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EFFECT OF BAST FIBRE CROPS AND THEIR BIOCHEMICALS ON NUTRITIONAL INDICES OF *SPILOSOMA OBLIQUA* (WALKER)

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ABSTRACT

This study is on the nutritional efficiency of the host plants viz., *Corchorus olitorius*, *C. capsularis*, *Hibiscus cannabinus*, *H. sabdariffa*, *Crotoloria juncea* and *Boemheria nivea* and their biochemical influences on Bihar hairy caterpillar *Spilosoma obliqua* (Walker) (Lepidoptera: Arctiidae). The results revealed that the nutritional and biochemical parameters varied significantly with the infested and uninfested host plants. The growth rate of 5th instar larvae varied from 13.06 mg/ day in *B. nivea* to 17.90 mg/ day in *C. olitorius*; it was 14.80 ± 0.69, 16.74 ± 0.74, 14.94 ± 0.29 and 15.06 ± 0.26 mg/ day on *C. capsularis, H. cannabinus, H. sabdariffa*, *C. juncea* and *B. nivea*, respectively. Thus, *C. olitorius* appeared to be the most suitable food source for growth and development of *S. obliqua*. Peroxidase and polyphenol oxidase were elicited by the infestation of *S. obliqua* indicating their role in insect defence. Higher phenol and peroxidase content in the host plants adversely affected the food utilization indices. This is the possible explanation for variation in food consumption and development of *S. obliqua;* and it might be due to significant differences in the biochemical contents of the evaluated bast fibre crops.

Key words: *Spilosoma obliqua*, *Corchorus olitorius*, *C. capsularis*, *Hibiscus cannabinus*, *H. sabdariffa*, *Crotoloria juncea*, *Boemheria nivea*, nutritional indices, biochemical contents, insect defence, food utilization

There are different species of jute and allied fibre crops but bast fibre crops are the most important textile fibre next to cotton. Bihar hairy caterpillar, *Spilosoma obliqua* (Walker) (Lepidoptera: Arctiidae) is a polyphagous pest attacking several crops including bast fibre crops viz*.,* tossa jute, *Corchorus olitorius*; white jute, *C. capsularis*; mesta, *Hibiscus sabdariffa* and *H. cannabinus*; sunnhemp, *Crotolaria juncea*; ramie, *Boehmeria nivea* and flax, *Linum usitatissimum* (Gupta and Bhattacharya, 2008; Sarkar et al., 2015; Selvaraj et al., 2015). This was once considered as a sporadic and irregular pest (Dutta, 1958), but now becomes a regular and major pest (Satpathy et al., 2013). *Corchorus olitorius* is more susceptible to *S. obliqua* than *C. capsularis* (Pandit, 1985), and jute is a more preferred host than mesta. The young larvae feed gregariously and scrap the chlorophyll content and later they disperse to the entire field and defoliate the entire plant. The third and fourth instar stages feed voraciously often completely skeletonizes the plant. The infestation besides having a direct adverse effect on yield also affects the quality of fibre. In recent years, outbreaks of this pest had been noticed during 2011 in jute, 2012 in sunnhemp and in 2015 in flax crop (Satpathy et al., 2013; Selvaraj et al., 2015).

The role of host plants especially food limitation is an important factor in regulating insect populations as the life cycle characteristics of herbivores may be affected by variation in host plant traits. The response of insect herbivores to changes in host plant quality is different according to food sources (Awmack and Leather, 2002). The variation in host plants and food quality among host plants would help to better understand the mechanism of host suitability. Quality and quantity of host plants could affect growth rate and population dynamics of insects (Slansky and Scriber, 1985; Rossiter, 1991; Ruan and Wu, 2001). There have been a number of studies on the biological parameters of *S. obliqua* on different host plants under different environmental conditions particularly in India (Prasad and Premchand, 1980; Deshmukh et al., 1982; Srivastava and Pandey, 1987; Dhaliwal et al., 1988). Yet, there are no comparative studies on the effect of bast fibre crops on nutritional indices against *S. obliqua*. The feeding of insects on plants induces biochemical and physiological changes in the host plants, affecting the life processes of host plants (Gomez et al., 2004). Plant respond to changes associated with insect feeding through various morphological, biochemical and molecular mechanisms. The defensive compounds are either produced constitutively or in response to plant damage and affect feeding, growth and survival of insects (War et al., 2012). Hence, the present study- to examine the six bast fibre crops and their differential level of biochemical contents on food utilization indices by the larvae of *S. obliqua* to determine the true value of each plant species as host; and to understand the influences of biochemical constituents that occurs in the host plants after infestation by *S. obliqua*.

