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Effect of different honey and protein sources on economic characters of silkworm *Bombyx mori* L.

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Abstract

An experiment was undertaken to know the effect of different honey bee species (*Apis cerana*, *A. florea*, *A. mellifera*, *A. dorsata* and *Trigona iridipennis*) and protein sources (pollen, soya flour, red gram flour and horse gram flour) on the economic traits of silkworm *Bombyx mori* L. by using of different concentrations (1%, 2%, 3%, 4%, 5% and 6%). Among the different treatments, *T. iridipennis* honey at 5% showed better performance on the silkworm growth and its economic parameters viz., larval weight (3.44g), cocoon weight (1.59g), shell weight (0.372g) and shell ratio (23.46%) followed by soya flour and red gram flour. The supplementation of 5% soya flour showed highest silk filament length (1321.15m) which was found to be on par with *T. iridipennis* honey (1312.15m).

Keywords: *Bombyx mori*, honey, protein sources, silkworm larva, economic characters

1. Introduction

Silkworm, *B. mori*, being monophagous insect feeds only mulberry leaves to make its cocoon, producing the silk. The growth and development of larvae, and subsequent cocoon production, are greatly influenced by the nutritional quality of mulberry leaves (Masthan *et al.*, 2011) [12]. The nutritional value of the mulberry leaves can be improved by enriching them with additional nutrients. The supplementation of honey increased the biological parameters and economic traits of silkworm (Zanoon *et al.*, Saad *et al.*, 2014; Kamel *et al.*, 2016; Thulasi and Siva Prasad, 2015, Alagumanikumar and Prema, 2016; Gad, 2013) [16, 6, 18, 1].

Studies on enrichment of mulberry leaves with soya flour showed significant influence in larval growth and development of silkworm (Nalini *et al.*, 1994; Manimegalai *et al.*, 2003; Pallavi and Muthuswami, 2012) [13, 11, 14]. The pollen is a natural nutritional source for increasing the silk productivity of silkworm (Mangammal *et al.*, 2014; Salman *et al.*, 2014) [10, 17]. The enrichment with flour diets increased the larval weight, silk gland weight and commercial cocoon characters of *B. mori* as compared to non-supplemented check (Ganga and Gowri, 1990) [5]. Eventhough the silkworm nutrients are balanced in mulberry leaves, the quantity available is not sufficient for robust larval growth and development (Ito, 1978) [7]. By keeping this view in mind, the present study has been undertaken to assess the effect of different honey and protein sources on economic characters of mulberry silkworm.

2. Materials and method

The study was carried out in the Department of Sericulture, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam. The silkworm, bivoltine Double Hybrid (CSR 2 × CSR 27) × (CSR 6 × CSR 26) was used for the study. Before commencement of rearing, the rearing room and rearing appliances were disinfected with 2.5% Sanitech (Stabilized ClO₂) + 0.5% slaked lime solution and the rearing room was kept closed in air tight condition for 24 hrs (Dandin and Giridhar, 2014) [3]. The silkworm rearing was carried out under ambient ecological conditions (28±2°C temp. & 80±5% RH) without any deviation in temperature or relative humidity according to the method advocated by Krishnaswami (1978) [9].

Different concentrations viz., 1, 2, 3, 4, 5 and 6 % of honey and protein sources were prepared using distilled water. Weighed quantities of fresh mulberry leaves were separately sprayed with different concentrations of honey from five bee species namely *A. cerana*, *A. florea*, *A. mellifera*, *A. dorsata* & *T. iridipennis* and four protein sources namely Pollen, Soya flour,

Horse gram flour and Red gram flour. The larval batch fed with mulberry leaves sprayed with distilled water and control without any treatment were also maintained. The treated leaves were shade dried and fed once from the first day of fourth instar to spinning. Each treatment was replicated thrice with 50 larvae per replication.

The observation on various economic traits *viz.*, larval weight (g), cocoon weight (g), shell weight (g), shell ratio (%) and filament length (m) were recorded. The data collected from various experiments were statistically analysed using Factorial Completely Randomised Design (FCRD) as described by Panse and Sukhatme (1957)^[15].

3. Results and Discussion

The experimental result showed that there were significant changes in the growth, development and economical attributes of silkworm due to supplementation of different honey and protein sources on silkworm.

