WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

SJIF Impact Factor: 6.711

ISSN: 2457-0400
Volume: 9
Issue: 5
Page N. 03-18
Year: 2025

Original Article www.wjahr.com

INFLUENCE OF GEOGRAPHIC LOCATION ON QUALITY, NUTRITIONAL COMPOSITION AND AMINO ACID PROFILE OF TWO EXPORTABLE SPECIES, GIANT FRESHWATER PRAWN (*MACROBRACHIUM ROSENBERGII*) AND GIANT TIGER SHRIMP (*PENAEUS MONODON*) IN BANGLADESH IN WINTER SEASON

M.A. Mansur*, M.S. Reza, Md. Ismail Hossain, Fatema Hoque Shikha, Tasmia Islam Kanta, Moshfiq Momtasir Neloy, Avijet Paul, Md. Hasibur Rahman and Md. Shahadat Hossain

Department of Fisheries Technology, Faculty of Fisheries Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Article Received date: 10 March 2025 **Article Revised date:** 31 March 2025 **Article Accepted date:** 21 April 2025

***Corresponding Author: M.A. Mansur**

Department of Fisheries Technology, Faculty of Fisheries Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

ABSTRACT

This research is conducted to know the influence of geographic location on quality, nutritional composition and amino acid profile from the flesh of two exportable species, Giant freshwater prawn (*Macrobrachium rosenbergii*) and Giant tiger shrimp (*Penaeus monodon*), Bangladesh. For this purpose, quality (TVB-N, TMA-N), proximate composition and amino acid profile were detected and estimated through laboratory analysis. Noticeable changes in the result of quality and proximate composition in *M. rosenbergii* and *P. monodon* were apparent. In *M. rosenbergii* and *P. monodon* moisture content was 73.78±0.40% and 77.16±0.29%, ash content was 0.92±0.11% and 0.98±0.14%, crude protein was 21.28±0.37% and 17.17±0.45%, lipid content was 1.52±0.26% and 1.73±0.20% respectively. Overall quality of *M. rosenbergii* and *P. monodon* was assessed by the parameters TVB-N and TMA-N for 4 weeks. Significant difference in TVB-N was observed in different weeks but the values remained within the acceptable limit (<30 mg/100g), while the value of TMA-N also varied across weeks but remained within the acceptable limit (<10 mg/100g). *M. rosenbergii* and *P. monodon* contain 44.08% and 42.91% essential and 55.92% and 57.09% non-essential amino acids respectively. Among the essential amino acids, Leucine, Lysine, Arginine and among the non-essential amino acids, Glutamic acid, Aspartic acid and Alanine were detected and estimated in high quantity which have specific vital functions. Therefore, the aim of this research is to know about the influence of geographical location on quality aspect, nutritional value and amino acid profile with their numerous health benefits and functions. The suggestion from this research is that due to the presence of essential amino acids in prawn and shrimp muscle, it can be used as a healthy dietary option for human consumptions.

KEYWORDS: Quality, nutritional composition, amino acid profile, *Macrobrachium rosenbergii*, *Penaeus monodon*.

INTRODUCTION

The most demanding and mouth-watering seafood found in both freshwater and saltwater environment are prawn and shrimp. Both are valuable in global cuisine, contributing to fisheries and aquaculture industries. Prawn and shrimp play a significant role in various aspects including nutritional, economic and environmental factors. Advances in techniques and the huge expansion of world demand for this species, continue to stimulate the growth of a multi-million-dollar industry (Michael Bernard New, 2000).[1] Giant freshwater prawn (*Macrobrachium rosenbergii*), locally called "Golda" is not only a highly valued seafood but also plays a crucial role in economic growth, nutrition and traditional cuisine. Its farming and consumption continue to rise, making it one of the most significant prawns in the global seafood industry. Giant tiger shrimp (*Penaeus monodon*), locally known as "Bagda" has got geographical indication certificate as the 10th product of Bangladesh. As it is one of the major export items in Bangladesh, its export markets are strong in the USA, UK, Europe, Japan and South Korea. The global shrimp production reach to 5.03 million tons in 2020 and is expected to grow up to 7.28 million tons by 2025 with compound annual growth rate (CAGR) of 6.1% from 2020 to 2025 (IMARC, 2020)(Nirmal et al., 2020).[2] Total shrimp and prawn production including capture was 144,352 MT in 2022-2023 which is 45.98% of total fish production and its current growth rate is 3.89% (DOF, 2023).[3] Giant tiger shrimp (*Penaeus monodon*) from salt water due to their enormous size and mouthwatering flavour, is a well-known food item both domestically and internationally. This variety of saltwater shrimp is a wonderful source of fat and protein. Lipid and protein both offer numerous health advantages in addition to providing energy. Prawns contain good amount of organic and inorganic constituents. The main constituents are protein, carbohydrate and lipid. In addition to that prawns also contain a significant proportion of minerals (Ca, P, Mg, Mn, I and Cl) and vitamins (A, C and D). Prawns and shrimp are highly perishable because of their high moisture content, low connective tissue and their high amino acid content (Ferdose & Hossain, 1970).[4] Body composition including protein, lipid, amino acid, fatty acid varies in different regions; such variation depends on some factors. Such variation depends on species, size, spawning, water temperature, geographical difference etc. (Connell, 1980) stated that in all species of fish seasonal changes in certain bodily characteristics occur although less noticeable in shell fish.[5] Shrimp and shrimp products are among the most commonly consumed seafoods because of their delicacy and nutritional value (Nirmal et al., 2020).[2] The proximate composition of most fish and shellfish is primarily water, proteins and lipids and these constituents make up about 98% of the total mass. The other minor constituents include carbohydrates, vitamins and minerals (Ahmed, 2022).[6]

The nutritional properties of fish and shellfish are valuable foodstuffs for human health (Usydus et al., 2011).[7] Fish and shellfish as a whole has a lot of food potential and can therefore provide relief from malnutrition, especially in the country like Bangladesh. It provides superior quality protein to that of meat, milk and eggs (Anwarul, 2017).[8] Freshwater prawn and saltwater shrimp species are a good source of edible minerals, fat soluble vitamins. Edible minerals play significant roles in the formation of bone and teeth; mediators of hormones and nervous system; muscle extension. These minerals are active against coronary heart disease and also maintain or regulate haemoglobin level of blood. The high moisture content, especially in shrimp, helps in flavour binding activity of protein by hydrophobic interaction, hydrogen bonding, electrostatic interaction (Mansur et.al., 2015).[9] Freshwater prawn and saltwater shrimp species are a good source of protein and lipid. Both protein and lipid supply energy and provide many health benefits. Edible protein and lipid supply energy in human cell 5 Kcal/g and 9 Kcal/g respectively. Protein plays an important role in living body such as in the formation of hormone, enzyme and other biochemical substances such as antibody and haemoglobin. It plays roles for the development of hair, nail, skin, new body tissues which are continuously lost by cutting and washing. Protein content might vary depending on species, age, size, sex, anatomical variation, physiological factors, ecological factors, foods etc. Proteins are defined as biomolecular polymer of amino acids linked with peptide bonds, having high molecular weight. The essential amino acids are abundantly found in prawn and shrimp. Therefore, consumption of prawn and shrimp protein ensures the supply of essential amino acids to human body.

