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Effect of Standardized Feed Additives on Rearing Parameters of Mulberry Silkworm Hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi)

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Abstract

An experiment was carried out to assess the effect of standardized feed additives on rearing parameters of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). The results revealed that maximum weight of fourth instar (2.380 g, 2.360 g ; 2.360 g, 2.330 g) and fifth instar (3.906 g, 3.890 g ; 3.670 g, 3.633 g), effective rate of rearing (91.70, 91.57, 94.70, 94.62%), lower percentage disease incidence (6.26, 6.37 ; 3.60, 3.63), shorter fourth (4.19, 4.22 ; 4.14, 4.16 days/h), fifth instar larval duration (7.03, 7.05. 7.01, 7.03 days/h) and hence shorter total larval duration (28.05, 28.07, 27.08, 27.11 days/h) were registered in $H_1D_1FA_4$, $H_1D_2FA_4$, $H_2D_1FA_4$ and $H_2D_2FA_4$, respectively with horse gram + grain amaranthus flour (50 : 50) feed additive application daily once and alternate day application from fourth instar up to spinning in both hybrids.

Key words : Silkworm hybrids, Horse gram, Grain amaranthus, Larval weight, Larval duration.

Sericulture as an agro-based industry plays an important role in transformation of Indian rural economy since it assures regular employment and periodic returns all round the year, improving the socio-economic status of farmers. With the development of new technologies in mulberry cultivation and silkworm rearing, sericulture has now emerged as a sustainable indispensable profession and cash crop for the rural folk of the country. In recent years, many attempts were made either to fortify the leaves with nutrients, spraying with antibiotics, juvenile hormone, plant products with JH-mimic principles, anti juvenile hormones or dusting with botanicals, extra foliation of mulberry leaves with sugars, hormones, food additives, protein rich flours, so as to imporve the quality and quantity of silk. Under Indian conditions, particularly in Karnataka, a schedule with feed additives is needed which will perhaps play a vital role in the development of silkworm, *Bombyx mori* L. Hence, the present investigation was conducted using two silkworm hybrids ($CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$) and two feeding schedules.

Methods

The popular bivoltine silkworm hybrid $CSR_2 \times CSR_4$ and a new multi × bi hybrid $ND_7 \times CSR_2$ (Jayalakshmi) was experimented with mulberry leaves of V_1 variety harvested from irrigated garden, and supplemented individually in combination by dusting with nine flours ; and simultaneously maintaining an unsupplemented control. Individual measuring cups and plastic sieves were utilized for each feed additive treatment. Bulk rearing of both hybrids was done upto third moult and late age worms were separated to cater to two feeding schedules with feed additive treatments. The flours of 5 g/10 g of each of the feed additives were weighed and placed separately in plastic measuring cups and level was marked in each cup with inerasable ink.

The feed additive application was through marked measuring cups, ensuring that the flours were sieved (150 μ), and dusted on mulberry shoots at 5 g/ 10 g per kg of shoots based on marked levels of measuring cups to simplify application and fed to silkworm hybrids ($CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$) by dusting with plastic sieves during late age. There were two batches in the schedule of feed additive application. Leaves dusted with the feed additives was provided once daily during fourth instar till spinning. In the second batch, feed additives were provided once every alternate day from fourth instar till spinning. In both batches however, the remaining two feeds/day

