Biochemical changes in alimentary canal due to food habits in certain moths & larva of lepidopteran insects

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Abstract

Insect feed many different kinds of food including brinjal, cotton & maize plant phloem and xylem sap, plant leaves, root, stem and fruits. There is no typical insect alimentary canal. Nevertheless, there are similarities in the structure of the alimentary canal in all insects and nearly all must digest some of the same complex molecules, such as proteins, lipids and carbohydrates. In every insect alimentary canal three regions can be identified morphologically and physiologically like foregut or stomadeum, the midgut or mesenteron, and the hindgut or proctodium. It is reviewed that the biochemical observation made on the alimentary canal of three moth's larvae reveals that the amount of moisture contents, proteins, carbohydrates and lipids have significant correlations to preferences.

Keywords: *Leucinodes orbonalis* (brinjal fruit & shoot borer), *Heliothis armigera* (cotton bollworm), *Chilo partellus* (Maize stem borer), host preference, deterrent

Introduction

Lepidopteron insect host plants are sole food of different insect. It was found that feeding behavior and intensity of herbivorous insect pest interrupt the normal metabolic activities. Moth larvae are seen laying eggs after the selection of host plants (Aheer, G. M., Ali, A., and Akram, M. 2009) [2]. Hence the larvae start first meal on the preferred host. The presence or absence of deterrent phagostimulants and in the right proportion facilitates optimal food selection and utilization. The term less preferred non host plants can be explained in term of some biochemical parameters of host plants like total carbohydrate, proteins, fats and moisture contents (Chapman, 1977; Miller and Stricker, 1984) [7, 14]. These larvae are voracious feeders and hence are serious pests on very useful plants of the environment. *Leucinodes orbonalis* (Brinjal Fruit and Shoot Borer; BFSB) is a very dangerous pest of brinjal. It not only reduces the yield by making holes in shoots as well as in fruits but also reduces the aesthetic value of the fruits so losses get doubled. It is a monophagous pest feeds only on Brinjal. The normal control measures like spraying of pesticides does not solve the problem instead making the environment polluted, ecological disturbance and vegetable poisoning. But if we understand the nature and behavior of each life stage of the cycle, it is easy to replace poisonous chemicals with knowledge, local resources and skills.