Edible crustaceans such as crab, shrimp, prawn, crayfish and lobster constitute one of the major sources of nutritious food for human being. Among seafood, prawns and shrimps contribute about 20% by volume of the world seafood market. The fibres in prawns have nutritional advantage in that it will assist in reducing constipation and other attendant problems in human consumers. The nutritive values of crustaceans depend upon their biochemical composition such as protein, amino acids, lipid, fatty acids, carbohydrate, vitamins and minerals (Bhavan, 2010).[10]

Generally, the quality of protein in food mainly depends on the protein content, essential amino acid content and proportion and digestibility (Anzani et al., 2020).[11] Amino acids are the building blocks of proteins and serve as body builders. They are utilized to form various cell structures of which they are key components and serve as source of energy (Babsky et al. 1989).[12] Amino acids are a group of organic compounds containing both amino and carboxyl functional groups. The amino group ($-NH_2$) is basic while carboxyl group (-COOH) is acidic in nature. The common amino acids are known as α-amino acids because both the carboxyl group (-COOH) and amino groups ($-NH_2$) are attached to the same carbon atom (α-carbon atom). Proteins are the polymer of L- α-amino acids. This analyses of a vast number of proteins from almost every conceivable source have shown that all proteins are composed of 20 amino acids which are called proteinogenic or standard amino acids. Based on the nutritional requirements, amino acids are grouped into two classes: Essential and Non-essential. Some of the 20 standard proteinogenic amino acids are called essential amino acids because the human body cannot synthesize them from other compounds through chemical reactions and they therefore must be obtained from food. Histidine and arginine are generally only considered essential in children because the metabolic pathways that synthesize these amino acids are not fully developed in children. They are required for proper growth and maintenance of the individual. The body can synthesize about 10 amino acids to meet the biological needs. Hence the need not be consumed in the diet. These are called non- essential amino acids. The amino acids consist of several significant properties such as solubility in water, higher melting point, taste, optical properties, amino acids as ampholytes, chemical properties, reaction of amino acids with formaldehyde

(Mansur et.al., 2015).[9]

Shrimp is an important resource of dietary amino acids for humans. Shrimp contains high- content protein, and the proportions of amino acids are balanced relative to human requirements. Therefore, shrimp protein has a high nutritional value (Liu, 2021).[13] Crustacean muscles contain high concentration of free amino acids such as arginine, glycine, proline, glutamine and alanine (Cobb et al., 1975).[14] The free amino acids have been shown to function in osmoregulation (Fang et al, 1992).[15] They have major contribution to the flavour of sea food (Thompson et al. 1980).[16] The amino acid, tryptophan plays an important role in the brain as a precursor of the neurotransmitter, serotonin, which has a major effect on the feeding behaviour of animals (Mullen and Mortin, 1992).[17]

Aquatic animal protein and lipid have many health beneficial functions in human body. It has already been mentioned that amino acids are the structural unit of protein. Amino acids have many properties of which taste is most noticeable e.g. Glutamic acid possess meaty flavour and taste, glycine, alanine, valine, serine possess sweet taste (Mansur et al., 2024).[18] All amino acids are necessary for health. But human body cannot synthesis some of the amino acids but these are necessary for health. These amino acids are called essential amino acids such as leucine, isoleucine, lysine, methionine, phenylalanine, threonine, valine, arginine, histidine, glutamic acid etc. Essential amino acids help in many biological functions in human cell e.g. anti-mutagenicity, anti-aging, anti-carcinogenicity etc. Prawn and fish protein contain all essential amino acids. Glutamine is one of the most abundant amino acids and participates in a variety of physiological functions, considered as a major fuel source for enterocytes, as a substrate for neo-glucogenesis in kidney, lymphocytes, and monocytes, a nutrient/substrate in muscle protein metabolism in response to infection, inflammation and muscle trauma. The role of glutamine as a protective agent in hepatobiliary dysfunction and as a supplement in total parenteral nutrition is well established, particularly, in patients under intensive care (Kulkarni, 2005).[19]

The main purpose of this study to determine the influence of geographical location on quality (TVB-N and TMA-N), proximate composition and amino acids profile of prawn and shrimp, especially to assess the essential amino acids which have major health benefits. We have conducted this experiment to detect and quantify the amino acid profile of freshwater prawn, *Macrobrachium rosenbergii* from Bagerhat and saltwater shrimp, *Penaeus monodon* from Satkhira which are two exportable species in Bangladesh. It also helps us to know the assessment of the quality and safety aspects of prawn and shrimp, raising awareness of health benefits. Understanding and optimizing the amino acid profile of prawn and shrimp contribute to the economic viability, nutritional value and future feasibility of the prawn and shrimp industry, benefiting both producers and consumers. The study on amino acids profile in prawn and shrimp has socio-economic implications that range from improving human nutrition and health to enhancing aquaculture practices, promoting trade and export, meeting consumer preferences and fostering research and innovation. By analysing the amino acids profile, researchers can determine the presence and quantity of beneficial amino acids which are associated with various health benefits like muscle growth & repair, immune system boost, heart health & circulation, gut health & digestion and brain & nervous system support. This knowledge allows consumers to make informed dietary choices and promotes the aquaculture production and consumption of healthier prawn and shrimp with their value- added products.

MATERIALS AND METHOD

Collection of raw material

Freshwater prawn (Giant freshwater prawn, *Macrobrachium rosenbergii*) from Bagerhat and salt water shrimp (Giant tiger shrimp, *Penaeus monodon*) from Satkhira were collected from a supplier of Bagerhat and Satkhira, Bangladesh. Prawn and shrimp were packed in a Styrofoam box with sufficient iced and transported to the Fish Processing and Quality Control Laboratory of the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202 which took nearly 10 hours journey by bus. On arrival to the laboratory, the shrimp and prawn samples were stored at -20℃ for subsequent laboratory analysis. A portion of samples were sent to the BCSIR (Bangladesh Council of Scientific and Industrial Research) for amino acid analysis. Samples were purchased from Bagerhat and Satkhira by a stakeholder.

Sample preparation

First the appendage, head, shell of *Penaeus monodon* and *Macrobrachium rosenbergii* were removed by forceps, scissors and knife. Only the flesh was taken for experiment. Accurately weighed 500 gm shrimp and prawn flesh was taken for amino acid analysis.

Laboratory analysis

For quality assessment, the two parameters, TVB-N and TMA-N were estimated by AMC (1979) method.[20] Proximate composition (Moisture, Ash, Crude Protein and Lipid) was estimated by A. O. A. C. (2006) method.[21] We conducted both methods in the Fish Processing and Quality Control Laboratory of the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202. The homogeneity of the samples was done by using a blender. All the determinations were made in triplicate.

The proximate components of prawn and shrimp were quantified using the AOAC methods (2006). Moisture content was conducted by using oven-drying at 105℃ (AOAC 950.46). Ash content was determined by using incineration in a muffle furnace at 550℃ (AOAC 920.153). Crude protein was determined by using the Micro-Kjeldahl procedure (AOAC 928.08). Lipid content was determined by using Soxhlet extraction (AOAC 991.36).

Analytical technique

Amino acid analysis: Sykam AAAS433-D Amino acid Analyzer. The method used for this assay was based on chromatographic technique.

Sample preparation

First the appendage, head, shell of *Penaeus monodon* were removed by forceps, scissors and knife. Only the flesh was taken for experiment. Accurately weighed 200-250 mg of prawn and shrimp flesh was taken. Then it was dissolved with hydrolysis solution (300 ml of 37% HCl, 200 ml of DI water and 0.5 g phenol to prepare 500 ml hydrlysis solution). After soaking and mixing, the samples were kept at 120℃ for 24 hours. After that the pH had been adjusted within the range of 2.9 to 3.1. After adjusting the pH, sample volume was adjusted to 250 ml. Then from this 250 ml sample stock 100 µL of sample was taken which was being filtered by 0.45 µM Syringe filter. With this 100 µL of sample, 900 µL of sample dilution buffer (Na-acetate buffer, pH = 2.9 to 3.1) was added. Then it was ready for run.