Table 1. Influence of feed additives on fourth instar larval weight (g) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$, H_2 : $ND_7 \times CSR_2$ (Jayalakshmi), D_1 : Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H_1 D_1	H_1 D_2	H_2 D_1	H_2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	2.210	2.186	2.150	2.120	2.166
FA_2 : Horse gram flour (100%)	2.196	2.170	2.103	2.080	2.137
FA_3 : Ragi flour + horse gram flour (50 : 50%)	2.310	2.290	2.250	2.226	2.269
FA_4 : Horse gram flour + Grain amaranthus flour (50 : 50%)	2.380	2.360	2.360	2.330	2.357
FA_5 : Fine mesh Ragi flour + 20% Activated Horse gram flour (50 : 50%)	2.243	2.230	2.166	2.133	2.193
FA_6 : 80% Activated Horse gram regular flour + 20% Ragi regular flour	2.336	2.310	2.283	2.256	2.296
FA_7 : 80% Fine mesh ragi flour + 20% Activated horse gram fine mesh flour	2.263	2.253	2.196	2.153	2.216
FA_8 : CFTRI mixture (100%)	2.360	2.336	2.326	2.283	2.326
FA_9 : Activated green gram flour (100%)	2.290	2.270	2.230	2.350	2.285
FA_{10} : Control/Unsupplemented	2.081		2.058		2.069
F-Test		*			*
SE ±		0.050			0.014
CD at 5%		0.080			0.040

were normal (unsupplemented). To keep the bed dry and to facilitate easy moulting, feeding was resumed half an hour later after dusting bed disinfectant (Resham Jyothi), when more than 95% of the worms were out of moult (1). To ascertain the effect of standardized feed additives on rearing parameters, the following observations viz., fourth and fifth instar larval weight (initial and terminal), disease incidence, effective rate of rearing, fourth and fifth instar larval duration and total larval duration were recorded during rearing period. The data were analyzed statistically using three way factorial CRD (completely randomized design) (2).

Results and Discussion

The late age silkworm hybrids, $CSR_2 \times CSR_4$ and

Table 2. Influence of feed additives on fifth instar larval weight (g) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$, H_2 : $ND_7 \times CSR_2$(Jayalakshmi), D_1: Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H_1 D_1	H_1 D_2	H_2 D_1	H_2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	3.723	3.696	3.496	3.473	3.597
FA_2 : Horse gram flour (100%)	3.703	3.676	3.473	3.443	3.573
FA_3 : Ragi flour + Horse gram flour (50 : 50%)	3.806	3.790	3.586	3.556	3.684
FA_4 : Horse gram flour + Grain amaranthus flour (50 : 50%)	3.906	3.890	3.670	3.633	3.774
FA_5 : Fine mesh ragi flour + 20% Activated horse gram flour (50 : 50%)	3.746	3.713	3.526	3.490	3.618
FA_6 : 80% Activated horse gram regular flour + 20% Ragi regular flour	3.830	3.813	3.606	3.570	3.704
FA_7 : 80% Fine mesh ragi flour + 20% Activated horse gram fine mesh flour	3.766	3.733	3.550	3.510	3.639
FA_8 : CFTRI mixture (100%)	3.873	3.846	3.646	3.596	3.740
FA_9 : Activated green gram flour (100%)	3.790	3.770	3.560	3.543	3.665
FA_{10} : Control/Unsupplemented	3.655		3.380		3.517
F-Test		*			*
SE ±		0.01			0.002
CD at 5%		0.01			0.007

Table 3. Influence of feed additives on ERR (%) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$ H_2 : $ND_7 \times CSR_2$ (Jayalakshmi). D_1 : Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H_1 D_1	H_1 D_2	H_2 D_1	H_2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	87.26	87.16	90.16	90.11	88.67
FA_2 : Horse gram flour (100%)	86.33	84.87	89.36	89.27	87.45
FA_3 : Ragi flour + Horse gram flour (50 : 50%)	90.40	90.32	92.74	92.68	91.53
FA_4 : Horse gram flour + grain amaranthus flour (50 : 50%)	91.70	91.57	94.70	94.62	93.14
FA_5 : Fine mesh Ragi flour + 20% Activated Horse gram floor (50 : 50%)	88.49	88.39	91.28	91.21	89.84
FA_6 : 80% Activated horse gram regular flour + 20% Ragi regular flour	90.78	90.70	93.64	93.56	92.17
FA_7 : 80% Fine mesh ragi flour + 20% Activated horse gram fine mesh flour	89.48	89.38	91.70	93.63	90.54
FA_8 : CFTRI mixture (100%)	91.43	91.35	94.26	94.21	92.81
FA_9 : Activated (green gram flour (100%)	89.70	89.60	92.39	92.33	91.00
FA_{10} : Control/Unsupplemented	84.70		87.34		86.02
F-Test		*			*
SE±		0.37			0.106
CD at 5%		0.60			0.298

