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IMPACT OF STANDARDIZED FEED ADDITIVES ON REELING TRAITS OF MULBERRY SILKWORM HYBRIDS $CSR_2 \times CSR_4$ AND $ND_7 \times CSR_2$ (JAYALAKSHMI)

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ABSTRACT

Among nine different flours of feed additives tested the silkworm hybrids $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi) in combination of Horse gram + Grain Amaranthus flour (50 : 50) recorded significantly maximum reeling traits, viz., higher per cent raw silk recovery (21.45, 21.41; 15.55, 15.48), per cent neatness (95.58,95.51; 91.25, 91.17), per cent cleanliness (97.45,97.36; 96.13, 96.05), lower sericin per cent (20.23, 20.38 p; 22.23, 22.29) and higher fibroin per cent (79.75, 79.61; 77.76, 77.69) respectively, when provided from fourth instar up to spinning in both hybrids.

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INTRODUCTION

Leaves of mulberry, *Morus alba* L. are the only food of mulberry silkworm, *Bombyx mori* L. Literature reveals that overall lower productivity and partial or total crop failures mainly at late instars are many times attributed to poor leaf quality. It becomes necessary to improve nutritive value of mulberry leaves, which influences growth and development of the silkworm, *Bombyx mori* L. Several researchers have conducted experiments on nutritional aspects and have proved that there is a great scope for utilizing enhanced nutrition for exploitation of the silkworm so as to improve the quantity and quality of silk output. One way of improving the cocoon yield is through achieving an increase in larval weight by enriching the feed of silkworm by supplementing mulberry leaves with extra nutrients. One of the effective methods to enrich the leaves is to supplement them with feed additives that are locally available. Further, if the feed additives enhance silk productivity, then its impact on the reeling parameters is a must. Hence the investigation was undertaken to assess the impact of feed additives on selected reeling tests.

MATERIALS AND METHODS

Mulberry silkworm hybrids, $CSR_2 \times CSR_4$ and $ND_7 \times CSR_2$ (Jayalakshmi) were reared at Main Research Station, Hebbal, Bangalore. Mulberry leaves of V_1, harvested from irrigated garden were supplemented individually or in combination with nine different flours in appropriate ratio, also maintaining unsupplemented control. Individual measuring cups and plastic sieves were utilized for each feed additive treatment. Bulk silkworm rearing was done upto third moult and then worms were separated to follow two feeding schedules with feed additive treatments. The feed additive flours of 5 g/10 g per kg of shoot were weighed and placed in plastic measuring cups. Feed additive application was through measuring cups having ensured that the flours were sieved (150 µ) and then dusted by plastic sieves on mulberry shoots @ 5 g/10 g per kg of shoots

and fed to silkworm hybrids (CSR_2×CSR_4 and ND_7×CSR_2) during late age. There were two batches in the schedule of feed additive application. Leaves dusted with the feed additives were provided once daily in one batch 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 were normal (unsupplemented). In order to keep the bed dry and to facilitate for easy moulting, feeding was resumed half an hour later after dusting bed disinfectant (Resham Jyothi), when more than 95 per cent of the worms were out of moult (Dandin *et al*., 2014). The reeling parameters data were analyzed statistically using three way factorial CRD (Completely Randomized Design).

RESULTS

The late age silkworm hybrids, CSR_2 x CSR_4 and ND_7 × CSR_2 (Jayalakshmi) reared on Mulberry leaves with flour

Table 1. Influence of feed additives on raw silk recovery (%) and neatness (%) of Mulberry silkworm hybrids CSR_2 × CSR_4 and ND_7 × CSR_2 (Jayalakshmi)

Feed additive treatments	Hybrids								Feed additive mean	
	H_1				H_2					
	Raw silk recovery		Neatness		Raw silk recovery		Neatness		Raw silk recovery	Neatness
	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2		
FA_1: Ragi flour (100 %)	19.59	19.49	93.70	93.62	14.58	14.45	87.68	87.57	17.02	90.64
FA_2: Horse gram flour (100 %)	19.47	19.39	93.38	93.27	14.25	14.18	87.35	87.32	16.82	90.33
FA_3: Ragi flour + Horse gram flour (50 : 50 %)	21.08	21.00	94.82	94.72	15.27	15.19	89.91	89.85	18.13	92.32
FA_4: Horse gram flour + Grain Amaranthus flour (50 : 50 %)	21.45	21.41	95.58	95.51	15.55	15.48	91.25	91.17	18.47	93.37
FA_5: Fine mesh Ragi flour + 20 % Activated Horse gram flour (50 : 50 %)	19.70	19.63	93.86	93.77	14.76	14.64	88.38	88.28	17.18	91.07
FA_6: 80 % Activated Horse gram regular flour + 20 % Ragi regular flour	21.16	21.08	95.20	95.13	15.38	15.32	90.18	90.11	18.23	92.65
FA_7: 80 % Fine mesh Ragi flour + 20 % Activated Horse gram fine mesh flour	19.85	19.76	94.32	94.22	14.90	14.82	88.66	88.52	17.33	91.43
FA_8: CFTRI mixture (100 %)	21.37	21.30	95.43	95.36	15.46	15.29	90.44	90.35	18.35	92.89
FA_9: Activated Green gram flour (100 %)	19.95	19.86	94.67	94.58	15.14	15.03	89.66	89.54	17.49	92.11
FA_{10}:Control / Unsupplemented	19.32		92.18		13.70		86.37		16.51	89.27
F-Test			*		*				*	*
S.Em ±			0.03		0.05				0.08	0.014
CD at 5 %			0.05		0.08				0.023	0.039

