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PALATABILITY OF TISSUES IN *HOLOTHURIA LEUCOSPILOTA* (BRANDT) FROM CENTRAL WEST COAST OF INDIA

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ABSTRACT: The palatability of various organs (body wall, cuvierian gland, viscera, longitudinal muscle bands and gonads) of sea cucumber *Holothuria leucospilota* (Brandt) was studied by feeding experiments, performed on a freshwater fish *Sarotherodon mossambicus* and a marine fish *Therapon jarbua*. The result shows that the food pellets of the body wall were less toxic and more palatable than the gonads, viscera and cuvierian gland ($p<0.001$).

KEY WORDS: Palatability - *Holothuria leucospilota* - *Sarotherodon mossambicus* - *Therapon jaruba* - India.

INTRODUCTION

Bakus (1968) has postulated that low incidence of exposed organisms are caused by grazing and browsing of fishes. The cryptofaunistic behaviour of these marine invertebrates are dissipated rapidly when they are exposed to fishes. Certain soft-bodied invertebrates, particularly sponges and holothurians when exposed to reef fishes, are reported to be toxic to the fishes (Bakus, 1974). These studies led to the postulation of a general hypothesis on the evolution of defensive mechaisms in invertebrates (Bakus 1969, 1974). Bakus *et al.* (1986) suggested that as species diveristy in fishes increased in tropical shallow marine waters, competition for food created pressure on the evolving sources *i.e.* in many cases to more specialized feeding habits. This competitive pressure was reflected in a natural selective force operating on the prey and grazed organisms which favours individuals with a built-in chemical defense mechanism, for preventing predation and grazing by fishes.

It has been demonstrated that certain marine animals make themselves distasteful to predators by the secretion of defensive 'repellent' substances (Garstang, 1890; Bullock, 1955; Thompson, 1960). Some marine organisms are known to contain toxins (Halstead, 1965; Rideout *et al.* 1979). Soft corals, sponges, holothurians and other invertebrates contain an extensive range of secondary organic molecules, majority of which fall into the terpene class of compound which are to be distasteful (Lucas *et al.,* 1979). Diterpenes, sinularin and dihydrosinularin and sarcophine compounds are quite toxic (Neeman *et al.*, 1974; Weinheimer *et al.*, 1977) and these secondary metabolites function as chemical defense against predation, fouling and parasitism.

Fishes eagerly accept some animal baits. On this basis, different degrees of 'palatability' ranging to 'unpalatability' was postulated (Russel, 1966). The studies, on the anti-predatory role of the marine invertebrates have resulted in this development of a technique for assaying fish (most frequently freshwater fish) in extracts of the test organism and observating toxic effects of secondary metabolities (Russel, 1966; Birkhead, 1972; Neeman *et al.*, 1974; Rideout *et al.*, 1979; Bakus and Thun, 1979; La Barre *et al.*, 1986; Camazine, 1983; Camazine *et al.*, 1983; Gerhart, 1984, 1986 and Pawlik *et al.*, 1986).

Holothurians have evolved a variety of anti-predatory mechanisms (Bakus, 1968, 1973, 1974; Bakus and Green, 1974). These include formation of cryptic and aposematic colouration, thick integument, toxic and noxious skin, autotomy and evisceration. Sea cucumbers can secrete mucus from their integument which may be toxic, saponin laden and hence play a vital role in the defensive capabilities of these animals (Russel, 1966; Bakus, 1973).

In the present study, feeding experiments were performed on two different fishes; freshwater fish *Sarotherodon mossambicus* (Peterson) and marine fish, *Therapon jarbua* (Forskål) to evaluate the palatability of different tissues of the sea cucumber, *Holothuria leucospilota*.

MATERIALS AND METHODS

Sea cucumbers, *H. leucospilota* measuring 20 - 30 cm in length were collected from the intertidal pools of Anjuna (15^0 34' 45" N; 73^0 44' 20" E), Goa, India and extracted separately for body wall, cuvierian glands, viscera, gonads and longitudinal muscle bands. The general technique used here to determine palatability was that by Bakus (1981) and Bakus and Thunn (1979). The test organisms (4 - 6 cm in length) of *S. mossambicus* and *T. jarbua* were collected from Government Fish Farm (Goa) and from the same intertidal pools where the holothurians were collected. The fishes were acclimatised to the laboratory conditions for 10 days. For each test 15 fishes were added to the aquarium (7 litre) and starved for 2 days prior to the initiation of the feeding experiment. Four trials were conducted with each fish by offering all different organ extracts, separately. Control fishes were fed plain (untreated) fish food. Each fish was observed for 8 hours and the observations were categorized as consumed, mouthed and rejected. Similar experiments were run by using the marine fish.

RESULTS

Table I incorporates the data on freshwater fish, *S. mossambicus* fed on pellets of various organs of *H. leucospilota*. Longitudinal muscle bands and body wall food pellets were consumed at the same rate as that of the control food. The cuvierian gland (78.33%), viscera (74%), and gonads (71.65%) were mouthed and rejected significantly more than the control ($p<0.001$). Viscera pellets were consumed by 26% and 74% rejected, while 66.7% of fishes consumed body wall pellets and 33.3% rejected. Longitudinal muscle pellets were consumed by 80% of the fishes and 20% rejected.

