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NUTRITIONAL INDICES FOR *HELICOVERPA ARMIGERA* (HÜBNER) ON DIFFERENT HOST PLANTS

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ABSTRACT

Nutritional indices *viz.* relative consumption rate (RCR), relative growth rate (RGR), efficiency of conversion of ingested food (ECI %), efficiency of conversion of digested food (ECD %) and approximate digestibility (AD %) were determined for nine different natural food in the laboratory. Based on RGR, ECI, ECD and AD, pea pod was found to be most preferred natural food followed by chilli and okra pod. These indices can well be used in selection of host – plant - resistance of test insect as well as for mathematical modeling, which will be of help in sustainable pest management programme.

Key words: *Helicoverpa armigera*, nutritional indices, natural food, pest management

Helicoverpa armigera (Hübner) is one of the most devastating pest worldwide and feeds on more than 300 plant species, and solely responsible for considerable damage to many field and horticultural crops (Arora *et al.*, 2005). In India, it is reported to cause crop damage worth about US $1 billion per annum (Chandrashekar *et al.*, 2005). The problem of this pest is magnified due to its direct attack on fruiting structures, voracious feeding habits, migration, host selection by learning and propensity for acquiring resistance against wide range of insecticides (Sarode, 1999). In the present day changing pest scenario, it has become one of the important polyphagous lepidopterans to be studied in depth for its differential reaction towards hosts. In order to development a sound management strategy, a thorough knowledge of the way in which insects interact with their food sources is essential for understanding their behavior, biology and ecology. Nutritional requirements for maintenance could be expected to correlate with tissue mass. A number of researchers have employed nutritional indices to study the intake, digestibility, and efficiency of conversion of food sources by lepidopteran larvae. These indices are mainly used to compare insects performance on different host plants (Klein and Kogan, 1974). Dauglas *et al.* (1986) was also of the view that nutritional index techniques are the best for measuring the effects of physiological stress on insects. Keeping in view, studies were conducted on nutritional indices of *H. armigera* on various natural host plants in laboratory under controlled environmental conditions.

MATERIALS AND METHODS

The test insect, *Helicoverpa armigera* was collected from the Research Farm of Indian Agricultural Research Institute, New Delhi. The mass rearing of the test insect was first conducted in laboratory during 2007-08 for one generation following Gupta *et al.* (2004). From F_1 population, the neonates were taken out and were released @ 10 in one crystal vial (dimension 5.5 x 1.5 cm.) on artificial diet and were reared till they reached the second instar. Thereafter these larvae were reared individually on artificial diet to avoid cannibalism. From this culture, third instar larvae were sorted out for the experiments related to nutritional indices on varied natural food under control conditions (temperature 27±1°C, relative humidity 65±5% and photoperiod 16: 8h scoto/photo regime).

Nine fresh natural food (pea pod, round gourd, okra fruit, chilli fruit, bitter gourd, french bean, bell pepper, brinjal fruit and cauliflower curd) were selected for the study. These food materials were thoroughly washed with running water and dried under fan for about 30 minutes to ensure elimination of extra water before provided to the larvae of test insect.The third instar larvae (mean weight 70-80 mg, 5-6 days old) were first starved for about 12h and weight individually before placing on the natural feed in the crystal vials. The larvae were allowed to feed on different host plants and finally weight individually to record weight gain, quantity of food consumed and excreta produced (Mahapatro *et al.*, 1999). Data were subjected to appropriate statistical

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analyses using Indostat Services® package. Moisture loss during experimental period from each natural food was calculated by using mean percentage of moisture loss in same natural food taken in separate crystal vials in control . The experiment was replicated thrice (20 larvae / replicate) for each natural food. Nutritional indices were calculated on the basis of fresh weight, as suggested by Farrar *et al.* (1989) and Koul *et al.* (1997):

$$\text{(i) Relative Consumption Rate (RCR)} = \frac{\text{weight of food consumed}}{\text{initial weight of larvae}}$$

$$\text{ii) Relative Growth Rate (RGR)} = \frac{\text{weight gain}}{\text{initial weight of larvae}}$$

