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Trace element content of Malaysian cockles (*Anadara granosa*)

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Neutron Activation Analysis (NAA) was used to determine the concentration of trace metals in Malaysian cockles (*Anadara granosa*). A total of 12 elements; Mg, Cl, Mn, K, As, Se, Br, Zn, Co, Fe, Rb and Cr were detected. Analyses were performed to examine the relationship between metal concentration and body weight. Results obtained showed a linear relationship between total metal concentration and body weight.

INTRODUCTION

The marine bivalve (*Anadara granosa*), cockles, locally known as 'kerang' are commercially cultured in the tidal mudflats along the western coast of Peninsular Malaysia. It is a popular gourmet seafood in Malaysia and its cultivation is a good revenue earner. Figure 1 shows the production tonnage of cockles for the years 1976–1991. In 1991, approximately 5500 hectares of cockle-rearing grounds produced about 55 500 metric tonnes of matured cockles. Apart from their exotic taste, cockles have more food value than beef (Panthasali & Soong, 1985).

Bivalves are known to have the ability to accumulate metals (Darracot & Watling, 1975). Although some of these metals may be essential, some may be hazardous for human metabolism especially when their concentration is high (Sherif *et al.*, 1979). The present study was conducted to determine the concentration of trace metals in *A. granosa* and the relationship between total metal concentration and body size of the cockle. We employ the methods of Neutron Activation Analysis (NAA). This technique provides a sensitive method for studying elemental content at meaningful precisions.

MATERIALS AND METHODS

Collection and treatment of samples

The marine bivalve mollusc (*A. granosa*) was collected as a single clump from the aqua culture area of Kuala Juru, Malaysia. Cockles of various shell length were depurated for 24 h before being transported to the laboratory in ice-cooled boxes. Upon reaching the laboratory, these cockles were kept frozen prior to further analysis. Tissues from the thawed samples were carefully removed using a stainless steel surgical blade and were then rinsed with distilled water before being oven-dried at 100°C for 6 h. Samples with almost the same body weight were then pooled together and five weight categories were obtained ($0{\cdot}53 \pm 0{\cdot}16$ g, $1{\cdot}12 \pm 0{\cdot}19$ g, $1{\cdot}58 \pm 0{\cdot}19$ g, $2{\cdot}21 \pm 0{\cdot}24$ g and $4{\cdot}75 \pm 0{\cdot}73$ g). For each weight category, the samples were homogenised and then triplicated for elemental analyses by INAA.

Sample irradiation

Tissue samples (200–300 mg) were placed in precleaned vials (2/5 dram). Standards were prepared from standard chemical solutions dropped onto filter paper and then placed in vials after drying. The procedure was carefully controlled to minimise the possible introduction of contaminants. These vials were heat-sealed and irradiated at the Malaysian Atomic Energy Unit (PUSPATI) TRIGA MK II research reactor with a thermal flux of 4×10^{12}n/cm^2/s. The short irradiation facility with a pneumatic transfer system (PTS) was used to detect elements whose radionuclides are short-lived (Mg, Cl, Mn, K). In order to detect elements with longer nuclide lifetime, the samples were irradiated for 10 h and cooled for at least two weeks before analysis.

Counting and analysis

The gamma ray activities of the samples were measured with a gamma ray detection system. This consisted of a horizontal hyperpure ORTEC HPGe detector coupled to a 4096 channel pulse height analyser. The counting system used in this study provided an energy resolution of 1·80 keV at 1332 keV gamma-ray emission of ^{60}Co. Peak identification and quantitation were performed by a PDPP combus computer connected to the system.

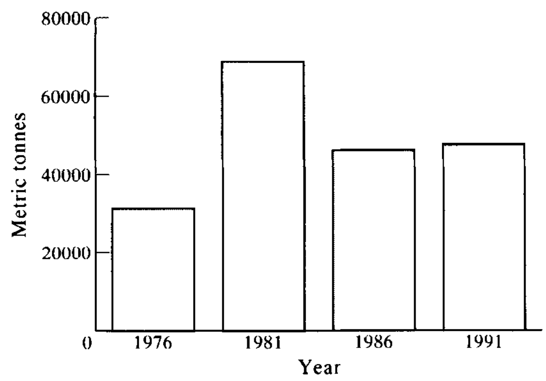

Fig. 1. Production of cockles for Peninsula Malaysia.