$ND_7 \times CSR_2$ (Jayalakshmi) reared on Mulberry leaves with flour combination of feed additives for both feeding schedules viz. daily once and alternate days were accepted and exhibited better larval traits than control (unsupplemented).

Significantly maximum weight of fourth instar (2.380 g, 2.360 g ; 2.360 g, 2.330 g, Table 1) and fifth instar (3.906 g, 3.890 g ; 3.670 g, 3.670 g, 3.633 g, Table 2), effective rate of rearing (91.70, 91.57, 94.70, 94.62%, Table 3), lower percentage disease incidence (6.26, 6.37 ; 3.60, 3.63, Table 4), shorter fourth (4.19, 4.22 ; 4.14, 4.16 days/h Table 5) and fifth instar larval duration (7.03, 7.05 ; 7.01, 703 days/h, Table 6) and hence shorter total larval duration (28.05, 28.07 ; 27.08, 27.11 days/h, Table 7) were registered in $H_1D_1FA_4$, $H_1D_2FA_4$, $H_2D_1FA_4$ and $H_2D_2FA_4$, respectively with horse gram + grain amaranthus flour (50 : 50) feed additive dusting application daily once and alternate day application from fourth instar up to spinning in both tested hybrids.

Table 4. Influence of feed additives on disease incidence (%) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$, H_2 : $ND_7 \times CSR_2$ (Jayalakshmi), D_1 : Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H_1 D_1	H_1 D_2	H_2 D_1	H_2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	10.68	10.75	5.40	5.44	8.06
FA_2 : Horse gram flour (100%)	11.26	11.33	5.57	5.61	8.44
FA_3 : Ragi flour + Horse gram flour (50 : 50%)	7.68	7.72	4.26	4.28	5.98
FA_4 : Horse gram flour + Grain amaranthus flour (50 : 50%)	6.26	6.37	3.60	3.63	4.96
FA_5 : Fine mesh ragi flour + 20% Activated horse gram flour (50 : 50%)	9.26	9.35	5.16	5.22	7.24
FA_6 : 80% Activated horse gram regular flour + 20% Ragi regular flour	7.36	7.39	3.86	3.89	5.62
FA_7 : 80% Fine mesh ragi flour + 20% Activated Horse gram fine mesh flour	8.38	8.44	4.59	4.63	6.51
FA_8 : CFTRI mixture (100%)	6.59	6.67	3.74	3.76	5.19
FA_9 : Activated green gram flour (100%)	8.16	8.22	4.44	4.47	6.32
FA_{10} : Control/Unsupplemented	12.93		6.19		9.56
F-Test		*			*
SE ±		0.030			0.007
CD at 5%		0.040			0.021

Table 5. Influence of feed additives on fourth instar larval duration (days/h) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$, H_2 : $ND_7 \times CSR_2$ (Jayalakshmi), D_1 : Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H_1 D_1	H_1 D_2	H_2 D_1	H_2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	5.16	5.18	5.12	5.15	5.15
FA_2 : Horse gram flour (100%)	5.18	5.20	5.15	5.18	5.17
FA_3 : Ragi flour + Horse gram flour (50 : 50%)	5.06	5.06	4.49	5.05	4.91
FA_4 : Horse gram flour + Grain amaranthus flour (50 : 50%)	4.19	4.22	4.14	4.16	4.18
FA_5 : Fine mesh ragi flour + 20% Activated horse gram flour (50 : 50%)	5.13	5.15	5.10	5.11	5.12
FA_6 : 80% Activated horse gram regular + 20% Ragi regular flour	4.22	5.03	4.20	4.23	4.42
FA_7 : 80% Fine mesh ragi + 20% Activated Horse gram fine mesh flour	5.11	5.13	5.08	5.10	5.10
FA_8 : CFTRI mixture (100%)	4.21	4.23	4.17	4.20	4.20
FA_9 : Activated green gram flour (100%)	5.09	5.10	5.03	5.07	5.07
FA_{10} : Control/Unsupplemented	5.21		5.20		5.21
F-Test		*			*
SE ±		0.070			0.021
CDat 5%		0.120			0.059