Analysis

100 µL of sample was taken. Then the sample was passed through the reaction chamber where it reacted with the reagent ninhydrin. The baseline for the isolation of amino acid was done by two different buffers with varied pH. One with acidic 1.9 to 3.1 and the another one with 10.5 to 11.85.

RESULT AND DISCUSSION

Moisture

The average moisture content of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira are 73.78±0.40% and 77.16±0.29% respectively (Table 1). The contents of moisture are found to be higher in *P. monodon* than *M. rosenbergii* (Figure 1). It could be as a result of age, diet and environmental factors in shellfish habitat(Gupta et al., 2007).[22] Prawns are highly perishable due to water activity, pH and autolytic enzymes (Dalgaard, 2000).[23] Due to higher moisture content, shrimp and prawn meat are highly perishable comparing to red meat. The higher moisture content in shrimp offers several health benefits like overall hydration, digestion and nutrient absorption. Thus, prawn and shrimp are nutritious choice for global cuisine.

Table 1: Change in moisture content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira.

Moisture content (%)	Sample 1	Sample 2	Sample 3	Average ±SD
M. rosenbergii	73.35	73.68	74.32	73.78±0.40
P. monodon	76.81	77.52	77.14	77.16±0.29

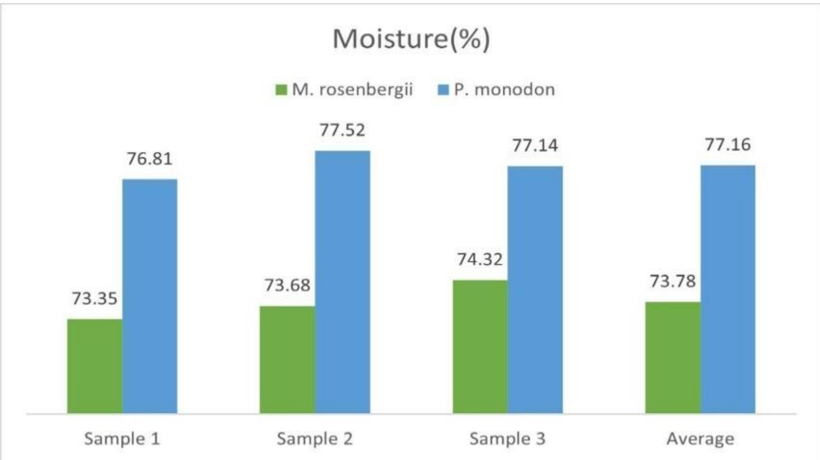

Figure 1: Change in moisture content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira Ash.

The nutrients of shellfish are highly necessary for the growth of human body. The average ash content of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira are 0.92±0.11% and 0.98±0.14% respectively (Table 2). The contents of ash were found to be slightly higher in *P. monodon* than *M. rosenbergii* (Figure 2) As ash represents the inorganic residues left after complete combustion of the meat of shrimp, a higher mineral concentration contributes to higher ash content. Since shrimp grow in highly saline environments or near estuaries, it may accumulate more minerals, increasing ash content. The prawn is valuable in the diet because it provides good quality protein, vitamins A and D as well as several important dietary minerals, especially calcium and iron (Abulude et al. 2006).[24] Ash content directly reflects the amount of minerals present in the shrimp which is essential for understanding its nutritional profile and whether it provides a balanced mineral intake (Ali, 2017).[25] Ash content can affect different characteristics of food including physiochemical and nutritional properties. Determination of ash content ensures the safety of foods, making sure there are no toxic minerals present. The ash content in food can also impact the taste, texture and stability of foods so it is vital to know the mineral content for quality control purposes.

Table 2: Change in ash content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira.

Ash content (%)	Sample 1	Sample 2	Sample 3	Average±SD
M. rosenbergii	1.05	0.94	0.78	0.92±0.11
P. monodon	1.81	1.16	0.98	0.98±0.14

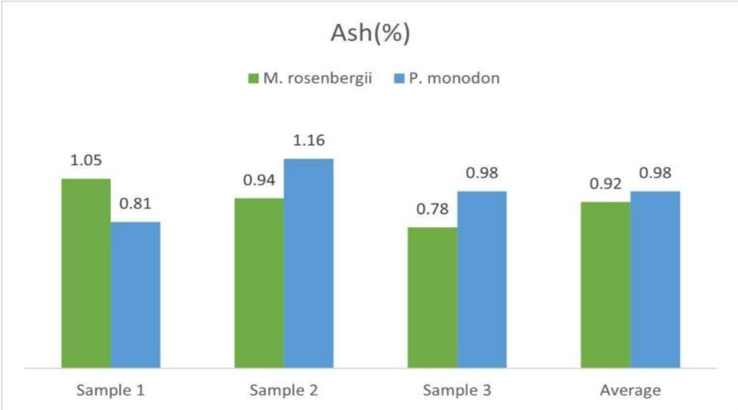

Figure 2: Change in ash content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira.

Crude protein

The average crude protein content of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira are 21.28±0.37% and 17.17±0.45% respectively (Table 3).The contents of crude protein were found to be higher in *M. rosenbergii* than *P. monodon* (Figure 3).The higher crude protein content in prawns can be attributed to several biological and environmental factors such as muscle composition, dietary habits, efficient protein metabolism, water content, rapid growth and reproductive needs, species-specific factors. Generally, shellfish contains 8-15% of protein and in fish it ranges from 15-24%. Prawn muscle contains hundreds of different proteins along with other non-protein nitrogen compounds (Ginson and Bindu, 2017).[26] However, contribution of non-protein nitrogenous (NPN) compounds to this value may reach up to a quarter of this amount. Free amino acids, peptides, amines, amine oxides, guanidine, quaternary ammonium compounds, polyamines, nucleotides and their breakdown products, urea and nucleic acids contribute to the overall content of NPN in seafoods (Shahidi,1994).[27] Protein is one of the most prominent biochemical components of crustaceans and its quantity in this class of organisms is largely influenced by the extent of fat and water contents, stage of maturity and sex of the organism (Dinakaran and Soundarapandian, 2009).[28]

Table 3: Change in crude protein content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira.

Crude protein (%)	Sample 1	Sample 2	Sample 3	Average±SD
M. rosenbergii	20.81	21.32	21.71	21.28±0.37
P. monodon	16.57	17.28	17.65	17.17±0.45

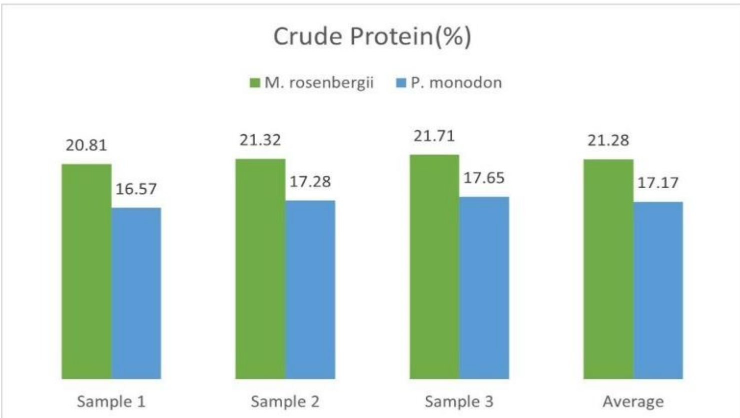

Figure 3: Change in crude protein content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira

Lipid.

