

Physiology of digestion in mango weevil, *Sternochetus gravis* (Fabr.) (Curculionidae : Coleoptera)

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Abstract

Sternochetus gravis has been proved to be a serious pest of mango fruit in Manipur. The insect during both of its larval and adult stages feed on the fruit pulp where the entire life cycle is completed. Certain physiological parameters of the pest and its food have been revealed significant interaction between them. The hydrogen-ion concentration has been observed to vary from 3.2 to 6.5 in the unripe and ripe fruit pulp and 4.5 to 6.2 in the larval and adult gut respectively. The qualitative estimation of digestive enzymes has revealed the presence of almost all the enzymes in the insect gut namely amylase, maltase, lactase, lipase and invertase to digest the different components of its food. Thus, the pest is host specific and is well adapted both physiologically as well as morphologically inside the growing food.

Keywords: *Sternochetus gravis*, hydrogen-ion concentration, digestive enzyme, amylase, maltase, lactase, lipase and invertase.

INTRODUCTION

Sternochetus gravis is one of the serious insect pests of mango fruit in Manipur and in other countries. It feeds on the edible part (fruit pulp) of the mango and differs from *S. mangiferae* (Fabr.) which feed on the fruit stone only. Therefore, no part of this important fruit is left for human consumption due to the infestation of these pests. Many workers such as Srivastava (1957), Srivastava & Srivastava (1957 & 1961), Lall & Ghai (1958), Krishna (1962), Mall & Chatteraj (1968), Chatteraj & Mall (1967 & 1968), etc. have studied the digestive physiology of insects but no information is on record on this insect. Therefore, an effort has been made to study certain aspects of physiology of digestion specially hydrogen-ion concentration and digestive enzymes in the different parts of the larval and adult digestive tract of the insect under report. An attempt has also been made to find out the way this insect pest has established interaction with its environment inside the fruit pulp.

MATERIAL AND METHODS

The experimental materials were procured from the infected mango fruits available in the local market in as well as in the orchard. They were kept alive in the laboratory on infested mango fruits. The experimental specimens were starved for about 1-2 days before taking up the experiment.

Determination of pH

Received: Revised Accepted

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For determining the hydrogen-ion concentration of this weevil, "Indicator Paper Technique and Universal Indicator Technique" were employed as adopted by David (1927). The procedure adopted in this experiment was according to those of Prasad & Shukla (1975). Each experiment was replicated 10 times and the average of each part was calculated.

Determination of digestive enzymes

For the qualitative detection of the digestive enzymes 50 larva and 50 adult individuals were collected and extract were prepared according to the method adopted by the Krishna (1955). The extract thus, prepared from the different parts of the alimentary tract were incubated with suitable substrates and buffer at 38°C for 24-96 hours or more for different enzymes. A control tube containing boiled tissue extract was also treated under similar condition for each test. To the extracts thus obtained, a few drops of the toluene were added to prevent the bacterial growth. Then, the various chemical tests were applied in order to confirm the presence or absence of the enzymes. The entire test was replicated at least 5 times for the confirmation of the results.

In order to learn certain physiological adaptability of the insect, the physiological parameters of the food (the pulp) especially pH, digestive enzymes were estimated and compared with those of the insect so as to find out the interaction between the pests and host in their physiology.

RESULTS AND DISCUSSION

Hydrogen-ion concentration

The different parts of the larval and adult gut of *Sternochetus gravis* show strong acidic pH ranging from 4.5 to 5.0, 5.4 to 5.6 in the foregut, 5.0 to 5.5, 6.0 to 6.2 in the midgut and 4.5 to 6.0, 5.5 to 5.7 in the hindgut of both individual respectively (Table1). The fruit which forms the natural food has strongly acidic P^H ranging from 3.2 to 6.4 in the unripe and ripe mango fruits (Table1).

Table1. pH in different parts of the larval and adult guts of *Sternochetus gravis* and the pulp its suitable food

Sl. No.	Specimen	Range pH					
		Insect gut parts		Food			
		Foregut	Midgut	Hindgut	Pulp	Stone	Rind
1	Larva	4.5-5.0	5.0-5.5	4.5-5.0	–	–	–
2	Adult	5.4-5.6	6.0-6.2	5.5-5.7	–	–	–
3	Unripe mango	–	–	–	3.2-3.5	6.0-6.1	5.0-5.2
4	Ripe mango	–	–	–	6.1-6.4	6.0-6.1	7.5-7.7

Digestive enzymes

Six digestive enzymes namely amylase, maltase, lactase, invertase, lipase and protease were detected in the sub-divisions of

the larval and adult gut of *S. gravis*. Five of them could be detected in both the larval and adult foregut, midgut and hindgut except protease which was found to be absent and amylase found to be present in the foregut of both the larval and adult.

