Article

Mineral composition of edible crab *Podophthalmus vigil* Fabricius (Crustacea: Decapoda)

P. Soundarapandian[1], **D. Varadharajan**[1], **S. Ravichandran**[2]

[1]Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai-608 502. Tamil Nadu, India

[2]Department of Zoology, Government Arts College, Kumbakonam, India

E-mail: soundsuma@gmail.com

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Abstract

Totally 7 minerals were reported in the present study. For the individual contribution 5 (Sodium>Calcium>Potassium>Iron>Magnesium),7(Sodium>Calcium>Iron>Potassium>Phosphorus>Magnesium>Zinc) and 4(Calcium>Sodium>Iron>Magnesium) minerals were reported in males, females and berried females respectively. In all sexes sodium and calcium were maximum and magnesium was minimum. Comparatively females contain maximum amount of minerals than males and berried females. Phosphorous and zinc were absent in males whereas potassium was absent in addition to phosphorous and zinc in berried females. Among different sexes females contain maximum amount of minerals (61.56 mg) followed by males (39.92 mg) and berried females (35.11 mg). From the study females contain maximum amount of minerals than berried females and males. So it is recommended to consume females to get maximum minerals.

Keywords minerals; males; females; berried females; *Podophthalmus vigil.*

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1 Introduction

Minerals are called as micronutrients and necessary for physiological and biochemical processes by which the human body acquires assimilates and utilized food to maintain health and activity but also ensuring adequate immune-competence and cognitive development. So exploring minerals from marine organisms is important especially in crabs. It becomes a worldwide delicacy amongst seafood aficionados and high in essential nutrients and is extremely beneficial for health (Soundarapandian and Ananthan, 2008; Soundarapandian et al., 2010). Thus, the meats are also prominent sources of minerals, mainly iron, calcium, potassium phosphorus and zinc, which aids in reducing oxidative damage to cells and tissues and acts as an antioxidant by cancelling out the carcinogenic effects. Mineral values of different crab species have been previously investigated in various parts of the world. Davis (1996) studied marine crustaceans; Küçükgülmez et al. (2006) studied

Callinectes sapidus; Moronkola et al. (2011) reported *Callinectes amnicola*. Jimmy and Arazu (2012) studied two edible Crabs *Callinectes amnicola* and *Uca tangeri*. However, the study of the mineral content in *Podophthalmus vigil* Fabricius is very limited. Since crab is consumed by local population on regular basis. In the present investigation mineral content was studied in all sexes of the crab, *P. vigil.*

2 Materials and Methods

The male, female and berried females of *P. vigil* were procured from Parangipettai (Lat. 11^{0}21' N; Long. 79^{0} 46' E) landing centres. The carapace of the crabs was opened and the edible parts of muscle tissues were removed with sharp forceps. The removed muscle tissues were homogenized with pestle and mortar. The grounded muscles were then freeze dried and powdered and eventually stored in refrigerator for further analysis. To the 5g of crab tissue samples, mixture of hydrochloric acid, nitric acid and perchloric acid at a ratio of 10:5:1 was added for digestion at 30 ºC. The digests were filtered suitably and aspirated in digital flame photometer (Modal No.CL 22D, Elico pvt, India), the values obtained were expressed in mg/100g (Guzman and Jimeneza, 1992).

The data were subjected to One-way Analysis of Variance (ANOVA) and difference between means were determined by Duncan's multiple range tests (P<0.05) using SPSS version 17.0.

3 Results

The minerals of the *P.vigil* muscle tissue is shown in Table1 and Fig. 1. Totally 7 minerals were reported in the present study. For the individual contribution 5 (Sodium>Calcium>Potassium>Iron>Magnesium), 7 (Sodium>Calcium>Iron>Potassium>Phosphorus>Magnesium>Zinc) and 4 (Calcium>Sodium>Iron> Magnesium) minerals were reported in males, females and berried females respectively. In all sexes sodium and calcium were maximum and magnesium was minimum. Comparatively females contain maximum amount of minerals than males and berried females. Phosphorous and zinc were absent in males whereas potassium was absent in addition to phosphorous and zinc in berried females. Among different sexes females contain maximum amount of minerals (61.56 mg) followed by males (39.92 mg) and berried females (35.11 mg).

