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NEUROENDOCRINE REGULATION OF SUCCINIC DEHYDROGENASE ACTIVITY IN THE INDIAN APPLE SNAIL *PILA GLOBOSA* (SWAINSON)

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ABSTRACT

In a preliminary study of the neuroendocrine regulation of succinic dehydrogenase activity in *Pila globosa* (Swainson) it was found that two distinct principles are employed to regulate the enzyme activity during active life and aestivation—one promotes the SDH activity and is mainly localized in the cerebral ganglia of active snails and the other inhibits the enzyme activity and is present in cerebral, pleuropedal and visceral ganglia of aestivating snails.

INTRODUCTION

EARLY investigations of Holtz and von Brand (1940)[1] have implied the existence of some sort of control in the metabolism of molluscs. Meenakshi (1956)[2] has shown the injection of cerebral ganglia extracts from aestivated snail decreased the oxygen consumption in active *Pila virens*. However, studies on metabolic regulation in molluscs are quite meagre[3–10] as most of the studies were concentrated on the regulation of cardiac activity,[5 11 12] vitellogenesis[10], ovulation[13–20] growth and reproduction[21] and cell differentiation[22].

The present investigation aims to study the neuroendocrine regulation of succinic dehydrogenase (SDH) activity by different ganglia of active and aestivated *Pila globosa* (Gastropoda, Mollusca) with special reference to digestive gland and foot tissues.

MATERIALS AND METHODS

Freshly collected snails were stored in aquarium tanks and fed *ad libitum* with *Hydrilla* and *Vallisneria* and used for experiments on the next day. A batch of snails were induced to aestivation as described elsewhere[23], for a period of six months. About one hundred snails were used in the present study. Cerebral, pleuropedal and visceral ganglia of active and aestivated snails were carefully isolated in cold and the like ganglia were pooled. One per cent homogenate was prepared in 80% ethanol and centrifuged. The clear 0·2 ml of supernatant was injected into each separate active snail. Control snails received 0·2 ml of 80% ethanol only. The animals were sacrificed at 15, 30, 60, 120 and 180 minutes and the foot and midgut gland tissues were excised, and used for the enzyme assay. Succinic dehydrogenase activity was estimated by the modified method of Nachlas *et al* [24,25].

RESULTS AND DISCUSSION

In the midgut gland of active animal, the SDH has shown more pronounced response to the cerebral

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ganglia extract than pleuropedal and visceral ganglia (Fig. 1). By 30 minutes, the SDH activity level

