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Effect of dietary inclusion of black soldier fly (H*ermetia illucens*) larvae meal on nutrients digestibility and biochemical parameters of meat type male ducks#

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Abstract

A study was conducted to evaluate the effect of feeding black soldier fly larvae meal (BSFLM) on nutrients digestibility and biochemical parameters of meat type male ducks. Ninety-six, day-old male ducklings were allotted into four dietary treatments with four replicates having six ducklings each in a completely randomized design. The different dietary treatments were fed with 0, 5, 10 and 15 per cent BSFLM as replacement to soya bean meal (SBM). The results showed that inclusion up to 15 per cent did not affect the nutrients digestibility and biochemical parameters of birds except significantly (p<0.05) lower blood serum triglycerides level in all BSFLM fed groups compared to control group.

Keywords: *Black soldier fly larvae, Hermetia illucens, meat type ducks, nutrient digestibility, biochemical parameters*

The human population is expected to reach nine billion before entering the second half of the century with 60 to 70 per cent expected increase in meat consumption (Makkar *et al*., 2014) and an increment of meat price by 30 per cent in comparison to 2000 (FAO, 2010). Protein from animal sources is an important food for human being. Among the livestock, poultry is considered as the potential sector to cover the gap between the expected production and demand in the near

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future. The poultry production increases by 1.8 per cent annually (Gariglio *et al.,*2019a) with an increase of 6.89 per cent duck population between 2014 and 2017 (Kovitvadhi *et al*., 2019)**.**

The increase in poultry production particularly duck production results in more demand for animal and plant-based protein and energy sources. The insects and their larvae have emerged as a suitable alternative protein cum energy source for conventional animal and plant-based protein and energy ingredients. Among these, black soldier fly larvae (BSFL) can be considered as best choice as they can be produced eco-friendly and economically with good quality. The protein and energy content of the larvae vary widely based on the substrate on which it grows.

The BSFL has good palatability, improves chick growth and health due to prebiotic effects of its chitin and polysaccharide content, digest harmful bacteria like *Salmonella enterica*, *Escherichia coli* etc. and also neutralise the aflatoxin ingested from feed.

Materials and methods

For establishing the stock colony, the fresh BSF eggs were collected from the premises of University Poultry and Duck Farm, Mannuthy, Thrissur, Kerala, India by keeping traps on the bait (Booth and Sheppard, 1984). The eggs were kept on four centimeter high stand covered with mosquito net and placed in a tray filled with one kg of quail breeder feed mixed with 1.5 litres of water. The top of tray was covered with mosquito net to avoid predation of eggs and young hatchlings by wall lizards. The tray was kept on a table with stands of the table submerged in water to prevent predation of eggs by ants. The five days old larvae were transferred to basins filled with organic substrates like quail manure and food wastes at a height of 15cm.They were fed *ad libitum* till reaches pre-pupal stage. The harvesting of larvae was done using two sieves fixed 20 cm apart, the upper one with the dimension of 1.5 x 1.5cm and lower one with the dimension of 0.4 x 0.4 cm. Due to photophobic behavior, they crawled down through the sieve holes along with smaller waste particles into the collection basin. Finally, they were separated from the smaller waste particles through quick manual sieving and washing (Dortmans *et al*., 2017). The larvae were anaesthetised overnight at 4°C, blanched at 60°C, pooled well, packed in air tight bags and stored at -20°C till the start of experiment. One week before the arrival of ducklings the stored larvae were thawed overnight at room temperature and dried in hot air oven at 80-90°C overnight (Vilela *et al*., 2021).

An experiment was conducted using 96, day-old meat type male ducklings purchased from a private farm in Thrissur district. All the ducklings were wing banded, weighed individually and randomly allotted to four dietary treatment groups, each with four replicates of six birds each, in a completely randomized design.