3.1 Larval weight (g)

The results revealed that supplementation of honey and protein sources had significant positive impact in larval weight (Table 1). Maximum mean weight of the larva was recorded in *T. iridipennis* honey (3.44g) which was found to be on par with soya flour (3.43g) and red gram (3.33g). The next best treatments were *A. dorsata* honey (3.32g), horse gram flour (3.24g), pollen (3.23g), *A. mellifera* honey (3.22g) and *A. florea* honey (3.07g). Minimum larval weight was observed in *A. cerana* honey (2.98g), distilled water spray (2.97g) and control (2.89g) which did not differ statistically. Among the different concentrations tested, 5 % was found to be better than all other concentrations. The present finding was strengthened by Thulasi *et al.* (2015)^[18] who revealed that the supplementation of 2% honey significantly increased the larval weight of 2.75g on 7th day of 5th instar. The investigation by Bhatti *et al.* (2019) also showed the highest larval weight (2.96g) under the influence of 2 % *A. dorsata* honey.

3.2 Cocoon weight (g)

Significantly higher cocoon weight was recorded in *T. iridipennis* honey (1.59 g) and soya flour (1.55g). These treatments were followed by *A. dorsata* honey (1.47g), pollen (1.46g), *A. mellifera* honey (1.45), horse gram flour (1.44g) and red gram flour (1.44g) which were found to be on par with each other. Significantly lower value (1.34g) was observed in *A. cerana* honey and control which were found to be on par with distilled water spray (1.35g). Among the different concentrations studied, 5 % was found to be superior and effective over all other concentrations. Similarly, the highest cocoon weight of 1.23g was recorded on 5% honey treated Egyptian hybrid silkworm (Khedr *et al.*, 2013)^[8]. The present observations are further strengthened by Saad *et al.* (2014)^[16] who revealed that the supplementation of camphor honey significantly increased the cocoon weight (1.37g) (Table 2).

3.3 Shell weight (g)

Higher shell weight was registered in *T. iridipennis* honey (0.372g) followed by soya flour (0.350g), red gram flour (0.334g), *A. dorsata* honey (0.330g), horse gram (0.323g), *A. mellifera* honey (0.308g), *A. florea* honey (0.296g) and *A. cerana* honey (0.284g). These treatments were observed to be statistically on par with each other. Significantly lower values of 0.263g and 0.257g were recorded in distilled water spray and control, respectively. Among the different concentrations

tested, 5 % showed significant impact in terms of shell weight over all other doses. This result is strengthened with the finding of Alagumanikumar *et al.* (2016)^[11], who observed that addition of 25% honey in mulberry leaves significantly increased the shell weight (0.256g) and also Manimegalai *et al.* (2003)^[11] who reported that supplementation of soya flour (10g/1kg) increased the shell weight (0.27g) (Table 3).

3.4 Shell ratio (%)

Supplementation of *T. iridipennis* honey (23.46%) improved the shell ratio significantly and found to be on par with red gram flour (23.33%). This was followed by soya flour (22.63%), horse gram flour (22.48%), *A. dorsata* honey (22.40%), *A. mellifera* honey (21.30%), *A. cerana* honey (21.29%) and *A. florea* honey (20.90%). Distilled water spray and control groups registered significantly lower shell ratio of 19.45% and 19.24 %, respectively. Among the different concentrations tested, the shell ratio was significantly enhanced at 5 % concentration. Mulberry leaves enriched with 6% honey (17.70%) showed significant increase in shell ratio (Kamel *et al.*, 2010) which can be corroborated with the present observations. This was further supported by Khedr *et al.*, (2013)^[8] who reported that 5% honey significantly enhance the shell ratio (21.95%) (Table 4).

3.5 Silk filament length (m)

The silk filament length was significantly increased due to the feeding of larvae with soya flour (1321.15m) and was found to be on par with *T. iridipennis* honey (1312.15m). These were followed by *A. dorsata* honey, *A. mellifera* honey, horse gram flour, pollen, red gram flour, *A. florea* honey and distilled water spray which recorded the silk filament length of 1278.38m, 1273.40m, 1262.37m, 1251.31m, 1235.13m, 1237.19m and 1233.15m, respectively. The lower silk filament length was recorded in control (1198.75m) which did not significantly differ with *A. cerana* honey (1214.35m). Among the different concentrations studied, the silk filament length was significantly improved at 5 % concentration and found to be superior over all other doses. This was supported by Saad *et al.* (2014)^[16], who found that 5 % camphor honey increased the silk filament length (1051.40m) over the control (837.10m). The present result corroborates with the findings of Khedr *et al.* (2013)^[8], who registered increased silk filament length of 1085.01 m, when silkworm larvae were supplemented with honey at 5 % concentration (Table 5).

