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Research Article

DETERMINATIONS OF MINERALS IN MARINE CRAB *CHARYBDIS LUCIFERA* (FABRICIUS, 1798)

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ABSTRACT

Crab meat is an excellent source of minerals, particularly calcium, iron, zinc, potassium and phosphours. The minerals in the edible parts of muscle of *Charybdis lucifera* different sexes (male, female and berried female) were determined by digital flame photometer. Totally 11 minerals are reported in the present study. Seven (Sodium> Potassium >Magnesium >Calcium>Manganese> Iron >Zinc) minerals were reported in all sexes. Sodium was maximum (137.55 mg) and zinc was minimum (1.76 mg) in all sexes. Copper, mercury and cadmium were available in trace amount in all sexes. However, arsenic was in trace amount in berried females and totally absent in males and females. Among different sexes, berried females contain maximum amount of minerals (156.24 mg) followed by females (121.76 mg) and males (95.5 mg).

Keywords: Minerals, Digital flame photometer, Marine crab, *Charybdis lucifera.*

INTRODUCTION

Crab is highly nutritious and healthy owing to its protein content, unsaturated fatty acids, carbohydrates and mineral composition. Minerals constitute important components of hormones, enzymes and enzyme activators in human nutrition (Kirtpatrick and Coffin, 1974; Khan *et al*., 1987; Lall, 1989, 1995). Food source and environmental factors affect minerals content (Anthony *et al*., 1983; King *et al*., 1990; Lee *et al*., 1993; Skonberg and Perkins, 2003; Gokoglu and Yerlikaya, 2003; Yannar and Celik, 2006). Mineral components such as sodium, potassium, magnesium, calcium, iron, phosphorus and iodine are important for human nutrition (Sikorski *et al*., 1990). Therefore determining the minerals in crab species has a great importance due to the good effect on human health. Calcium and iron are necessary to maintain an optimal bone development. 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).The phosphorous (adenosine polyphosphate) act as a key substance for energy release and present in phospholipids (Decker and Tuczek, 2000). Both minerals being required during childhood and growing stages to prevent rickets and osteomalacia. Calcium also has an essential role in blood clotting, muscle contraction and nerve transmission. Iron is an important mineral; it is required to help our red blood cells deliver oxygen to the rest of the body. Iron is essential for many proteins and enzymes that maintain good health; transporting oxygen in the blood to all parts of the body as well as proper functioning of the liver. Zinc is a constituent of many enzymes and is essential for the proper functioning of these various enzymes. Zinc is essential for the metabolism and structural stability of nucleic acids. Zinc has been associated with a variety of bodily functions such as healing of wounds, reproduction, growth and maintenance of glucose tolerance in the body. The aim of this study is to demonstrate the nutritive value and thereby to encourage an increase in the consumption and utilization of *C. lucifera*.

MATERIALS AND METHODS

The male, female and berried females of *C.lucifera* were collected from Parangipettai landing centres. After reaching the laboratory they were washed carefully with distilled water to remove the dust and algal particles and ice killed. The carapace of the crabs was opened and the edible parts of muscle tissues were removed with sharp forceps. To the 5g of wet 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

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obtained values were expressed in mg/100g (Guzman and Jimeneza, 1992).

Statistical Analysis

The data was 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.

RESULTS

The mineral compositions of the *C. lucifera* muscle tissue is shown in table 14 and Figure 8. Totally 11 minerals are reported in the present study. Seven (Sodium> Potassium>Magnesium>Calcium>Manganese> Iron >Zinc) minerals were reported in all sexes. Sodium was maximum (137.55 mg) and zinc was minimum (1.76 mg) in all sexes. Copper, mercury and cadmium were available in trace amount in all sexes. However, arsenic was in trace amount in berried females and totally absent in males and females. Among different sexes, berried females contain maximum amount of minerals (156.24mg) followed by females (121.76 mg) and males (95.5mg).

Table 1. Minerals (mg/100g) in the muscle of *C.lucifera.*

S.No	Minerals	Male	Female	Berried female	Total
1	Calcium	11.20±0.45^{c}	12.54±0.39^{b}	22.10±0.43^{a}	45.84±1.29
2	Magnesium	18.26±0.59^{c}	22.15±0.54^{b}	31.20±0.36^{a}	71.61±2.12
3	Iron	1.04±0.42^{c}	1.42±0.22^{b}	2.58±0.39^{a}	5.04±2.21
4	Sodium	37.48±1.32^{c}	46.71±0.47^{b}	53.36±0.51^{a}	137.55±0.58
5	Potassium	25.92±0.37^{c}	36.79±0.15^{b}	43.28±0.52^{a}	105.99±0.38
6	Zinc	0.31±0.39^{c}	0.53±0.38^{b}	0.92±0.47^{a}	1.76±1.29
7	Copper	Trace	Trace	Trace	Trace
8	Manganese	1.30±0.38^{c}	1.62±0.30^{b}	2.80±0.28^{a}	5.72±2.38
9	Mercury	Trace	Trace	Trace	Trace
10	Cadmium	Trace	Trace	Trace	Trace
11	Arsenic	-	-	Trace	-
	Total	95.5±2.20^{c}	121.76±2.13^{b}	156.24±1.13^{a}	373.51±2.13

Values are mean of three values SE.