The average lipid content of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira are 1.52±0.26% and 1.73±0.20% respectively (Table 4). The contents of lipid were found to be slightly higher in *P. monodon* than *M. rosenbergii* (Figure 4). The higher lipid content in shrimp can be influenced by various biological, environmental and dietary factors such as temperature and environmental conditions, seasonal variations, hepatopancreas function, dietary influence, species variation, energy reserve for reproduction. Lipid provides a source of indispensable nutrients and act as carriers of certain non-fat nutrients, notably the fat- soluble vitamins like A, D, E and K. The hepatopancreas is the main lipid storage organ, triglycerides and phospholipids being its major lipid components, while the muscle contained mainly phospholipids (Muriana et al., 1993).[29]

Table 4: Change in lipid content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira.

Lipid content (%)	Sample 1	Sample 2	Sample 3	Average ±SD
M. rosenbergii	1.21	1.49	1.85	1.52±0.26
P. monodon	1.84	1.91	1.45	1.73±0.20

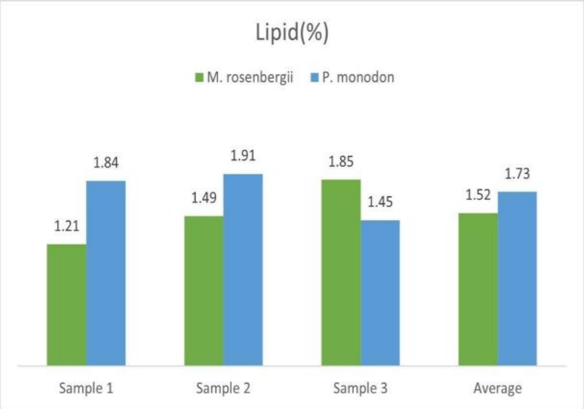

Figure 4: Change in lipid content (%) of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira.

Total Volatile Base-Nitrogen (TVB-N)

Changes in Total Volatile base Nitrogen (TVB-N) during fresh and frozen condition, the initial TVB-N value of fresh prawn, *M. rosenbergii*, in batch 1,collected from Bagerhat was 9.14 mg/100g, in 2nd week it increased to 11.19 mg/100g, in the 3rd week the TVB-N value was increased to 14.34 mg/100g and at the 4th week the TVB-N value showed 17.85 mg/100g respectively (Table 5). In contrast, changes in Total Volatile base Nitrogen (TVB-N) during fresh and frozen condition, the initial TVB-N value of fresh shrimp, *P. monodon*, in batch 1,collected from Satkhira was 10.61 mg/100g, in 2nd week it increased to 13.16 mg/100g, in the 3rd week the TVB-N value was increased to 17.51 mg/100g and at the 4th week the TVB-N value showed 18.67 mg/100g respectively (Table 5). Comparing to *M. rosenbergii*, TVB-N is higher in *P. monodon* over the 4 weeks (Figure 5).

Table 5: Change in TVB-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 1 from week 1 to 4.

TVB-N (Batch 1) mg/100g	Week 1	Week 2	Week 3	Week 4	Average
M. rosenbergii	9.14	11.19	14.34	17.85	13.13
P. monodon	10.61	13.16	17.51	18.67	14.99

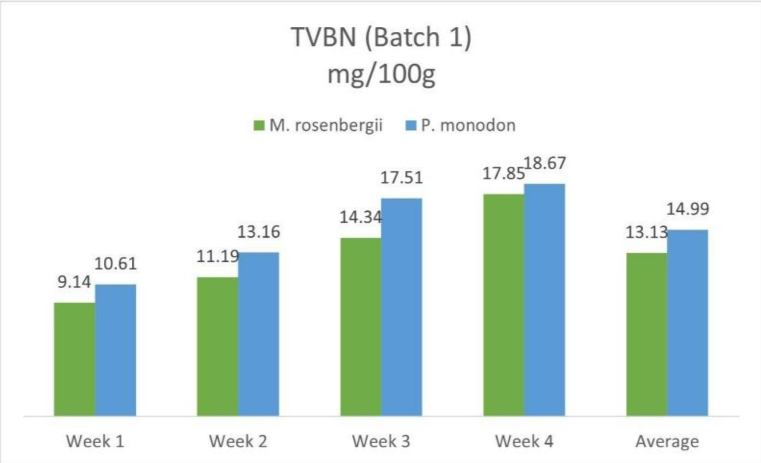

Figure 5: Change in TVB-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 1 from week 1 to 4.

M. rosenbergii, in batch 2, collected from Bagerhat, TVB-N was 9.57mg/100g, in 2nd week it increased to 11.35mg/100g, in the 3rd week the TVB-N value was increased to 14.78 mg/100g and at the 4th week the TVB-N value showed 18.13 mg/100g respectively (Table 6). In contrast, *P. monodon*, in batch 2, collected from Satkhira, TVB-N was 10.36 mg/100g, in 2nd week it increased to 13.26 mg/100g, in the 3rd week the TVB-N value was increased to 17.25 mg/100g and at the 4th week the TVB-N value showed 18.53 mg/100g respectively (Table 6). Comparing to *M. rosenbergii*, TVB-N is higher in *P. monodon* over the 4 weeks (Figure 6).

Table 6: Change in TVB-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 2 from week 1 to 4.

TVB-N (Batch 2) mg/100g	Week 1	Week 2	Week 3	Week 4	Average
M. rosenbergii	9.57	11.35	14.78	18.13	13.46
P. monodon	10.36	13.26	17.25	18.53	14.85

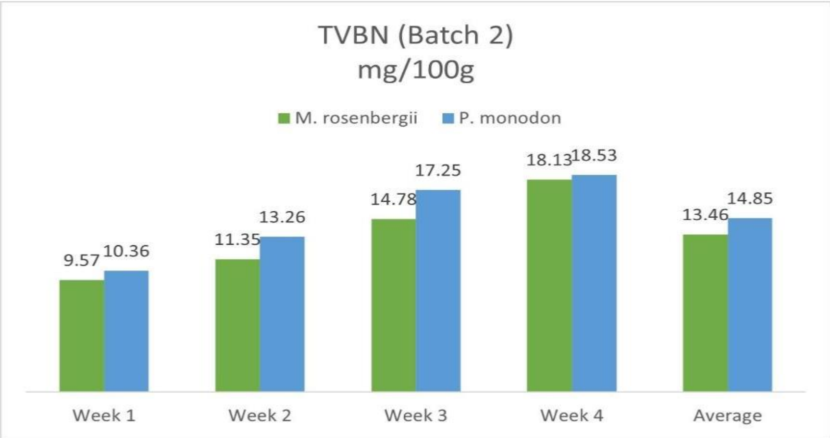

Figure 6: Change in TVB-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 2 from week 1 to 4.

M. rosenbergii, in batch 3, collected from Bagerhat, TVB-N was 9.81 mg/100g, in 2nd week it increased to 11.92 mg/100g, in the 3rd week the TVB-N value was increased to 15.31 mg/100g and at the 4th week the TVB-N value showed 18.69 mg/100g respectively (Table 7). In contrast, *P. monodon*, in batch 3, collected from Satkhira, TVB-N was 10.83 mg/100g, in 2nd week it increased to 13.56 mg/100g, in the 3rd week the TVB-N value was increased to 17.32 mg/100g and at the 4th week the TVB-N value showed 18.92 mg/100g respectively (Table 7). Comparing to *M. rosenbergii*, TVB-N is higher in *P. monodon* over the 4 weeks (Figure 7).