Table 1: Effect of different honey and protein sources on larval weight (g) of silkworm

Treatments	Concentrations						
	1%	2%	3%	4%	5%	6%	Mean
<i>A. cerana</i>	2.83	2.91	2.97	2.99	3.13	3.07	2.98
<i>A. florea</i>	2.93	2.97	2.99	3.09	3.27	3.18	3.07
<i>A. mellifera</i>	3.07	3.13	3.18	3.25	3.39	3.31	3.22
<i>A. dorsata</i>	3.11	3.19	3.27	3.36	3.56	3.42	3.32
<i>T. iridipennis</i>	3.23	3.31	3.38	3.46	3.68	3.57	3.44
Pollen	3.07	3.15	3.19	3.27	3.38	3.32	3.23
Soya flour	3.26	3.33	3.41	3.49	3.59	3.53	3.43
Horse gram	3.10	3.19	3.21	3.27	3.37	3.32	3.24
Red gram	3.17	3.23	3.31	3.37	3.48	3.41	3.33
Distilled water	2.81	2.93	2.98	3.01	3.08	3.05	2.97
Control	2.78	2.83	2.89	2.91	2.98	2.95	2.89
Mean	3.03	3.11	3.16	3.22	3.36	3.28	3.19
F value	SEd			CD (0.05)			
	T= 0.06			T= 0.11*			
	C= 0.04			C= 0.09**			
	TC= 0.14			TC= 0.27*			

T-Treatment, C-Concentration, * Significant, ** Highly significant

Table 2: Effect of different honey and protein sources on cocoon weight (g) of silkworm

Treatments	Concentrations						
	1%	2%	3%	4%	5%	6%	Mean
<i>A. cerana</i>	1.28	1.31	1.33	1.34	1.40	1.36	1.34
<i>A. florea</i>	1.31	1.36	1.41	1.45	1.49	1.47	1.42
<i>A. mellifera</i>	1.32	1.35	1.42	1.47	1.59	1.53	1.45
<i>A. dorsata</i>	1.36	1.39	1.43	1.48	1.62	1.55	1.47
<i>T. iridipennis</i>	1.42	1.48	1.54	1.63	1.78	1.69	1.59
Pollen	1.32	1.37	1.42	1.49	1.61	1.54	1.46
Soya flour	1.41	1.45	1.51	1.58	1.71	1.63	1.55
Horse gram	1.36	1.38	1.41	1.43	1.58	1.47	1.44
Red gram	1.31	1.35	1.39	1.47	1.57	1.52	1.44
Distilled water	1.29	1.31	1.34	1.37	1.42	1.39	1.35
Control	1.27	1.31	1.33	1.35	1.39	1.37	1.34
Mean	1.33	1.37	1.41	1.46	1.56	1.50	1.44
F value	SEd			CD (0.05)			
	T= 0.03			T= 0.05**			
	C= 0.02			C= 0.04**			
	TC= 0.07			TC= 0.13*			

T-Treatment, C-Concentration, * Significant, ** Highly significant

Table 3: Effect of different honey and protein sources on shell weight (g) of silkworm

