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Mineral and nutritional elements in the edible salted clam *Donax semistriatus* Poli, 1795

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Filter feeders found around Egyptian coasts could feed a billion people. Is it the time we pay more attention to these bivalves? This natural source of protein is full of essential nutrients. It can be a viable alternative to farmed meat. The proximate composition of the edible part of the salted clam *Donax semistriatus* revealed 25.03 % protein, 2.58 % lipid, 4.62 % carbohydrate, 67.14 % ash, and 0.63 % fibers. The mineral composition of the clam tissue showed the presence of sodium and potassium as major microelements with concentrations of 18896.76 mg/kg and 4448.02 mg/kg, respectively. Zinc (24.28 mg/kg), iron (164.25 mg/kg), phosphorus (2.6 mg/kg), and manganese (36.28 mg/kg) were detected in minor quantities while copper and cobalt were not detected in the clam tissues. Calcium content was 1.24 %. Bioaccumulation of toxic heavy metals such as lead occurred in the tissue of the clam as a result of its filtering activity. Lead had a level of 2.6 mg/kg in the salted clam tissue which exceeded the permissible limit for lead presence in shellfishes. This study approved that the salted clam *Donax semistriatus* is nutritive for human however; Pb levels must be monitored continuously in the future.

[**Keywords**: Bivalves, Calcium, *Donax semistriatus*, Heavy metals, Proximate composition]

Introduction

No one can deny the need for a good source of cheap protein, especially with the growing population in developing countries. Also, the problem of malnutrition is a case that must be dealt with. In addition, recent biotechnological approaches are been attentive in marine biomolecules, especially protein, which may have medicinal uses. The bivalves are considered as an important source of protein, lipids, carbohydrates, and minerals and provide a good nutritional status. In the present time, clams have been widely used as a good source of food for humans. In Indonesia, the freshwater bivalve (*Pilsbryoconcha exilis*) is used as a possible local mineral source in weaning foods to control stunting in Grobogan, Central Java[1]. Many marine animals can provide a good source of protein and minerals. Shellfishes are the most important constituents of seafood production. The protein content in shellfish is higher than that in finfishes[2]. Bivalves are the most important marine animals that exist on the Egyptian shores, which can be one of the most important sources for the seafood industry; especially the clams. *Donax semistriatus* Poli, 1795 (Common name; Omm elkholol) is found in the Egyptian markets throughout the year. It is preserved by salting which is one of the good methods for preservation of fishes and marine animals. Salting removes water that is responsible for microbial growth causing degradation of tissues. However, processing methods have an observed effect on protein, lipid, and water contents[3]. El-Bassir *et al.*[4] showed a significant difference in moisture, ash, protein, sodium, and iron content between fresh and salted fish.

The biochemical constituents of food, primarily minerals, proteins, and fats have a vital role in the human systems. Sufficient amounts of these nutrients are essential for maintaining good health. There are many symptoms and diseases resulting from a deficiency of minerals and trace elements[5]. Proximate composition and minerals were determined for some species of shellfishes marketed in the northwest. Generally, shellfishes are an important source of zinc, while Pacific oysters, Manila clams, and blue mussels are also important sources of iron[6].

It was found that fish products and shellfishes were sources of protein, iodine, phosphorus, and selenium[7]. Faye & Dong[8] reported that shellfishes are low in saturated fat, but rich in iron, zinc, and copper, in addition they are a good protein source. The chemical constituents and mineral contents of the tissues of four species of shellfish collected from the Calabar River, Nigeria revealed that they are a good source of protein-rich food with low carbohydrate and fat content. Also, they are filled with minerals such as iron, copper, sodium, calcium, and manganese which are important for vital cellular functions[9]. Srilatha *et al.*[10] studied the nutritional qualities of *Meretrix casta* from Cuddalore and Parangipettai Coast, South East Coast of India and reported five macro minerals and two trace minerals in addition to a good percentage of protein, lipid, and carbohydrate. Bassey *et al.*[11] found that *Egeria radiata* (clams) and *Pomacea paludosa* (gastropods) are rich in carbohydrate, crude fat, crude protein, fiber, and ash. Also, the surf clam *Mactra violacea* is a source of minerals and protein with small amount of fat[12]. It was concluded that clams are a source of iron, zinc, iodine, magnesium, and copper[13]. Further, Singh *et al.*[14] concluded that the average content of protein, lipid, and carbohydrates in *Donax scortum* was 62.95 %, 7.33 %, 21.67 %, respectively.

The salted clam, *Donax semistriatus* is a marine bivalve widely consumed in Egypt. The biochemical composition of *D. semistriatus* was analyzed to describe its nutritional value and to promote its entry into the dietary supplements industry as a good inexpensive source of minerals. The present investigation is the first to evaluate the proximate and mineral content of salted clam *D. semistriatus.*

Material and Methods

Proximate composition analysis

The salted specimens of the bivalve clam *D. semistriatus* (Fig. 1) collected from Kafrelshiekh fish market were brought to the laboratory in a plastic container. The samples were ground to fine and homogeneous powder and stored at -18 °C until analysis. Protein content was estimated using micro-Kjeldahl method[15]. Moisture was estimated using oven drying at 105 °C[(ref. 16)]. The total lipids were determined according to Bligh & Dyer[17]. Total dietary fiber was estimated according to Horwitz & Latimer[15]. Total carbohydrate was determined by summing values of total dietary fiber, starch, and oligosaccharides. The oligosaccharides contents were estimated as mentioned by Cicek[18].