Table 1 Mineral composition (mg/100g) in the muscle of *P. vigil.* (Values are mean of three values ±SE)

S.No.	Minerals	Male	Female	Berried
1	Calcium	11.46 ± 0.43^{c}	14.58 ± 0.37^{a}	12.98 ± 0.48^{b}
2	Magnesium	0.99 ± 0.54^{c}	2.50 ± 0.49^{a}	1.09 ± 0.39^{b}
3	Iron	7.45 ± 0.46^{c}	13.32 ± 0.48^{a}	8.54 ± 0.36^{b}
4	Sodium	11.5 ± 0.34^{c}	15.89 ± 0.41^{a}	12.50 ± 0.51^{b}
5	Potassium	8.52±0.36	10.52±0.48	-
6	Phosphorus	-	3.09±0.33	-
7	Zinc	-	1.66±0.39	-
Total		39.92 ± 2.13^{b}	61.56 ± 2.95^{a}	35.11 ± 1.66^{c}

-: Trace amount. Different superscripts in a rows are significantly different (P<0.05).

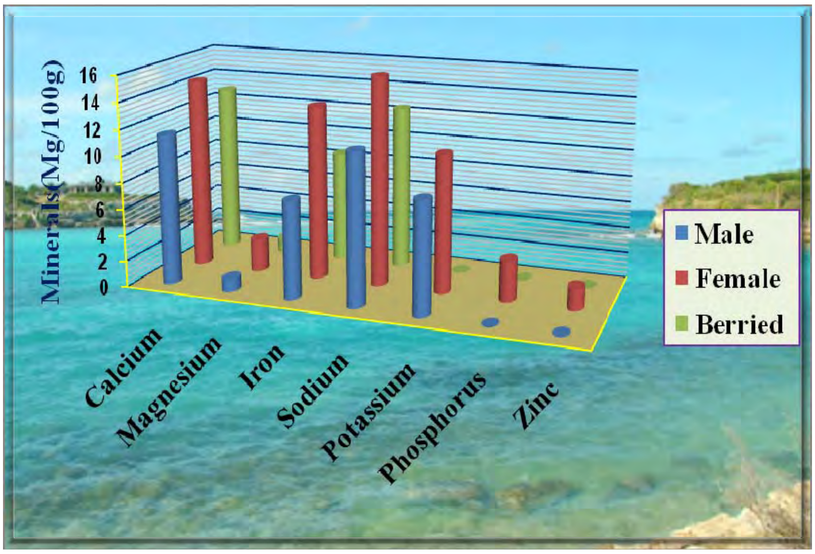

Fig. 1 Mineral composition (mg/100g) in the muscle of *P. vigil.*

4 Discussion

Marine foods are very rich sources of mineral components. The total content of minerals in the raw flesh of marine fish and invertebrates is in the range of 0.6 – 1.5% wet weight. Mineral components such as sodium, potassium, magnesium, calcium, iron, phosphorus and iodine are important for human nutrition (Sikorski et al., 1990). Crustaceans are also good sources of various minerals and high quality protein. Crab meat is an excellent source of minerals, particularly calcium, iron, zinc, potassium and phosphours (Sifa et al., 2000; Adeyeye, 2002; Gokoglu and Yerlikaya, 2003; Naczk et al., 2007). Living organisms require trace amounts of some heavy metals including iron, cobalt, copper, manganese, molybdenum, strontium, vanadium and zinc. Excessive levels of these metals, however, can be detrimental to living organisms (Prajapati et al., 2012). Other heavy metals such as cadmium, lead and mercury have no known beneficial effect on organisms and their accumulation over time in the bodies of mammals can cause serious illness (Hawkes, 1997). The fish and shellfish can absorb minerals directly from the aquatic environment through gills and body surfaces. Almost all the elements that occur in seawater are found to some extent in aquatic animals and these includes Na, K, Ca, P, Al, Ba, Cd, I, Cr, Pb, Li, Hg, Ag, St and Va. Eyo (2001) reported that the mineral content of fish makes unavoidable in the diet, as it is a source of different minerals that contribute greatly to good health.