RESULTS AND DISCUSSION

Table 1 shows the assurance quality of the analytical methods employed in the present investigation. Generally the results of metal concentrations are within 10% of the certified values of the SRM Bovine Liver (NBS 1577). It can therefore be suggested that our metal analysis using the method of INAA is accurate.

Table 2 shows the concentrations of trace elements obtained by INAA for various weight categories. A total of 12 elements: Mg, Cl, Mn, K, As, Se, Br, Zn, Co, Fe, Rb and Cr were detected. As can be seen from

Table 1. Trace element concentrations (ppm) in bovine liver (NBS 1577) standard reference material

Elements	Certified values	Our values
Mg	600	587
Cl	2800	2698
Mn	9·9	10·8
Se	1·1	1·2
Br	9·0	9·5
Zn	123	141
Co	0·21	0·21
Fe	194	212
Rb	13	13

Table 2. Concentration of elements ($\mu g/g$) in different body weights by the method of INAA

Elements	Average body weight (g)				
	0·53	1·12	1·58	2·21	4·75
Mg	4612	5418	4892	4282	5770
Cl	55912	51219	53409	49230	51470
Mn	10·8	10·5	10·7	12·7	11·0
K	1·02%	1·05%	1·00%	1·10%	9·91%
As	18·7	18·0	20·2	19·2	18·8
Se	5·1	4·7	4·5	4·2	3·7
Br	215	211	223	187	209
Zn	236	207	206	192	185
Co	0·36	0·31	0·31	0·32	0·27
Fe	1770	1426	1946	1650	2075
Rb	7·2	5·6	6·7	6·0	5·8
Cr	4·2	3·7	4·7	2·5	2·8

our analysis the concentration of iron (Fe) is high, ranging from 1426 to 2075 ppm. Thus cockles might perhaps be viewed as having some importance as good dietary supplements for anaemics. Arsenic (As) and zinc (Zn) contents are also high and these two elements together with Br are known to be toxic in nature (Greig, 1979).

Analyses were also performed on the relationship between total metal content and body weight. Figure 2 shows graphs of the relationship between the logarithmic transformed values for trace element total contents and body weight for three elements; Mn, Cl and Mg. The regression coefficients varied from 0·88 to 1·08 for all elements analysed. Since the coefficient values are approximately close to unity we therefore conclude that the total metal content is directly proportional to body weight.

In conclusion, it has been shown that the cockles popularly consumed by people in South-East Asia,

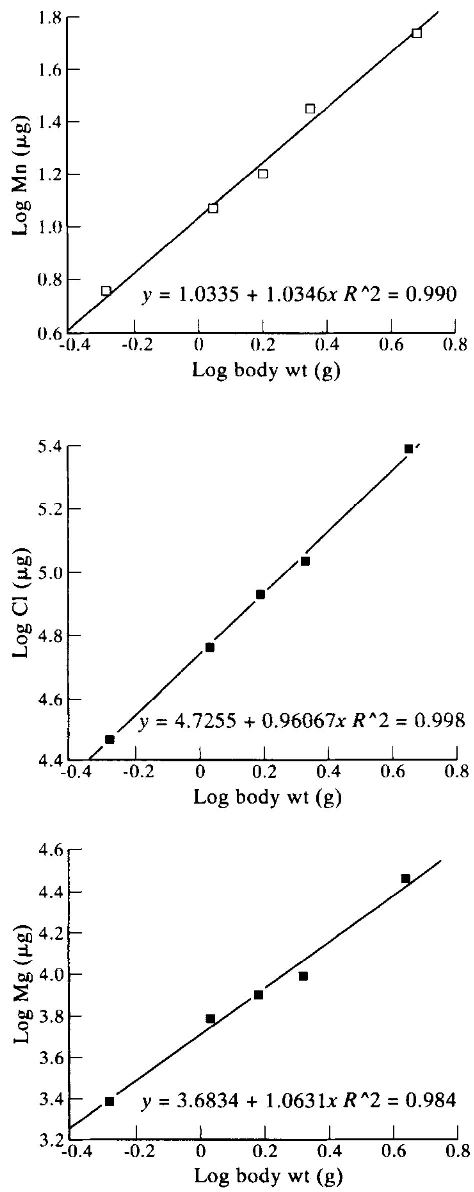

Fig. 2. Relationship between metal concentration and body weight.

particularly in Malaysia, contain trace metals which are useful and also toxic in nature. Also, the total metal content is directly proportional to the body weight. The bigger the size the higher is the total metal content.

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