Macronutrient and mineral profiling of Tegillarca granosa (blood clam) sourced from Vashi Creek, Navi Mumbai, Maharashtra, India

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India is one of the 193 member states of the United Nations that is a signatory to the UN's Agenda 2030 which has at its core a set of 17 Sustainable Development Goal (SDGs) of which SDG 2 on Zero Hunger calls for ending all forms of hunger by year 2030 (UNSDG, 2017). Deficiency arising due to lack of intake of micronutrients causes micronutrient malnutrition also referred to as hidden hunger. According to WHO, more than 2 billion people suffer from hidden hunger and it is a worsening challenge worldwide (FAO, IFAD, UNICEF, WFP and WHO, 2021). Though required in minute quantities, their deficiency causes serious, sometimes life-threatening health conditions. Also, micronutrient deficiencies (MiND) may cause more subtle effects like fatigue and low mental clarity resulting in compromising of critical development outcomes like reduced growth, increased susceptibility to disease, exacerbation of illness, and an overall decrease in work efficiency and capability.

Globally, iron deficiency is one of the most commonly occurring MiND with WHO estimating that 0.5 billion women between ages 15 to 49 and 269 million children between ages 6-59 months are anemic, followed by zinc and iodine deficiencies (WHO, 2021). Worldwide, 1.8 billion people suffer from iodine deficiency and about 30% of people are at risk of zinc deficiency due to inadequate intake. MiND rates are significantly higher in South Asia and Sub-Saharan Africa; for instance, anemia affects over 60% of the population in some countries. According to a study by the Consumer Health Division of Bayer over 80% of Indians suffer from MiND (Consumer Health Division of Bayer, 2022). More than half of women of reproductive age, i.e. about 57% in India suffer from iron deficiency anemia according to National Family Health Survey (NFHS)-(V) and 32% and 3.9% of adolescents have zinc and iodine deficiencies respectively (MoHFW, 2021).

While the status quo regarding MiND seems dismal, ailments associated with MiND can be easily prevented through nutrition awareness creation, intake of healthy, diverse, and nutrient-dense foods, food fortification and supplementation of nutrients. While these strategies have contributed to a significant reduction in rates of MiND globally as well as in India, more concerted efforts are essential for the achievement of SDG 2. Seafood including fish and shellfish contains good quality, readily digestible protein, minimal fat that is rich in healthy omega 3 fatty acids, vitamins like D & B2 and minerals including iron & zinc with clams being advocated as particularly good sources of iron.

Clams thrive in marine environments in addition to fresh water and brackish water habitats and are by far the most prolific and extensively occurring bivalves. They form an important part of the sustenance fisheries of coastal fishing villages and are crucial for both their nutritional needs and economy. Abundant beds of *Tegillarca granosa* or *Anadorra granosa* commonly called blood clams, due to the occurrence of blood red hemoglobin pigment, occur alongside the southwest coast of Maharashtra. *T. granosa* forms a crucial part of local fisher-folk diets providing them with affordable nutrition in terms of protein and minerals meeting a vital part of their daily nutritional needs. This paper describes the proximate composition analysis and mineral profiling of fresh blood clams collected from Vashi Creek, Navi Mumbai.

The meat was shucked out of clam shells soon after harvest and 200 g of edible portion was immediately iced and transported to Mumbai Research Center, ICAR-CIFT, Vashi for the study. Clam meat was minced and used for the proximate composition analysis (protein, moisture, fat and ash), using standard AOAC Official Methods of Analysis 2015, 18th Edition (AOAC, 2015). Briefly, for estimating moisture content, 10g of clam samples were subjected to drying at 120 °C for 2 hr or until a constant weight was obtained. About 0.1 g of homogenized clam meat was acid digested, distilled and titrated to determine the crude protein using the Kjeldahl method (Nitrogen value X 6.25 conversion factor). The crude lipid content of clam samples (5g) was determined by continuous soxhlet extraction of lipid with petroleum ether. AOAC method (AOAC, 2015) for mineral profiling constitutes microwave acid digestion followed by quantitative determination by ICP-OES which was done at the Quality Assurance and Management Division of ICAR-CIFT, Cochin. Analysis was carried out in triplicates and values were expressed as mean ± standard deviation.

Information on the organic chemical constituents of foods is vital as the nutritive value is reflected in their biochemical content. Chemical composition is a reflection of the physiological state of the animal, the availability of food and factors related to the habitat. The proximate composition of blood clams is given in Table 1. Blood clams show a significant amount of protein 13.3% and their nutritive value comes not only from the high quality of protein but also the relatively low-fat content (1.54 %) and the significant level of ash content of nearly 2%. Typically, fish contain negligible carbohydrate content, but contents in shellfish are reported to vary from nearly 1 to 10% (Karnjanapratum et al., 2013) and blood clams showed 3.49 % of carbohydrates.

