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Accumulation Pattern of Po-210 In *Anadara Granosa* Collected From a Coal Burning Power Plant Area

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***Abstract*:** *Consumption of seafoods containing radioactive elements is one of the main sources of natural radiation exposure. Therefore many countries and international organizations are concern about the safe consumption of marine food species. The present study investigated the accumulation pattern of Po-210 in marine cockle (Anadara granosa) collected from a cola burning power plant area. The study revealed that the concentration of Po-210 in the samples are comparatively higher than other areas which might be the impact of coal burning.*

Keywords: *Coal, polonium, cockle, kapar*

1. Introduction

Seafood and their products are considered to be one of the major sources of protein for coastal public and have high export significance. Marine organisms have the capability of accumulating radionuclides and toxic elements from water, and that is why the determination of radioactivity and toxic metals in marine food supplies presumed to be greater importance. Among the various radionuclides occurring in the marine environment, Po-210 assumes greater importance because of their high accumulation potential, especially in seafoods. However, Po-210 is known to be the major contributor (90%) to the natural radiation dose coming from alpha emitting radionuclides received by most marine organisms [1, 2]. It is also a major contributor to critical group doses from seafood consumption, in particular from consumption of molluscs [3]. Malaysia is among the countries with highest fish consumption in the world and relies on seafood as the main source of animal protein. It is known to be the highest consumer of seafood in the Southeast Asia region, both in terms of per capita intake and percentage of protein. Thus, information on the intake of Anadara granosa is important. In the present study, the accumulation pattern of Po-210 in Anadara granosa collected from a coal burning power plant area of Malaysia was investigated.

2. Materials and Methods

The sample of cockle (Anadara granosa) has been collected from the local fish market which is very near to Sultan salauddin abdul aziz coal burning power plant. The power station lies between the mouth of the Kapar Besar and Serdang Kecil rivers and is adjacent to the coast. Two residential villages, Tok Muda and Sungai Serdang are situated along the same coast and have a greater intake of seafood because of their fishing heritage. However, it is suspected that the organisms surviving in the coastal area of Kapar might be affected by the coal burning and hence this area has been selected for the present study.

The radiochemical separation method was used to estimate Po-210 in the samples [4] [5] About 0.5 g of the dried sample was taken and Po-209 of a known activity was added as a yield tracer. Then the samples were digested with nitric acid and perchloric acid. The solution was filtered and gently evaporated to dryness. Then the samples were dissolved in 50 ml of 0.5 M HCl along with a pinch of ascorbic acid to reduce Fe (III) and Po-210 was spontaneously deposited on brightly polished silver discs (2 cm diameter) for a period of 3-4 hours at a temperature of 70-90ºC. To ensure the quality of the methodology, Po-210 was estimated in a certified reference material IAEA-134 (Cockle flesh) and the measured values were under the 95% confidence interval. Po-210 activity has been calculated in the wet weight value according to the following equation:
Activity in wet weight = Activity in dry weight ×Sample weight/Sample wet weight

3. Results and Discussion

The total length of collected cockles ranged from 2.10 to 4.30 cm whereas the total weight varied between 5 to 19 g. Expressing radiometric data in terms of dry weight, the concentration of Po-210 in the soft part of cockle ranged between 47.20±2.11 and 725.90±32.39 $Bqkg^{-1}$ with the mean value of 239.20±163.24 $Bqkg^{-1}$. The Shapiro-Wilk's test discovered a non-normal distribution of the data set (Figure 1) and therefore the non-parametric Kruskal-Wallis test was performed to compare the Po-210 accumulation in cockle during three sampling periods. At the $\alpha = 0.05$ level of significance, there exist enough evidence to conclude that there is a significant difference in the mean test scores among the three sampling period [H (2) = 45.06, p = 0.000]. It was observed in several species that radionuclide concentrations were not constant over time. Indeed, there was an inter-individual variation of radionuclide concentrations as well as a variation related to body size and physiological condition. This was observed, for example, in a detailed study performed on Po-210 and Pb-210 in marine mussels [6]. For bivalve mollusc species large variations between spring and autumn values were observed for Adriatic Sea [7]. This can be attributed more to the differences in length of the animals than to seasonal variations. Namely, the larger is the animal, the lower is the Po-210 activity concentration. This is due to the slower metabolism of the larger, older and heavier animals [8, 9]. Po-210 concentration in mussels is reportedly size-dependent [10].

