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AMYLASE ACTIVITY OF THE DIGESTIVE TRACT OF THE PRAWNS, *PENAEUS INDICUS* AND *METAPENAEUS MONOCEROS*

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ABSTRACT

S. K. Karunakaran and K. P. Dhage (1977). *Amylase activity of the digestive tract of the prawns,* Penaeus indicus *and* Metapenaeus monoceros. Bull. Inst. Zool., Academia Sinica **16**(2): 85-90. Amylase activity of the extract of the different parts of the alimentary canal and hepatopancreae of the prawns, *Penaeus indicus* and *Metapenaeus monoceros*, has been studied. The activity was determined by using 3, 5-dinitrosalicylate reagent. The activity was maximum in the extracts of the hepatopancreas and decreased along the posterior parts of the alimentary canal. In both the species the extracts of the cardiac foregut, pyloric foregut and hepatopancreas showed the optimum activity at slightly acidic medium, whereas intestinal extracts showed the optimum activity at neutral medium. Temperature optimum was between 35° and 40° for both the species. Optimum activity of the enzyme was between 3.0 and 3.5 per cent of starch.

A number of workers (Roaf[9,10]; Yonge[15]; Wiersma and van der Veen[14]; Reddy[8]; Gopalakrishnan[5]; Sarojini[11]; Agrawal[1,2]; Chinnayya[3]) have recorded the presence of amylolytic and/or lipolytic enzymes in the hepatopancreas or in the different parts of the alimentary canal of various crustacea. However, almost nothing is known about the distribution and functional characteristics of these enzymes in the food canal or in the digestive glands, of two economatically important and commonly occurring marine prawns, *penaeus indicus* and *Metapenaeus monoceros* of India. A comprehensive study of these aspects in the biology of these animals is likely to elucidate the probable nature of the complex and diverse feed of these animals and thus provide useful information for adjusting their diet to procure better growth in prawn-cultural practices.

This communication specifically deals with the determination of amylase activity of the different parts of the alimentary tract and hepatopancreas of these two crustaceans in relation to pH, temperature and substrate concentration.

MATERIALS AND METHODS

Live specimens of *Panaeus indicus* and *metapenaeus monoceros* were produced from Verosva and Thana creeks, Bombay, respectively. They were acclimatized to the laboratory conditions and starved for four days.

The live specimens were sacrificied and the alimentary canal along with the hepatopancreas was removed and kept at 0°C. The cardiac foregut, pyloric foregut, intestine and hepatopancreas were separated and they were washed with water at 0°C after removing the outer covering. One per cent aqueous extracts of the above parts were prepared in water at 0°C. These extracts were then centrifuged and supernatants were used as the source of the enzyme. A few drops of toluene were added to prevent any fungal or bacterial growth and the extracts were used immediately thereafter.

The estimation of the amylase activity was made as described by Hawk[6] using dinitrosalicylate reagent (DNSA). The reaction mixture consisted of 1 ml of 1.0 per cent starch solution, 1 ml of 0.5 per cent NaCl, 2 ml of Sorensen's phosphate buffer and 1 ml of the enzyme extract. To study the effect of H-ion concentration on the amylase activity the buffer solutions ranging from pH 5.8 to 7.8 were used. In order to study the effect of substrate concentration on the amylase activity the starch solution ranging from 0.5 per cent and 4.0 per cent were used at optimum pH. These reaction mixtures were incubated for 30 minutes at 37°C. In order to determine the effect of temperature on the amlase activity the reaction mixture at optimum pH was incubated at different temperatures between 20°C and 50°C for 30 minutes. The optical density of the solution was measured using Spectronic 20, at 530 mμ(wave length), in comparison with the control tubes in which boiled extract was used.

RESULTS AND DISCUSSION

Enzymes in the digestive gland, its nature and strength are presume to be depending on the feeding habits of the animal concerned (Yonge[16]; Vonk[12,13]).

Vonk[13] reported that in crustaceans the enzymes are entirely secreted by the hepatopancreas. So far amylase is concerned its presence in crustaceans has been detected in this tissue

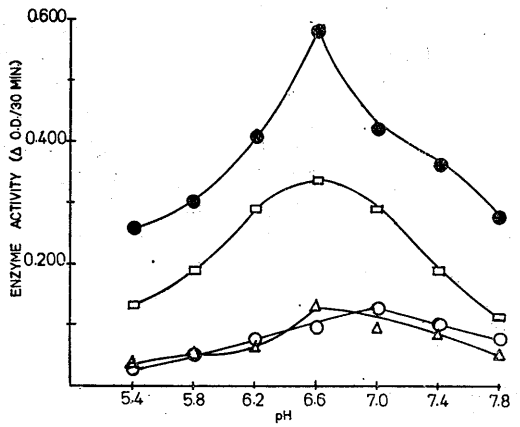

Fig 1. Effect of H-ion concentration on amylase activity in *Penaeus indicus*

●—Hepatopancreas; □—Cardiac foregut; △—Pyloric foregut; ○—Intestine.