MATERIALS AND METHODS

The experiment was conducted on six host plant species in the laboratory of Crop Protection Division of ICAR-Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore (88^{0}26'E, 22^{0}45'N), Kolkata, West Bengal. The seeds were procured from seed bank of ICAR-CRIJAF and sown in earthen pots (37.5cm upper radius × 27 cm height) which filled with farm yard manure and soil at 1:3 ratios. Host plants are maintained as per the standard agronomic package of practices to raise healthy crops with recommended fertilizer (60: 30: 30 NPK/ ha.) with natural light conditions. Healthy plants of these crops were maintained under insecticide free conditions. Similarly, the host culture *S. obliqua* was maintained in the laboratory on jute plant and neonate larvae were used in this experiment.

To study the indices based on consumption and utilization of food, respective host plants were obtained during 60-90 days old host plant leaves and placed in 30 plastic rearing jar (13x 13 cm) after recording their fresh weight. Preweighed 3 hr starved five neonate larvae were released in each rearing jar. Larval feeding on leaves, the weights of larvae and the uneaten food were observed at 24 hr interval up to pupation. These jars were maintained in incubator (25± 2^{o}C, 85% RH, 12 L: 12D light). The growth and development was monitored regularly and the larval faeces were collected in individual rearing jar. The uneaten food, *S. obliqua* larvae and the faeces were dried in a hot air oven at 55°C for three days, and their dry weights were recorded. The experiment was replicated five times in a randomized block design under laboratory conditions. Various indices of food consumption and utilization were calculated as proposed by Waldbauer (1968).

The variability in nutritional quality of host species was estimated by subjecting the uninfested and *S. obliqua* infested leaves to standard biochemical analysis such as polyphenol oxidase (Augustin et al., 1985), peroxidase (modified Summer and Gjessing, 1943), total phenols (Bray and Thorpe, 1954) and protein content (Lowry et al., 1951). Two weeks after the release of *S. obliqua*, leaves were taken for estimation. Similarly, for the estimation of biochemical contents of healthy leaves, samples were collected from 50-70 days old host plant as the peak infestation of pest collected and replicated 10 times. The data obtained on food utilization indices of *S. obliqua* and biochemical analysis of host plant leaves were subjected to one-way ANOVA. The biochemical contents were subjected to % changes (decrease or increase) in the infested and healthy leaves and analysed. Means of each variable were separated by using the least significant difference test at α=0.05.

RESULTS AND DISCUSSION

Food utilization efficiency

The food utilization efficiency of *S. obliqua* varied significantly in terms of growth parameters such as growth rate, consumption rate, relative growth rate, consumption index on six bast fibre crops. The quality of host plant is associated with herbivore suitability including physical attributes, allele chemicals and/ or nutritional composition (Mattson and Scriber, 1987; Hasan and Ansari, 2010). The growth rate (GR) of 5th instar larvae varied from 13.06 mg/ day in *B. nivea* to 17.90 mg/ day in *C. olitorius* (Table 1). The growth rate was 14.80± 0.69, 16.74± 0.74, 14.94± 0.29 and 15.06± 0.26 mg/ day on *C. capsularis, H. cannabinus, H. sabdariffa*, *C. juncea* and *B. nivea,* respectively. The role of host plant is an important factor in regulating the insect populations as the concentrations and proportion differ greatly among the species (Schoonhoven et al., 2005). There were differences in consumption rate (CR) between all the host plant species. The CR was maximum (128.42 mg/ day) and high relative growth rate (0.24 mg/ day) was observed on *C. olitorius* (Table 1). The growth duration, growth rate, consumption rate, utilization efficiency, developmental time, longevity, fecundity and survival of *S. obliqua* showed significant differences among the six host plants tested with respect to their food quality (Awmack and Leather, 2002; Shabana et al., 2010).