Note: H_1: CSR_2 × CSR_4 H_2: ND_7 × CSR_2 (Jayalakshmi) D_1: Daily once D_2: Alternate day

Table 2. Influence of feed additives on cleaness (%) of Mulberry silkworm hybrids CSR_2 × CSR_4 and ND_7 × CSR_2 (Jayalakshmi)

Feed additive treatments	Hybrids				Feed additive mean
	H_1		H_2		
	D_1	D_2	D_1	D_2	
FA_1: Ragi flour (100 %)	94.28	93.86	92.36	92.07	93.14
FA_2: Horse gram flour (100 %)	93.75	93.65	91.64	91.48	92.63
FA_3: Ragi flour + Horse gram flour (50 : 50 %)	96.39	96.28	94.66	94.53	95.46
FA_4: Horse gram flour + Grain Amaranthus flour (50 : 50 %)	97.45	97.36	96.13	96.05	96.74
FA_5: Fine mesh Ragi flour + 20 % Activated Horse gram flour (50 : 50 %)	94.49	94.39	93.50	93.42	93.95
FA_6: 80 % Activated Horse gram regular flour + 20 % Ragi regular flour	96.76	96.69	95.46	95.34	96.06
FA_7: 80 % Fine mesh Ragi flour + 20 % Activated Horse gram fine mesh flour	95.34	95.25	93.72	93.63	94.48
FA_8: CFTRI mixture (100 %)	97.22	97.13	95.82	95.70	96.46
FA_9: Activated Green gram flour (100 %)	95.74	95.65	94.36	94.25	95.00
FA_{10}:Control / Unsupplemented	92.68		90.59		91.64
F-Test		*			*
S.Em ±		0.08			0.023
CD at 5 %		0.013			0.064

Note: H_1: CSR_2 × CSR_4 H_2: ND_7 × CSR_2 (Jayalakshmi) D_1: Daily once D_2: Alternate day

Table 3. Influence of feed additives on sericin and fibroin content (%) of Mulberry silkworm hybrids CSR_2 × CSR_4 and ND_7 × CSR_2 (Jayalakshmi)

Feed additive treatments	Hybrids								Feed additive mean	
	H_1				H_2					
	Sericin content		Fibroin content		Sericin content		Fibroin content		Sericin content	Fibroin content
	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2		
FA_1: Ragi flour (100 %)	24.20	24.60	75.80	75.39	25.33	25.41	74.65	74.58	24.88	75.10
FA_2: Horse gram flour (100 %)	24.47	24.68	75.52	75.31	25.45	25.53	74.53	74.45	25.03	74.95
FA_3: Ragi flour + Horse gram flour (50 : 50 %)	21.64	21.73	78.34	78.26	23.50	23.50	76.55	76.48	22.59	77.40
FA_4: Horse gram flour + Grain Amaranthus flour (50 : 50 %)	20.23	20.38	79.75	79.61	22.23	22.29	77.76	77.69	21.28	78.70
FA_5: Fine mesh Ragi flour + 20 % Activated Horse gram flour (50 : 50 %)	23.16	23.21	76.82	76.77	25.17	25.21	74.81	74.77	24.19	75.79
FA_6: 80 % Activated Horse gram regular flour + 20 % Ragi regular flour	21.26	21.40	78.72	78.58	23.25	23.35	76.74	76.63	22.31	77.66
FA_7: 80 % Fine mesh Ragi flour + 20 % Activated Horse gram fine mesh flour	22.53	22.59	77.44	77.40	24.40	24.47	75.58	75.51	23.50	76.48
FA_8: CFTRI mixture (100 %)	20.59	20.68	79.39	79.30	22.41	22.47	77.57	77.51	21.54	78.44
FA_9: Activated Green gram flour (100 %)	22.33	22.39	77.66	77.60	24.28	24.34	75.71	75.64	23.33	76.65
FA_{10}:Control / Unsupplemented	24.73		75.26		25.60		74.38		25.60	74.82
F-Test			*		*				*	*
S.Em ±			0.050		0.04				0.014	0.011
CD at 5 %			0.080		0.06				0.038	0.032