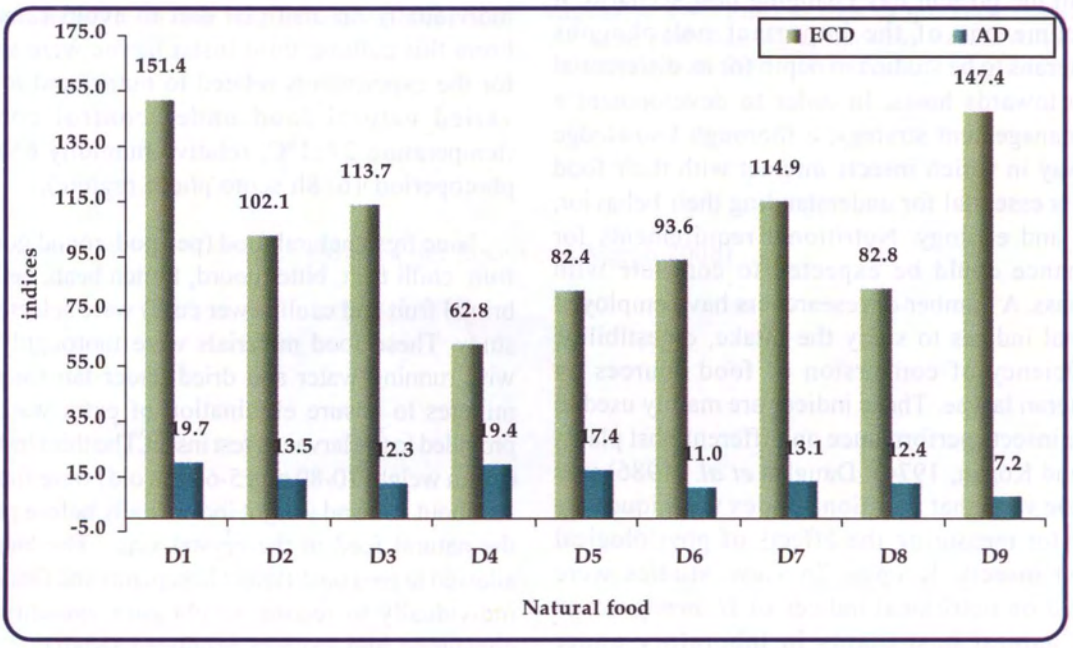
$$\text{iii) Efficiency of Conversion of Ingested food material (ECI \%)} = \frac{\text{weight gain}}{\text{weight of food consumed}} \times 100$$

$$\text{iv) Efficiency of Conversion of Digested food (ECD \%)} = \frac{\text{weight gain}}{\text{food ingested-frass (excreta) weight}} \times 100$$

$$\text{v) Approximate Digestibility (AD \%)} = \frac{\text{food ingested-excreta weight}}{\text{food ingested}} \times 100$$

RESULTS AND DISCUSSION

Growth of an insect depends primarily on the extent to which it can feed, get proper nutrition from the food and utilizes those constituents. Thus, difference in consumption, nutritive values and utilization of food from various plants would affect its establishment on them. An insect requires all nutrients (*e.g.* protein, carbohydrate, fat, vitamin and mineral) for its better growth and development. The proportion of ingested food that is actually digested is denoted by approximate digestibility (AD), the assimilation efficiency also called "approximate digestibility". Of the nutrients absorbed, parts are expended in the processes of respiration and work. The proportion of digested food that is actually transformed into net insect biomass is denoted by efficiency of conversion of digested food (ECD). A parallel parameter, efficiency of conversion of ingested food (ECI), indicates the efficiency of conversion of ingested food. In short, AD indicates how digestible a food is, whereas ECD and ECI indicate how efficient a herbivore is in converting that food into biomass (Lindroth, 1993). Data on these aspects were collected in present experiment and presented in Table 1 & Fig 1. Table shows that pea pod is more nutritionally rich food and even small amount of this food could successfully support maximum insect growth (RGR 1.27) as evidenced by high ECI (29.76 %), ECD



ECD = Efficiency of Conversion of Digested food AD= Approximate Digestibility
D1=Pea pod, D2=Bitter gourd, D3=Round gourd, D4=Brinjal fruit, D5=Chilli fruit
D6=Bell pepper, D7=Okra pod, D8=French bean and D9=Cauliflower curd

Fig.1. Nutritional indices of *Helicoverpa armigera*

Table 1. Nutritional indices for third instar larvae of *Helicoverpa armigera*

Natural foods	Nutritional indices (on fresh weight basis)		
	RGR	ECI (%)	RCR
Pea pod (*Pisum sativum*)	1.27±0.15	29.76±0.59 *(33.06)	4.27±0.37
Bitter gourd (*Momordica charantia*)	0.60±0.12	13.80±0.71 *(21.80)	4.32±0.14
Round gourd (*Praecitrullus fistulosus*)	0.75±0.15	13.95±0.94 *(21.92)	5.37±0.47
Brinjal fruit (*Solanum melongena*)	0.96±0.14	12.20±0.14 *(20.44)	7.84±0.10
Chilli fruit (*Capsicum annus*)	0.71±0.12	14.34±0.19 *(22.25)	4.98±0.79
Bell pepper (*Capsicum annum.*)	0.57±0.16	10.31±0.20 *(18.37)	5.57±0.36
Okra pod (*Abelmoschus esculentus*)	1.05±0.10	15.03±0.23 *(22.81)	6.97±0.16
French bean (*Phaseolus vulgaris*)	1.15±0.15	10.26±0.27 *(18.68)	11.21±0.96
Cauliflower curd (*Brassica oleracea*)	1.24±0.11	10.59±0.22 *(18.99)	11.71±0.94
S.Em ±	0.08	0.22	0.33
C.D. (P=0.05)	0.23	0.65	0.99