Significantly higher level of consumption index (CI) (0.91± 0.06 mg/ day), approximate digestibility (AD)

Table 1. Food utilization efficiency of 5[th] instar larvae of *S. obliqua* reared on bast fibre crops

Growth parameters	*C. olitorius*	*C. capsularis*	*H. cannabinus*	*H. sabdariffa*	*C. juncea*	*B. nivea*	LSD (P=0.05)
GR (mg/ day)	17.90±1.19	14.80±0.63	16.74±0.74	14.94±0.29	15.06±0.26	13.06±0.97	0.98
CR (mg/ day)	128.42±1.97	116.36±3.31	104.06±2.16	97.44±2.48	99.70±1.73	114.20±3.42	3.35
RGR (mg/ day)	0.24±0.03	0.13±0.02	0.16±0.03	0.11±0.02	0.12±0.03	0.11±0.02	0.03
CI (mg/ day)	0.91±0.06	0.45±0.05	0.54±0.02	0.37±0.04	0.43±0.02	0.40±0.02	0.04
AD (%)	45.94±0.40	37.36±1.92	39.34±0.71	32.53±0.86	34.59±0.81	31.75±1.19	1.41
ECI (%)	15.04±0.63	13.08±0.05	14.48±0.37	11.94±0.31	12.70±0.20	10.98±0.48	0.56
ECD (%)	32.76±0.99	35.98±0.71	33.13±0.29	36.55±0.46	35.38±1.10	36.35±0.42	0.93
LS (%)	80.68±1.41	70.44±1.58	72.65±1.03	53.92±1.20	63.02±1.96	55.21±1.27	1.80

GR=Growth rate, CR: Consumption rate, RGR: Relative growth rate, CI: Consumption index, AD: Approximate Digestibility, ECI: Efficiency of conversion of ingested food, ECD: Efficiency of conversion of digested food, LS: Larval survivability

Table 2. Biochemical content of bast fibre crops before and after infestation of *S. obliqua*

Host plants	Protein content (µg/ ml)			Peroxidase content (µg/ ml)			Phenol content (µg/ ml)			Polyphenol content (µg/ ml)		
	Un-infested	In-fested	Mean	Un-infested	In-fested	Mean	Un-infested	In-fested	Mean	Un-infested	In-fested	Mean
C. olitorius	2.74	1.71	2.22[b]	1.11	2.94	2.02[d]	1.79	1.42	1.60[d]	1.67	1.37	1.52[c]
C. capsularis	2.32	2.08	2.20[b]	1.71	2.97	2.34c	2.49	1.94	2.21[c]	1.72	2.14	1.93[b]
H. cannabinus	3.00	1.11	2.05[c]	2.36	3.00	2.68[a]	2.95	2.05	2.50[b]	1.12	0.98	1.05[f]
H. sabdariffa	2.86	1.14	2.00[c]	2.16	2.82	2.49[b]	2.99	2.49	2.74[a]	2.95	1.13	2.04[a]
C. juncea	2.77	1.21	1.99[c]	1.11	3.00	2.05[d]	1.26	1.16	1.21[e]	1.79	0.49	1.14[e]
B. nivea	2.97	2.16	2.56[a]	2.44	2.77	2.60[a]	1.16	0.67	0.91[f]	1.51	1.11	1.31[d]
Mean	2.77[a]	1.56[b]	--	1.81[b]	2.91[a]	--	2.10[a]	1.62[b]	--	1.79[a]	1.20[b]	--
LSD (P=0.05)	HP= 0.07, INF= 0.04, HP x INF=0.14			HP= 0.10, INF= 0.05, HP x INF=0.76			HP= 0.04, INF= 0.027, HP x INF=0.09			HP= 0.07, INF= 0.04		

Within the columns means followed by same letter/s not significantly different (DMRT)

(45.94± 0.40), efficiency conversion of ingested Food (ECI) (15.04± 0.63) was observed in the larvae fed on *C. olitorius* whereas it was the least in *B. nivea* with 0.40± 0.02 mg/ day; 31.75± 1.19 and 10.98± 0.48% in CI, AD and ECI, respectively (Table 1). Nutritional requirements for insect growth and reproduction depends on the ability of the insect to ingest assimilate and convert food into body tissue (Nation, 2001). Similarly, the efficiency conversion of digested food (ECD) was more in *H. sabdariffa* (36.55 ± 0.46%) and it was the least in *C. olitorius* (32.76± 0.99%) but there was significant difference among other host plant species. Differences among efficiencies of food materials are exhibited through food consumption and insect growth (Andreeva, 2010; Ansari et al., 2012). The larval survival was significantly more (80.68± 1.41%) in *C. olitorius* compared to the least in *H. sabdariffa* (153.92± 1.20%). In the previous study, Nabanita et al. (2018) also indicated that *C. olitorius* was the most suitable host for the growth and reproduction of *S. obliqua* as compared to other bast fibre crops. Clear variation was observed in food consumption and development of *S. obliqua* when fed with these six host plants. The possible explanation for variation in food consumption and development in this insect is due to significant differences in biochemical content. The concentration and proportion of nutrients might vary considerably within a particular species in its developmental stages, which influences food utilization, development and reproduction of herbivorous insects (Jeyabalan and Murugan, 1996; Schoonhoven et al., 2005).

