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Effect of Salinity on Bioenergetic Content of *Melanoides tuberculata* (Gastropoda: Mollusca)

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Abstract

Energy content of *Melanoide tubercylata* collected from Wadi Fatimah area at western region of kingdom of Saudi Arabia was studied in snails exposed to different concentrations of salinities using a microbomb calorimeter. The survival rate was affected by salinity, the lower mortality occurs between 2-6% salinity, LD_{50} lies between 8-12% while the upper mortality occurs between 14-25% of salinity. The results showed clearly that exposing snails to different salinity percentage for 6 weeks affected the energy content of these snails. The present results indicated that the energy content of *M. tuberculata* elevates with the increase in salinity level.

Introduction

The survival of organisms under stress conditions of salinity was studied by many investigators, (Arnold, 1972; Jones, 1975; Sander and Moore, 1974; Tolba, 1981; Holdich & Tolba, 1981; Hijji, 1986 and Tolba & Hijji, 1992). Many techniques are now being used to determine the relationship between the physiological activities of the living organisms and the ranges in the environmental parameters such as respiration, growth, food consumption, energy content (Adams & McLean, 1985; Brafied, 1985 and Cui & Wootton, 1989). Bio-energetic modeling such as mathematical one provided a powerful technique for estimating the growth and rates of food consumption of fish in natural population (Kitchell, 1983). But these models are too relatively time- consuming to be measured. However, the calorimetric technique is commonly used in determining the calorific values of organic compounds in the field of thermodynamic studies (Jones, 1975; Khadzhiev, et al., 1980, Da Silva, et al., 1984 and Knauth & Sabbah, 1989).

Experimental techniques in consumption calorimetry consist of burning a sample in bomb field with pure oxygen and measuring the amount of energy transferred to calorimeters. Conventional calorimeters are designed for small samples; one of these calorimeters is the one which has been used in the present study. Application of calorimetric technique in measuring the bioenergetic content of the living organisms is very rare in spite of the advantages which this technique has, such as, the simplicity, the accuracy as well as time saving. Wadi Fatima lies at the Western coast of Saudi Arabia. In this area many salt wells are present. The gastropod *M. tuberculata* is widely existing in the fresh water bodies at this area near the salt wells and this made the possibility of exposing to different salinities. Therefore, the present work was conducted to study the possible effect of different salinity levels on the calorific value of this snail.

Material and Methods

1- Collection of Snails:

Sample of the young fresh water snail, *Melanoides tuberculata* were collected from the water bodies at Wadi Fatima area in Makkah Al-Moukarramah using specially designed net. The collected samples were brought back to the laboratory of Faculty of Applied Sciences, Umm Al-Qura University. At the laboratory the snails were kept in glass containers with some vegetations from the collected area. The snails were fed lettuce and maintained at a temperature of 20 ± 5°C.

Snails with shell length between 12-14 mm were used in this investigation. Groups of 20 snails were exposed to low and high salinity levels which were prepared by addition of different concentrations of sodium chloride. For determinations of salinity limits, the animals were first acclimated for 48 hr. to various test conditions and then exposed to different salinity levels for 6 weeks. The number experiment deaths as well as the survival rate were determined. Shell weight, and dry body weight were made using an electric balance. The dry weight was obtained after drying the snails in an oven at 60°C until a constant weight was obtained.

2- Preparation of samples for calorimetric determinations:

Snails were removed from the experimental media after 6 weeks and the fleshes were removed from the shells. The fleshes were then plotted on a filter paper to remove the adhering water, dried in oven until constant weight was obtained. The dry flesh of each group was then grinded in horns. Tablets of the grinding materials were prepared using a pellet press. Preparing and loading the micro-bomb calorimeter were carried out in the same way as it has been described by Tolba and Hijji (1992).

Results

1- Survival Rate:

Data in table (1) show the survival rate in snails exposed to different concentrations of salinity. The lower mortality occurs between 2 and 6%, LD_{50} lies between 8 - 12% while the upper mortality occurs between 14-25% of salinity.

2- Changes in shell and dry weight:

Table (2) shows the mean values of shell weights and dry weights of *M. tuberculata* exposed to different percentages of salinity. It is clear that the differences between the mean of shell weight of the three groups are not significant. The mean dry weight showed insignificant increase being 28.3 ± 5.9 mg in the third group in comparison with 23.4 ± 4.2 mg in the controls.

3- Changes in calorimetric contents:

Data in table (3) shows the changes in sample mass and calorific contents in the three groups of snails. The mean calorific value in snails of the first group (2-6% of salinity) showed no difference from control group and the mean value was 0.142 ± 0.01 in group1 in comparison with 0.143 ± 0.01 cal / mg in control. On the other hand, the mean calorific values increased in the second (8 - 12 % salinity) and third group (14-25). This increase became significant ($P < 0.05$) in the third group and the mean calorific value was 0.277 ± 0.013 cal. / mg.

