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# Trace and Heavy Metal Accumulation in Squilla (*Oratosquilla nepa*) off Saurashtra Coast

**L. N. Murthy*, C. O. Mohan[2] and R. Badonia[3]**

[1] *Mumbai Research Center of Central Institute of Fisheries Technology, CIDCO, Admin Building, Sector-1, Vashi, Navi Mumbai - 400 703, India*

[2] *ICAR- Central Institute of Fisheries Technology, P. O. Mastyapuri, Cochin - 682 029, India*

[3] *Veraval Research Centre of CIFT, Bhidia, Veraval, India*

## Abstract

Information on the concentration of trace metals in stomatopod crustaceans is scarce. In the present investigation, an attempt was made to determine the proximate composition, mineral and heavy metal content of stomatopod *Oratosquilla nepa* (squilla) off Saurashtra coast. The moisture, crude protein, total lipid and total ash contents of squilla were 81, 10.15, 0.6 and 5.1%, respectively. Potassium, sodium and iron content in squilla were 86.09, 76.45 mg% and 42.03 ppm, respectively. Comparison of trace and heavy metal residue accumulation in squilla weighing 5-8 and 8–12 g were compared for gut, exoskeleton and edible meat portion. Significant difference ($p<0.05$) was observed between the two size groups in the accumulation of copper and nickel contents in gut. No significant variation was observed in exoskeleton between the two size groups. Higher level of cadmium (1.94 ppm) was observed in the gut of squilla, however other heavy metals like mercury and lead and trace metals like cobalt were below the detectable limit.

**Key words**: Heavy metals, proximate composition, mineral content, *Oratosquilla nepa*

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* *E-mail: murthycift@gmail.com*

## Introduction

Global heavy metal pollution of water is a major environmental problem. With the advent of agricultural and industrial revolution, most of the water resources are becoming contaminated (Khare & Singh, 2002). Industrial discharges containing toxic and hazardous substances, including heavy metals (Gbem et al., 2001; Woodling et al., 2001) contribute tremendously to the pollution of aquatic ecosystems causing cytotoxic, mutagenic and carcinogenic effects in animals and the Arabian Sea is not an exception (Mitra & Choudhury, 1993). Among environmental pollutants, metals are of particular concern due to their potential toxic effects and the possibility of bioaccumulation in aquatic ecosystems (Censi et al., 2006). Aquatic invertebrates take up and accumulate trace metals (both essential or non-essential) (Rainbow, 2007). Presence of cadmium above the permissible limits in oceanic squids and commercial cephalopod samples of Gujarat region has been reported by Murthy et al. (2008; 2009). The present investigation was aimed to evaluate the accumulation of trace and heavy metals in different organs of squilla which is one of the raw materials for the production of fish-meal, shrimp and poultry feed and pet food.

## Materials and Methods

Squilla (*Oratosquilla nepa*) available along Gujarat coast was collected onboard CIFT research vessel MFV Sagarkripa and other commercial multiday fishing vessels of Veraval, Gujarat region. The samples were collected in clean polypropylene bags and transported to the laboratory in iced condition by maintaining a temperature less than 5ºC. Samples were segregated into two size groups 5-8 and 8-12 g based on the weight distribution of the catch. The samples were dissected for collecting the gut, soft meat portion and exoskeleton. Different body organs were subjected for analysis of residue-contaminants like cadmium, nickel, lead, copper, zinc, cobalt, iron and mercury and only soft meat was subjected to proximate composition.

For chemical analyses, the fish muscle was taken and ground using a mixer grinder. Proximate composition of squilla meat was determined by AOAC (1998) method. Minerals such as potassium, sodium and iron were determined as per standard methods (AOAC, 1990).

Samples collected for the detection of trace and heavy metals were digested in Teflon containers using a microwave digester (Ethos plus High Performance Microwave Lab station, Milestone, USA) and cadmium, copper, zinc and lead were detected by Atomic Absorption Spectrophotometer (GBC 932AA, Varian, Scientific Instruments, Australia) by following the AOAC method in triplicate (AOAC, 1998). Mercury content in the sample was analyzed following ICMR (1990) method.

