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Effect of dietary addition of black soldier fly larvae (*Hermetia illucens*) on growth performance of male goat kids

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Abstract
The current research titled "Effect of Dietary Addition of Black Soldier Fly Larvae (*Hermetia illucens*) on Growth Performance of Male Goat Kids" was carried out at Goat Farm, Division of Animal Husbandry and Dairy Science, Dr. Sharadchandra Pawar College of Agriculture, Baramati during the years 2024-2025. This research aimed to assess how the dietary addition of black soldier fly larvae influences the growth performance of male goat kids. A total of twenty male goat kids, each around three months old, were chosen and randomly divided into four groups, with five kids in each: T_0 (Control group with a basal diet), T_1 (Basal diet supplemented with 10 g of dried black soldier fly larvae per 200 g of concentrate), T_2 (Basal diet supplemented with 20 g of dried black soldier fly larvae per 200 g of concentrate), and T_3 (Basal diet supplemented with 30 g of dried black soldier fly larvae per 200 g of concentrate). The feeding trial lasted for 90 days. The results revealed significant (p<0.05) improvement in body weight gain with increasing levels of BSF supplementation. The final body weights were 10.30 kg (T_0), 11.02 kg (T_1), 12.98 kg (T_2), and 14.88 kg (T_3).
In conclusion, the inclusion of black soldier fly larvae at 15% of concentrate (T_3) resulted in optimal growth performance, enhanced nutrient utilization, and improved weight gain status in male goat kids. The study supports the recommendation of black soldier fly larvae as an effective and natural feed supplement in small ruminant nutrition.

Keywords: Black soldier fly larvae, goat, kids, body weight

1. Introduction
Over the past decade, insects have emerged as a feasible alternative source of protein and fat for animal feed, helping to alleviate issues related to conventional feed components such as soybean and fish meal. Notably, the black soldier fly (BSF), scientifically known as *Hermetia illucens*, has attracted considerable interest because of its exceptional nutritional profile and positive environmental impact.
The larvae of the black soldier fly (BSF) have emerged as a viable sustainable protein source for animal feed, particularly for ruminants such as goats. Research shows that adding BSF larvae to goat diets can improve both growth performance and feed efficiency. Astuti *et al.* (2022) [1] found that using BSF meal as creep feed led to better performance in goats when compared to control groups.
Insects are increasingly acknowledged as a feasible source of livestock feed due to their capacity to convert substrates that are deficient in nutrients into biomass abundant in nutrients (Wang and Shelomi, 2017) [2]. Additionally, their production is thought to exert a lesser environmental impact in comparison to conventional feed sources (Zanolli, 2014; Smetana *et al.*, 2019; Allegretti *et al.*, 2018) [3-5]. Notably, Black Soldier Fly larvae (BSFL) are distinguished for their potential in extensive feed applications, which is attributed to their remarkable nutrient composition (47.0%-58.0% dry matter, crude protein, 39.0% fat; Newton *et al.*, 2005; St. Hilaire *et al.*, 2007; Lock *et al.*, 2016) [6, 7, 8], scalability (English *et al.*, 2021) [9], and efficient feed conversion rates (Oonincx *et al.*, 2015) [10].

Earlier investigations have shown that BSFL can act as a replacement for traditional protein feeds in the diets of poultry, swine, and fish (Newton *et al.*, 1977; Al-Qazzaz *et al.*, 2016; Driemeyer, 2016; Cockcroft, 2018) [11, 13, 14, 15]. Supplementation levels of Black Soldier Fly Larvae (BSFL) below 20% have been reported to exert no adverse effects on growth performance, biochemical parameters, or meat quality in poultry. Similarly, studies conducted on swine have illustrated that BSFL inclusion does not negatively influence growth performance or meat quality; however, a reduction in feed conversion efficiency was observed (Insects, 2022) [16]. While the potential benefits of incorporating black soldier fly insect meal into animal diet are promising. The effects on the performance of male goats have not been extensively studied. Male goats are the most common type of animals which used for meat production, and their growth, feed efficiency, and overall performance are crucial for the profitability and sustainability of the goat production industry.