Table 7: Change in TVB-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 3 from week 1 to 4.

TVB-N (Batch 3) mg/100g	Week 1	Week 2	Week 3	Week 4	Average
M. rosenbergii	9.81	11.92	15.31	18.69	13.93
P. monodon	10.83	13.56	17.32	18.92	15.16

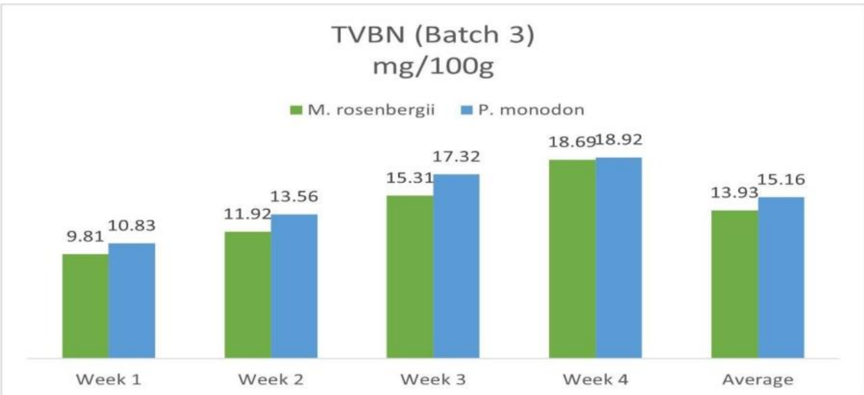

Figure 7: Change in TVB-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 3 from week 1 to 4.

Over the 4 weeks, TVB-N was higher than previous weeks in every sample of *P. monodon*. The increase in TVB-N in shrimp is primarily associated with the degradation of proteins and other nitrogen-containing compounds during spoilage. TVB-N is used as an indicator of the freshness and quality of seafood, results higher levels signal spoilage. The main reasons for increasing TVB-N levels in shrimp are microbial activity, enzymatic activity, autolysis, temperature abuse, prolonged storage, pH, moisture content, post-mortem biochemical changes. The combined action of autolytic enzymes as well as bacterial activity measures the spoilage i.e. quality of fish and prawn, fishery products. Many years this parameter, TVB-N, was used as spoilage indicator. But now-a-days TVB-N is used as spoilage indicator as well as safety indicator. Because among the volatile bases the quantity of ammonia is nearly 75%, ammonia is highly detrimental to health. Hence TVB-N is now-a-days considered as quality indicator and safety indicator. (Shofiqul Islam et al., 2024).[30] Over the 4 weeks, TVB-N remained within the maximum allowable limit (30 mg/100g flesh), but continuously being higher. This is due to the free drip gain by the muscle in frozen storage. Connell (1975) states that the upper limit of TVB-N is 30 mg/100g was considered for fin fish acceptability.[31] EOS (2005) recommended that the permissible limit for TVB-N not more than 30 mg/100g.[32] TVB-N of fresh and frozen fillets samples were 19.50 and 23.42 respectively, while for fresh and frozen shrimp were 20.90 and 24.65 mg/100g respectively. Fresh shrimp showed the TVBN value of 20.90 mg/100g and increased in frozen condition to 24.65mg/100g meets the agreement with the corresponding author. (Hassan and Ali, 2011).[33]

Tri-methyl amine Nitrogen (TMA-N)

Changes in Tri-methyl amine Nitrogen (TMA-N) during fresh and frozen condition, the initial TMA-N value of fresh prawn, *M. rosenbergii*, in batch 1,collected from Bagerhat was 2.36 mg/100g, in 2nd week it increased to 3.72 mg/100g, in the 3rd week the TMA-N value was increased to 5.12 mg/100g and at the 4th week the TMA-N value showed 6.99 mg/100g respectively (Table 8). In contrast, changes in Tri-methyl amine Nitrogen (TMA-N) during fresh and frozen condition, the initial TMA-N value of fresh shrimp, *P. monodon*, in batch 1,collected from Satkhira was 3.17 mg/100g, in 2nd week it increased to 4.64 mg/100g, in the 3rd week the TMA-N value was increased to 6.44 mg/100g and at the 4th week the TMA-N value showed 7.08 mg/100g respectively (Table 8). Comparing to *M. rosenbergii*, TMA-N is higher in *P. monodon* over the 4 weeks (Figure 8).

Table 8: Change in TMA-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 1 from week 1 to 4.

TMA-N (Batch 1) mg/100g	Week 1	Week 2	Week 3	Week 4	Average
M. rosenbergii	2.36	3.72	5.12	6.99	4.55
P. monodon	3.17	4.64	6.44	7.08	5.33

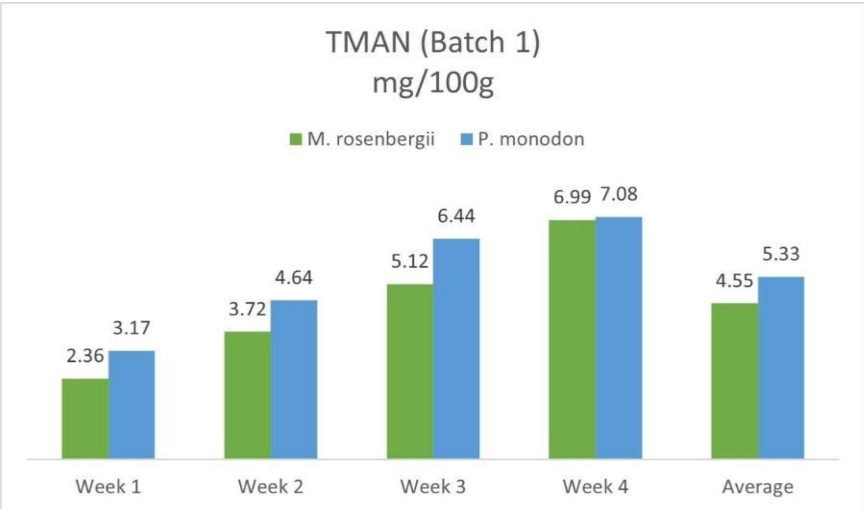

Figure 8: Change in TMA-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 1 from week 1 to 4.

M. rosenbergii, in batch 2, collected from Bagerhat, TMA-N was 2.55 mg/100g, in 2nd week it increased to 3.89 mg/100g, in the 3rd week the TMA-N value was increased to 5.39 mg/100g and at the 4th week the TMA-N value showed 7.12 mg/100g respectively (Table 9). In contrast, *P. monodon*, in batch 2, collected from Satkhira, TMA-N was 3.24 mg/100g, in 2nd week it increased to 4.89 mg/100g, in the 3rd week the TMA-N value was increased to 6.56 mg/100g and at the 4th week the TMA-N value showed 7.29 mg/100g respectively (Table 9). Comparing to *M. rosenbergii*, TMA-N is higher in *P. monodon* over the 4 weeks (Figure 9).

Table 9: Change in TMA-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 2 from week 1 to 4.