^{a}: Different superscripts in the rows are significantly different ($P<0.05$).

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. 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. 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 to good health.

Minerals serve 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 an important component of hormones, enzymes and enzyme activators (Belitz and Grosch, 2001).

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. Some elements such as Mg, Al, Ca, Fe, Co, Cu and Zn are necessary for maintenance of optimum health and 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 the bio-indicator to assess bioavailability of contaminant concentrations in coastal water in environmental studies (Mohapatra *et al*., 2007). The concentration of minerals in the meat of crab species can be influenced by a number of factors such as seasonal and biological differences (species, size, age, sex and sexual maturity), food source and environment (water chemistry, salinity, temperature and contaminants) (Kucukgulmez and Celik, 2008). The seasonal and sex differences observed are most probably related with the reproductive state and metabolism.

The aquatic environment and its 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.

Totally 11 minerals are reported in the present study. Among these 7 (Sodium> Potassium >Magnesium >Calcium>Manganese> Iron >Zinc) minerals are reported in all sexes. Sodium is maximum (137.55 mg) and zinc is minimum (1.76 mg) in all sexes. Comparatively berried females (156.24 mg) contain maximum amount of minerals than females (121.76mg) and males (95.5 mg). These are very much comparable with the studies of Hagashi *et al*. (1979), Anon (1999), Thirunavukkarasu (2005), Sudhakar *et al*. (2009a), Soundarapandian *et al.* (2013) and Soundarapandian *et al.* (2014). Gokoglu and Yerlikaya (2003) investigated the mineral contents of blue crab *C.sapidus* and swim crab *P. pelagicus* and suggested that Na, Ca, Zn, Cu values for blue crab and swim crab were not significantly different. Trace elements content in haemolymph of mud crab was observed by Jintana Salaenoi *et al*. (2006). The mineral contents of green tiger shrimp and speckled shrimp were showed seasonal differences ($p<0.05$), except the Ca content in green tiger shrimp. The average Ca contents of green tiger shrimp and speckled shrimp were 60.28 mg/10 g and 60.44 mg/10 g, respectively (Yanar and Celik, (2006). Chen and Zhang (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.* (2007) 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.* (2009b) recorded the minerals content of hard and soft shell crabs of *P.sangiunolentus.*

In the present study sodium and potassium alone is contributed 50%. Calcium is maximum in berried females (22.10 mg) than females (12.54 mg) and males (11.20 mg) of *C.lucifera.* Similar results were reported in *P.sanguinolentus* (Sudhakar *et al*., 2009b), *S.tranquebarica* (Thirunavukkarasu, 2005), *E.sinesnsis* (Chen and Zhang, 2007), *C.amnicola* (Moronkola *et al*., 2011), *P. potamios* (Bilgin and Fidanbas (2011), *C. amnicola and U. tangeri*, (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *C. armatum* and *C. amnicola* (Omotayo *et al*., 2013), *C.natator* (Soundarapandian *et al*., 2013) and *P. vigil* (Soundarapandian *et al*., 2014), *C.lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and Soundarapandian, 2014). Calcium also 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 the 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. 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 berried females (31.20 mg) than females (22.15 mg) and males (18.26 mg). Magnesium was already reported in *P.sanguinolentus* (Sudhakar *et al*., 2009b), *S.tranquebarica* (Thirunavukkarasu, 2005), *E.sinesnsis* (Chen and Zhang, 2007), *C.amnicola* (Moronkola *et al*., 2011), *P. potamios* (Bilgin and Fidanbas (2011), *C.amnicola and U.tangeri*, (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *C. armatum* and *C. amnicola* (Omotayo *et al*., 2013), *C. natator* (Soundarapandian *et al*., 2013) and *P. vigil* (Soundarapandian *et al*., 2014), *C. lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and Soundarapandian, 2014). Magnesium is important for human nutrition and it is required for the 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. Magnesium is cofactor for enzyme systems (Food and Nutrition Board, National Research Council, 1989).