2. Methodology

The present study of 90 days was conducted to access the effect of dietary addition of black soldier fly larvae on the growth performance of male goat kids. Twenty healthy male goats (kids), around 3 months old, were purchased from the local market. These goats were maintained on a standard diet of a concentrate mixture, wheat straw, and maize silage for one month before the actual experiment began. They were housed at the Goat Farm, Division of Animal Husbandry and Dairy Science, Dr. Sharadchandra Pawar College of Agriculture in Baramati, which offered facilities for individual feeding and watering. The kids were vaccinated against Peste Des Petits Ruminants (PPR), Black Quarter (BQ), and Haemorrhagic Septicaemia (HS) following established protocols. After a month of adaptation, the kids were divided into four groups of five based on their body weights, using a randomized block design (RBD).

2.1 Treatment details

Treatment	Details
T_0	Maize silage + Wheat straw + Readymade concentrates (200 gm/animal/day)
T_1	Maize silage + Wheat straw + Readymade concentrates (190 gm/animal/day) + insect meal of black soldier fly larvae (10g/animal/day)
T_2	Maize silage + Wheat straw + Readymade concentrates (180 gm/animal/day) + insect meal of black soldier fly larvae (20g/animal/day)
T_3	Maize silage + Wheat straw + Readymade concentrates (170 gm/animal/day) + insect meal of black soldier fly larvae (30g/animal/day)

2.2 Recording of body weights

The body weights of all animals were recorded weekly in the morning with an electronic scale, before they received any feed or water. Subsequently, a predetermined amount of concentrate mixture, wheat straw, and maize silage was offered to them.

2.3 Statistical analysis

The gathered data were analyzed statistically using the Randomized Block Design (RBD) to evaluate differences, following the methods described by Amble (1975).

3. Result and discussion

3.1 Growth Performance

3.1.1 Body weight

The exceptionally high protein content in Black Soldier Fly (BSF) larvae significantly contributes to muscle development and promotes rapid weight gain in growing animals. BSF larvae represent a highly effective alternative source of protein owing to their abundance of essential amino acids, which are vital for tissue synthesis, metabolic regulation, and overall growth performance. These amino acids enhance the nutritional profile of the diet, making it more balanced and efficient. In addition to their protein richness, BSF larvae contain bioactive compounds that exhibit antioxidant properties, which aid in mitigating oxidative stress. This, in turn, contributes to enhanced health, immunity, and productivity in livestock.

Table 1: Average weekly body weight of kids under different treatments (kg/week)

Week	Treatment				SEM	CD At 5%
	T_0	T_1	T_2	T_3		
0	8.66	8.58	8.72	8.63	0.0376	NS
1	8.75	8.68	8.84	8.74	0.0416	NS
2	8.88	8.83	9.01	8.92	0.0472	NS
3	8.99^{c}	9.08^{c}	9.28^{b}	9.51^{a}	0.0452	0.1393
4	9.12^{c}	9.27^{c}	9.65^{b}	10.01^{a}	0.0483	0.1489
5	9.24^{d}	9.44^{c}	10.00^{b}	10.51^{a}	0.0523	0.1612
6	9.35^{d}	9.61^{c}	10.34^{b}	11.01^{a}	0.0574	0.1769
7	9.47^{d}	9.79^{c}	10.70^{b}	11.52^{a}	0.0630	0.1941
8	9.61^{d}	9.98^{c}	11.07^{b}	12.06^{a}	0.0659	0.2031
9	9.74^{d}	10.17^{c}	11.43^{b}	12.60^{a}	0.0675	0.2082
10	9.87^{d}	10.38^{c}	11.80^{b}	13.15^{a}	0.0686	0.2116
11	10.01^{d}	10.59^{c}	12.19^{b}	13.71^{a}	0.0698	0.2153
12	10.15^{d}	10.79^{c}	12.57^{b}	14.28^{a}	0.0720	0.2219
13	10.30^{d}	11.02^{c}	12.98^{b}	14.88^{a}	0.0748	0.2305

