groups. The results of the present study also revealed no significant difference in the fatty acid profile of breast meat between the different treatment groups.

Keywords: Black soldier fly larvae meal, proximate composition and Fatty acid profile, broiler

Introduction

Soybean has been one of the major protein sources that has been studied and widely applied in poultry and livestock diets. During the last decade, owing to higher cost and low supply of conventional protein sources, researchers and producers are looking for alternative and effective protein sources for broilers and livestock diets that could result in better profitability and sustainability. Attempts have been made to replace soya with several other plants sources such as canola, sunflower, cotton seed, field beans and peas, but results have indicated negative impact on growth performance in broilers mainly attributed to low digestibility, less favorable amino acid profiles and presence of anti nutritional factors from these plant sources (Mattila *et al.*, 2018) [7]. Black soldier fly larvae can provide high-value feedstuff being rich in protein (40% to 44%) with a better amino acid profile compared with that of soya bean meal (Tran *et al.*, 2015) [14]. They have a high Dry Matter (DM) content (35% to 45%), they are rich in lysine (6% to 8% of the CP), Ca (5% to 8% DM) and P (0.6% to 1.5% DM) (Makkar *et al.*, 2014) [6]. Black soldier fly larvae are also rich in fat which has an extreme quantitative (15% to 49%) and qualitative variability depending on the chemical composition of the rearing substrate (St-Hilaire *et al.*, 2007) [13]. An attempt was made to incorporate and evaluate the effect of inclusion of black Soldier fly larvae meal in broiler diet on proximate composition and fatty acid profile of breast meat of commercial broilers.

Materials and Methods

A total of one hundred and twenty (120) day old commercial broiler chicks were procured from Venkateshwara Hatcheries Pvt. Ltd. Bengaluru and all the chicks were weighed and wing banded individually. The study was carried out with permission from Institutional Animal Ethics Committee, Veterinary College, Hebbal, Bangalore. The chicks were allocated to four

different treatment groups each consisting of three replicates with 10 chicks each (30 chicks per treatment). Each of the treatment groups were fed with different types of experimental diets. The control group T1 was fed with soyabean meal based basal diet as per BIS (2007) [2] standards. Black Soldier Fly Larvae meal was procured from Sri Kalleshwari feeds Pvt Ltd, Kerala. The composition of BSF larvae meal is presented in Table 1. Birds in treatment groups T2, T3, T4 were fed diet with 5, 10 and 15 percent of black soldier fly larvae meal respectively and all the diets will be formulated to meet isocaloric and nitrogenous by manipulating the diet inclusion level in the basal diet. (Table 2, 3 and 4). The chicks were reared in deep litter system and will be maintained under standard managemental practices till 6th weeks of age. Feed and water will be provided *ad libitum* throughout the experimental period. At the end of the 6th week, six (6) birds from each treatment will be slaughtered as per standard protocol and evaluated the carcass composition and fatty acid profile of breast meat of commercial broilers. Proximate compositions such as crude protein, ether extract

and ash were estimated as per the procedure outlined by AOAC (2005) [1]. Fatty acid profile of meat samples was estimated following the procedure outlined by Palmquist and Jenkins (2003) [8] with slight modification. The descriptive statistics for the different types of data were determined as per Snedecor and Cochran (1994) [12] and the SPSS 20 statistical software. The differences between the mean values were evaluated using Tukey's Range Test at a significance level of 0.05 ($p \leq 0.05$).

Table 1: The proximate composition of BSF larvae meal as under

Proximate	Value
Metabolizable energy (kcal/kg)	3970.1
Crude protein (%)	59.7
Calcium (%)	2.3
Phosphorus (%)	1.6
Lysine (g/100 g)	2.8
Methionine (g/100 g)	1.0

Table 2: Percent ingredient and nutrient composition of pre-starter diet

Ingredient	T1	T2	T3	T4
Yellow Maize	54.2	56.15	58	59.8
Soyabean meal	39.1	33.3	26.5	20
BSF larvae meal	0	5	10	15
Oil	3	2	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Limestone	1.4	1.5	1.45	1.45
Dicalcium phosphate	1.1	1.4	1.3	1
Mineral mixture	0.1	0.1	0.1	0.1
Lysine	0.2	0.2	0.3	0.3
Methionine	0.2	0.15	0.15	0.15
Vitamin Premix	0.1	0.1	0.1	0.1
Choline chloride	0.1	0.1	0.1	0.1
Total	100	100	100	100
Nutrient composition				
Nutrient	T1	T2	T3	T4
Metabolizable energy (kcal/kg)	3000.1	3000.98	3020.71	3034.61
Crude protein (%)	23.06	23.01	23.11	23.13
Calcium (%)	1.06	1.01	1.11	1.14
Phosphorus (%)	0.7	0.71	0.74	0.72
Lysine	1.33	1.32	1.36	1.33
Methionine	0.5	0.51	0.52	0.54