Treatments	Concentrations						
	1%	2%	3%	4%	5%	6%	Mean
<i>A. cerana</i>	0.268	0.273	0.279	0.283	0.309	0.292	0.284
<i>A. florea</i>	0.275	0.284	0.291	0.299	0.319	0.307	0.296
<i>A. mellifera</i>	0.283	0.294	0.305	0.314	0.331	0.320	0.308
<i>A. dorsata</i>	0.296	0.312	0.329	0.337	0.356	0.348	0.330
<i>T. iridipennis</i>	0.348	0.357	0.369	0.378	0.393	0.387	0.372
Pollen	0.271	0.283	0.289	0.295	0.313	0.298	0.292
Soya flour	0.325	0.338	0.347	0.356	0.372	0.361	0.350
Horse gram	0.301	0.312	0.323	0.329	0.343	0.331	0.323
Red gram	0.312	0.323	0.331	0.339	0.354	0.347	0.334
Distilled water	0.253	0.258	0.261	0.265	0.273	0.269	0.263
Control	0.243	0.251	0.257	0.261	0.268	0.263	0.257
Mean	0.289	0.299	0.301	0.314	0.330	0.320	0.310
F value	SEd			CD (0.05)			
	T= 0.005			T= 0.013*			
	C= 0.004			C= 0.008**			
	TC= 0.013			TC= 0.025*			

T-Treatment, C-Concentration, * Significant, ** Highly significant

Table 4: Effect of different honey and protein sources on shell ratio (%) of silkworm

Treatments	Concentrations						
	1%	2%	3%	4%	5%	6%	Mean
<i>A. cerana</i>	20.94	20.84	20.98	21.12	22.07	21.77	21.29
<i>A. florea</i>	20.99	20.88	20.64	20.62	21.41	20.88	20.90
<i>A. mellifera</i>	21.44	21.78	21.48	21.36	20.82	20.92	21.30
<i>A. dorsata</i>	21.76	22.45	23.01	22.77	21.97	22.45	22.40
<i>T. iridipennis</i>	24.51	24.12	23.96	23.19	22.01	22.89	23.46
Pollen	20.53	20.66	20.35	19.80	19.44	19.35	20.02
Soya flour	23.05	23.31	22.98	22.53	21.75	22.15	22.63
Horse gram	22.13	22.61	22.91	23.01	21.71	22.52	22.48
Red gram	23.82	23.92	23.81	23.06	22.55	22.83	23.33
Distilled water	19.61	19.69	19.48	19.34	19.22	19.35	19.45
Control	19.13	19.16	19.32	19.33	19.28	19.19	19.24
Mean	21.63	21.77	21.72	21.47	21.11	21.30	21.50
F value	SEd			CD (0.05)			
	T= 0.39			T= 0.78*			
	C= 0.29			C= 0.57*			
	TC= 0.96			TC= 1.90*			

T-Treatment, C-Concentration, * Significant, ** Highly significant

Table 5: Effect of different honey and protein sources on filament length (m) of silkworm

Treatments	Concentrations						
	1%	2%	3%	4%	5%	6%	Mean
<i>A. cerana</i>	1214.35	1214.98	1223.15	1228.23	1243.91	1241.15	1214.35
<i>A. florea</i>	1235.13	1236.28	1238.37	1240.25	1265.38	1262.51	1235.13
<i>A. mellifera</i>	1273.40	1274.41	1276.71	1276.51	1293.17	1281.49	1273.40
<i>A. dorsata</i>	1278.38	1278.37	1279.31	1280.10	1294.45	1281.31	1278.38
<i>T. iridipennis</i>	1312.15	1312.31	1329.31	1333.71	1350.76	1334.35	1312.15
Pollen	1251.31	1252.16	1252.23	1254.78	1257.12	1256.13	1251.31
Soya flour	1321.15	1323.25	1324.23	1328.15	1331.46	1328.89	1321.15
Horse gram	1262.37	1264.15	1265.13	1267.28	1269.25	1268.31	1262.37
Red gram	1237.19	1238.45	1239.35	1240.78	1257.31	1241.70	1237.19
Distilled water	1233.15	1234.78	1235.67	1237.19	1241.36	1238.54	1233.15
Control	1198.75	1199.36	1203.82	1204.69	1210.59	1207.95	1198.75
Mean	1256.12	1257.14	1260.66	1262.88	1274.07	1267.48	1256.12
F value	SEd			CD (0.05)			
	T= 20.27			T= 40.11**			
	C= 14.97			C= 29.62**			
	TC= 49.66			TC= 98.24*			

Treatment, C-Concentration, * Significant, ** Highly significant

4. Conclusion

It is crystal clear from the observations of present study that supplementation of silkworm with different honey and protein sources significantly enhanced the economic traits of *B. mori*. Among the different sources and concentrations tested, it was revealed that *T. iridipennis* honey at 5 % showed superior performance in improving the growth, development as well as the economic traits.

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