The initial weights of 8.66, 8.58, 8.72, and 8.63 kg were elevated to 10.30, 11.02, 12.98, and 14.88 kg following a 90-day feeding period in the respective treatments. The goat kids in the T_3 treatment group demonstrated a markedly higher total body weight in comparison to the T_0, T_1, and T_2 groups. In contrast, the T_0 group recorded the lowest final body weight among all treatment groups.

The total weight gain in goat body weight for those receiving the experimental rations T_0, T_1, T_2, and T_3 at the conclusion of the 90-day trial was 1.64, 2.43, 4.26 and 6.25 kg, respectively. The variation in body weight among the different treatment groups was significantly greater in male goat kids from T_3, followed by T_2, T_1, and T_0. Furthermore, the total body weight gain of the male goat kids was significantly influenced by the addition of dried black soldier fly (*Hermetia illucens*) larvae in their diet. While the kids from the T_0 group showed the least total body weight gain, significant differences in total body weight gain were noted among the T_0, T_1, T_2, and T_3 treatment groups.

Table 2: Effect of black soldier fly larvae on total body weight of kids (kg)

Treatment	Initial body weight (kg)	Final body weight (kg)	Total body Weight gain (kg)
T_0	8.66	10.30	1.64
T_1	8.58	11.02	2.43
T_2	8.72	12.98	4.26
T_3	8.63	14.88	6.25
Mean	8.64	12.29	3.64
SEM	0.0376	0.0748	0.0866
CD At 5%	NS	0.2305	0.2668

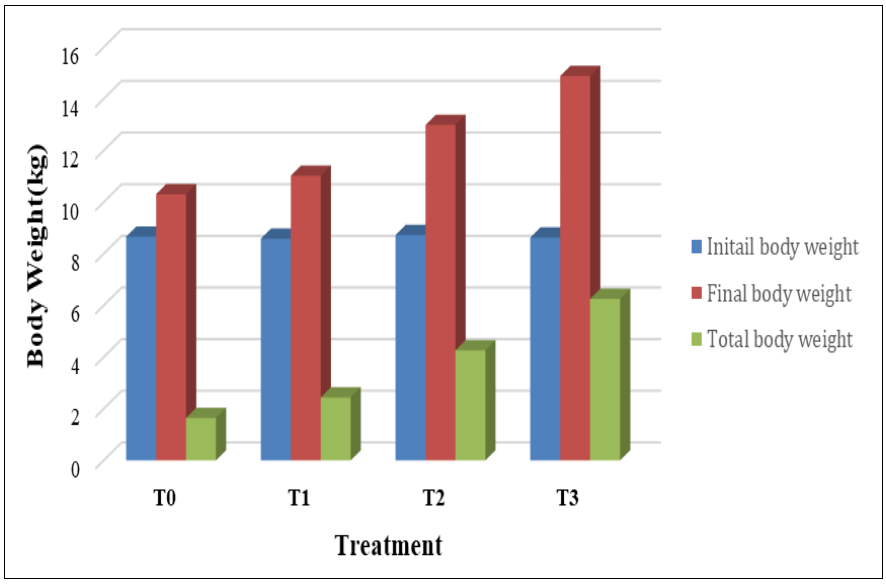

Fig 1: Effect of black soldier fly larvae on total body weight of kids (kg)

4. Conclusion

The inclusion of dried Black Soldier Fly (BSF) larvae into the ration of male goat kids, substituting 5%, 10%, and 15% of the concentrate on a dry matter basis, led to an improvement in their body weight.

Conflict of Interest

Not available

Financial Support

Not available

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