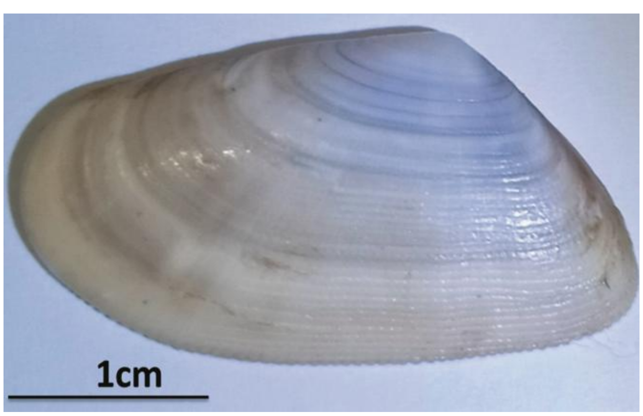

Fig. 1 — *Donax semistriatus* Poli, 1795

Elemental composition analysis

After digestion and filtration, samples were diluted to a suitable concentration[15]. Trace elements and heavy metals concentrations in the digested samples were determined using a flame atomic absorption spectrophotometer. Standard solutions of Fe, Cu, Zn, Mn, and Pb were prepared by dilution of tested standard solutions to the required concentration[15].

Proximate and elemental composition analysis was performed in the laboratory of the faculty of agriculture, at Kafrelsheik University.

Result and Discussion

Proximate composition

Protein is the most important nutritional component for maintaining the structure of the human body, whereas; lipids are important in maintaining the structural and physiological safety of cellular and sub-cellular membranes. The nutritional composition of salted *Donax semistriatus* (on a dry matter basis) indicated the presence of 67.14 % ash, 25.03 % protein, 4.62 % carbohydrates, 2.58 % lipids, and 0.63 % fibers (Table 1).

These results more or less agreed with that of Periyasamy *et al.*[19] who reported that protein, carbohydrate, and lipid contents in *Donax incarnatus* (from Cuddalore southeast coast of India) tissue were 23.51 %, 10.13 %, and 1.34 %, respectively. While, Abirami *et al.*[20] reported that *Donax cuneatus* (from Veerampattinam beach, India) had 42.05 % of protein content, 14.73 % of carbohydrate, 9.75 % of lipid and 2.59 % of ash on a dry weight basis. In the present

Table 1 — Proximate composition of the edible part of *Donax semistriatus*

Chemical constituents	On a dry matter basis %	As feed basis %
nietorP	25.03	19.09
dipiL	2.58	1.97
Carbohydrates	4.62	3.52
hsA	67.14	51.20
srebiF	0.63	0.48

Table 2 — Proximal composition of different bivalve species

Bivalve species	Protein %	Lipid %	Carbohydrate %	References
Donax cuneatus	23.93	1.24	8.3	Gopalsamy *et al.*[26]
Donax incarnatus	23.51	1.34	10.13	Periyasamy *et al.*[19]
Donax cuneatus	42.05	9.75	14.73	Abirami *et al.*[20]
Meretrix meretrix	26.9	1.45	7.44	Bhaskar *et al.*[31]
Meretrix casta	30.02 – 45.67	1.11 – 5.63	4.21 – 15.67	Srilatha *et al.*[10]
Gafrarium divaricatum	26.32	1.29	11.23	Eswar *et al.*[27]

study, the relatively high percentage of ash may be due to the salts used in the salting process. Akpang & Oscar[9] reported that protein and ash contents were highest in the edible part of clam *Egeria radiata* (32.10±0.06 % and 3.80±0.01 %) among other shellfishes examined. The two clams *Donax trunculus* and *Chamelea gallina* were investigated for the proximate compositions by Ozden *et al.*[21] wherein the ranges of carbohydrate, protein, fat, ash and moisture contents were 2.70 – 4.50 %, 6.86 – 8.99 %, 0.58 – 1.20 %, 2.44 – 2.95 % and 82.70 – 86.57 % for *C. gallina*, and 2.31 – 3.18 %, 8.13 – 10.61 %, 0.69 – 1.33 %, 3.19 – 4.06 % and 81.09 – 85.55 % for *D. trunculus*, respectively. King *et al.*[6] mentioned that the total lipid in the blue mussels was 3.1 %. The protein content of *Mactra violacea* was determined as 11.9 %, ash 3.2 %, fat 1 %, and moisture 80 %[(ref. 12)]. Abraha *et al.*[22] reported that proteins, fats, and minerals are the important constituents that can be changed during the processing methods of fish (such as drying, smoking, freezing, cooking, and canning). The total protein content of the bivalve clam, *Meretrix casta* (from Cuddalore and Parangipettai Coast, South East Coast of India) was found to range between 45.67 % and 30.021 %. Lipids were varied from 5.63 to 1.11 %. The carbohydrate contents varied from 4.21 to 15.67 %, respectively at the region I and II[10]. Also, seasonal variation in the nutritional elements of the tissues of the freshwater bivalve *Lamellidens jenkinsianus* (from River Tunga, Karnataka, India) was reported to be, lipids (4.7 – 8.6 %), proteins (40.8 – 61.2 %), carbohydrate (15.39 – 40.7 %) and ash content (10.3 – 32.1 %) of dry tissue weight[23]. This study was conducted on salted clams to evaluate their nutritional elements despite the salting process. The proximal composition of different bivalve species is summarized in Table 2.

