RESEARCH ARTICLE
Open Access

Journal of Veterinary and Animal Sciences
ISSN (Print): 0971-0701, (Online): 2582-0605
https://doi.org/10.51966/jvas.2022.53.3.429-434

Influence of Black Soldier Fly (*Hermetia illucens*) larvae feeding on carcass characteristics of Gramasree hens#

Avinash Nilugonda[1], S. Sankaralingam[1], P. Anitha[1], D. K. Deepak Mathew[2] and P. B. Aswathi[2]
Department of Poultry Science,
College of Veterinary and Animal Sciences, Mannuthy, Thrissur - 680651,
Kerala Veterinary and Animal Sciences University, Kerala, India.

Citation: Avinash, N., Sankaralingam, S., Anitha, P., Deepak, M. D. K. and Aswathi, P. B. 2022. Influence of Black Soldier Fly (*Hermetia illucens*) larvae feeding on carcass characteristics of Gramasree hens. *J. Vet. Anim. Sci.* **53** (3): 429-434
DOI: https://doi.org/10.51966/jvas.2022.53.3.429-434

Received: 18.02.2022 *Accepted: 12.04.2022* *Published:30.09.2022*

Abstract

The study on the evaluation of carcass characteristics of Gramasree hens by feeding fresh black soldier fly larvae (BSFL) as soya bean meal replacer at 0, 25, 50, 75 and 100 per cent levels was carried out at University Poultry and Duck Farm, Mannuthy, Thrissur, Kerala, for a period of 8 weeks. Eighty numbers of 40 week old Gramasree hens were allotted to five treatment groups with four replicates each and with four birds in each replicate. Slaughter parameters like pre-slaughter body weight, dressing percentage and eviscerated percentage were not affected by the inclusion of fresh BSFL. Abdominal fat was significantly ($p<0.05$) lower in BSFL fed groups compared to control. Breast yield was significantly ($p<0.05$) lower in 75 and 100 per cent groups compared to control. No significant difference was noticed in thighs yield. Drumsticks yield was significantly ($p<0.05$) lower in 50 per cent group and wing yield was significantly ($p<0.05$) lower in 50 and 100 per cent replacement groups compared to control. The heart, liver and gizzard yield were not affected by BSFL feeding. This study concludes that although fresh BSFL contains higher percentage of ether extract, the presence of chitin and chitosan prevents the abdominal fat deposition and also influences certain carcass characteristics negatively.

Keywords: *Black soldier fly larvae*, *Hermetia illucens, carcass characters*, *abdominal fat, hen*

#Part of MVSc thesis submitted to Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala

1. *MVSc Scholar*
2. *Assistant Professor*
3. *Professor and Head*
4. *Assistant Professor, Department of Livestock Production and Management, College of Veterinary and Animal Sciences, Pookode, Wayanad - 673576*
5. *Assistant Professor, Department of Poultry Science, College of Veterinary and Animal Sciences, Pookode, Wayanad – 673576*

**Corresponding Author email id: sankaralingam@kvasu.ac.in*

The rising global population and climate change have created challenges to fulfill population demand for food security. In poultry sector feed alone costs around 70 percent of cost of production and constant fluctuation in cost of soya bean meal (SBM) and maize cause economical loss to small scale farmers. To fulfill market demand and reduce over dependence on SBM as protein source better alternatives are required (FAO, 2013). The black soldier fly larvae (BSFL) are one of the promising insect larvae which have similar protein content as of SBM and fish meal (FM). The BSFL can grow on different types of decaying organic wastes like manure, kitchen waste and sewage waste and convert them into valuable biomass (Makkar *et al*., 2014). The BSFL can be used to recycle nutrients from organic wastes to animal feed rich in valuable protein and energy. Production of BSFL is eco-friendly, needs less land area and helps to minimize house fly menace. The BSFL contain 30 to 50 percent crude protein and 7 to 40 percent crude fat on dry matter basis depending upon the composition of substrate in which they grow. Feeding BSFL to poultry has been approved by European Union vide Commission regulation (EU) 2021/1372. The current study was carried out to evaluate the influence of fresh BSFL feeding on carcass characteristics of Gramasree hens. Gramasree is a synthetic dual purpose chicken breed developed by University Poultry and Duck Farm, Mannuthy, Thrissur, Kerala, India for backyard rearing.

Material and methods

The BSFL were produced by using kitchen waste as substrate. The larvae were harvested using sieve and washed with water. Harvested larvae were anesthetized by cooling, blanched, pooled and sample was taken for analysis of chemical composition (AOAC, 2012). The chemical composition of the harvested larvae is presented in Table 1. The entire lot of BSFL was stored at -20°C and daily requirement was thawed overnight and used for feeding.