Note: H_1: CSR_2 × CSR_4 H_2: ND_7 × CSR_2 (Jayalakshmi) D_1: Daily once D_2: Alternate day

combination of feed additives for both feeding schedules viz., daily once and alternate days were accepted and exhibited better reeling parameters than control (unsupplemented). Significantly higher per cent raw silk recovery (21.45, 21.41; 15.55, 15.48 Table 1), per cent neatness (95.58, 95.51; 91.25, 91.17 Table 1), per cent cleanliness (97.45, 97.36; 96.13, 96.05 Table 2), lower sericin per cent (20.23, 20.38 p; 22.23, 22.29 Table 3) and higher fibroin per cent (79.75, 79.61; 77.76, 77.69 Table 3) was 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 per cent) feed additive application daily once and alternate day application from fourth instar up to spinning in both hybrids. 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, in respect of per cent raw silk recovery (21.37, 21.30; 15.46, 15.29 Table 1), per cent neatness (95.43, 95.36; 90.44, 90.35 Table 1), per cent cleanliness (97.22, 97.13; 95.82, 95.70 Table 2), lower sericin per cent (20.59, 20.68; 22.41, 22.47 Table 3) and higher fibroin per cent (79.39, 79.30; 77.57, 7.51 Table 3), respectively. Comparatively, minimum reeling 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 cocoon yield (19.32; 13.70 Table 1), per cent neatness (92.18; 86.37 Table 1), per cent cleanliness (92.68; 90.59 Table 2), lower sericin per cent (24.73; 25.60 Table 3) and higher fibroin per cent (75.26; 74.38 Table 3), respectively followed by hybrid Jayalakshmi ($H_2D_1FA_{10}$ and $H_2D_2FA_{10}$).

DISCUSSION

Nutrient status of mulberry leaves was improved by value addition through supplementation of Horse gram + Grain Amaranthus flours and separately CFTRI mixture by any of the two feeding schedules (daily once and alternate day) might have encouraged the larvae to accept the feed additives along with mulberry leaves and thereby enhancing the reeling parameters. The protein content of mulberry leaves (V_1 variety) estimated to be 22.20 per cent. Horse gram and Grain Amaranthus as well as CFTRI mixture is a rich source of protein, fat, minerals and carbohydrate. Combination of Horse gram + Grain Amaranthus and separately CFTRI mixture gave significant reduction in sericin content of silk filament and enhanced the reeling parameters than control among four different feed fortificants offered to the silkworm. This is attributed to variable assimilation of protein in the body of silkworm and there might have been reduction in sericin protein biosynthesis in middle silk gland. The feed fortificants namely Horse gram + Grain Amaranthus and CFTRI mixture being nutritionally rich in protein might have been assimilated and stored in the body during the late age. During ripening, the breakdown of these body reserves might have enhanced the potential of fibroin synthesis in posterior silk gland. Structure of fibroin consists of two models, one consists of a single chain in which crystalline region alternate with amorphous region and the second is a multi chain structure in which at least two separate polypeptide chains are joined by special covalent bonds such as ester bonds (Tazima, 1978), which does not get altered by cooking or reeling process as it is not water soluble. Higher fibroin content of silk is an advantage in the reeling industry.

Increased fibroin content and enhanced reeling traits with supplementation of cereal flour has been documented by Ganga and Gowri (1990) while Seenivasagaperumal *et al*. (1994) reported similar trend with supplementation of soybean flour and one per cent crude termite extract. Subburathinam *et al*. (1990) reported similar trend on magnesium chloride supplementation. Similarly, Nagesh (1998) and Sundar Raj (1998) recorded finer reeling traits on mulberry leaves supplemented with 'sericare' and cereal flour. Rekha (2004) reported increased fibroin content and cocoon parameters as compared to unsupplemented control with supplementation of pulse flour. The present findings are in agreement with the recent findings of Vanitha *et al*. (2006a and 2006b) who reported reduction in sericin content, higher fibroin content and better reeling characters with 80 per cent fine mesh Ragi flour + 20 per cent activated Horse gram fine mesh flour supplemented from fourth instar upto spinning in hybrid CSR_2 x CSR_4 as compared to unsupplemented control. From the present investigation, practicing shoot feeding with the feed additive flour combination of Horse gram + Grain amaranthus applied in equal quantities during late age enhances all reeling traits of bi × bivoltine (CSR_2 x CSR_4) and multi × bivoltine hybrid (ND_7 × CSR_2), which are desirable in the sericulture industry.

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