Minerals

Trace elements are naturally occurring inorganic substances required in the human body in amounts <100 mg/day. All the vital chemical reactions cannot be completed without them[24]. Fairweather-Tait & Cashman[5] reported that essential minerals together with trace elements have important physiological functions within the body and there are many symptoms accompanied by deficiency of them (Tables S1 & S2).

Table 3 — Minerals profile of the salted clam *D. semistriatus*

Minerals	Kg/mg
Na	18896.76
K	4448.02
Zn	24.28
Cu	*ND
Co	*ND
Fe	164.25
Mn	36.28
Pb	2.6

*ND: Not Detected

The minerals profile of the salted clam *D. semistriatus* is recorded in Table 3. The mineral composition of the clam tissue showed the presence of sodium with a concentration of 18896.76 mg/kg. Preservation by salting was the cause of this high level of sodium. The concentration of potassium was 4448.02 mg/kg. Tabakaeva *et al.*[25] found that the main macroelements in the edible bivalve species (*Anadara broughtonii* and *Mactra chinensis*) were Na (1134 – 1527 mg/100g) and K (1088 – 2293 mg/100g).

The present work revealed that Zinc (24.28 mg/kg), iron (164.25 mg/kg), phosphorus (2.6 mg/kg), and manganese (36.28 mg/kg) were observed in minor quantity while copper and cobalt were not detected in the clam tissue. On the other hand, calcium content recorded 1.24 %. Abirami *et al.*[20] stated that that calcium content in *D. cuneatus* was 2.46 %. While Gopalsamy *et al.*[26] recorded calcium in higher concentration (138.2 mg/g) in the tissue of *Donax cuneatus*. The edible clam *Egeria radiata* contains calcium of about 66.72±0.01 mg/100 g[(ref. 9)]. Eswar *et al.*[27] evaluated the mineral composition in the tissue of clam *Gafrarium divaricatum* from Mumbai, West Coast of India and observed the presence of sodium (89.93 mg/g), calcium (312.74 mg/g), potassium (21.38 mg/g), and magnesium (61.11 mg/g) as major microelements and zinc (0.38 mg/g), copper (1.43 mg/g) and iron (1.37 mg/g) as minor quantity. Clam can be used as a bioindicator for pollution level in the sea because being the filter feeders; they filter toxic heavy metals from seawater besides nutrients. Lead is a toxic metal that accumulates in aquatic organisms. The waste resulting from industries with petrol derivatives causes the increase in concentration of lead in the sea waters. In this study, lead has a level of 2.6 mg/kg in the salted clam tissue which exceeded the permissible limit for lead presence in shellfishes (1.50 mg/kg) in the European Commission[28].

Colakoglu *et al.*[29] revealed that the mean concentrations of trace elements (mg/kg wet weight) in the tissues *Chamelea gallina* were as follows: Cu: 0.71 – 5.30; Mn: 0.30 – 5.94; Zn: 13.08 – 77.76; Fe: 2.46 – 114.22; Pb: 0.18 – 3.24; Co: 0 – 0.43. They added that Pb and Zn exceeded the legal concentrations of European Commission and Turkish legislation. Ozden *et al.*[30] reported that the concentrations of sodium, potassium, magnesium, calcium, iodine, and selenium in the tissues of the bivalve species *D. trunculus* and *C. gallina* exceeded the acceptable limits for human consumption. Further they recorded the percentages of Pb, Cu, Zn, Fe, Al, Mn, and Ni in the tissues and suggested that the two species are not at risk for human consumption if they consumed moderately[30].

Conclusion

This is the first study on the proximate composition and mineral contents analysis of the salted clam *Donax semistriatus*. The study recorded a good level of protein and carbohydrate and low-fat content in the edible clam. It also contains major elements (sodium, potassium, calcium) and minor trace elements (iron, zinc, manganese). Its nutritive value promotes use in the dietary supplements industry as a good inexpensive source of proteins and minerals. However, great attention must be paid to monitoring pollutants such as lead. Currently, its therapeutic potential for antioxidant activities is under investigation.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at https://nopr.niscpr.res.in/jinfo/ijms/IJMS_53(02)62-66_SupplData.pdf

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