Eighty numbers of 40-week-old Gramasree hens were grouped into five treatment groups with four replicates each and with four birds in each replicate by completely randomised design. The experimental duration was from 41 to 48 weeks of age. The birds in control group were fed with layer diet as per IS 1374 (2007). The birds in other four groups were fed with 25, 50, 75 and 100 per cent fresh BSFL as SBM replacer on dry matter basis and the remaining portion of the feed was provided as balancer diet. The chemical composition of the experimental diets is presented in Table. 2. As the fresh BSFL contain more fat, the feed formulation was made by assuming the moisture content of the fresh BSFL as inert ingredient. Each day, the fresh BSFL and the balancer diet were mixed in such a way that the nutrient contents were similar to that of control diet on dry matter basis. The ingredient composition of different experimental diets is presented in Table 3. Birds were fed *ad libitum* and clean drinking water was provided during the course of the experiment. The birds were maintained under uniform management conditions with the photoperiod of 16 hours a day.

Table 1. Chemical compositions of Black soldier fly larvae

Components	Level (%)
Moisture	60.09
Crude protein	32.51
Ether extract	40.3
Crude fibre	4.98
Total ash	6.8
Calculated Nitrogen free extract	15.41
Acid insoluble ash	2.81
Calculated ME (Kcal/kg)	5102.7
Calcium	1.72
Phosphorus	0.84

Two birds from each replicate of all five treatment groups were slaughtered humanely at 48 weeks of age and pre-slaughter weight, dressing percentage (weight of slaughtered bird without feathers, head and shank), eviscerated percentage (weight of slaughtered bird without feathers, head shank and visceral organs), abdominal fat percentage, yield of cut-up parts (Breast, thighs, drumsticks and wings) and yield of giblets (heart, liver and gizzard) were measured and calculated as percentage of pre-slaughter weight (carcass weight). The data were analysed using one-way ANOVA of SPSS (Version 24.0).

Table 2. Chemical composition of experimental diets

Components (%)	T1 (Control)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Dry matter	89.00	76.78	66.69	58.20	49.97
Crude protein	16.80	18.38	21.18	21.70	26.25
Ether extract	1.07	2.01	4.63	8.05	12.77
Crude fibre	4.85	4.79	5.96	8.09	12.09
Total Ash	12.20	18.31	18.94	18.29	20.32
Acid insoluble ash	3.99	4.84	5.08	4.94	5.71
Calculated NFE	65.08	56.51	49.29	43.87	28.57
Calcium	2.97	3.28	3.59	3.81	4.15
Phosphorus	0.55	0.73	0.87	0.70	0.88
Calculated ME (kcal/kg)	2656.96	2791.90	2859.87	2979.34	3004.35

*As the moisture content of the fresh BSFL is assumed as inert ingredient, there is variation in the chemical composition of ingredients on dry matter basis

Table 3. Ingredient composition of different experimental diets

Sl. No.	Ingredients (%)	T1 (control)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
1	Maize	47	41	29	17	4
2	Wheat Bran	7	5	6	5	5
3	DORB	7.36	6.85	13	7.85	9.35
4	Soya Meal	26	19.5	12	6.5	0
5	BSF larvae	0	6	22	33	45
6	Calcite	4	4	4	4	4
7	DCP	1.4	1.4	1.4	1.4	1.4
8	Shell grit	5	5	5	5	5
9	Salt	0.25	0.25	0.25	0.25	0.25
10	Inert material (Moisture content of live BSFL)	0	6	12	18	26
	Feed additives					
1	Vitamin premix	0.025	0.025	0.025	0.025	0.025
2	Lysine	0	0	0	0	0
3	Methionine	0.02	0.02	0.02	0.02	0.02
4	Inta-O-Tox	0.1	0.1	0.1	0.1	0.1
5	Choline	0.2	0.2	0.2	0.2	0.2
6	Trace mineral	0.125	0.125	0.125	0.125	0.125
7	Liver tonic	0.025	0.025	0.025	0.025	0.025

Results and discussion

The effect of feeding fresh BSFL at different levels on carcass characteristics of Gramasree hens is presented in Table 4. There was no significant difference in pre-slaughter body weight, dressing percentage, eviscerated percentage, yield of heart, liver and gizzard. Similar results were reported by Wallace *et al.* (2018) for pre-slaughter body weight, eviscerated percentage, heart, liver and giblet yield in guinea fowls and Loponte *et al.* (2017) for eviscerated percentage, heart yield and liver yield in Partridge. Contrary to these findings, significantly ($p<0.05$) higher pre-slaughter body weight was reported by Tahamtani *et al*. (2021) in layers, Hartinger *et al*. (2021) for dressing percentage and eviscerated percentage in broilers, Anankware *et al.* (2018) for heart and gizzard yield.