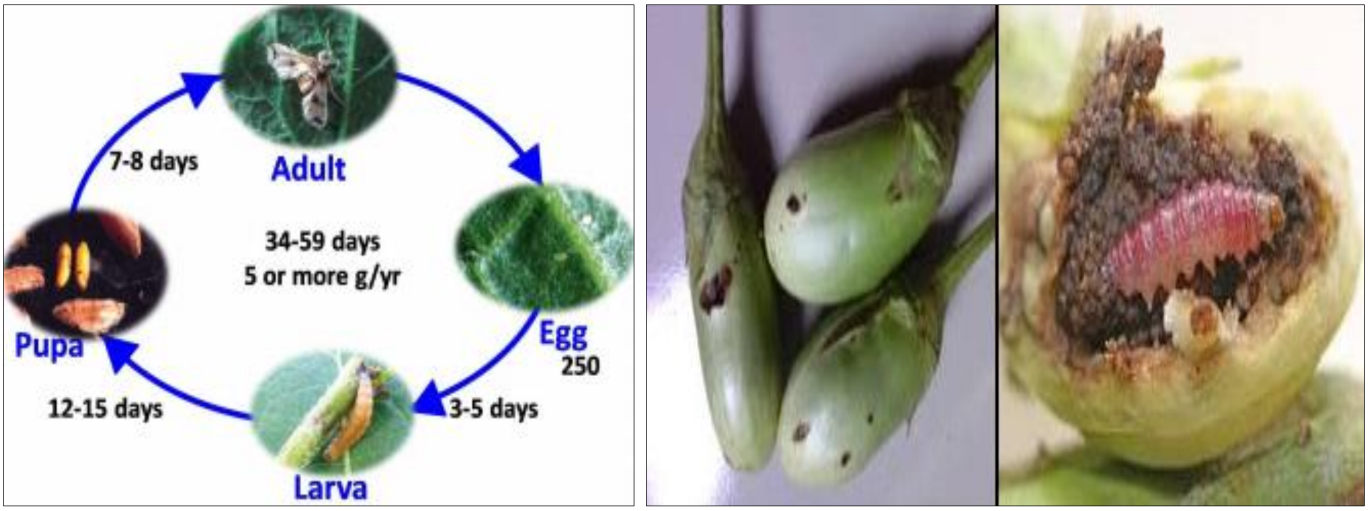
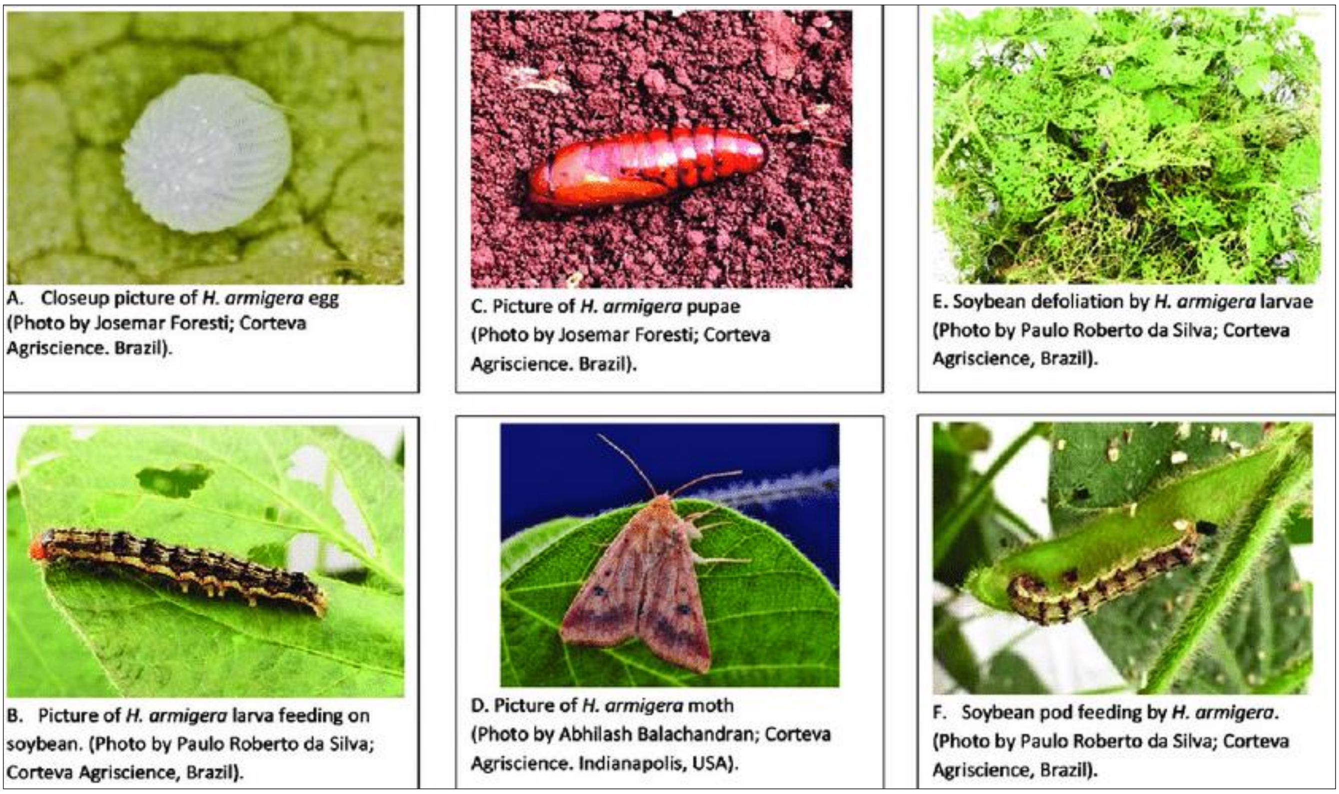


Fig 1

Helicoverpa armigera larvae prefer to feed on reproductive parts of hosts (flowers and fruits) but may also feed on foliage. Feeding damage results in holes bored into reproductive structures and feeding within the plant. It may be necessary to cut open the plant organs to detect the pest. Secondary pathogens (fungi, bacteria) may develop due to the wounding of the plant. Frass may occur alongside the feeding hole from larval feeding within (A.Q.A.S. 2012) [1].