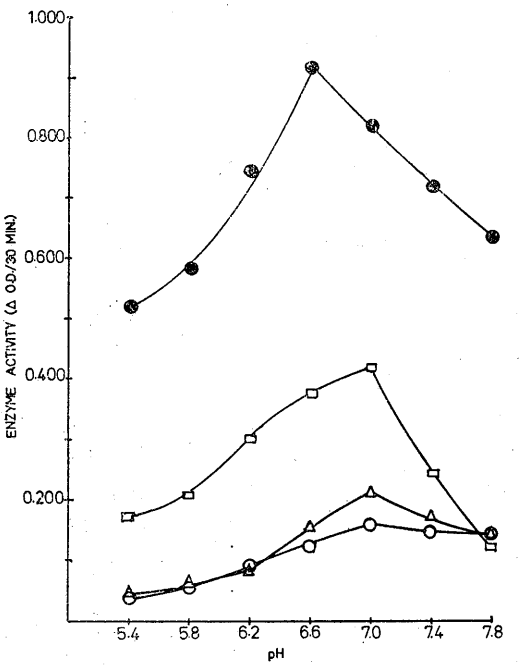

Fig. 2. Effect of H-ion concentration on amylase activity in *Metapenaeus monoceros*

●—Hepatopancreas; □—Cardiac foregut; △—Pyloric foregut; ○—Intestine.

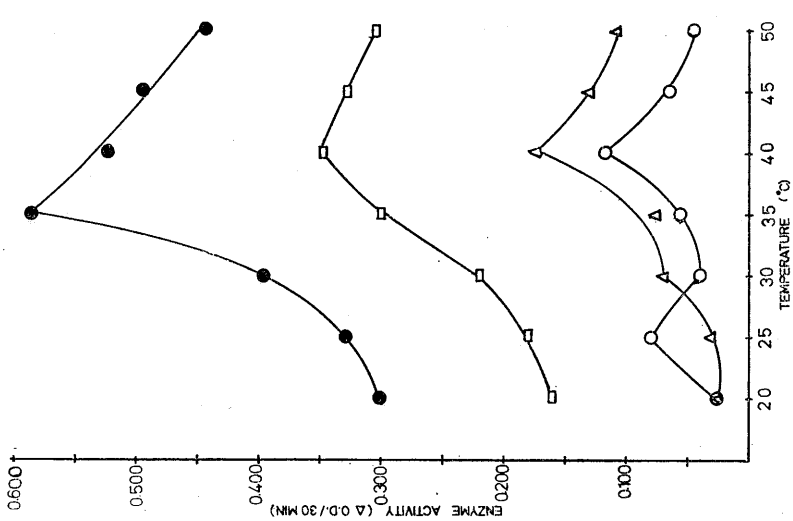

Fig. 3. Effect of temperature on amylase activity in *Penaeus indicus*

●—Hepatopancreas; □—Cardiac foregut; △—Pyloric foregut; ○—Intestine.

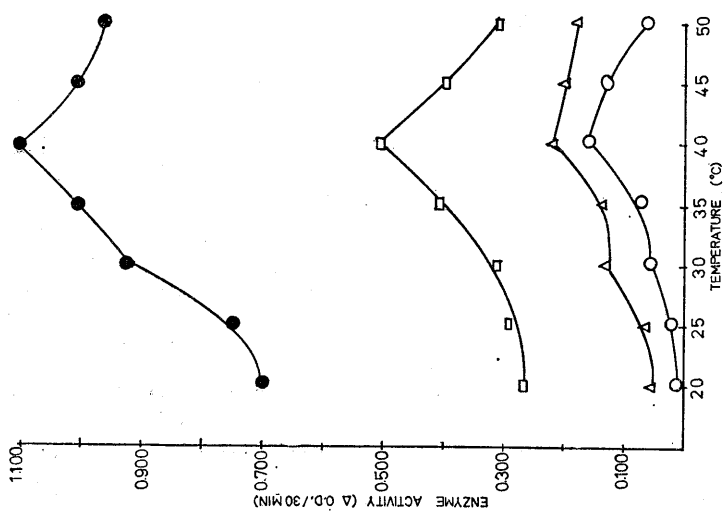

Fig. 4. Effect of temperature on amylase activity in *Metapenaeus monoceros*

●—Hepatopancreas; □—Cardiac foregut; △—Pyloric foregut; ○—Intestine.

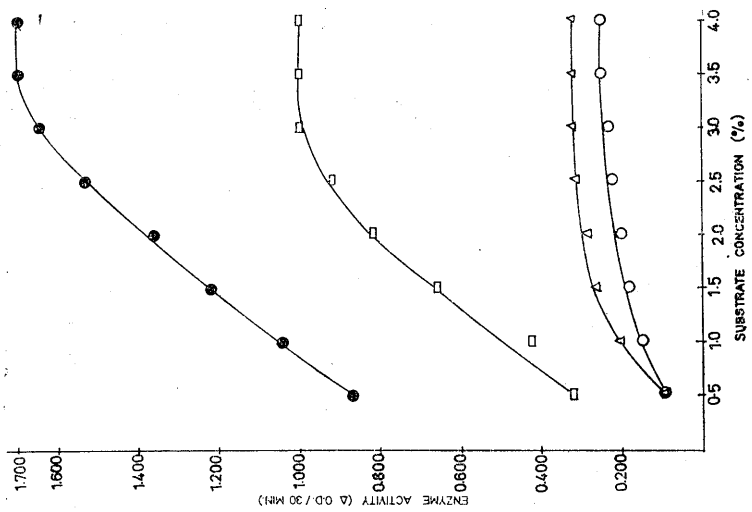

Fig. 6. Effect of substrate concentration on amylase activity in *Metapenaeus monoceros*.
●—Hepatopancreas; □—Cardiac foregut;
△—Pyloric foregut; ○—Intestine.