Birds were housed in 16 pens each having dimension of 1.50 × 2.00m with plastic slatted floor. The birds of four treatment groups were fed with four different broiler starter diets from 0-4 weeks of age and broiler finisher diets from 5-8 weeks of age formulated as per IS 1374 (2007) by incorporating 0, 5, 10 and 15% black solder fly larvae meal (BSFLM), respectively, which are isonitrogenous and isocaloric. Standard managerial practices were followed throughout the experiment. The feed and water were given *ad libitum* to the birds. The proximate chemical composition of the dried BSFLM was estimated (AOAC, 2012) and presented in Table 1. The ingredients

Table 1. Chemical composition of black soldier fly larvae meal

Chemical composition	Amount (%)
Moisture	5.40
Dry matter	94.60
Crude protein	42.50
Ether extract	18.19
Crude fiber	5.75
Total ash	24.22
Nitrogen free extract	9.34
Acid insoluble ash	0.14
Calcium	3.00
Phosphorus	0.80
Metabolisable energy (kcal/kg)	3361

Table 2. Ingredient composition of starter diets, per cent

Ingredient	T_1	T_2	T_3	T_4
Maize	48.10	50.00	49.64	51.34
De oiled rice bran	0.00	0.00	2.00	1.50
Soya bean meal	39.95	34.84	29.50	24.50
BSFLM	0.00	5.00	10.00	15.00
Calcite	1.00	0.50	0.50	0.50
Dicalcium phosphate	2.50	2.50	2.00	2.00
Rice bran oil	6.80	5.50	4.70	3.50
Salt	0.50	0.50	0.50	0.50

Table 3. Ingredient composition of finisher diets, per cent

Ingredient	T_1	T_2	T_3	T_4
Maize	52.75	54.75	53.00	54.44
Wheat Bran	0.00	0.00	1.00	0.00
De oiled rice bran	0.00	0.00	2.00	2.50
Soya bean meal	34.60	29.60	24.54	20.00
BSFLM	0.00	5.00	10.00	15.00
Calcite	1.00	1.00	0.50	0.50
Dicalcium phosphate	2.500	2.00	2.00	2.00
Rice bran oil	7.500	6.00	5.30	3.90
Salt	0.50	0.50	0.50	0.50

Table 4. Feed additives for starter and finisher diets, per cent

L-Lysine[1]	0.400	0.400	0.400	0.400
DL-Methionine[2]	0.200	0.200	0.200	0.200
Vitamin AB_2D_3K mix[3]	0.050	0.050	0.050	0.050
Toxin binder [4]	0.100	0.100	0.100	0.100
Anticoccidial [5]	0.025	0.025	0.025	0.025
Choline chloride [6]	0.200	0.200	0.200	0.200
Trace mineral mix[7]	0.125	0.125	0.125	0.125
Liver tonic[8]	0.025	0.025	0.025	0.025

composition of the experimental rations are presented in Table 2, 3 and 4.

At the end of the eighth week, blood sample of two birds from each replicate was collected from the jugular vein in vials without anti-coagulant and the serum was separated for biochemical analysis. Blood serum parameters *viz.* albumin, globulin, cholesterol, triglycerides and calcium were analysed and the albumin / globulin ratio was calculated. Two birds from each replicate were transferred to metabolism cages after eight weeks study period, destined to an in-vivo digestibility trial. After three days of adaptation period, birds were fasted for 24h and then fed with their corresponding experimental diets for three days and again subjected to one day fasting for getting accurate data on feed intake and excreta. The excreta were collected daily from each cage and chilled. The excreta of birds from each replicate were pooled, dried, ground and stored at 4°C until further analysis. Total feed provided and feed left over at the end of the 4th day of excreta collection were measured and proximate composition of feed samples and droppings were analysed replicate-wise as per AOAC (2012). The above-mentioned data were analysed by one-way ANOVA using SPSS (version 24.0).

Results and discussion

The effects of dietary inclusion of BSFLM at different levels on nutrients digestibility of meat type male ducks is presented in Table 5. There was no significant

Table 5. Mean (± SE) nutrients digestibility of meat type male ducks in different dietary treatments, co-efficient

Parameters	Treatment				p-value
	T_1 (control)	T_2 BSFLM (5%)	T_3 BSFLM (10%)	T_4 BSFLM (15%)	
Dry matter	0.81±0.01	0.80±0.02	0.79±0.02	0.79±0.03	0.938
Crude protein	0.80±0.02	0.79±0.03	0.79±0.02	0.78±0.03	0.931
Ether extract	0.81±0.01	0.84±0.02	0.87±0.01	0.85±.0.02	0.096
Crude fibre	0.46±0.03	0.45±0.11	0.42±0.06	0.47±0.05	0.959
Nitrogen free extract	0.87±0.01	0.88±0.01	0.86±0.01	0.86±0.02	0.763
Total ash	0.46±0.01	0.46±0.09	0.46±0.06	0.46±0.07	1.000
Calcium	0.70±0.12	0.76±0.02	0.93±0.01	0.83±0.03	0.106
Phosphorous	0.56±0.04	0.57±0.09	0.36±0.15	0.36±0.11	0.297