Biochemical contents vs food utilization indices

The biochemical content varied significantly among the different test host plants and in infested and uninfested plant (Table 2). The variability in nutritional quality of six host plants was influenced by the infestation of *S. obliqua*. The feeding of insects on plants induces biochemical and physiological changes in the host plants, affecting the life processes of host plants (Gomez et al., 2004). The possible explanation for variation in food consumption and development of *S. obliqua* may be due to significant differences in biochemical contents of the various jute and allied fibre crops (Gotyal et al., 2015). The protein content of uninfested leaves ranged from 2.32µg/ g (*C. capsularis*) to 3.00µg/ g (*H. cannabinus*) and *B. nivea,* respectively. Similar was the case with the protein content, which decreased after insect infestation because in insect stressed plants decelerates the rate of protein synthesis (Singh et al., 2013). The protein content in the uninfested plants was significantly more than infested plants across the host plant species and it decreased after infestation of *S. obliqua* may be due to biotic stresses decelerates the rate of protein synthesis (Table 2).

The present results are comparable with those of Punithavalli et al. (2013) who studied the decrease in protein content with a leaf folder, *Cnaphalocrocis medinalis* infested rice genotypes. The peroxidase content in all the host species increased after *S. obliqua* infestation and it was more than double as compared to the uninfested plans indicating the significant increase in mean peroxidase activity i.e. 1.81 µg/ g in uninfested and 2.91 µg/ g in infested species (Table 2). Over expression of some oxidative peroxidases had been reported as defence mechanism in plants. Peroxidases are key enzyme of defences' related pathways in plant and play vital role to aid range of biotic stresses (Singh et al., 2013). Accumulation of various compounds in accordance with the kind and degree of damage in the plant is to counter insect attack as defense mechanism (War et al., 2012; Punithavalli et al., 2013). Peroxidase and polyphenol oxidase were elicited by the infestation of *S. obliqua* indicating their role in defence against phytophagous pests. Thus, the present study provides a better understanding of defensive mechanism by biochemical changes due to the impacts of *S. obliqua* infestation in bast fibre crops.

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REFERENCES

Andreeva E M. 2010. What can nutritional indices tell us about gypsy moth larvae *(Lymantria dispar* L.)? Pesticide Phytomedicine (Belgrade) 25: 71-77.

Ansari M S, Hasan F, Ahmad N. 2012. Influence of various host plants on the consumption and utilization of food by *Pieris brassicae* (Linn.). Bulletin of Entomological Research 102: 231-237.

Augustin M A, Ghazil H M, Hashim H. 1985. Polyphenoloxidase from guava (*Psidium guajava* L). Journal of Agricultural Food Chemistry 36: 1259-1265.

Awmack C S, Leather S R. 2002. Host plant quality and fecundity in herbivorous insects. Annual Review of Entomology 47: 817 - 844.

Bhattacharyya N, Selvaraj K, Satpathy S, Gotyal B S. 2018. Biology and life table study of *Spilosoma obliqua* Walker (Arctiidae: Lepidoptera) on different bast fibre crops. Journal of Entomological Research 42 (1): 97-102.

Bray H G, Thorpe W V. 1954. Analysis of phenolic compounds of interest in metabolism. Methods of Biochemical Analysis 1: 27-52.

Deshmukh P D, Rathore Y S, Bhattacharya A K. 1982. Effect of temperature on the growth and development of *Diacrisia obliqua* Walker on five host plants. Indian Journal Entomology 44(1): 21-33.

Dhaliwal J S. 1988. Development of *Diacrisia obliqua* Walker on some fodder crops. Journal of Research Punjab Agricultural University 25 (4): 616-618.

Gomez K S, Oosterhuis D M, Rajguru S N, Johnson D R. 2004. Molecular Biology and Physiology: Foliar antioxidant enzyme responses in cotton after aphid herbivory. Journal of Cotton Science 8: 99-104.