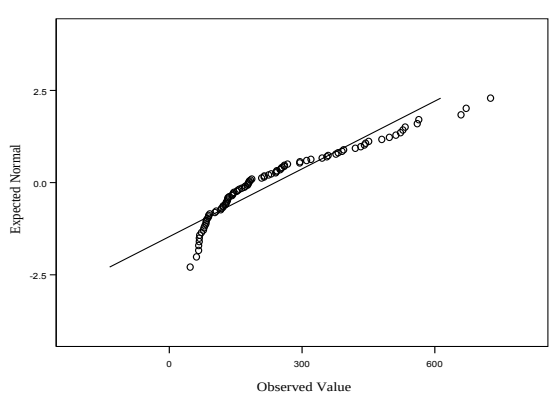

Fig 1: Normal Q-Q plot of Po-210 concentration in *Anadara granosa*

An analysis using Pearson's correlation coefficient indicates a statistically significant linear relationship between the Po-210 concentration and the total weight of cockles ($r = 0.62$, $p < 0.01$) (Figure 2), whereas the correlation between Po-210 and total length was low ($r = 0.37$, $p < 0.01$) (Figure 3). In general, Po-210 activity in the study area was higher in August 2008 (southwest monsoon). During this time the wind flow is usually light (below 15 knots). Thus the fly ash from the power plant gets enough time to mix into the surrounding area, resulting in a higher Po-210 activity. On the other hand, during the northeast monsoon, when there is a strong

wind flow of usually more than 30 knots, the fly ash from the power plant is quickly dispersed and therefore the activity in the surrounding area is low. In case of Kuala Selangor, Theng et al [11] also suggested that the concentration of Po-210 in the soft parts of cockle differed significantly between each sampling date and influenced by the environmental factors. The calculated values for *Anadara granosa* are higher than the values found in the literature, where specific activities vary from 9 to 175 $Bqkg^{-1}$ fresh weight [9, 12, 13]. Samad et al [14] described that mussels like *Patella vulgate* concentrate high Po-210 and Pb-210 radionuclides in their tissues. Also these radioactivity levels are related to the sampling location and the anthropogenic activities on the surrounding areas, whose effluents may increase the concentrations of naturally occurring radionuclides in the environment specially Po-210 and Pb-210. This explains the highest concentrations found in cockles of Kapar coastal area, where the coal burning power station is situated.

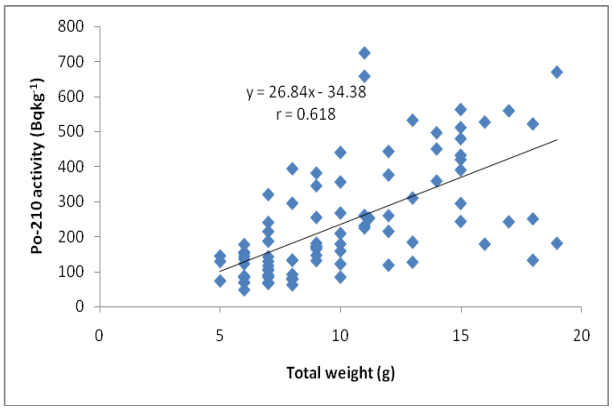

Fig 2: Relationship between Total weight and Po-210 concentration in *Anadara granosa*