A. Closeup picture of *H. armigera* egg (Photo by Josemar Foresti; Corteva Agriscience. Brazil).

C. Picture of *H. armigera* pupae (Photo by Josemar Foresti; Corteva Agriscience. Brazil).

E. Soybean defoliation by *H. armigera* larvae (Photo by Paulo Roberto da Silva; Corteva Agriscience, Brazil).

B. Picture of *H. armigera* larva feeding on soybean. (Photo by Paulo Roberto da Silva; Corteva Agriscience, Brazil).

D. Picture of *H. armigera* moth (Photo by Abhilash Balachandran; Corteva Agriscience. Indianapolis, USA).

F. Soybean pod feeding by *H. armigera*. (Photo by Paulo Roberto da Silva; Corteva Agriscience, Brazil).

Fig 2

When the larvae of *Chilo partellus* (Maize stem borer) are fully grown, they pupate and remain inside the maize stem. After 7-14 days adults emerge from pupae and come out of the stem. They mate and lay eggs on maize plants again and continue damaging the crop. During the dry season, larvae may enter a state of suspended development diapauses for several months and will only pupate with the onset of rains (Overholt W.A. *et al*, 2001) [15]. Adults emerge from pupae in the late afternoon or early evening. They are active at night and rest on plants and plant debris during the day. They are rarely seen, during the day unless they are disturbed. The whole life cycle takes about 3-4 weeks, varying according to temperature and other factors. Five or more successive generations may develop in favourable conditions. In regions where there is sufficient water and an abundance of host plants, the spotted stem borer can reproduce and develop all year-round. Are relatively small moths with wing lengths ranging from 7-17 mm and a wingspan of 20-25 mm. Forewings are brown yellowish with darker scale patterns forming longitudinal stripes. In males, hind wings are a pale straw color, and in females, they are white.

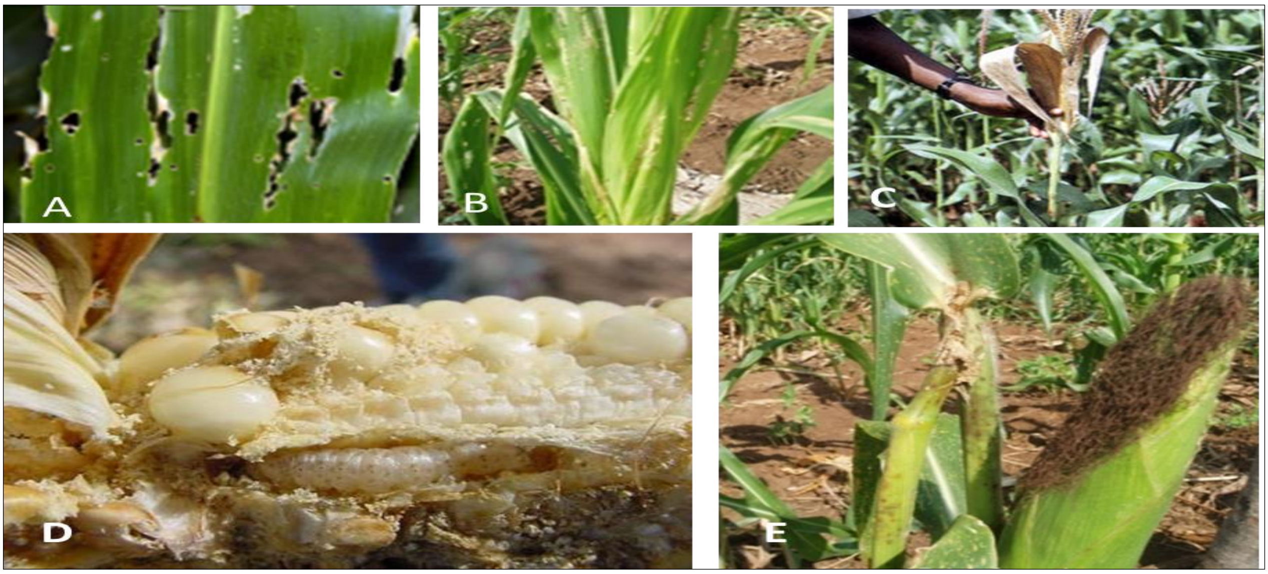


Fig 3

Materials and Methods

Different Lepidopteron insect fully develop larvae of *Leucinodes orbonalis*, *Heliothis armigera* and *Chilo partellus* were collected from their preferred host plant like brinjal fruit, Cotton leaf and Maize stem respectively. The alimentary canal was dissected out and separated into foregut, midgut, hindgut, and weight and dried at 60ºC for 20 days. Then the dry weights become constant in each larva.