TMA-N (Batch 2) mg/100g	Week 1	Week 2	Week 3	Week 4	Average
M. rosenbergii	2.55	3.89	5.39	7.12	4.74
P. monodon	3.24	4.89	6.56	7.29	5.49

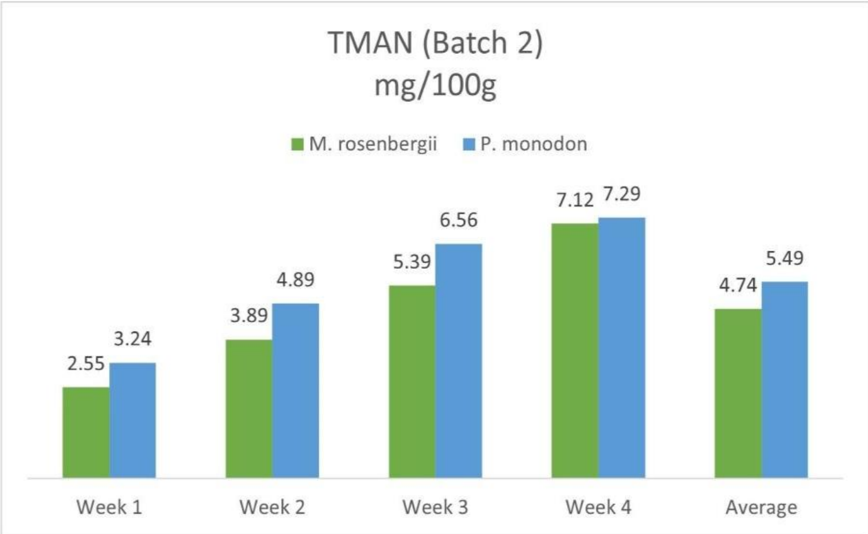

Figure 9: Change in TMA-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 2 from week 1 to 4.

M. rosenbergii, in batch 3, collected from Bagerhat, TMA-N was 2.69 mg/100g, in 2nd week it increased to 3.97 mg/100g, in the 3rd week the TMA-N value was increased to 5.44 mg/100g and at the 4th week the TMA-N value showed 7.29 mg/100g respectively (Table 10). In contrast, *P. monodon*, in batch 3, collected from Satkhira, TMA-N was 3.57 mg/100g, in 2nd week it increased to 4.92 mg/100g, in the 3rd week the TMA-N value was increased to 6.79 mg/100g and at the 4th week the TMA-N value showed 7.42 mg/100g respectively (Table 10). Comparing to *M. rosenbergii*, TMA-N is higher in *P. monodon* over the 4 weeks (Figure 10).

Table 10: Change in TMA-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 3 from week 1 to 4.

TMA-N (Batch 3) mg/100g	Week 1	Week 2	Week 3	Week 4	Average
M. rosenbergii	2.69	3.97	5.44	7.29	4.85
P. monodon	3.57	4.92	6.79	7.42	5.68

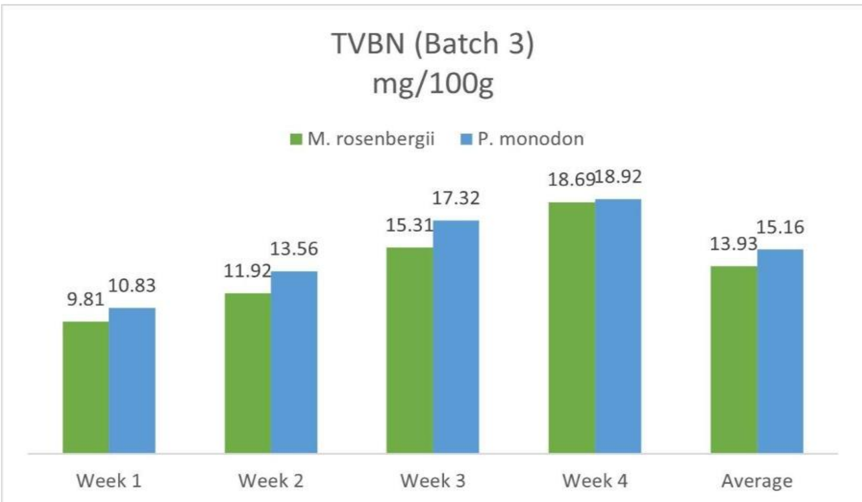

Figure 10: Change in TMA-N of *M. rosenbergii* from Bagerhat and *P. monodon* from Satkhira in batch 3 from week 1 to 4.

Over the 4 weeks, TMA-N was higher than previous weeks in every sample of *P. monodon*. TMA-N is the measure of spoilage caused by bacterial activity in fish and prawn, fishery products etc. (Mansur et. al., 2024).[30] When it comes to stored shrimp, an increase in TMA-N typically indicates a higher microbial load which can result from poor handling, storage conditions or contamination. Increased TMA-N in stored shrimp is generally considered bad. It can lead to spoilage, off-flavours or even foodborne illnesses as certain bacteria can multiply and produce toxins. Proper storage, refrigeration, and hygiene practices are essential to control microbial growth and ensure the shrimp remains safe for consumption.

Both the parameters are used as quality indicator of fish, prawn, fishery products in many countries including EU. TVB-N and TMA-N are useful tests for measuring spoilage in fish and fishery products including prawn and shrimp (Hassan and Ali, 2011).[33] These two tests are applicable for the chilled, frozen, salted, dried, fermented, canned fish and prawn. The normal range or acceptable range of TVB-N specified for chilled fish and prawn was mentioned as 30 mg/100 g fish or prawn. Normal range or acceptable range of TMA-N specified for chilled prawn was mentioned as <10 mg/100 g fish flesh or prawn flesh. The maximum allowable limit of TVB-N and TMA-N is different among the countries and regulatory agencies (Mansur et al., 2024).[30] Maximum Allowable Limit for TVB-N and TMA-N has been recommended for raw fish to be used for canning, chilled fish and prawn, dried fish, salted fish, fermented fish, European pickled herring, canned fish all such products. European Union has accepted these two tests for the quality assessment of fish and prawn because of the usefulness of these two tests (Pearson and Muslemuddin, 1969; Burt et. al., 1976).[34,35]

Amino acid profile of *M. rosenbergii*

The protein of the flesh of *M. rosenbergii*, collected from Bagerhat, contains 44.08% essential amino acids and 55.92% non-essential amino acids of total amino acids (Figure 11).

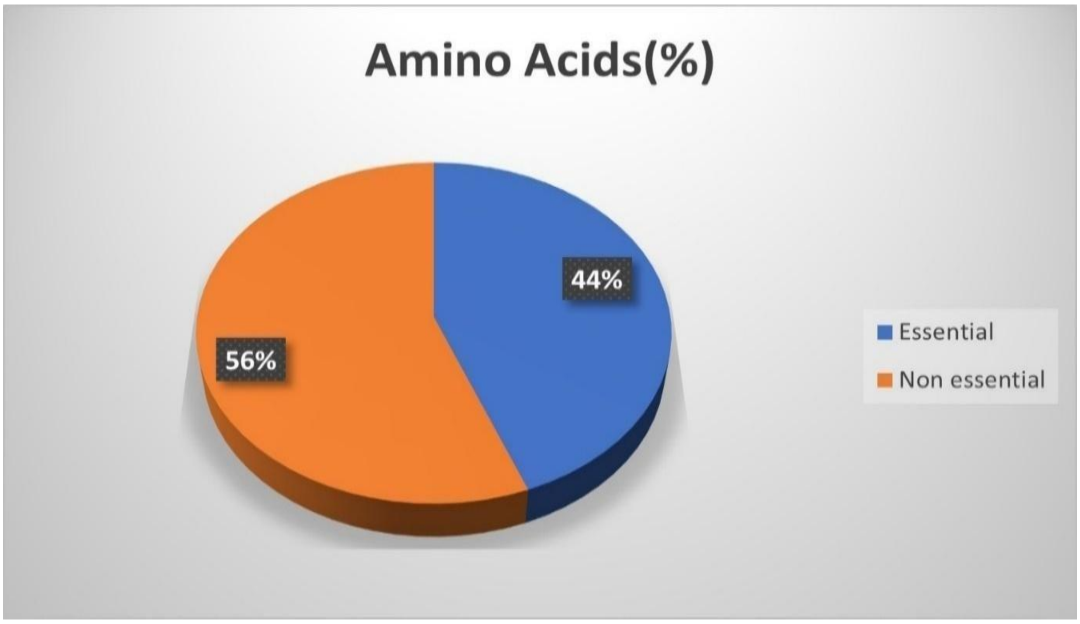

Figure 11: Amino acid groups estimated in *M. rosenbergii* from Bagerhat.