All the analyses were done in triplicate. The data was subjected to ANOVA by statistical software, SPSS version 16.0. Duncan's multiple range tests was used to find out the significant difference between mean values of experimental data of the treatments at 5% level of significance.

## Results and Discussion

Proximate composition of squilla meat showed a moisture, crude protein, total lipid and total ash contents of 81.04±0.22, 10.15±0.21, 0.6±0.002 and 5.1±0.37% respectively, indicating squilla as lean variety with a fair quantity of protein. The results of proximate composition are in agreement with that of *Harpiosquilla raphidea* (Wardiatno et al., 2012). The energy value of soft meat of squilla estimated using FAO (1989) factors was very low (48.75 k cal 100 $g^{-1}$). Squilla soft meat had good quantity of minerals like potassium, sodium and iron. Minerals namely phosphorus (2217.0±0.57 mg%), sodium (76.45±12.0 mg%), potassium (86.09±16.0 mg%) and iron (42.43±14.43 ppm) were found in the squilla meat. Potassium and sodium content of the squilla was lower compared to mantis shrimp (Wardiatno et al., 2012). Variations in the composition of squilla and other related species found in the literature could be attributed to the variation in the habitat, feeding habits and seasonal variations.

Cadmium concentrations varied from 0.86 to 1.94 ppm in different regions of squilla as shown in Fig.1. Significant variation in cadmium content between two size groups was also observed ($p<0.05$). In the gut, significantly higher levels ($p<0.05$) of cadmium (1.94 ppm) above the permissible acceptable limit were observed. Cadmium content was found to be more than permissible levels in all the organs of different size class of squilla. Significantly ($p<0.05$) higher levels of cadmium were observed in the gut content of different size classess followed by soft meat in 8 – 12 g size class of squilla. Cadmium levels in exoskeletons did not show any variation between the size classes. The higher levels of cadmium in the gut could be due to the tendency of bottom dwelling organisms to accumulate trace metals in gut, liver and kidney. Similar observations have been made by Lakshmanan (2003) for cadmium levels of non edible body components of cephalopods from Mumbai and Gujarat coast. Cadmium can enter water through disposal of wastes from industries. Fertilizers often contain some cadmium. Cadmium and mercury damage the kidney and cause signs of chronic toxicity, including impaired kidney function, poor reproductive capacity, hypertension, tumors and hepatic dysfunction (Afshan et al., 2014). Mercury and lead content was not observed in any organs in both size classes of squilla. Cobalt content in all the organs of squilla was below the detection limit for both the size classes. Copper content of squilla is shown in Fig. 2. Copper levels were found to be higher (12.3 ppm) in exoskeleton of squilla of 8 - 12 g size, whereas lower levels of copper were observed in the meat portion of squilla. Copper content in meat, gut and exoskeleton of bigger size squilla was almost same and significantly higher ($p<0.05$) compared to smaller squilla. In small size squilla, copper content was highest in exoskeleton followed by gut and soft meat. Zinc content varied from 8.84 to 13.26 ppm for different parts of squilla belonging to different size groups (Fig. 3). Zinc content was found to be highest in


Fig. 1. Cadmium content of different size groups of squilla for meat, gut and exoskeleton portions

meat part compared to gut and exoskeleton. Zn content which is highly essential trace metal, was found maximum in meat of 8-12g size class squilla (13.26 ppm). Iron and Nickel content is given in Fig. 4 and Fig. 5 respectively. Both iron and nickel were found to be maximum in exoskeleton followed by gut and meat. The smaller size squilla had higher levels of iron and nickel in all the organs studied. The levels of heavy metal in squilla were found to be higher than the reported values for squilla species from different regions (Wardiatno et al., 2012; Fang et al., 2002; Yue, 2001; He et al., 2001) but were below the maximum permissible limit except for cadmium content. Size may affect the accumulated concentration in organisms (Phillips, 1980). This study revealed that squilla can accumulate high amount of heavy metals. The assimilation of trace metals from food can be the main route of metal uptake into aquatic invertebrates.