Table 1. Macronutrient composition of blood clams Tegillarca granosa collected from Vashi Creek, Navi Mumbai, Maharashtra

S. No.	Macronutrient	Percentage*
1.	Moisture	79.74±1.3
2.	Protein	13.30±1.1
3.	Fat	1.54±0.3
4.	Carbohydrate (by difference)	3.49±0.6
5.	Ash	1.93±0.3

**Values are expressed as the mean of three determinations ± standard deviation*

The concentrations of the various minerals determined in the edible portion of the blood clams is shown in Table 2. Among the microminerals detected in the blood clams, Fe and Zn show the highest quantities followed by Mn, Cu, Ni, Se, Mo and Co. The exceptionally high content of Fe of nearly 1g/kg make blood clams an excellent source of Fe. This may be as a result of the blood pigment hemoglobin that is dispersed in the blood and tissues imparting red color to the muscle (Mohite S. and Meshram A.M., 2015). Anemia, which occurs due to deficiency of iron, is a condition where an individual's blood lacks enough red blood corpuscles for efficient transport of oxygen. Iron deficiency is a consequence of low dietary intake or decreased absorption arising due to poor bioavailability of iron. Bioavailability is a function of several factors like the type of iron; it being heme or non-heme type, presence of enhancers (like vitamin C) or inhibitors (like phytates) in food. With this viewpoint, it is important to evaluate blood clams for their potential to provide bioavailable iron. Nonetheless, the inclusion of blood clams in diets of populations, vulnerable to insufficient iron intake like adolescent girls at least thrice a week may be a useful strategy to address iron deficiency. Zn, though a trace metal is a vital part of over 300 enzymes that catalyze diverse reactions in metabolic pathways influencing cell growth, cell division, immunity, wound healing etc. Zn deficiency symptoms include growth retardation, immune dysfunction and cognitive impairment (Prasad, 2013). Blood clams showed Zn levels of nearly 90 mg/kg and the RDA for Zn ranges from 8 to 12 mg (Koe, 2021). In this context, a serving size of 100 g of blood clam would fulfill the daily requirement of Zn. Similarly, Mn, Cu, Ni, Se, Mo and Co are trace elements with important physiological roles in humans and are present in significant quantities in blood clams.

Among the macrominerals in blood clams, Ca and P levels were found to be over 10g/kg indicating that clams are a good source of these minerals. Ca and P together are essential for healthy bones and teeth and are the main components of hydroxyapatite, the bone mineral that gives strength to the organic matrix. Men and women of all ages are susceptible to Ca deficiency which reduces bone strength leading to osteoporosis, characterized by fragile bones while deficiency of P causes osteomalacia and rickets in addition to conditions like anemia and low mental clarity. K (7g/kg) and Mg (2g/kg) are both essential for optimal function of the heart and muscles and are important for metabolic pathways as they are constituents of enzymes. Deficiency as a result of low intake though rare is characterized by arrhythmia, fatigue and muscle weakness.

Table 2. Macro and micro minerals in blood clams Tegillarca granosa collected from Vashi Creek, Navi Mumbai, Maharashtra

S. No.	Mineral	Concentration*
	Macrominerals	**(g/kg)**
1.	Calcium (Ca)	10.97±0.8
2.	Magnesium(Mg)	2.13±0.1
3.	Phosphorous(P)	10.22±0.5
4.	Potassium (K)	7.27±0.3
5.	Sodium (Na)	6.52±0.6
	Microminerals	**mg/kg (ppm)**
6.	Copper (Cu)	7.94±0.4
7.	Cobalt(Co)	0.94 ±0.04
8.	Manganese(Mn)	29.87±1.4

9	Molybdenum	1.10±0.06
10.	Iron (Fe)	978.92± 32
11.	Nickel (Ni)	4.41±0.6
12.	Selenium (Se)	3.75±0.25
13.	Zinc(Zn)	89.90± 3.7

**Values are expressed as mean of three determinations ± standard deviation*

In conclusion, blood clams can be referred to as a storehouse of macro and micro nutrients essential for proper functioning of the human body and incorporating them regularly in diets will help meet daily requirements of these nutrients. With India striving to achieve the agenda 2030 of the UN, addressing MiND is very crucial and regular consumption of blood clams especially by people where it is a local fishery can contribute substantially to achieving this significant milestone.

Reference

UNSDG (2017) United Nations Sustainable Development Group, Mainstreaming the 2030 Agenda for Sustainable Development - Reference Guide for UN Country Teams, 137p https://unsdg.un.org/resources/mainstreaming-2030-agenda-sustainable-development-reference-guide-un-country-teams

FAO, IFAD, UNICEF, WFP and WHO. 2021. The State of Food Security and Nutrition in the World 2021. Transforming food systems for food security, improved nutrition and affordable healthy diets for all. Rome, FAO https://doi.org/10.4060/cb4474en

Consumer Health Division of Bayer (2022, April 19) https://www.bayer.in/en/thisisbayer/consumerhealth

MoHFW (2021) National Family health survey (NFHS-5) 2019-21, https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf

AOAC Official Method 2015.01; "Determination of Heavy Metals in Food by Inductively Coupled Plasma-Mass Spectrometry First Action" (2015).

Karnjanapratum S, Benjakul S, Kishimurab H, Tsaic Y-H. Chemical compositions and nutritional value of Asian hard clam (Meretrix lusoria) from the coast of Andaman Sea. Food Chem. 2013;141:4138–4145

Mohite S, Meshram AM (2015) On Haematological Characteristics of Blood Clam, Tegillarca rhombea (Born, 1778). J Aquac Mar Biol 3(2): 00065.

Prasad AS. Discovery of human zinc deficiency: its impact on human health and disease. Adv Nutr. 2013 Mar 1;4(2):176-90.

Koe, T. (2021, July 26). India's new RDA rules see increase in vitamin A, C, zinc levels, while biotin remains unchanged. https://www.nutraingredients-asia.com/Article/2021/07/26/India-s-new-RDA-rules-see-increase-in-vitamin-A-C-zinc-levels-while-biotin-remains-unchanged

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