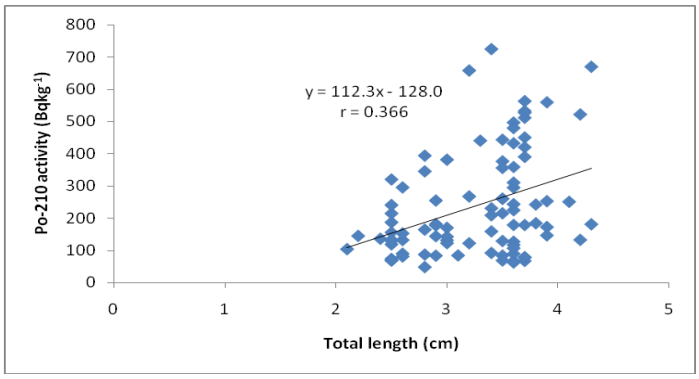

Fig 3: Relationship between Total length and Po-210 concentration in *Anadara granosa*

Po-210 uptake from water column was estimated using the concentration factor (CF) for the marine organisms analyzed in this study. The CF is the ratio of the Po-210 concentration in organism and the Po-210 concentration in water column. Therefore the internal concentration equals the concentration in water times the CF value. In general, concentration factors value are used as transfer parameters in assessments of the public dose from radioactivity in the marine environment [15].

The BCF is calculated on the basis of the values for Po-210 activities measured in organism and water samples [11]. In this case the following equation is used,

CF = Activity in wet weight of specified tissue sample ($Bqkg^{-1}$)/ Activity in filtered water (Bql^{-1})

The concentration factor ranged from 7364.12 to 383187.44 in cockle. The observed concentration factor values obtained for molluscs was compared with other studies [16-18] comparatively higher than the values published by the IAEA [9] which is 2×10^4 for molluscs. Furthermore, the concentration factor value of cockle

analyzed in this study is lower than the values reported by Suriyanarayanan et al [19] who studied about the radioactivity in nuclear power plant area of India.

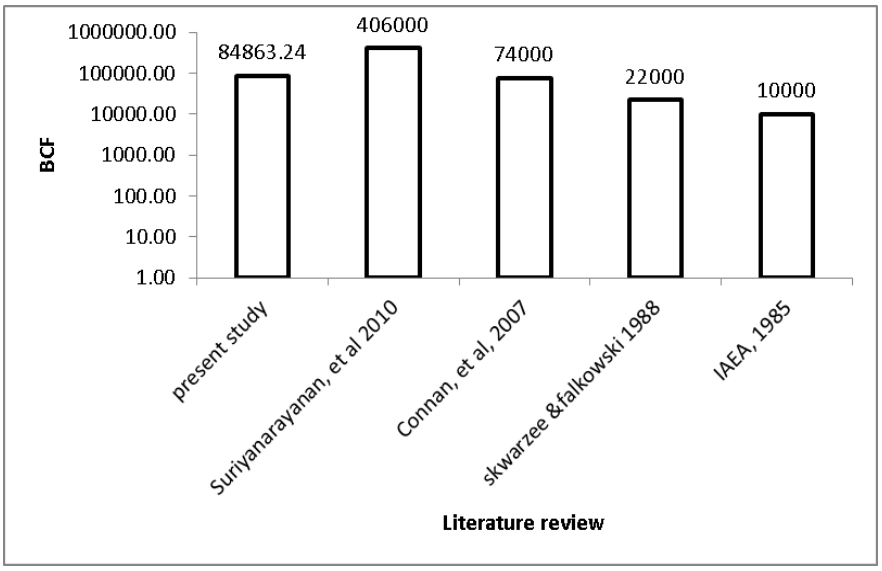

Fig 4:.Comparison of BCF in mollusc with the literature review.

4. Conclusion

In the present study, *Anadara* granosa exhibited comparatively higher concentration of Po-210 in the soft tissue. There was statistically significant difference in the accumulation of Po-210 between different sampling periods in the studied samples. This study revealed that the accumulation of Po-210 in the organisms was not related to the body size. A statistically significant linear relationship exists between Po-210 concentration and the total weight of cockles whereas the correlation between Po-210 and total length was low. The calculated values of concentration factors for *Anadara granosa* was higher than the standard values dictated by the IAEA.

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