

Role of salivary glands in the maintenance of midgut amylase activity in *Periplaneta americana* L.

O. P. Agrawal and J. Bahadur¹

School of Studies in Zoology, Jiwaji University, Gwalior-474002 M.P., (India), 17 April 1978

Summary. It was experimentally demonstrated, by the surgical removal of salivary glands and severance of salivary ducts, that most of the amylase in the gut of *Periplaneta americana* comes from the salivary glands.

The digestive enzymes found in the salivary secretions and regions of the digestive tract of various insects have been examined by many workers and comprehensively reviewed by House² and Dadd³. Amylase is the most active and important carbohydrase in *P. americana*. It is believed that most of the gut amylase is salivary in origin, because extremely high amylase activity has been shown in the salivary gland homogenates^{4,6}. But no attempt, except a preliminary one⁷, has been made to trace the origin of amylase activity in the gut.

Material and methods. 10-day-old adult *P. americana* of both sexes were taken for experiments from a stock-colony maintained in the laboratory. Extirpation of salivary glands and severance of salivary ducts were done according to the method described by Agrawal and Bahadur⁸. After introducing a few crystals of penicilline-streptomycin mixture, the wound was sealed with molten wax. Sham-operated and unoperated roaches from the same batch were maintained as controls. All the insects were fed as usual after 1 day of surgery. Some salivarectomized roaches were injected with 0.1 ml of salivary gland extract in the haemocoel about 3 h before dissection. This extract was prepared by homogenizing 5 pairs of salivary glands from normal adults in 1 ml of cold cockroach Ringer's solution.

The roaches were first starved for 3 days, then fed for 2 h and sacrificed on the next day. Amylase activity was determined by the method of Noelling and Bernfeld⁹.

Results. Since, the midgut is the main site for enzyme

action, amylase activity was estimated in the midgut at various periods after salivarectomy and the results are summarized in table 1. Amylase activity of sham-operated roaches was not significantly different from that of unoperated roaches, and hence enzyme activity for these 2 groups has not been given separately. It is clear from our observations that depletion of salivary glands causes a significant reduction (up to about 90%) in midgut amylase activity, and this decline increases with time following the experiment (table 1). Most of the reduction in midgut amylase activity is completed within 15 days in females but it takes about 90 days in males, thus the effect of salivarectomy is more pronounced and faster in females than in males.

For further clarifications 2 more experiments were conducted: 1stly, the severance of salivary ducts, and 2ndly, injection of salivary gland extract in the haemocoel of salivarectomized roaches. Almost a similar decline in midgut amylase activity was noticed in roaches whose salivary ducts were severed and intact glands were retained inside the body (table 2). Furthermore, injection of salivary gland extract in haemocoel of salivarectomized roaches was observed to have no effect on the enzyme levels in the midgut (table 2).

Discussion. 2 possible reasons may account for the decrease in midgut amylase activity following salivarectomy, viz., a) most of the amylase may be secreted within the salivary glands and conveyed to the gut through the salivary ducts, b) some factor from the salivary glands may induce non-exocrinally (hormonally) amylase activity in the midgut.

Present observations, a similar effect of salivarectomy as well as duct severance and failure of salivary extract injection in improving midgut amylase levels in salivarectomized roaches, support the first possibility. These results demonstrate that it was reasonably considered by previous workers⁴⁻⁷ that most of the gut amylase activity is due to salivary glands, and the possibility of the involvement of some non-exocrine factor from the salivary glands in midgut amylase activation is unlikely.

The effect of salivarectomy is much more immediate and pronounced in female roaches than in the males. The reason for this difference is not clear at present and needs further investigation.

Table 1. Showing the effect of salivarectomy on midgut amylase activity

Days after experiment	Males			Females		
	Salivar-ectomized	Control	% decline	Salivar-ectomized	Control	% decline
15	190 ± 25	466 ± 52	59.22	79 ± 11	1050 ± 128	92.47
30	217 ± 24	573 ± 66	62.18	68 ± 11	1005 ± 126	93.23
60	127 ± 30	523 ± 66	75.71	47 ± 7	915 ± 41	94.86
90	50 ± 8	470 ± 67	89.36	55 ± 8	1093 ± 125	94.96

All the values are the means of 10 determinations ± SEM.

Table 2. Showing midgut amylase activity in salivarectomized, duct severed, salivarectomized who received salivary extract injection and control roaches, 15 days after the experiments

	Amylase activity (absorption units × 10 ³ at 550 nm)			
	Salivar-ectomized	Duct severed	Salivar-ectomized received salivary extract injection	Control
Males	190 ± 25	157 ± 30	153 ± 22	466 ± 52
Females	79 ± 11	131 ± 32	72 ± 10	1050 ± 128

All the values are the means of 10 determinations ± SEM.

- 1 We wish to acknowledge Prof. H. Swarup (Jiwaji University, Gwalior, M.P.) for working facilities provided at School of Studies in Zoology, Vikram University, Ujjain, M.P., and Council of Scientific and Industrial Research, New Delhi, for financial support in the form of Junior Research Fellowship to one of us (O.P.A.).
- 2 H.L. House, Physiology of Insects, vol. 2. Ed. M. Rockstein. Academic Press, London 1965.
- 3 R.H. Dadd, Chemical Zoology, vol. 5. Ed. M. Florkin and B.T. Sheer. Academic Press, London 1970.
- 4 V.B. Wigglesworth, Biochem. J. 21, 797 (1927).
- 5 M.F. Day and R.F. Powning, Aust. J. scient. Res. 2, 175 (1949).
- 6 M.F. Day, Aust. J. scient. Res. 4, 136 (1951).
- 7 O.P. Agrawal and J. Bahadur, Natl Acad. Sci. Lett. 1, 41 (1978).
- 8 O.P. Agrawal and J. Bahadur, Bioresearch, in press (1978).
- 9 G. Noelling and P. Bernfeld, Helv. chim. Acta 31, 286 (1948).