The total protein contents were estimated as per methods described by (Lowry et. al, 1951) [13]. The total lipids were estimated with a Soxhlet extraction apparatus (Colowick and Kaplaon, 1993) [8]. Carbohydrates were determined by using Orcinol reagent (Frank Consolazio, 1963) [10]. Student "t" test was employed to analyze the variable factor (Dixon and Massey, 1957) [9]. The variation in data is denoted by ±SE (Statistical error).

Result and Discussion

The result obtained from the present study suggests that the tissues of alimentary canal are directly manifested in biochemical composition of their host plants. In *Leucinodes orbonalis* (brinjal fruit & shoot borer), water is more than the required amount but lipids are highly limited. Proteins and carbohydrates are also in limited quantities (Table-1). *Heliothis armigera* (Cotton bollworm), protein are more or show high percentage, water contents are low in all its regions of gut, lipids and carbohydrates show an average distribution (Table-2). *Chilo partellus* (Maize stem borer), a fair amount of water is present. Carbohydrates and lipid contents are quite high and proteins show an average distribution (Table-3).

Table 1: Average value of measurement in the digestive tract of *Leucinodes orbonalis* (brinjal fruit & shoot borer), host: Solanaceous plants

Division of Alimentary Canal	Water Contents %	Proteins %	Lipids %	Carbohydrate %
Foregut (Stomadeum)	69.5 ± 0.26	9.5 ± 0.26	8.9 ± 0.25	11.50 ± 0.44
Midgut (Mesenteron)	70.50 ± 0.30	10.9 ± 0.29	9.5 ± 0.36	12.30 ± 0.29
Hindgut (Proctodaeum)	62.54 ± 0.44	9.8 ± 0.39	8.4 ± 0.31	10.6 ± 0.37

±SE= Statistical Error

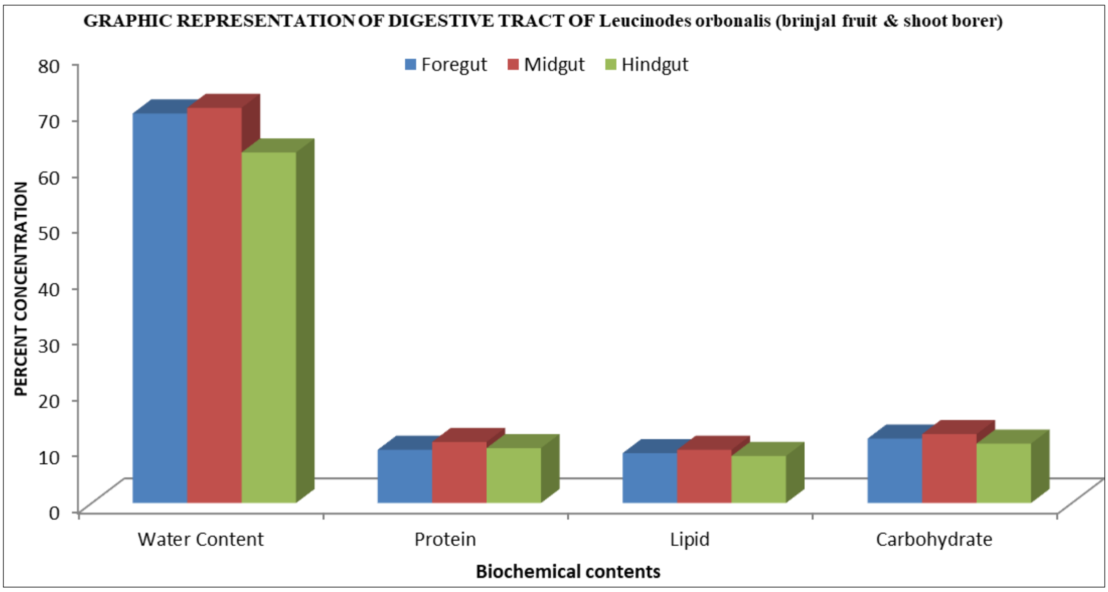


Fig 4

Table 2: Average value of measurement in the digestive tract of *Heliothis armigera* (Cotton bollworm), host: Papilionaceous plants

Division of Alimentary Canal	Water Contents %	Proteins %	Lipids %	Carbohydrate %
Foregut (Stomadeum)	55.5 ± 0.32	14.45 ± 0.30	10.22 ± 0.31	14.6 ± 0.26
Midgut (Mesenteron)	59.4 ± 0.38	15.55 ± 0.33	11.44 ± 0.28	11.88 ± 0.31
Hindgut (Proctodaeum)	51.33 ± 0.26	14.88 ± 0.29	11.99 ± 0.37	11.51 ± 0.29