¹Provides per kg: Calcium - 230g and Phosphorus - 180g

²Provides per kg: Mn - 80mg, Zn - 80mg, I - 3.29mg, Fe - 32mg and Se - 0.1mg

³Provides per kg: A - 12375IU, D3 - 18000IU, B2 - 7.5mg, B1 - 4mg, B6 - 8mg, B12 - 40µg, E - 20mg, Niacin - 60mg and Calcium pantothenate - 12.5mg.

^aanalyzed values, ^bcalculated value

Table 3: Percent ingredient and nutrient composition of starter diet

Ingredient	T1	T2	T3	T4
Yellow Maize	55.1	56.6	59.95	62.5
Soyabean meal	37	31	24	17
BSF larvae meal	0	5	10	15
Oil	4.4	3.8	2.2	1.5
Salt	0.5	0.5	0.5	0.5
Limestone	1.2	1.2	1.5	1.7
Dicalcium phosphate ¹	1.1	1.5	1.2	1
Mineral mixture ²	0.1	0.1	0.1	0.1
Lysine	0.2	0.15	0.2	0.25
Methionine	0.2	0.15	0.1	0.15

Vitamin Premix ³	0.1	0.1	0.1	0.1
Choline chloride	0.1	0.1	0.1	0.1
Total	100	100	100	100
Nutrient	T1	T2	T3	T4
Metabolizable energy (kcal/kg) ^b	3102.1	3100.08	3104.34	3119.51
Crude protein (%) ^a	22.01	22.01	22.06	22.13
Calcium (%) ^b	1.00	1.01	1.10	1.12
Phosphorus (%) ^b	0.7	0.71	0.70	0.71
Lysine ^b	1.21	1.22	1.21	1.2
Methionine ^b	0.49	0.48	0.48	0.49

¹Provides per kg: Calcium - 230g and Phosphorus - 180g

²Provides per kg: Mn - 80mg, Zn - 80mg, I - 3.29mg, Fe - 32mg and Se - 0.1mg

³Provides per kg: A - 12375IU, D3 - 18000IU, B2 -7.5mg, B1 - 4mg, B6 - 8mg, B12 - 40µg, E - 20mg, Niacin - 60mg and Calcium pantothenate - 12.5mg.

^aanalyzed values, ^bcalculated value

Table 4: Percent ingredient and nutrient composition of finisher diet

Ingredient	T1	T2	T3	T4
Yellow maize	58	62.5	64.6	65.7
Soyabean meal	33	25.4	18.6	13.5
BSF larvae meal	0	5	10	15
Oil	5	4	2.5	1.2
Salt	0.5	0.5	0.5	0.5
Limestone	1.3	1.05	1.5	1.5
Dicalciumphosphate ¹	1.6	1.5	1.5	1.8
Mineral mixture ²	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.35	0.3
Methionine	0.2	0.1	0.15	0.1
Vitamin Premix ³	0.1	0.1	0.1	0.1
Choline chloride	0.1	0.1	0.1	0.1
Total	100	100	100	100
Nutrient composition				
Nutrient	T1	T2	T3	T4
Metabolizable energy (kcal/kg) ^b	3201	3200.67	3203.45	3206.47
Crude protein (%) ^a	20.04	20.09	20.11	20.14
Calcium (%) ^b	1.00	1.02	1.05	1.07
Phosphorus (%) ^b	0.71	0.71	0.73	0.72
Lysine ^b	1.09	1.12	1.15	1.09
Methionine ^b	0.45	0.45	0.48	0.45

¹Provides per kg: Calcium - 230g and Phosphorus - 180g

²Provides per kg: Mn - 80mg, Zn - 80mg, I - 3.29mg, Fe - 32mg and Se - 0.1mg

³Provides per kg: A - 12375IU, D3 - 18000IU, B2 -7.5mg, B1 - 4mg, B6 - 8mg, B12 - 40µg, E - 20mg, Niacin - 60mg and Calcium pantothenate - 12.5mg.