In a similar experiment, with the marine fish (*T. jarbua*) observations were contrary to those reported above. The fish readily consumed the food pellets of body wall and longitudinal muscle (100%). After 2 hours, 100% mortality was observed due to the consumption of body wall. However, in the case of longitudinal muscle no mortality occurred even after 24 hours of the consumption. The fishes, took the food pellets of gonad, viscera, and cuvierian glands in the mouth but rejected immediately. The fishes which were offered the cuvierian gland food pellets died within 30 minutes, though they had not consumed the food whereas among the fishes which were offered the viscera food pellets, 50% mortality was observed in 4 hours, and for gonad food pellets, 100% mortality occurred in an hour (Tables I and II).

TABLE I: Palatability of body wall, longitudinal muscle bands, gonads, viscera and cuvierian glands of *Holothuria leucospilota* to *Saratheradon mossambicus* (No mortality was observed).

Category	Body wall	Longitudinal muscle bands	Gonads	Viscera	Cuvierian glands
I. Consumed	40 (66.7%)	40 (80.0%)	17 (28.33%)	13 (26.0%)	13 (21.67%)
II. Mouthed & rejected	20 (33.3%)	10 (20.0%)	43 (71.67%)	37 (74.0%)	47 (78.33%)

TABLE II: Palatability of body wall, longitudinal muscle bands, gonads, viscera and cuvierian glands of *Holothuria leucospilota* to *Therapon jarbua*

Category	Body wall		Longitudinal muscle bands		Gonads		Viscera		Cuvierian glands	
	Consumed	Mortality at (hrs)	Consumed	Mortality at (hrs)	Consumed	Mortality at (hrs)	Consumed	Mortality at (hrs)	Consumed	Mortality at (hrs)
I	45 (100%)	< 2 (100%)	45 (100%)	-	7 (15.56%)	< 1 (100%)	4 (6.67%)	4 (60%) 24 (100%)	3 (5%)	0.5 (100%)
	Mouthed & rejected	Mortality at (hrs)	Mouthed & rejected	Mortality at (hrs)	Mouthed & rejected	Mortality at (hrs)	Mouthed & rejected	Mortality at (hrs)	Mouthed & rejected	Mortality at (hrs)
II	0	-	0	-	38 (84.44%)	< 1 (100%)	56 (93.33%)	4 (60%) 24 (100%)	57 (95%)	< 0.5 (100%)

DISCUSSION

Field and laboratory studies on holothurians, reported earlier (Bakus, 1969, 1973, 1974), show that the starved fish rarely consumed the tropical forms but readily ate mildly toxic non-tropical species. Bakus (1981) has designed his experiments to inquire how marine fish can detect and/or reject a toxic food source in the field. The white muscle of a common toxic holothurian, *Holothuria atra*, was mouthed frequently by fish but rejected. This suggests that the colour may be unimportant but chemo-reception is important. The fact that black epidermis was mouthed in the present experiments may indicate that toxins from small pieces of epidermis of *H. leucospilota* are not deterrent to fish feeding. Previous observations have demonstrated that toxin is secreted in copious amounts but only when *H. atra* are irritated (Bakus, 1969, 1973). The results of Rideout *et al.*, (1979) and Lucas *et al.*, (1979), suggest that marine fish may learn to avoid toxic organisms by trial and error feeding.

It has been inferred that toxicity offers an important adaptation for organisms otherwise defenseless against predation (La Barre *et al.*, 1986; Faulkner and Giselin, 1983). The toxicity, although common, does not occur in high frequency lacking mechanisms of escape or physical defense (Bakus, 1981).

Devore and Brodie (1982) have shown that the tissues of sea cucumber *Thyone briareus* (Lesueur) are avoided by fish predators. The presence of tough integument discourages predation. In some trials the integument blocked the fish's oesophagus or lodged in the throat. In *T. briareus*, the integument has a monolayered epidermis which secretes mucus through epidermal cells, desmosomes (Menton and Eisen, 1970).

Holothuria leucospilota has thick body wall and toxic cuvierian glands. The food pellets of gonads, viscera and cuvierian glands are distasteful to the fish experimented presently. The preference to the body wall of *H. leucospilota* by the fish can be explained by its less toxic nature. Though the toxic saponin concentrations were low in the food pellets of different organs, it caused mortality of the fish, *T. jarbua*, which could be explained on the basis that the species used has lesser tolerance to the toxic solution compared to that of *S. mossambicus*.

It has been reported (Scheuer, 1978) that tropical holothurians have developed certain defensive mechanisms such as secretion of toxic cuverian tubules which paralyses or entraps the predator. The toxins from the cuvierian tubules and the integument are used for prey capture. The noxiousness of the cuvierian glands, viscera and gonads increase the survival and existence of sea cucumbers more than the toxic nature of other tissues (Lane, 1968). This suggests that the components which are responsible for repulsing the fish predators have evolved as antipredator adaptions.

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