Table 11 states the amino acid profile of the protein of *M. rosenbergii* from Bagerhat, estimated by analytical technique, Sykam AAAS433-D Amino acid Analyzer. Remarkable variation in the percentage of essential and non-essential amino acids was observed (Figure 11). Among the essential amino acids, Leucine, Lysine and Arginine were been detected and estimated in high quantity of 61.83mg/g, 61.45mg/g and 59.86mg/g respectively from the protein of prawn flesh (Figure 12). Isoleucine, Phenylalanine, Threonine, Valine, Methionine and Histidine were also been detected and estimated in a remarkable quantity. On the other hand, among the non-essential amino acids, Glutamic acid, Aspartic acid and Alanine were been detected and estimated in high quantity of 150.10mg/g, 88.71mg/g and 52.49mg/g respectively (Figure 13). Other non-essential amino acids, Cystine, Glycine, Tyrosine, Proline and Serine were also been detected and estimated in a remarkable quantity.

Table 11: Amino acid profile of *Macrobrachium rosenbergii* from Bagerhat.

Species	Amino acid type	Amino acids	Amount(mg/g)
M. rosenbergii	Essential	Leucine	61.83
		Lysine	61.45
		Arginine	59.86
		Isoleucine	33.78
		Phenylalanine	31.81
		Threonine	30.52
		Valine	27.74
		Methionine	21.12
		Histidine	18.37
		Glutamic acid	150.10
	Non-essential	Aspartic acid	88.71
		Alanine	52.49
		Cystine	34.80
		Glycine	30.42
		Tyrosine	29.47
		Proline	27.97
		Serine	26.35

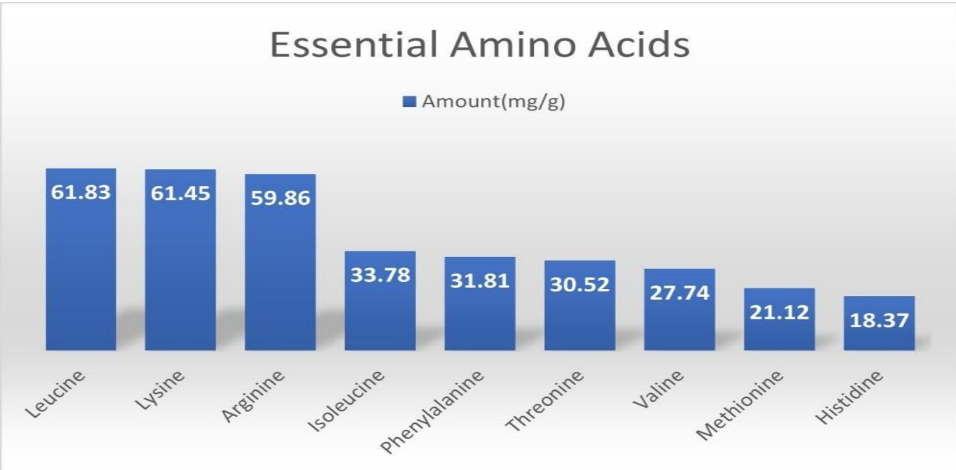

Figure 12: Essential amino acids detected from *M. rosenbergii.*

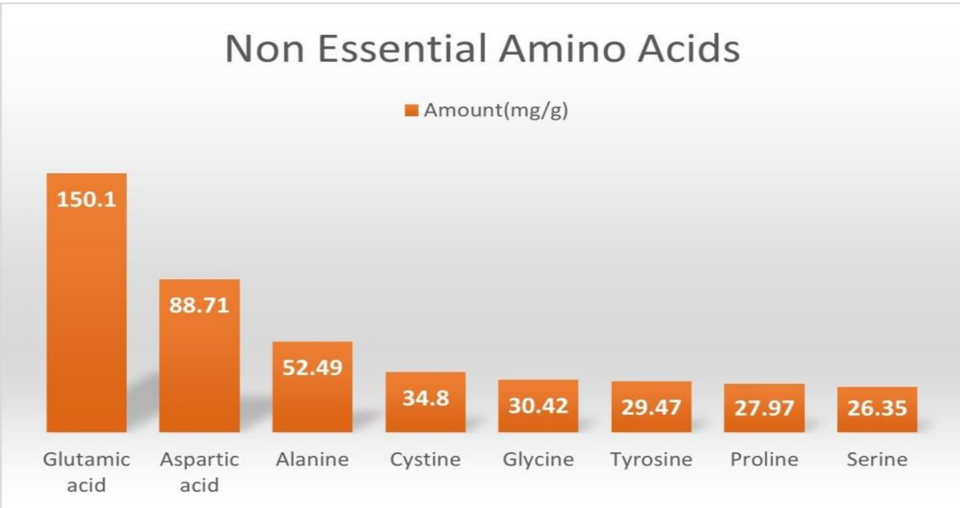

Figure 13: Non-essential amino acids detected from *M. rosenbergii.*

Amino acid profile of *P. monodon*

The protein of the flesh of *P. monodon*, collected from Satkhira, contains 42.91% essential amino acids and 57.09% non-essential amino acids of total amino acids (Figure 14).

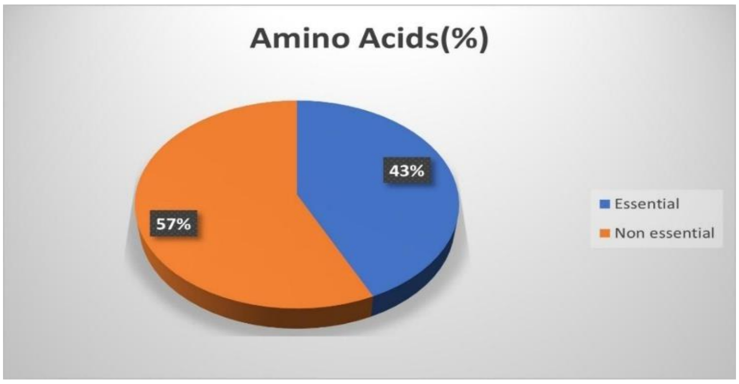

Figure 14: Amino acid groups estimated in *P. monodon* from Satkhira.

Table 12 states the amino acid profile of the protein of *P. monodon* from Satkhira, estimated by analytical technique, Sykam AAAS433-D Amino acid Analyzer. Remarkable variation in the percentage of essential and non-essential amino acids was observed (Figure 14). Among the essential amino acids, Arginine, Lysine and Leucine were been detected and estimated in high quantity of 61.99mg/g, 58.12mg/g and 55.68mg/g respectively from the protein of shrimp flesh (Figure 15). Isoleucine, Phenylalanine, Threonine, Valine, Methionine and Histidine were also been detected and estimated in a remarkable quantity. On the other hand, among the non-essential amino acids, Glutamic acid, Aspartic acid and Alanine were been detected and estimated in high quantity of 139.92mg/g, 79.19mg/g and 51.59mg/g respectively (Figure 16). Other non-essential amino acids, Cystine, Glycine, Tyrosine, Proline and Serine were also been detected and estimated in a remarkable quantity.