Gotyal B S, Selvaraj K, Meena P N, Satpathy S. 2015. Host Plant Resistance in cultivated jute and its wild relatives towards jute hairy caterpillar, *Spilosoma obliqua* (Lepidoptera: Arctiidae*)*. Florida Entomologist 98 (2): 721-727. doi.org/10.1653/024.098.0248.

Gupta G, Bhattacharya A K. 2008. Assessing toxicity of post-emergence herbicides to the *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae). Journal of Pesticide Science 81: 9-15.

Hasan F, Ansari M S. 2010. Effect of different cole crops on the biological parameters of *Pieris brassicae* (L.) (Lepidoptera: Pieridae) under laboratory condition. Journal of Crop Science and Biotechnology 13: 195-202.

Lowry O H, Rosebrough N J, Farr A L, Randall R J. 1951. Protein measurement with the Folin phenol reagent. Journal of Biological and Chemical 193: 265.

Mattson W J, Scriber J M. 1987. Nutritional ecology of insect folivores of woody plants: nitrogen, water, fibre and mineral conditions. In: Slansky FJR, Rodriguez JG (Eds.), Nutritional Ecology of Insects, mites, spikes and related invertebrates. John Wiley and Sons, New York. 105-146 pp.

Nation J L. 2001. Insect physiology and biochemistry, CRC. Press, Boca Raton, F. L. Pp.485

Pandit N C. 1985. Studies on the bioecology of major pests of jute. In: Annual Report: 1985, ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata. p. 65.

Prasad D, Chand P. 1980. Growth and development of *Diacrisia obliqua* Walker on various food plants. Journal of Entomology 42(4): 611-616.

Punithavalli M, Muthukrishnan N M, Balajirajkumar M. 2013. Defensive responses of rice genotypes for resistance against rice leaf folder *Cnaphalocrocis medinalis*. Rice Science 20 (5): 363-370.

Rossiter M C. 1991. Environmentally based maternal effects- a hidden force in insect population dynamics. Oecologica 87: 288-294.

Ruan Y M, Wu K J 2001. Performances of the cotton bollworm, *Helicoverpa armigera* on different food plants. Acta Entomology Bohemoslov 44: 205-212.

Sarkar S K. Hazra S K, Sen H S, Karmakar P G, Tripathi M K. 2015. Sunnhemp in India, ICAR- Central Research Institute for Jute and Allied Fibre Crops, Barrackpore, Pp. 140.

Satpathy S, Biswas C, Sarkar S K, Selvaraj K, Gotyal B S, De R K, Gawande S P, Ramesh Babu V, Tripathi A N, Tripathi M K. 2013. Changing pest and disease status and prospects of pest management in jute and allied fibre crops. Presented in national seminar on Jute and allied fibres in changing times: issues and Strategies on 3-5 January, 2013, Kolkata p.52.

Schoonhoven L M, Van Loon J J A, Dicke M. 2005. Insect Plant Biology. Oxford University Press, Oxford.

Selvaraj K, Meena P N, Gotyal B S, Ramesh Babu V. (2015). Occurrence of Bihar hairy caterpillar *Spilosoma obliqua* Walker on Flax (*Linum usitatissimum* L.). Jafnews 13(2): 14

Shobana K, Murugan A, Kumar N. 2010. Influence of host plants on feeding, growth and reproduction of *Papilio polytes*. Journal of Insect Physiology 56: 1065-1070.

Singh I, Singh G. 1995. Biology of Bihar hairy caterpillar, *Spilosoma obliqua* (Walker) on sunflower in Punjab. Journal of Insect Science (Online) 8: 48-54.

Singh Y R, Varatharajan R. 1999. Host range of Bihar hairy caterpillar, *Spilosoma obliqua* (Walker) (Arctiidae: Lepidoptera). Hexapoda 11(1/2): 65-74.

Slansky F J, Scriber J M. 1985. Food consumption and utilization. In: Kerkut G A, Gilbert L I (eds.). Comprehensive insect physiology, biochemistry and pharmacology- Pergamon Press, Oxford, 4: 87-163.

Srivastava S C, Pandey P N. 1987. Establishment of *Diacrisia obliqua* Walker on certain plants of Compositae. Indian Journal Entomology 49: 7-15.

Waldbauer G P. 1968. The consumption and utilization of food by insects. Advances in Insect Physiology 5: 229-289.

War A R, Paulraj M G, Ahmad T, Buhroo A A, Hussain B, Ignacimuthu S, Sharma H C. 2012. Mechanisms of plant defence against insect herbivores. Plant Signalling and Behavior 7(10): 1306-1320.

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