The minerals are serving as components of bones, soft tissues (Sulfur amino acids, metalloproteins) co-factors and co-activators of various enzymes important in human nutrition. Calcium, phosphorus, magnesium and electrolytes (sodium and potassium) are considered to be as macro elements and iron, copper, zinc, iodine, chromium, cobalt, manganese, molybdenum, selenium are considered as trace elements that are required for normal functioning, for instance the more soluble minerals such as Ca, P, Na, K and Cl are involved in the maintenance of acid-base balance and membrane potential. The main functions of essential minerals include skeletal structure, maintenance of colloidal system and regulation of acid-base equilibrium. Minerals also constitute important component of hormones, enzymes and enzyme activators (Belitz and Grosch, 2001). It is known that variations in the mineral composition of marine foods are closely related to seasonal and biological differences (species, size, dark/white muscle, age, sex and sexual maturity), area of catch, processing method, food source and environmental conditions (water chemistry, salinity, temperature and contaminant).

Considering the elemental composition of common food items (dairy products, meat, fish, cereals and fruits), *C. pagurus* hepatopancreas is a good source of Ca, Fe, Cu, Zn and Se (FAO/WHO, 2002; Martins, 2006). The more soluble minerals such as Ca, P, Na, K and Cl also have osmoregulatary function and the maintenance of acid-base balance and membrane potentials (Davis et al., 1992). Some elements such as Mg, Al, Ca, Fe, Co, Cu and Zn are necessary for maintenance of optimum health thus are important from nutrition point of view. Metals such as Pb, Cd, As and Hg are detrimental to optimum health and have toxicological effect and the tissue samples are also used as a bio-indicator to assess bioavailability of contaminant concentrations in coastal water in environmental studies (Mohapatra et al., 2007).

The aquatic environmental/ecosystem and their inhabitants are exposed and sensitive to effects of environmental pollution from heavy metal contamination. Aquatic animals accumulate large quantities of these xenobiotics and the accumulation depends upon the intake and elimination from their body (Karadede et al., 2004). Among different aquatic organisms; oysters, crab and mussels, accumulate large quantities of heavy metals due to their habitat and feeding nature. Many metals (Co, Cu, Mn, Fe and Zn) are essential trace elements for aquatic organisms and are involved in biochemical processes such as enzyme activation (Lall, 1989).

In the present study, sodium and calcium was maximum and Magnesium was minimum irrespective of the sex. In individual contribution 5(Sodium > Calcium > Potassium > Iron > Magnesium), 7 (Sodium > Calcium > Iron> Potassium > Phosphorus > Magnesium > Zinc) and 4(Calcium> Sodium > Iron > Magnesium) minerals are reported in males, females and berried females respectively. These are very much comparable with studies of Hagashi et al. (1979), Anon (1999), Thirunavukkarasu (2005) and Sudhakar (2009). Gokoglu and Yerlikaya (2003) investigated the mineral contents of blue crab, *C. sapidus* and swimming crab *P. pelagicus* and suggested that Na, Ca, Zn, Cu values for blue crab and swimming crab were not significantly different. Trace elements content in haemolymph of normal and red sternum mud crab were observed by Salaenoi et al (2006). The average Ca contents of green tiger shrimp and speckled shrimp were 60.28mg/10 g and 60.44 mg/10 g, respectively (Yannar and Celik, 2006). Chen *et al.* (2007) reported the concentration of nine elements (Zn, Fe, K, Na, Mn, Cu, Mg, Ca, and P) in different tissues of crab meat and edible viscera of Chinese mitten crab, *E. sinensis*. Mohapatra et al. (2009) studied the concentration of 10 elements (ppm) (K, Ca, Mn, Fe, Cu, Zn, Se, Br, Sr and Pb) in *S. serata, S. tranquebarica, P. monodon, P. indicus* and *M.rosenbergii*. Sudhakar et al. (2009) assessed the minerals content of hard and soft shell crabs *P. sangiunolentus*. Mohapatra et al. (2009) recorded the concentration of nine elements (K, Ca, Mn, Fe, Cu, Zn, Se, Br and Pb) in different tissues of mud crab *S. serrata*.