In the present study, abdominal fat percentage was significantly ($p<0.05$) lower in all BSFL fed groups compared to control. Similarly, Hartinger *et al.* (2021) reported significantly ($p<0.05$) lower abdominal fat in broilers fed

Table 4. Mean (±SE) values of carcass characteristics in Gramasree hens fed with BSF larvae as protein replacer at different levels at 48 weeks of age

Parameters	Treatment groups					p-value
	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	
Pre-Slaughter body Wt (kg)	1.98 ±0.09	1.97 ±0.12	2.25 ±0.16	2.07 ±0.12	2.12 ±0.04	0.426
Dressed yield (%)*	87.20 ±0.99	86.49 ±1.17	84.54 ±2.75	87.51 ±0.99	86.41 ±0.75	0.679
Eviscerated yield (%)*	69.36 ±2.06	69.79 ±1.75	72.21 ±1.30	71.25 ±2.93	69.48 ±0.80	0.784
Abdominal fat (%)*	9.04^{a} ±4.90	5.41^{b} ±0.39	4.75^{b} ±0.43	4.95^{b} ±0.15	5.00^{b} ±0.29	0.001
Breast yield (%)*	18.14^{a} ±0.95	17.95^{ab} ±0.33	16.36^{bc} ±0.67	16.02^{c} ±0.29	15.00^{c} ±0.19	0.006
Thighs yield (%)*	9.34 ±0.26	9.79 ±0.21	10.23 ±0.32	9.67 ±0.10	9.48 ±0.14	0.095
Drumsticks yield (%)*	9.25^{a} ±0.27	8.73^{ab} ±0.27	7.90^{c} ±0.22	8.26^{bc} ±0.15	8.32^{bc} ±0.10	0.001
Wings yield (%)*	7.25^{a} ±0.18	6.69^{ab} ±0.26	6.32^{b} ±0.31	6.63^{ab} ±0.16	6.36^{b} ±0.10	0.050
Heart (%)*	0.41 ±0.13	0.43 ±0.02	0.41 ±0.04	0.41 ±0.02	0.38 ±0.02	0.797
Liver (%)*	1.92 ±0.14	1.77 ±0.06	1.91 ±0.06	1.81 ±.0.06	2.08 ±0.18	0.715
Gizzard (%)*	1.63 ±0.07	1.45 ±0.09	1.24 ±0.09	1.39 ±0.16	1.45 ±0.07	0. 182

Means bearing different superscript within a row differ significantly ($p<0.05$). *The values are calculated and are the percentage of pre-slaughter weight

with black soldier fly larvae meal (BSFLM). On the other hand, no significant difference was reported by Bovera *et al.* (2018) in layers. Contrary to the present study, significantly ($p<0.05$) higher abdominal fat percentage was reported in *ad libitum* live BSFL fed hens at 31 weeks of age (Tahamtani *et al.,* 2021). The lower abdominal fat percentage of the birds fed with BSFL in the present study could be due to positively charged chitosan which has the ability to combine with fatty acids, other lipids and bile acids and prevent their absorption through intestine and also by preventing lipid emulsification (Ylitalo *et al*., 2002).

The yield of breast, drumsticks and wings were significantly ($p<0.05$) lower in BSFL fed groups compared to control and the yield of thighs showed no significant difference. Similar results were reported by Anankware *et al.* (2018) in broilers by feeding BSFLM. On the other hand, Pieterse *et al.* (2018) reported no significant difference for commercial cut-up parts and Sumbule *et al.* (2021) reported no significant difference for breast yield and drumsticks yield and significantly ($p<0.05$) higher yield of thighs and wings.

Conclusion

The results of present study concludes that although fresh BSFL contains higher percentage of ether extract, the presence of chitin and chitosan prevents the abdominal fat deposition and also influences certain carcass characteristics negatively.

Acknowledgment

The authors are thankful to the Dean, College of Veterinary and Animal Sciences, Kerala Veterinary and Animal Sciences University, Mannuthy, Thrissur, Kerala for providing all necessary facilities and financial support for the research.

Conflict of interest

The authors report no conflict of interest.

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