However, the next best feed additive was CFTRI mixture in $H_1D_1FA_8$, $H_1D_2FA_8$, $H_2D_1FA_8$ and $H_2D_2FA_8$ over unsupplemented control, with regard to fourth instar larval weight (2.360, 2.336 ; 2.326, 2.283 g, Table 1), fifth instar larval weight (3.873, 3.846 ; 3.646, 3.596 g, Table 2), effective rate of rearing (91.43, 91.35 ; 94.26, 94.21%, Table 3), lower percentage disease incidence (6.59, 6.67 ; 3.74, 3.76, Table 4), shorter fourth instar larval duration (4.21, 4.23, 4.17, 4.20 days/h, Table 5), fifth instar larval duration (7.06, 7.08 ; 7.05, 7.06 days/h, Table 6) and hence also shorter total larval duration (28.15, 28.17 ; 27.16, 27.18 days/h Table7), respectively.

Comparatively inferior larval traits was recorded in unsupplemented control for hybrid $CSR_2 \times CSR_4$ ($H_1D_1FA_{10}$ and $H_1D_2FA_{10}$), in respect of fourth instar larval weight (2.081 g ; 2.058 g Table 1), fifth instar larval weight (3.655 g, 3.380 g Table 2), effective rate of rearing (84.70 per cent ; 87.34 per cent Table 4), percentage disease incidence (12.93 ; 6.19 Table 3), fourth instar larval duration (5.21 days/h ; 5.20 days/h Table 5) and fifth instar larval duration (9.06 days/h ; 9.04 days/h Table 6) and hence also total larval duration (30.18, 29.17 days/h, Table 7), respectively followed by hybrid jayalakshmi ($H_2D_1FA_{10}$ and $H_2D_2FA_{10}$).

Table 6. Influence of feed additives on fifth instar larval duration (days/h) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$, H_2 : $ND_7 \times CSR_2$ (Jayalakshmi), D_1 : Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H_1 D_1	H_1 D_2	H_2 D_1	H_2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	8.16	8.18	8.10	8.14	8.15
FA_2 : Horse gram flour (100%)	8.20	8.20	8.15	8.18	8.18
FA_3 : Ragi flour + Horse gram flour (50 : 50%)	7.16	7.19	7.12	7.14	7.15
FA_4 : Horse gram flour + Grain amaranthus flour (50 : 50%)	7.03	7.05	7.01	7.03	7.03
FA_5 : Fine mesh ragi flour + 20% Activated Horse gram flour (50 : 50%)	8.12	8.13	8.04	8.06	8.09
FA_6 : 80% Activated horse gram regular flour + 20% Ragi regular flour	7.11	7.13	7.08	7.10	7.11
FA_7 : 80% Fine mesh ragi flour + 20% Activated Horse gram fine mesh flour	8.08	8.11	7.20	7.21	7.65
FA_8 : CFTRI mixture (100%)	7.06	7.08	7.05	7.06	7.06
FA_9 : Activated green gram flour (100%)	8.04	8.09	7.15	7.18	7.61
FA_{10} : Control/Unsupplemented	9.06		9.04		9.05
F-Test		*			*
SE ±		0.020			0.005
CDat 5%		0.030			0.013

Table 7. Influence of feed additives on total larval duration (dys/h) of mulberry silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi). H_1 : $CSR_2 \times CSR_4$, H_2 : $ND_7 \times CSR_2$ (Jayalakshmi), D_1 : Daily once, D_2 : Alternate day.