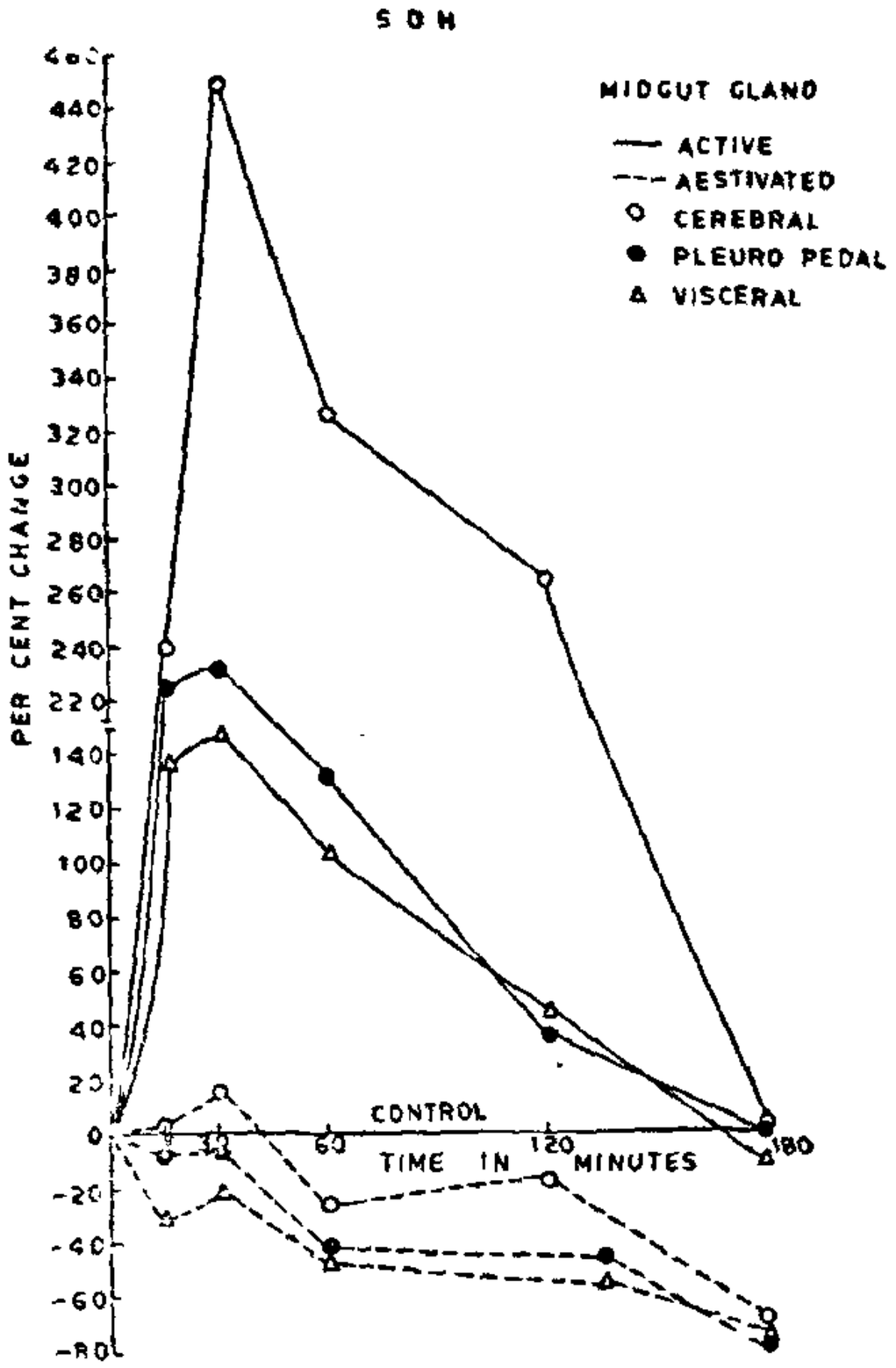

FIG. 1. SDH activity in the midgut gland of active snail *Pila globosa*: effect of cerebral, pleuropedal and visceral ganglia extracts of active and aestivated snails on enzyme activity. Enzyme activity in experimentals shown as per cent change over control.

showed an increase of 450% over the controls, which later on gradually decreased and returned towards the control level in about 3 hours, due to the effect of cerebral ganglia whereas the pleuropedal and visceral ganglionic extracts showed elevations of 230 and 150% respectively in 30 minutes which later on gradually showed a decrease reaching the control level in about 3 hours. Thus the cerebral ganglia of active animal appear to exercise a distinct activating effect than the other two ganglia.

Contrary to this pattern of increased enzyme activity, the administration aestivated snail ganglia extracts showed an inhibitory tendency by all the three types of ganglia, while visceral ganglia elicited somewhat higher inhibition than the cerebral and pleuropedal ganglia, in general. It is likely that the activating principle of the active snail ganglia is neither present nor synthesized in the aestivating snail ganglia.

In foot tissue, the SDH response to the administration of ganglionic extracts was different (Fig. 2).

