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Changes in Carbohydrate Metabolism in Tissues of Freshwater Mussel (*Lamellidens marginalis*) Exposed to Phosphamidon[1]

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Water pollution has been increasing at an alarming rate due to indiscriminate use of pesticides (PINKOVSKI 1972). Organophosphorus pesticides are widely used since they are biodegradable and seldom leave residues but for a short time (BOOKHOUT & MONROE 1977). Much work has been conducted by earlier workers on the metabolism and biodegradation of pesticides in different animals (O'BRIEN et al. 1961; HULLINGWORTH et al. 1967; CAPPON & NICHOLAS 1975). In the present investigation, the changes in the carbohydrate metabolism in selected tissues of freshwater mussel were studied during induced toxicity of phosphamidon, an organophosphorus pesticide. These mussels are not only indicators of local pesticide distribution, because they do not migrate extensively within or from their native stream, but also as filter feeders, they are exposed to particulate components and can sorb toxic materials as well as dissolved substances in water (CHAISE-MARTIN 1977). Apart from this, these mussels have some economic value, since they are consumed by some poor people in certain areas of south India.

MATERIALS AND METHODS

Lamellidens marginalis were collected from the ponds in and around Tirupati and fed ad libitum with plankton. Prior to use, they were acclimatized to laboratory conditions for one week and starved before the day of experimentation (JONES 1972). The LC_{50} (20 ppm) was determined by the method of BAYNE et al. (1977). Mussels exposed to a sublethal concentration (8 ppm) of phosphamidon for 48 h were used in the present study. Hepatopancreas, foot, and mantle tissues isolated from the normal and experimental mussels were used for the present study.

Determination of glycogen and lactate levels: 5% Tissue homogenates were prepared in 10% trichloroacetic acid (TCA) and cen-

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tifuged at 750 g for 10 min. The supernatants were collected, and the glycogen levels were determined by the method of CARROL et al. (1956). The lactate levels were determined by the method described by BARKER & SUMMERSON (1941).

Estimation of aldolase activity: 5% Tissue homogenates were prepared in cold distilled water and centrifuged at 1000 g for 15 min. The supernatants were used for the estimation of aldolase activity by the method described by BRUNS & BERGMEYER (1965).

Estimation of lactate (LDH), succinate (SDH) and malate (MDH) dehydrogenases: 5% Tissue homogenates were prepared in cold 0.32 M sucrose solution and centrifuged at 1000 g for 15 min to remove the cell debris. A clear cell-free extract was used for the estimation of the dehydrogenases by the method described by NACHLAS et al. (1960) with slight modification.

Protein content was determined by the method described by LOWRY et al. (1951).

RESULTS

The glycogen levels were decreased in the tissues of mussel on exposure to phosphamidon. The decrease was more in hepatopancreas as compared to the foot and mantle tissues. Whereas, the lactate levels were increased and the increase was more in the foot followed by hepatopancreas and mantle (Table 1).

Table 1. Levels of glycogen and lactate (mg/g wet wt. tissue) in tissues of normal and experimental mussels (each value is ± SD of 6 observations.

	Hepatopancreas		Foot		Mantle	
	cont.	expt.	cont.	expt.	cont.	expt.
Glycogen	26.73 ±1.96	18.73[a] ±1.82 (-29.9)	22.79 ±2.09	17.60[a] ±1.52 (-22.8)	17.65 ±1.45	14.96[a] ±1.38 (-15.2)
Lactate	0.065 ±0.008	0.081[b] ±0.007 (+24.6)	0.095 ±0.008	0.124[a] ±0.009 (+30.5)	0.042 ±0.005	0.048[c] ±0.003 (+14.3)

Values in parentheses are per cent deviations over control.
P values a = $P < 0.001$; b = $P < 0.005$; c = $P < 0.01$

An increase in aldolase activity and a decrease in LDH, SDH & MDH activity levels were observed in the tissues of experimental mussel (Table 2). In general these changes were more pronounced in hepatopancreas and foot as compared to the mantle.

Table 2. Activity levels of aldolase (µmoles of fructose 1,6-diphosphate cleaved/mg protein/h) and dehydrogenases (µmoles of formazan formed/mg protein/h) in tissues of normal and experimental mussels (each value is ± SD of 6 observations).

Enzyme	Hepatopancreas		Foot		Mantle	
	cont.	expt.	cont.	expt.	cont.	expt.
Aldolase	1.35 ±0.09	1.68[a] ±0.09 (+24.4)	1.08 ±0.09	1.34[a] ±0.09 +24.1)	0.85 ±0.07	0.96[a] ±0.08 (+12.9)
LDH	0.36 ±0.02	0.28[a] ±0.02 (-22.2)	0.30 ±0.02	0.22[a] ±0.02 (-26.7)	0.24 ±0.02	0.20[a] ±0.02 (-16.7)
SDH	0.69 ±0.04	0.52[a] ±0.04 (-24.6)	0.56 ±0.04	0.45[a] ±0.03 (-19.6)	0.47 ±0.02	0.39[a] ±0.02 (-17.0)
MDH	0.73 ±0.05	0.57[a] ±0.04 (-21.9)	0.61 ±0.05	0.51[a] ±0.03 (-16.4)	0.51 ±0.04	0.44[b] ±0.03 (-13.7)

Values in parentheses are per cent deviations over control.
P values a = $P < 0.001$; b = $P < 0.005$

DISCUSSION

The decrease in glycogen content in the tissues of mussels exposed to phosphamidon suggests its mobilization to meet the energy demand warranted by the toxic environment (WASSERMANN et al. 1970). EDWARDS (1973) has reported that the synthesis and utilization of glycogen are altered during pesticide toxic stress. The decrease in glycogen levels observed in the present study might be due to the prevalence of hypoxic or anoxic conditions which normally increase glycogen use (DEZWAN & ZANDEE 1972). An anoxic condition in mussels exposed to methyl parathion was reported in this laboratory (SRINIVASA MOORTHY 1982). Increased lactate levels in the tissues of experimental mussel also supports this speculation. An increase in aldolase and a decrease in LDH activity levels resulted in the elevation of lactate levels in the tissues. This suggests that there is a shift in the respiratory metabolism towards anaerobiasis. The prevalence of facultative anaerobiasis generally results in decreased oxidative metabolism (SRINIVASA MOORTHY et al. 1982). The decreased activity levels of tricarboxylic acid (TCA) cycle enzymes, SDH and MDH could be attributed to the decrease in respiratory rate during organophosphorus pesticide stress (O'BRIEN 1967). Most of the TCA cycle enzymes are of mitochondrial origin, and any structural change in these enzymes induced by the pesticide might influence their activity levels (MIVOGLAW 1973). The present study concludes that phosphamidon decreases oxidative metabolism in the tissues of the mussels. Consequently these mussels switch over to anaerobiasis as an adaptive measure to combat the induced pesticide toxicity.

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