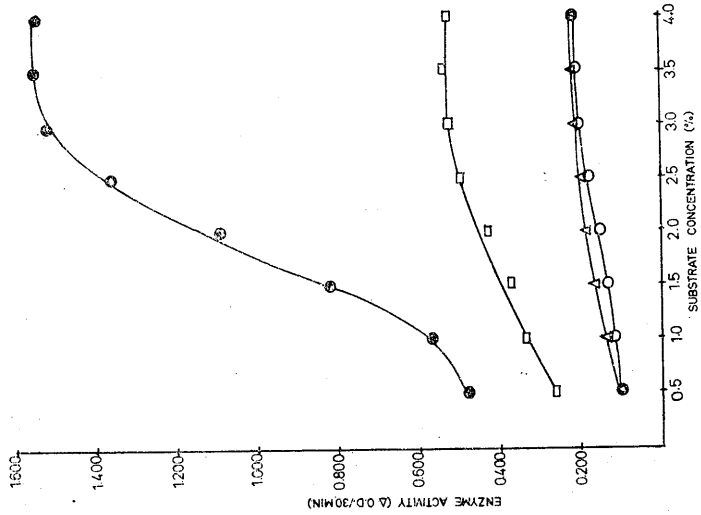

Fig. 5. Effect of substrate concentration on amylase activity in *Penaeus indicus*.
●—Hepatopancreas; □—Cardiac foregut;
△—pyloric foregut; ○—Intestine.

of *Nephrops* (Yonge[15]). *Astacus* (Wiersma and Van der Veen[14]), *Penaeus* (Gopalakrishnan[5]), and a member of *Caridina* (Chinnayya[3]). Its occurrence in the digestive tract, in general, was however recorded by Kooiman[7] in *Homarus* and *Astacus* by Agrawal[1,2] in *Orchestia* and *Potaman.* In the present study the activity of amylase was monitored in the cardiac foregut, pyloric foregut, intestine and in the hepatopancreas of both *P. indicus* and M. *monoceros.*

Concerning the effect of H^+ concentration on the amylase activity of the hepatopancreas, Wiersma and Van der Veen[14] reported the optimum pH as 5.5 and 5.8 in *Astacus.* Reddy[8] described the pH optima, at neutral medium, in *Paratelphusa.* Goplakrishnan[5] described the optimum pH at 7.0 and 7.2 in *P. indicus,* while Chinnayya[3] reported 6.8 as otimum pH in *Caridina.*

The present study, however, shows that the pH optima for the amylase activity of hepatopancreas, cardiac foregut and pyloric foregut at pH 6.6 and of intestine at pH 7.0 in *P. indicus* (Fig. 1). In *M. monoceros* the hepatopancreas showed 6.6 as optimum activity pH while cardiac foregut, pyloric foregut and intestinal extract showed optimum activity at pH 7.0 (Fig. 2).

Referring the temperature optima, Wiersma and Van der Veen[14] showed the temperature optima for the amylase activity between 45° and 50°C in hepatopancreas of *Astacus* and Yonge[15] in *Nephrops* described the optimum amylase activity between 54° and 58°C, which has been reported as lethal temperature for *M. monoceros* (Karunakaran and Dhage[4]. The present work elucidates that in *P. indicus* the amylase activity of hepatopancreas was optimum at 35°C, whereas for cardiac foregut, pyloric foregut, intestine the optimum temperature was at 40°C (Fig. 3) In *M. Monoceros,* however all the parts of the alimentary canal including hepatopancreas showed 40°C as optimum temperature (Fig. 4).

There are no reports so far on the effect of starch concentration on amylase activity in crustaceans.

The present work which is first of the kind, at least in India, revealed that the amylase activity for both the species of prawns, *Penaeus indicus* and *M. monoceros,* showed maximum activity at 3.0 to 3.5% of starch (Fig. 5 & 6).

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蝦消化道之澱粉分解酵素

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蝦 (*Penaeus indicus* 及 *Metapenaeus monoceros*) 之消化道各部份及肝胰臟內之澱粉分解酵素活性分佈分別被測定。其中以肝胰臟具有最高之酵素活性，愈往消化道之後部，則此酵素活性愈低。幽門、賁門及肝胰臟之澱粉分解酵素最適活性是在微酸性 pH，而小腸之酵素則在中性 pH 下具有最高活性。酵素活性之最適溫度爲 30° 及 40°。酵素之最適基質濃度爲 3.0% 及 3.5% 的澱粉液。