±SE= Statistical Error

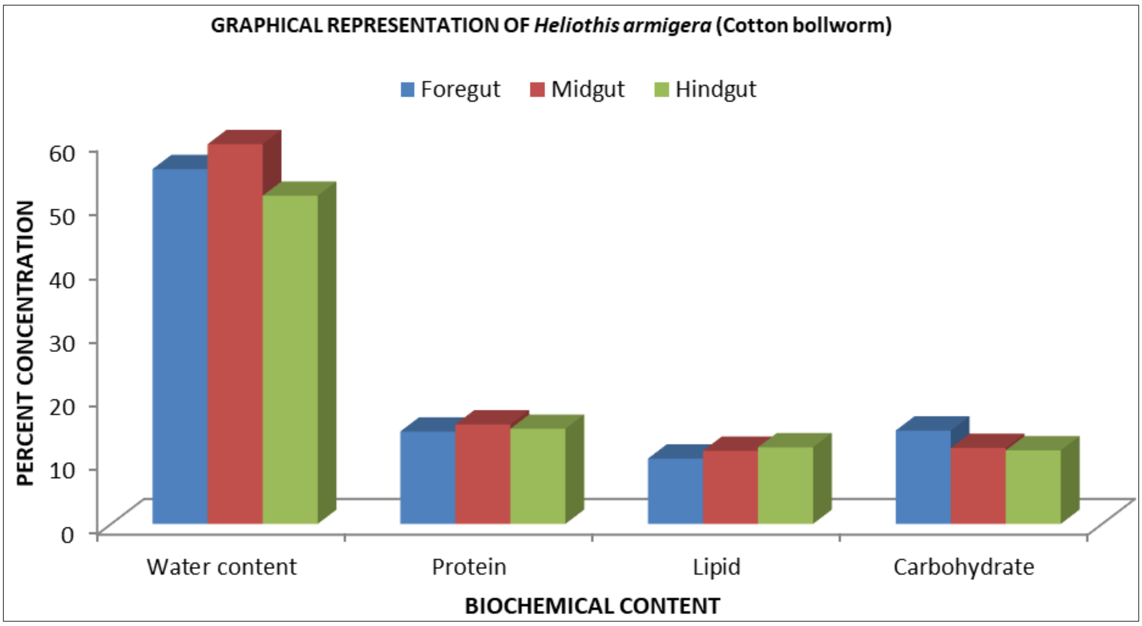


Fig 5

Table 3: Average value of measurement in the digestive tract of *Chilo partellus* (Maize stem borer), host: Graminaceous plants

Division of Alimentary Canal	Water Contents %	Proteins %	Lipids %	Carbohydrate %
Foregut (Stomadeum)	61.8 ± 0.399	10.5 ± 0.31	15.5 ± 0.39	14.66 ± 0.36
Midgut (Mesenteron)	60.8 ± 0.29	11.3 ± 0.25	16.4 ± 0.24	15.88 ± 0.27
Hindgut (Proctodaeum)	52.5 ± 0.23	9.3 ± 0.34	14.6 ± 0.31	14.22 ± 0.28