Iron is maximum in berried females (2.58 mg) than females (1.42 mg) and males (1.04 mg). Iron was already reported in *E.sinensis* (Chen and Zhang, 2007), *C.amnicola* (Moronkola *et al*., 2011), *P. potamios* (Bilgin and Fidanbas, 2011), *C. amnicola and U. tangeri*, (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *C. armatum* and *C.amnicola* (Omotayo *et al*., 2013), *C.natator* (Soundarapandian *et al*., 2013) and *P. vigil* (Soundarapandian *et al*., 2014), *C. lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and

Soundarapandian, 2014). Iron is one of the very important essential trace elements since it has several vital functions in the 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, and the intake is quantitatively inadequate or contains elements that render the iron unavailable for absorption (Blitz 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). Copper and iron are important minerals found in fish as respiratory pigment, while cobalt is present in vitamin $B_{12.}$

Sodium contribution is maximum in the present study irrespective of the sex. In individual contribution sodium is maximum in berried females (53.36 mg) followed by females (46.71 mg) and males (37.48 mg) of *C. lucifera*. Sodium was already reported in *P. sanguinolentus* (Sudhakar *et al*., 2009b), *S. tranquebarica* (Thirunavukkarasu, 2005), *E. sinesnsis* (Chen and Zhang, 2007), *C.amnicola* (Moronkola *et al*., 2011), *P. potamios* (Bilgin and Fidanbas, 2011), *C. amnicola and U. tangeri*, (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *Cardisoma armatum* and *C. amnicola* (Omotayo *et al*., 2013), *C. natator* (Soundarapandian *et al*., 2013), *P. vigil* (Soundarapandian *et al*., 2014), *C. lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and Soundarapandian, 2014). 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 berried females (43.28 mg) than females (36.79 mg) and males (25.92 mg) of *C. lucifera*. Potassium was already reported in *S.tranquebarica* (Thirunavukkarasu, 2005), *E. sinesnsis* (Chen and Zhang, 2007), *P. sanguinolentus* (Sudhakar *et al*., 2009b), *C. amnicola* (Moronkola *et al*., 2011), *P. potamios* (Bilgin and Fidanba, 2011), *C. amnicola and U .tangeri*, (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *C. armatum* and *C. amnicola* (Omotayo *et al*., 2013), *C. natator* (Soundarapandian *et al*., 2013), *P. vigil* (Soundarapandian *et al*., 2014), *C.lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and Soundarapandian, 2014). Potassium is important to maintain the pH, storage and transfer of energy and nucleotide synthesis.

Zinc is maximum in berried females (0.92mg) than females (0.53 mg) and males (0.31 mg) of *C. lucifera.* Zinc was already reported in *S. tranquebarica* (Thirunavukkarasu, 2005), *E. sinesnsis* (Chen and Zhang, 2007), *P. sanguinolentus* (Sudhakar *et al*., 2009b), *C. amnicola* (Moronkola *et al*., 2011), *P. potamios* (Bilgin and Fidanbas, 2011), *C. amnicola and U. tangeri*, (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *C. armatum* and *C. amnicola* (Omotayo *et al*., 2013), *C. natator* (Soundarapandian *et al*., 2013), *P. vigil* (Soundarapandian *et al*., 2014), *C. lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and Soundarapandian, 2014). Zinc is an essential trace element for all living species, since it is an important component of several enzymes and plays an essential role in a number of biological processes involved in growth and development (FAO/WHO, 2002). MacFarlane *et al*. (2000) reported higher Cu and Zn accumulation in females than males of semaphore crab, *Helioecius cordiformis*.

Manganese is maximum in berried females (2.80 mg) than females (1.62 mg) and males (1.30 mg) of *C. lucifera.* It is already reported in *S.tranquebarica* (Thirunavukkarasu, 2005), *E.sinesnsis* (Chen and Zhang, 2007), *P. sanguinolentus* (Sudhakar *et al*., 2009b), *C. amnicola* (Moronkola *et al*., 2011), *Potamon potamios* (Bilgin and Fidanbas, 2011), *C. amnicola* and *U. tangeri* (Udo Paul Jimmy and Vivian Nneka Arazu, 2012), *C. armatum* and *C. amnicola* (Omotayo *et al*., 2013), *C.natator* (Soundarapandian *et al*., 2013), *P.vigil* (Soundarapandian *et al*., 2014), *C. lophous* (Kathirvel *et al*., 2014) and *S. hydrodroma* (Varadharajan and Soundarapandian, 2014). Manganese is important for the development of bones. It also act as an activator of enzyme systems, but the connection with the deficiency symptoms in crustacean is not entirely clear.

Copper, mercury, cadmium and arsenic are available very less in the present study. *C. lucifera* contains sufficient nutrients and minerals that are beneficial to humans as food. It could especially serve as supplements to patients deficient in them if taken appropriately. It could also be concluded that the concentration of minerals in these species is within WHO recommended safe limits for elements in aquatic organisms. From the study berried females bear maximum amount of minerals than females and males. So, it is recommended to consume berried females and females to get maximum minerals.

CONCLUSION

In the present study, totally 11 minerals are reported in the edible parts of muscle of *C. lucifera*. Seven minerals (Sodium> Potassium> Magnesium> Calcium>Manganese> Iron>Zinc) were reported in all sexes. Sodium was maximum (137.55 mg) and zinc was minimum (1.76 mg) in all sexes. Copper, mercury and cadmium were available in trace amount in all sexes. However, arsenic was in trace amount in berried females and totally absent in males and females. Among different sexes, berried females contain maximum amount of minerals (156.24 mg) followed by females (121.76 mg) and males (95.5 mg).

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