The calcium and phosphorus together account for 70 to 80% of the minerals in the skeleton of fish (Nair and Mathew, 2000). In the present study calcium and megnesium alone contribute 50%. Calcium is maximum in females than males of *P. vigil.* Similar results were reported in *P. sanguinolentus* (Sudhakar et al. 2009), *S. tranquebarica* (Thirunavukkarasu, 2005) and *E. sinesnsis* (Chen et al., 2007). Ca has an essential role in blood clotting, muscle contraction and nerve transmission. Calcium is nutritionally very important (up to 1.9% Ca is available in human body) and provides rigidity to the skeleton and plays a role in many metabolic processes (FAO/WHO, 2002). It is also essential for hard tissue structure, blood clotting, muscle contraction, nerve transmission and osmoregulation and as a cofactor for enzymatic procession (Lovel, 1989). The higher Ca content in male crabs are likely because this species has a sexual dimorphism, in which males have bigger claws and harder exoskeletons (composed by calcium phosphate). Particularly during the premoult period of *C. pagurus,* hepatopancreas accumulates Ca that is likely used in the exoskeleton calcification (Luquet and Marin, 2004).

Magnesium is maximum in females than berried females and males. Magnesium was already reported in *P. sanguinolentus* (Sudhakar et al., 2009), *S. tranquebarica* (Thirunavukkarasu, 2005) and *E. sinesnsis* (Chen et al., 2007). Magnesium is important for human nutrition and it is required for body's enzyme system. In addition to maintain bone health, magnesium acts in all cells of soft tissues, where it forms part of the protein-making machinery and necessary for energy metabolism. Mg is cofactor for enzyme systems (Food and Nutrition Board, National Research council, 1989).

Iron is maximum in females than berried females and males. Iron was already reported in *E.sinesnsis* (Chen et al., 2007). Iron is one of the very important essential trace elements since it has several vital functions in human system. It serves as a carrier of oxygen to tissues from the lungs by red blood cell. Adequate Fe in the diet is very important for avoiding some major health problems (Belitz and Grosch, 2001; Camara et al., 2005). Adequate iron in the diet is very important for decreasing the incidence of anaemia, which is considered a major health problem, especially in young children. Iron deficiency occurs when the demand for iron is high, e.g., in growth, high menstrual loss, and pregnancy (Belitz and Grosch, 2001; Camara et al., 2005). Transition metal ions, particularly Cu and Fe, have been known as the major catalysts for oxidation (Thanonkaew et al., 2006).

Sodium contribution is maximum irrespective of the sex. In individual contribution sodium is the highest in females followed by berried females and males of *P. vigil*. Sodium was already reported in *P. sanguinolentus* (Sudhakar et al., 2009), *S. tranquebarica* (Thirunavukkarasu, 2005) and *E. sinesnsis* (Chen et al., 2007). Sodium is the principal cation of the extra cellular fluid and regulator of its volume. Sodium also helps to maintain acid-base balance and is essential for nerve system.

Potassium is maximum in females than males and totally absent in berried females. Potassium was already reported in *P. sanguinolentus* (Sudhakar et al., 2009), *S. tranquebarica* (Thirunavukkarasu, 2005) and *E. sinesnsis* (Chen et al., 2007). Potassium is important to maintain the pH, storage and transfer of energy and nucleotide synthesis. Phosphorous is available only in females and totally absent in males and berried females. Phosphorous was already reported in *E. sinesnsis* (Chen et al., 2007). The phosphorous (adenosine polyphosphate) act as a key substance for energy release and present in phospholipids (Decker and Tuczek, 2000). Ca and P are necessary to maintain an optimal bone development, with more of both minerals being required during childhood and growing stages to prevent rickets and steomalacia. The calcium and phosphorous together account for 70 to 80% of the minerals in the skeleton of fish (Nair and Mathew, 2000).

Zinc is available only in females and totally absent in males and berried females. Zinc was already reported in *P. sanguinolentus* (Sudhakar et al., 2009), *S.tranquebarica* (Thirunavukkarasu, 2005) and *E. sinesnsis* (Chen et al., 2007). Zinc is an essential trace element for all living species, since is an important component of several enzymes (Chen et al., 2007) and plays an essential role in a number of biological processes involved in growth and development (FAO/WHO, 2002). MacFarlane et al. (2000) in semaphore crab also reported higher Cu and Zn accumulation in females than to males. From the study female contains maximum amount of minerals than berried females and males. So it is recommended to consume females to get maximum minerals.

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