±SE= Statistical Error

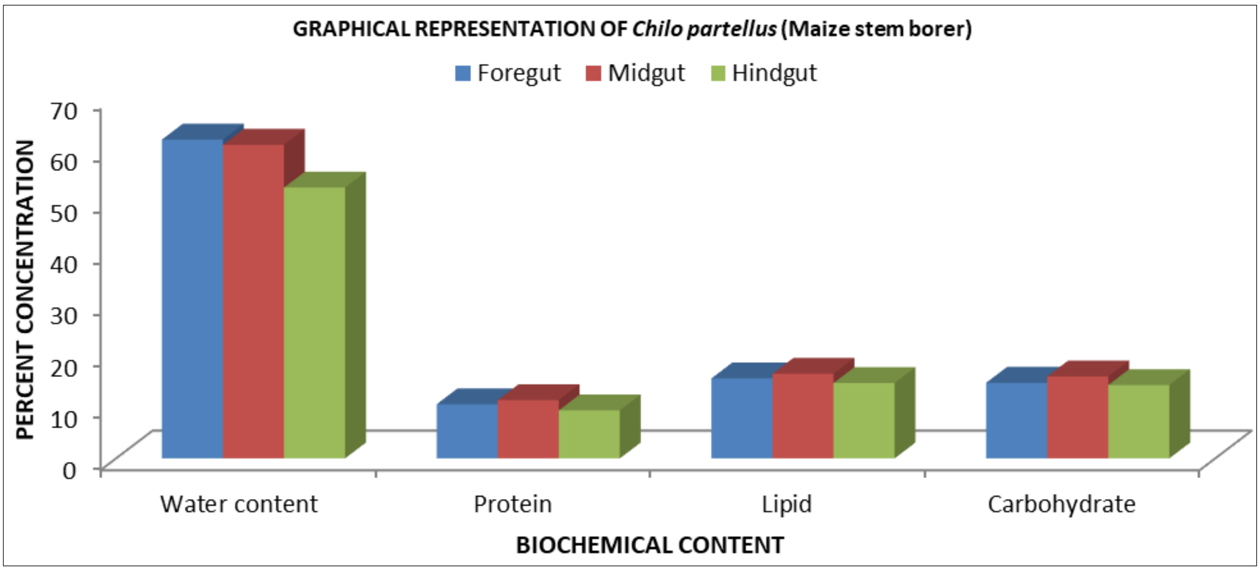


Fig 6

In recent years, so many pest control methods are being growled in biological warfare. In other words biological control is the most important against harmful insects (Bhatt, N. J. and P. K. Patel. 2001) [5]. In order to produce effectively control methods, biology, physiology, biochemistry are important to know. Proteins are the most important organic constituents of animal tissues including lepidopteron insects and play an important role in energy production. In the development process, various agents such as protein are required for the synthesis of ATP (Taşkın and Aksoylar, 2011) [18]. In another study conducted to determine the effects of host density on development time, egg dispersion, fecundity, sex ratio, longevity, and glycogen, total sugar and lipid levels of insect gut (Shimizu, K. and K. Fujisaki. 2002) [16]. As a result of research conducted that Host density had no significant effect on glycogen levels of female and male wasp, whereas sugar and lipid levels showed some variations in both sexes (Isitan *et al*., 2011) [11]. Lipids are used in so many insects as energy source, hormone precursors and structural members (Bantewad, S. D. and S. V. Sarode. 2000) [3]. It is stored in different regions in the insect body. Also lipids located in the egg play an important role in meeting the energy needs for developing embryo (Boz and Gülel, 2012) [6]. The moth larvae generally take longer and continuous meal on fresh leaves of the host plants. It is observed from our result that the choice of plants made by the larvae is based on the presence or absence of feeding deterrent in smaller amounts. Infect, the feed depends on the balance between feeding deterrents and phagostimulants (Bernay and Chapman, 1978) [4]. Higher water content is required by insect larvae for faster increase in size. Protein is generally needed for normal growth and behavior. Carbohydrates are observed in limited quantities as they undergo simplification to glucose and glycogen which in turn gets convert to lactic acid that assist basal metabolism (Kfir R. *et al*, 2002) [12]. All these biochemical constituents, proteins, lipids and carbohydrates are important to selection of effective biological control agents of lepidopteron insect.

Conclusion

To extracts produce significant alterations in the biochemical profiles of solanaceous, papilionaceous & graminaceous pest of larvae. Further, the impacting factors of extracts on carbohydrate, lipid and protein contents of larvae are species and specific extraction. It indicates the disturbed metabolic activity of the larvae. It is concluded that the impacting factors of extracts on carbohydrate, lipid and protein contents in treated larvae are different species and specific extraction. The lowering of these biochemical components indicates that these extracts can lowered the feeding and proper digestion of food. They further interrupt with protein synthesis hormones resulting in its decline (Sidde Gowda, D. K., S. *et al*, 2002) [17]. In contrast, the increase in certain profiles demonstrates the physiological stress induced by the extract and the disturbed metabolic activity of the larvae. The effect of extracts on the metabolism of treated larvae depends on their nature and probably also on the action of different phytochemicals in these extracts. Many examples of biological control studies mentioned above indicate that a detailed knowledge of the ecology and biochemistry including proteins, lipids and carbohydrates of solanaceous, papilionaceous & graminaceous pest of larvae necessary to achieve successful control. Insect control strategies interfering with α amylases, and thus food digestion, are known to reduce insect survival and growth, and for this reason, many studies have focused on biochemical studies including Protein, lipids, water content & carbohydrates in solanaceous, papilionaceous & graminaceous pest of larval alimentary canal different part with significant correlation to their different host plants.

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