Present study revealed that squilla is good source of trace minerals and contains about 10% crude protein. It was also found that the energy value of squilla was very low which is of considerable interest to energy conscious consumers. The levels of heavy metals in the present investigation were below the maximum allowable permissible limits except for cadmium content. Proper segregation with respect to both size and organs is needed for feed industry utilizing squilla as raw material to minimize the cadmium levels in feed. Further study is needed to understand the spacio temporal variations in heavy metal accumulation of squilla.

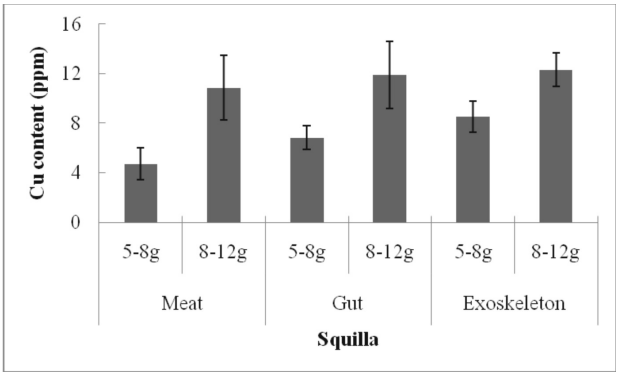


Fig. 2. Copper content of different size groups of squilla for meat, gut and exoskeleton portions

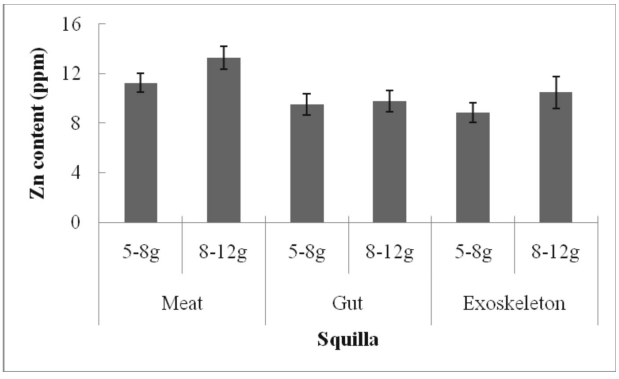


Fig. 3. Zinc content of different size groups of squilla for meat, gut and exoskeleton portions

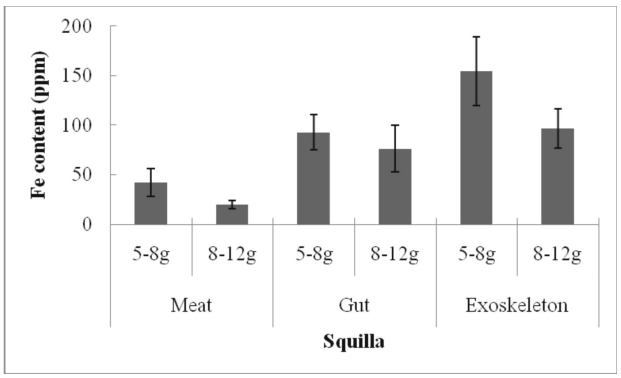


Fig. 4. Iron content of different size groups of squilla for meat, gut and exoskeleton portions

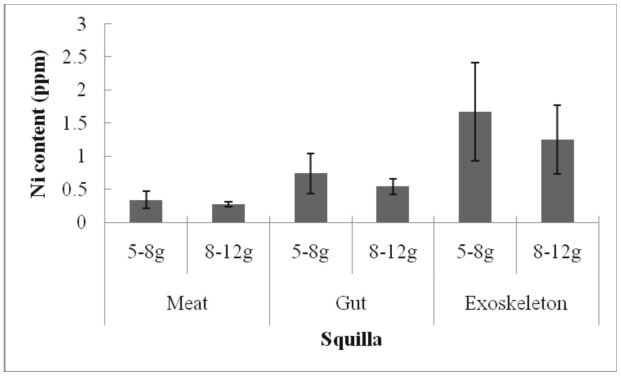


Fig. 5. Nickel content of different size groups of squilla for meat, gut and exoskeleton portions

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