Discussion

The present results showed that snails *M. tuberculata* tolerate salinity at percentage of 2-6. Increased salinity percentage has resulted in greater mortality rate. This result, seems to be supported by Kinne's observation that, in general, invertebrates considered stenohaline tolerate salinity ranges of 10% or less (Kinne, 1971). The effect of salinity on freshwater invertebrates was studied by some investigators. Evans (1984) studied the tolerance of *Asellus aquaticus* to different salinity levels at different temperatures and pH levels. She found that increasing salinity resulted in greater mortality. Schemitz et al., (1967) investigated the salt tolerance of *Gammarus pulex* by toxicity experiments using mixed salt solutions starting from brackish water of marine type and relative ionic concentrations of Na^{+}/

Mg^{++}/ K^{+} and Ca^{++}. They found a higher proportion of Mg^{++} at the expense of Na^{+} decreases the salt tolerance and an optimum situation is found at the ionic relation of marine water in which Mg^{++} had been totally replaced by Na^{+}, the tolerance was slightly decreased again.

Famo and Rossi (1978) reported that increasing the salt concentration and time of exposure caused increased mortality. Tolba and Hijji (1994) found that the survival and development of *Gammarus aequicauda* eggs increased with decreasing salinity.

The results showed that salinity has a significant effects on the bioenergetic contents of *M. tuberulata.* Increased salinity elevated the bioenergetic contents as well. This can be explained due to the fact that the amount of energy for building up tissues for *M. tuberculata* under stress induced by different salinity degrees is more than the energy for those kept in normal conditions. However, the physiological response of living organisms to salinity variations has been reported by Jones (1975), Marsden (1973) and Dorgilo (1977). Most of these studies showed that any slight variation in salinity affected the physiological activities of living organisms.

Bioenergetic technique used in the present study provides a potentially valuable method for assessing the physiological state of *M. tuberculata.* The effective use of this technique will depend on further experimental studies which assess the environmental parameters, e.g. the effect of temperature, food items, reproductive state and pollution. In addition, the future possibilities of this technique should be briefly discussed for other organisms. For such studies special procedures should be developed in each investigation.

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تأثير الملوحة على الطاقة الحيوية فى القوقع ميلانويدس تربكيولاتا

(بطنقدميات: رخويات)

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درس هذا البحث تأثير درجة الملوحة على الطاقة الحيوية للقوقع ميلانويدس تربكيولاتا. تم تجميع العينات من وادى فاطمة بالمنطقة الغربية بالمملكة العربية السعودية ونقلت إلى المعمل وعرضت لدرجات ملوحة مختلفة. أظهرت النتائج أن معدل البقاء فى القواقع قد تأثر بالملوحة. وكانت أقل نسبة موت للحيوانات عند درجة ملوحة ٢-٦% بينما كانت LD_{50} عند ٨-١٢% درجة ملوحة ، أما أكبرها فكانت عند درجة ملوحة ١٤-٢٥%. وقد أظهرت النتائج أيضا أن الطاقة الحيوية للقواقع المعرضة لدرجات مختلفة من الملوحة لمدة ٦ أسابيع قد تأثرت حيث زادت الطاقة الحيوية بزيادة الملوحة.

Table (1): Survival rates of snails at various salinity during the experimental period

Groups	G1					G2			G3		
Salinity (%)	2	3	4	5	6	8	10	12	14	15	25
Experiment deaths	2	2	2	3	2	2	1	1	1	1	1
Survival rate	75	75	70	65	60	50	50	50	45	40	30

Total no. of animals = 20 per each salinity %.

Table (2): Values and ranges of shell weight and dry weight of *M. tuberculata* in three different groups of salinity

	Control				G1				G2				G3			
	Min.	Max.	Mean	S.E.	Min.	Max.	Mean	S.E.	Min.	Max.	Mean	S.E.	Min.	Max.	Mean	S.E.
Shell Wt.(mg)	155	239	177.2	5.6	154	240	178.3	5.9	153	243	179.9	6.2	159	245	185.7	6.6
Dry Wt. (mg)	23	25	23.4	4.2	22	25	23.7	4.3	24	27	25.5	5.1	27	29	28.7	5.9

Table (3): Values and ranges of sample mass and calorific values of *M. tuberculata* in three different groups of salinity

	Control				G1				G2				G3			
Sample mass	Min.	Max.	Mean	S.E.	Min.	Max.	Mean	S.E.	Min.	Max.	Mean	S.E.	Min.	Max.	Mean	S.E.
	22	52	28	3	23	53	29	3.1	25	55	39	3	26	56	42	2.7
Cal. value (cal/gm)	0.123	0.222	0.142	0.01	0.124	0.226	0.143	0.010	0.128	0.237	0.198	0.012	0.139	0.299	0.227*	0.013

* Significant at $P < 0.05$