Table 6. Mean (±SE) serum parameters of meat type ducks in different dietary treatments at eight weeks of age

Parameters	Treatment				p-value
	T_1 (control)	T_2 BSFLM (5%)	T_3 BSFLM (10%)	T_4 BSFLM (15%)	
Total protein (g/dl)	2.96±0.15	2.93±0.12	2.86±0.10	2.85±0.06	0.878
Albumin (g/dl)	1.33±0.10	1.50±0.06	1.34±0.07	1.45±0.08	0.330
Globulin (g/dl)	1.64±0.10	1.43±0.12	1.53±0.12	1.40±0.08	0.391
A/G ratio	0.84±0.09	1.10±0.08	0.93±0.10	1.07±0.10	0.174
Cholesterol (mg/dl)	163.69 ±6.50	161.73±4.72	169.85±8.46	183.05±4.22	0.088
Triglyceride (mg/dl)	101.41^{a}±6.66	52.74^{b}±3.52	70.66^{b}±4.23	65.01^{b}±9.75	0.0001
Calcium (mg/l)	76.26±3.28	79.58±2.07	78.36±4.28	80.05±0.91	0.0801

A/G ratio= Albumin/globulin ratio. Means bearing different superscripts within the same row differ significantly ($p<0.05$)

difference in nutrients digestibility coefficient among treatment groups. This result is in accordance with that of Gariglio *et al.* (2019a) who observed no significant effect on apparent dry matter, crude protein and crude fibre digestibility in female Muscovy ducks. Similar results related to dry matter and crude protein digestibility were reported by Vilela *et al.* (2021) in broilers and Cullere *et al.* (2016) in meat type quails, while Bovera *et al*. (2018) and Cutrignelli *et al*. (2018) reported significantly ($p<0.05$) lower dry matter digestibility in birds fed with BSFL compared to those fed with control diets. Similar result related to ether extract digestibility was reported by Attivi *et al.* (2020) in broilers, Mulyono *et al.* (2021) in quails, Bovera *et al*. (2018) and Cutrignelli *et al*. (2018) in layers. Results on nitrogen free extract, total ash, calcium and phosphorous digestibility coefficient agree with reports of Attivi *et al.* (2020) and Vilela *et al.* (2021) in broilers and Khan *et al*. (2016) in broilers fed with diets containing house fly maggot meal.

The effects of dietary inclusion of BSFLM at different levels on biochemical parameters of meat type male ducks is presented in Table 6. There was no significant effect on serum total protein, albumin, globulin, cholesterol and calcium contents and albumin/globulin ratio among treatment groups while serum triglycerides content was significantly ($p<0.05$) lower in all BSFLM fed groups compared to control group. The results on serum total protein, albumin and albumin/globulin ratio agree with reports of Marono *et al.* (2017) and Bovera *et al.* (2018) in layers and Wallace *et al*. (2017, 2018) in guinea fowl. However, Marono *et al.* (2017) and Bovera *et al.* (2018) reported significantly ($p<0.05$) higher serum globulin content in layers fed with diets containing BSFLM than control group. The result on serum triglycerides content agrees with the report of Gariglio *et al*. (2019b), who observed significant ($p<0.05$) decrease in serum triglycerides level with linear increase in BSFLM inclusion level. The result on serum calcium

content agrees with the report of Gariglio *et al*. (2019b), who observed no significant effect of dietary inclusion of BSFLM up to 9 per cent on serum calcium content in Muscovy ducks. The results on cholesterol content agrees with the report of Loponte *et al.* (2017) who found no significant effect of feeding BSFLM on serum cholesterol content in Barbary partridge. Similar result was reported by Dabbou *et al*. (2018) in broilers and also Wallace *et al*. (2017, 2018) in guinea fowl while Gariglio *et al.* (2019b) reported significantly ($p<0.05$) lower serum cholesterol level in Muscovy ducks fed with diets containing BSFLM compared to the control group.

Conclusion

The dietary inclusion of BSFLM in meat type ducks lowered the serum triglycerides content, with no adverse effect on other serum biochemical parameters or nutrients digestibility coefficient. Therefore, the dietary inclusion of BSFLM can be recommended in meat type duck diet up to 15 per cent of the total ration.

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Conflict of Interest

The authors report no conflict of interest.

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