^aanalyzed values, ^bcalculated value

Table 5: Proximate composition of breast meat in commercial broilers fed with black soldier fly larvae meal

Parameters	T1	T2	T3	T4
Moisture	73.97 ± 0.68	74.04 ± 0.66	74.43 ± 0.36	74.67 ± 0.72
Crude protein	21.86 ± 0.35	22.15 ± 0.65	21.40 ± 0.96	21.79 ± 1.11
Ether extract	1.35 ± 0.03	1.32 ± 0.02	1.35 ± 0.03	1.30 ± 0.02
Total ash	1.01 ± 0.01	0.96 ± 0.02	0.98 ± 0.04	0.97 ± 0.04
Gross energy	1349 ± 12.10	1358 ± 21.80	1354 ± 13.98	1409 ± 29.92

T1 represents control (Basal diet), T2 represents (5% BSF larvae meal inclusion), T3 represents (10% BSF larvae meal inclusion) and T4 represents (15% BSF larvae meal inclusion).

Table 6: Fatty acid composition of breast meat in commercial broilers fed with Black soldier fly larvae meal

Parameters	T1	T2	T3	T4
Palmitic acid	24.87 ± 0.52	24.80 ± 0.37	25.18 ± 0.36	24.81 ± 0.20
Stearic acid	5.87 ± 0.11	6.31 ± 0.22	5.88 ± 0.10	6.05 ± 0.24
Oleic acid	40.08 ± 0.34	39.60 ± 0.33	40.28 ± 0.45	39.86 ± 0.26
Linoleic acid	17.31 ± 0.31	16.85 ± 0.56	16.48 ± 0.51	17.62 ± 0.42

Linolenic acid	0.71 ± 0.01	0.79 ± 0.02	0.74 ± 0.03	0.80 ± 0.01
Arachidic acid	0.170 ± 0.005	0.165 ± 0.004	0.175 ± 0.004	0.170 ± 0.005
Behenic acid	1.72 ± 0.03	1.78 ± 0.03	1.73 ± 0.04	1.80 ± 0.02
Ecosapentaenoic acid	0.133 ± 0.01	0.120 ± 0.01	0.125 ± 0.01	0.133 ± 0.01
Docosahexaenoic acid	0.40 ± 0.03	0.34 ± 0.01	0.38 ± 0.02	0.41 ± 0.02
Palmitoleic acid	7.18 ± 0.34	7.21 ± 0.32	7.46 ± 0.44	6.79 ± 0.19

T1 represents control (Basal diet), T2 represents (5% BSF larvae meal inclusion), T3 represents (10% BSF larvae meal inclusion) and T4 represents (15% BSF larvae meal inclusion)

Results and Discussion

The Mean ± SE of moisture, crude protein, ether extract, total ash and gross energy of meat from commercial broilers fed with Black soldier fly larvae meal are presented in the Table 5. The findings of the present study indicated no significant difference in proximate composition (moisture, protein, fat, ash and gross energy) between the different treatment groups. These findings are in accordance with Popova *et al.* (2020) [10] who reported that feeding of 5 percent partially defatted and 5 percent full fat BSF larvae meal did not cause any significant effect on the protein content of breast muscle and Pieterse *et al.* (2019) [9] who reported that inclusion of BSF larvae meal in the broiler chicken diets did not significantly influence the proximate composition of the both raw and cooked broiler breast meat as compared to that of control. In similar lines several researchers have observed no significant effect of feeding black soldier fly larvae meal on the proximate composition of broiler meat and quail meat (Cullere *et al.*, 2018; Schiavone *et al.*, 2017) [3, 11].

The Mean ± SE Myristic acid, Palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, Arachidic acid, Behenic acid, Ecosapentaenoic acid, Docosahexaenoic acid and Palmitoleic acid of breast meat from commercial broilers fed with Black soldier fly larvae meal are presented in the Table 6. The results of the present study revealed no significant difference in the fatty acid profile *viz.* Myristic acid, Palmitic acid, stearic acid, Oleic acid, Linoleic acid, Linolenic acid, Archidic acid, Behenic acid, Ecosapentaenoic acid, Docosahexaenoic acid, and Palmitoleic acid content of breast meat between the different treatment groups. Similar findings have been reported by Dabbou *et al.* (2018) [4] who reported that breast meat from broilers fed up to 15 percent BSFL did not show significant differences in saturated, monounsaturated, or polyunsaturated fatty acid content compared to control. However, Popova *et al.* (2020) [10] and Daszkiewicz *et al.* (2022) [5] reported that inclusion of BSF meal resulted in increase in saturated fatty acids, particularly lauric acid (C12:0) and Myristic acid (C14:0), in breast and thigh meat, whereas polyunsaturated fatty acids, especially linoleic acid (C18:2n-6) decreased with BSF meal due to lower dietary intake from soybean meal replacement.

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