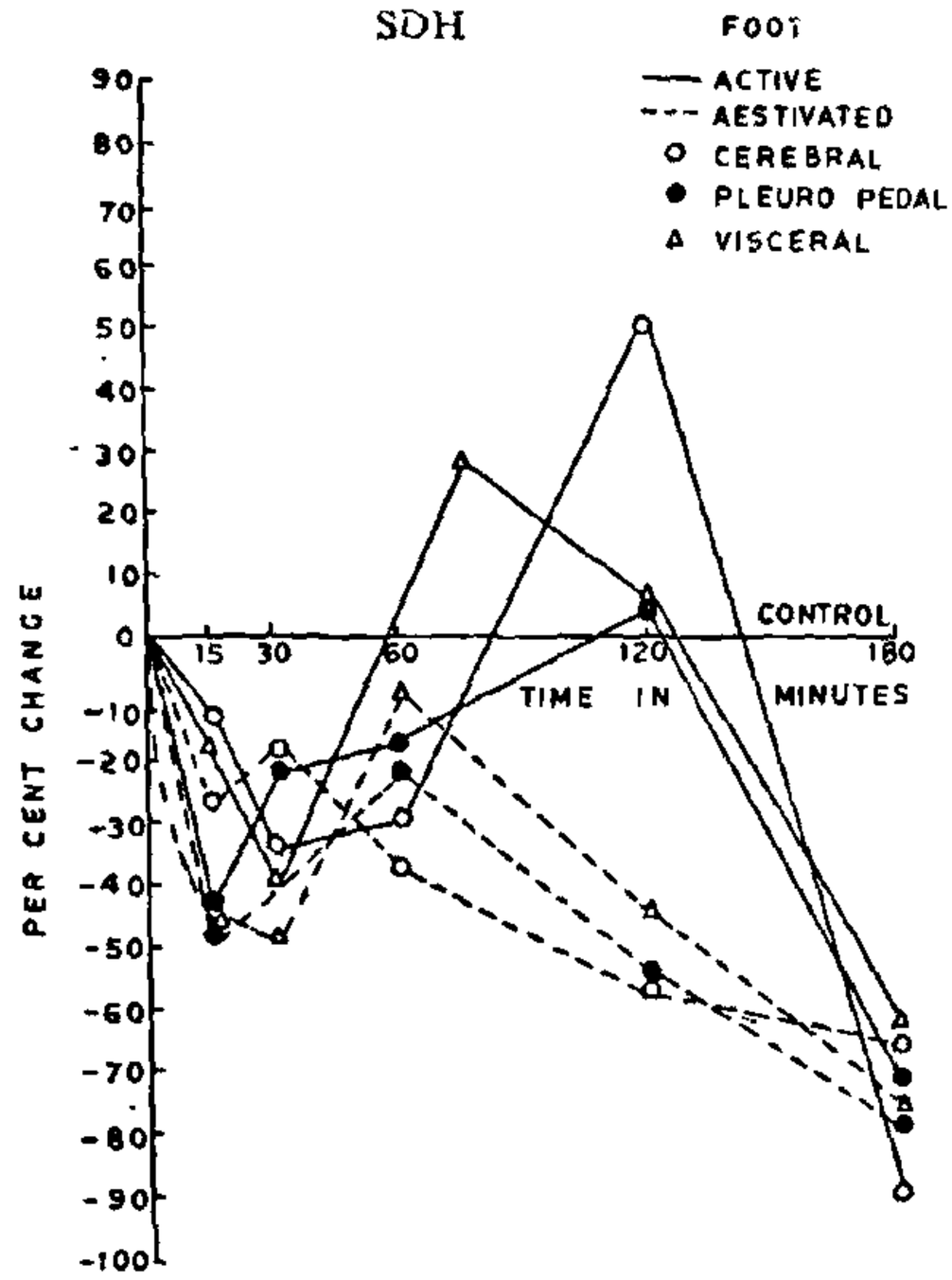

FIG. 2. Effect of active and aestivated snail ganglia (cerebral, pleuropedal and visceral) extracts on the SDH activity of foot tissue of active snail *Pila globosa*. Enzyme activity shown as per cent change in experimental over control.

In general, there was inhibition of enzyme activity by the active snail ganglia extracts till one hour. However, there was an increase in the enzyme activity at two hours and the increase was significant in the case of cerebral ganglia only. Later, the enzyme activity decreased and the per cent decrease was between 60 to 90 for all the three ganglia from active snails.

The administration of aestivated snail ganglia extracts showed a marked inhibition of SDH activity throughout the temporal sequence. However, the inhibition was not consistent till one hour and thereafter the nhibition steadily increased in response to all the three types of neuronal extracts. Evidently, the inhibitory effect is more pronounced in the case of aestivated snail ganglia extracts than those of active snails.

In the present stcdy, a significant feature is that, in both the midgut gland and foo tissues, the extracts of all the three ganglia from aestivated snails have inhibited the SDH activity throughout the time course of the experiment. Of all the three ganglia from active

snails, the cerebral ganglia seem to have a major role in the regulation of oxidative metabolism of the snail. On the other hand, the aestivated snail ganglia not only lost the activating principle but also synthesized an inhibitory principle.

Though the response was different in the SDH activity of foot, the cerebral ganglia extract of active animal had shown about 50% increase in the later period of the temporal sequence. Thus, the cerebral ganglia seem to be the major site of synthesis of a principle which promotes SDH activity in the active snail whereas the inhibitory agent seems to be present almost in equal proportions in all the three ganglia of the aestivated snails.

Earlier observations on the enzyme activity have shown that SDH activity decreases significantly during aestivation in *Pila globosa*[26-27] and the present investigation adds credence to their contention and shows that the decreased SDH activity during aestivation may be due to the neuro endocrine factors elaborated in the ganglia of the nervous system. Injections of cerebral ganglia extracts have decreased the oxygen consumption in *Pila virens*[2]. Based on the observations of Meenakshi[2], in addition to his own observations, Raghupathirami Reddy[26] had suggested that the inhibition of SDH activity may be due to a steroid hormone. There is good evidence that the steroid hormones inhibit the oxidative enzyme[28] and electron transport[29].

In *Pila globosa*, steroid hormones may be the likely candidates as the principles in question have been extracted in 80% ethanol in the present study and the concept gains further support in the light of Meenakhi's[2] observation that the sterol concentration increases ten fold during aestivation in the cerebral ganglia of *Pila virens*.

Thus, the present preliminary investigation has revealed the operation of two distinct types of neuroendocrine principles (probably steroid in nature), to regulate the SDH activity, during the active and aestivated life of the Indian apple snail, *Pila globosa* —the activating principle mainly localized in the cerebral ganglia of active snail and the inhibitory principle almost uniformly distributed in all the three ganglia tested from the aestivated animals.

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