RGR =Relative Growth Rate, ECI =Efficiency of Conversion of Ingested food, RCR = Relative Consumption Rate
*Data in parenthesis are arcsine- transformed values; SEm±: Standard error of mean; CD: Critical difference; ±: Standard deviation

(151.36 %) and AD (19.66%) amongst the test-food used in the present experiment. Though the RCR is high in cauliflower curd (11.71) as compared to pea pod (4.27), yet is not nutritionally rich diet, as the test insect feeds more in quantity to meet their requirement. All other parameters in cauliflower curd were far below than the pea pod.

As pea pod is nutritionally rich, small amount of this food could successfully support insect growth maximum, as evidenced by RGR (1.27), ECI (29.76%), ECD (151.36 %) and AD (19.66%). All these indices were maximum amongst the test-food showing the nutritional superiority of pea pods, consequence of that it is most preferred by the test insect. The present finding is in accordance with the work of Ajanta *et al.* (1999), who have also found pea pod as most preferred natural food for *H. armigera.*

Variation in the nutritive values of the diet from different plants and the extent to which they are consumed and utilized by *H. armigera*, considered as the determining factors of its growth and establishment. The present study shows significant differences in the capacity of *H. armigera* grown on

different diets. Efficiency of conversion of ingested food measures the overall ability of the insect to convert ingested food to body matter. These indices decrease as the proportion of digested food metabolized for energy increased and also decrease with a drop in the nutritional quality of the food. Since these indices are affected by both the approximate digestibility and efficiency of conversion of digested food and increase or decrease on one, while the other remains constant will cause a corresponding rise or fall in this index. Such observations will help in selection of host – plant - resistance of test insect as well as for constructing mathematical model, which will be helpful in developing strategy for sustainable management against this pest.

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REFFERENCES

Arora, R., Sharma, H.C., and Dreissche, E. Van. 2005. Biological activity of lectins from grain legumes and garlic against the legume pod borer, *Helicoverpa armigera. ejournal.icrisat.org*, Volume-1, Issue-1, pp-1-3.

Chandrashekar, K., Kumari, A., Kalia, V. and Gujar, G. T. 2005. Baseline susceptibility of the American bollworm, *Helicoverpa armigera* (Hübner) to *Bacillus thuringiensis* Berl var. *kurstaki* and its endotoxins in India. *Current Science*, **88** (1): 167-175.

Chandra, Ajanta, Kaushik, N. C. and Gupta, G. P. 1999. Studies on growth and development of *Helicoverpa armigera* (Hübner) on different foods. *Journal of Cotton Research and Development*, **13** (2) : 123-125.

Dauglas, J.S. and Reese, J.C. 1986. Sources of error in nutritional index studies of insects on artificial diet. *Journal of Insect Physiology*, **32** (3):193-198.

Farrar, R. R. Jr., Bardour, J. D. and Kennedy, G.G. 1989. Quantifying food consumption and growth in insects. *Annals of Entomological Society of America*, **82** (5): 593-598.

Gupta, G. P., Ajanta, Birah and Seema, Rani 2004. Development of artificial diet for mass rearing of American bollworm, *Helicoverpa armigera. Indian Journal of Agricultural Sciences*, **75** (10): 548-551.

Klein, I. and Kogan, M. 1974. Analysis of food intake, utilization and growth in phytophagous insects - a computer program. *Annals of Entomological Society of America*, **67**: 295-97.

Koul, O., Shankar, J. S., Mehta, N., Taneja, S.C., Tripathi, A. K. and Dhar, K. L. 1997. Bioefficacy of crude extracts of *Aglaia species* (Meliaceae) and some active fractions against lepidopteran larvae. *Journal of Applied Entomology*, **121**: 245-248.

Lindroth, Richard L., 1993. Food conversion efficiencies of insect herbivores: insect food conversion efficiencies. *The Food Insects Newsletter*, **6**(1): pp-1-3 (http://www.hollowtop.com)

Mahapatro, G. K., Meenakshi and Gupta, G. P. 1999. Nutritional studies for two noctuids, *Earias vittella* Fab. and *Spodoptera exigua* Hübn. on natural diets in laboratory. *Shashpa*, **6** (2): 183-184.

Sarode, S.V. 1999. Sustainable management of *Helicoverpa armigera* (Hübner). *Pestology*, Special Issue, **13** (2): 279-284.

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