Table 2. Distribution of digestive enzymes in the different parts of the digestive tract of *Sternochetus gravis*.

Sl.No.	Name of enzymes	Foregut		Midgut		Hindgut	
		Larva	Adult	Larva	Adult	Larva	Adult
1	Amylase	+	+	–	–	–	–
2	Maltase	+	+	+	+	+	+
3	Lactase	+	+	+	+	+	+
4	Invertase	+	+	+	+	+	+
5	Lipase	+	+	+	+	+	+
6	Protease	–	–	+	+	+	+

Note: "+" indicates presence and "–" indicates absence.

The digestive tract of this pulp weevil has strongly acidic P^H ranging from 4.5 to 6.2 in both the larval and adult gut respectively. It has been observed to be ranging from 4.5 to 5.5 in larval foregut and 5.4 to 6.2 in the adult gut. This finding is in conformity with those of Chatteraj & Mall (1967) in *Galerucella* who reported almost similar P^H ranging from 4.0 to 4.5.

The gut is starved and normal fed individuals in this insect has exhibited almost identical P^H value. This has revealed that the starvation seems to have no appreciable influence on the P^H of the alimentary tract. The present observation therefore is at par with those of Bodine (1925), Srivastava (1957), Rastogi & Datta Gupta (1962), Mall & Chatteraj (1968) and Prasad & Shukla (1975).

The mango pulp which forms the major and natural food of this weevil has the strongly acidic P^H ranging from 3.2 to 6.4 in the unripe and ripe one. Almost similar range of P^H has been detected in the larval and adult insect gut also. This elucidates that the acidic nature of food has marked influence on the P^H of the alimentary tract of this insect. However, this finding is not in agreement with those of earlier workers like Swingle (1931a), Day & Powning (1949), Waterhouse (1949), Srivastava & Srivastava (1961).

The hydrogen-ion concentration within the gut of the larva and adult *S. gravis* seems to be favourable for optimal activity of almost all the digestive enzymes thus ensuring complete digestion of the corresponding substrates. In the adult gut also there is a close correlation between the P^H of the gut and optimum P^H of the different enzymes. This observation is thus, in conformity with those of Krishna (1955, 1958, 1960 & 1962) and Bhatnagar (1962) who reported almost similar observation in *Tribolium* and *Trogoderma* and *Latheticus oryzae* Waterh. larvae respectively.

The qualitative test of the enzymes (Table 2) reveals that maltase, invertase, lactase and lipase are present in all parts of the alimentary canal of the larva and adult of the insect. The enzymes such as amylase could be detected in both the larval and adult foregut but absent from midgut and hindgut but absent from the foregut in both the cases. This finding is at par with that of Balyan (1975) in *Agrotis ypsilon* Rott. and *Heliothis amigera* Hubner.

The presence and absence of amylase and proteases respectively indicates the partial digestion of the corresponding substrates in the respective regions like carbohydrates in the foregut and proteins in the hindgut. The presence of enzymes like amylase, maltase, invertase, lactase, lipase and proteases in midgut implies that both the larva and adult are able to digest the different component like starch, maltose, sucrose, fat and protein present in the food. This observation is in full agreement with these of Day & Powning (1949), Fisk (1950), Lall & Ghai (1958), Chatteraj & Mall (1969) and Balyan (1973, 1975).

The occurrence of all the digestive enzymes mentioned above except amylase in the larval and adult hind gut reveals that the enzymes might have been carried to the hindgut with digestive food. Such an observation was recorded by Saxena (1955), Rastogi & Datta Gupta (1962), Mall & Chatteraj (1968) and Verma & Prasad (1972, 1973) also. Rastogi & Datta evident that the weevil is host specific during both its stages and well adapted to such an internal environment. There exists a remarkable phenomenon of pest and host interaction between the plant tissue and insect. It is so intimate that if it is isolated from its pulp, the grub will die and the adult is compelled to undergo hibernation under the influence of environmental factors.

ACKNOWLEDGEMENTS

The authors are thankful to Principal and Head, Department of Zoology, D.M. College of Science, Imphal for providing the necessary laboratory facilities. Thanks are also due to UGC for providing financial assistance during the work.

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