Feed additive treatments	Hybrids H1 D_1	H1 D_2	H2 D_1	H2 D_2	Feed additive mean
FA_1 : Ragi flour (100%)	29.79	30.10	28.47	28.49	29.21
FA_2 : Horse gram flour (100%)	30.13	30.15	29.07	29.09	29.61
FA_3 : Ragi flour + Horse gram flour (50 : 50%)	29.07	29.10	28.05	28.07	28.57
FA_4 : Horse gram flour + Grain amaranthus flour (50 : 50%)	28.05	28.07	27.08	27.11	27.57
FA_5 : Fine mesh ragi flour + 20% Activated horse gram flour (50 : 50%)	29.20	29.22	28.17	28.19	28.69
FA_6 : 80% Activated horse gram regular flour + 20% Ragi regular flour	28.18	28.21	27.21	27.22	27.70
FA_7 : 80% Fine mesh ragi flour + 20% Activated Horse gram fine mesh flour	29.19	29.20	28.15	28.17	28.67
FA_8 : CFTRI mixture (100%)	28.15	28.17	27.16	27.18	27.66
FA_9 : Activated green gram flour (100%)	29.13	29.15	28.11	28.13	28.63
FA_{10}: Control/Unsupplemented	30.18		29.17		29.67
F-Test		*			*
SE ±		0.13			0.037
CD at 5%		0.21			0.104

This response might be due to the reason that nutrient status of cultivated mulberry leaves improved by value addition through supplementation of horse gram + grain amaranthus flour (50 : 50) and followed by CFTRI mixture application with two feeding schedules (daily once and alternate day) have stimulated larvae to accept feed additive along with mulberry leaves. The protein content of cultivated and harvested mulberry leaves (V_1 variety) was estimated to 22.22%. Horse gram and grain amaranthus are rich source of protein, fat, minerals and carbohydrate. Similarly, CFTRI mixture has rich source of protein (35%) which act as building blocks of tissues making them robust and thus impart healthiness to larvae due to better growth and development on account of nutritious feed provided.

D-form of carbohydrates and dietary sterols act as gustatory feeding stimulants (3, 4). There are reports of soybean protein supplementation (5), sericare supplementation (6) and use of defatted soy bean (7) indicating increased effective rate of rearing.

Similar increase in larval characters was observed due to increased protein through mulberry leaves supplemented with soybean flour (8—10). The present findings are in tune with observation of Nagesh (6), who observed increased larval weight when reared with sericare and Sundar Raj et al. (11) who observed increased mature larval weight with defatted soybean flour supplementation. The present findings are supported by earlier works (12—14) who reported that three was no significant improvement in total larval duration due to fortified Mulberry leaves.

The present findings are in agreement with the findings of Rekha (15) reported that $CSR_2 \times CSR_4$ reared on leaves supplemented with soybean was at par with horse gram flour and green gram flour supplementation which gave 3.870 g of larval weight. Several factors might have influenced the silkworm hybrids, $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ experimented in present study in gaining enhancement for all larval traits with horse gram + grain amaranthus fortification and CFRTI mixture. Recently, similar increase in larval traits of $CSR_2 \times CSR_2$ and $PM \times CSR_2$ worms reared on leaves supplemented with 80% fine mesh ragi flour + 20% activated horse gram fine mesh flour was reported by Vanitha et al. (16). However, Neelu Nangia et al. (17) reported the consumption indicies of $PM \times CSR_2$ and $CSR_2 \times CSR_4$ both on fresh and dry weight basis with horse gram flour supplementation was at par with values of supplementation with flour of soybean on M_5 mulberry variety. Similarly, Neelu Nangia et al. (18) reported enhanced productivity parameters with two popular silkworm hybrids and suggested ragi flour and horse gram flour as alternative feed additives with mulberry variety Kanva-2 or M_5

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