Table 12: Amino acid profile of *Penaeus monodon* from Satkhira.

Species	Amino acid type	Amino acids	Amount(mg/g)
P. monodon	Essential	Arginine	61.99
		Lysine	58.12
		Leucine	55.68
		Phenylalanine	29.27
		Threonine	28.46
		Isoleucine	28.01
		Valine	21.80
		Methionine	19.42
		Histidine	15.82
	Non-essential	Glutamic acid	139.92
		Aspartic acid	79.19
		Alanine	51.59
		Glycine	41.07
		Proline	31.31
		Cystine	30.64
		Tyrosine	26.79
		Serine	23.40

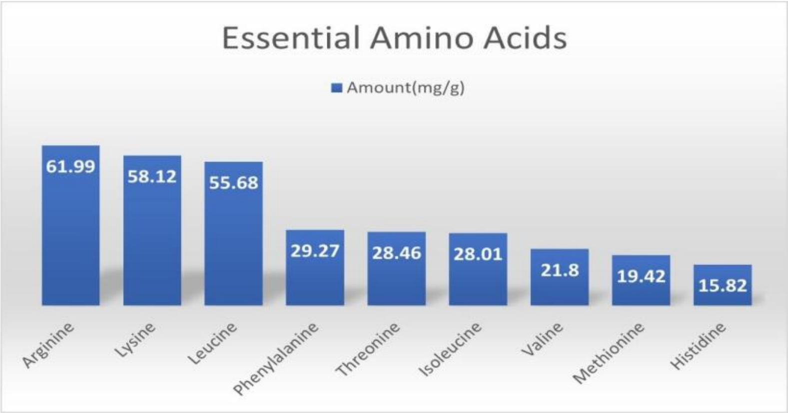

Figure 15: Essential amino acids detected from *P. monodon*.

Figure 16: Non-essential amino acids detected from *P. monodon.*

Essential amino acids are those amino acids which are unable to synthesis by human body but essential for human life. We should get essential amino acids from dietary sources. Both prawn and shrimp consist of same essential and non-essential amino acids. From table 11 and 12, we can see that Leucine, Lysine and Arginine are high in both *M. rosenbergii* and *P. monodon*. Essential amino acids help in many biological functions in human cell, e.g. anti- mutagenicity, anti-aging, anti-carcinogenicity etc. (Mansur et.al., 2024).[30] Leucine, isoleucine and valine (Branched-Chain Amino Acids, BCAAs) are vital for muscle protein synthesis. They help with muscle growth and repair after exercise, contributing to muscle mass and strength (Wolfe, 2017).[36] Lysine is essential for the synthesis of collagen which is important for skin, joints and bones. It also supports immune function, hormone production and the absorption of calcium. Isoleucine is one of the branched-chain amino acids (BCAAs) and is essential for muscle repair, energy production and immune function. It helps regulate blood sugar levels and boosts endurance during physical activities (Jackman et al., 2017).[37] Phenylalanine is a precursor for tyrosine which is used to produce dopamine, norepinephrine and epinephrine which are neurotransmitters that affect mood, stress and cognitive function. It also plays a role in appetite regulation. Threonine is involved in the formation of proteins, collagen and elastin. It also supports the digestive system and immune function by contributing to mucus production in the gastrointestinal tract (Wu, 2013).[38] Tryptophan is a precursor for serotonin, a neurotransmitter that regulates mood, appetite and sleep. Adequate tryptophan intake can help prevent mood disorders like depression (Young, 2007).[39] Histidine is crucial for the production of histamine, a neurotransmitter involved in immune responses, digestion, and sleep regulation. It also plays a role in the production of red and white blood cells (Yoshikawa et al., 2014).[40] Histidine is also an indispensable amino acid involved in many metabolic functions which take part in allergic and inflammatory reactions. It plays a very important role in maintaining the osmoregulatory process and is related to energy production or is used in other metabolic pathways during certain emergencies/ harsh conditions (Abe and Ohmama,1987).[41] Methionine is important for the synthesis of proteins, plays a crucial role in detoxification processes by providing sulphur for the body. It is also a precursor for other important amino acids like cysteine. Valine is involved in many metabolic pathways and is considered indispensable for protein synthesis and optimal growth.

Non-essential amino acids possess different properties of which taste is an important or mentionable property. Sweet, tasteless, bitter, meaty flavour are the examples of such taste. Glycine, alanine, valine, serine etc. possess sweet taste. leucine is taste less; arginine is bitter, glutamic acid possesses meaty flavour. *Macrobrachium rosenbergii* possesses different types of taste in different seasons due the difference of glutamic acid (Mansur et al., 2024).[30] From table 11 and 12, we can see that Glutamic acid, Aspartic acid and Alanine are high in both *M. rosenbergii* and *P. monodon*.

Glutamic acid possesses meaty flavour and taste whereas Glycine and Serine possess sweet taste. L-Glutamic acid (L-GA) physiologically exists as glutamate. Glutamate along with glutamine plays a major role in amino acid metabolism and thus in maintaining nitrogen balance in the body. Glutamate is a well-established excitatory neurotransmitter in the central nervous system. There has been convincing evidence on protective activity of L-GA and α- ketoglutarate in vincristine-induced neurotoxicity. Looking at the wide profile of activity, it has been proposed that though L-GA and glutamine were once considered nonessential for health, may now be considered as - 'conditionally essential' amino acids (Kulkarni, 2005).[19]

Alanine helps with energy production by converting into glucose in the liver. It is also involved in the metabolism of tryptophan and helps detoxify the body (Brosnan & Brosnan, 2006).[42] Aspartic acid plays a role in energy production and is involved in the synthesis of other amino acids. It also supports neurotransmitter function and can aid in the detoxification process (Fukuda et al., 2016).[43] Glycine has several benefits including its role in collagen synthesis for skin and joint health. It is also an inhibitory neurotransmitter, contributing to neuroprotection in the central nervous system (Betz, 1992).[44] Proline is important for the synthesis of collagen and the health of connective tissues, skin and joints. It also contributes to wound healing and tissue repair. Tyrosine is a precursor to dopamine, norepinephrine and epinephrine and supports mood regulation, cognitive function and stress responses. Tyrosine supplementation has been shown to improve mental performance during stressful situations. Serine is involved in the synthesis of phospholipids which are essential for cell membrane function. It also supports the synthesis of neurotransmitters and is important for the function of the immune system.

CONCLUSION

The knowledge gained from quality, nutritional composition and amino acid profile analysis of prawn and shrimp from different geographic location ultimately enhances our understanding of the health benefits and promoting overall socio-economic well-being. The findings for *M. rosenbergii* from Bagerhat and *P. monodon from* Satkhira showed some differences in quality and proximate composition. Moisture, ash, lipid, TVB-N and TMA-N were higher in *P. monodon* comparing to *M. rosenbergii*; but crude protein content was higher in *M. rosenbergii* than *P. monodon*. We found similar amino acids (both essential and non-essential) from the protein of *M. rosenbergii* from Bagerhat and *P. monodon from* Satkhira. Amino acid profile provides information about the health benefits of prawn and shrimp. Studying the amino acid profile of *M. rosenbergii* and *P. monodon* from different geographic location helps in determining the protein quality and its suitability for human consumption. There are numerous health benefits in prawn and shrimp muscle due to such amino acids in a remarkable quantity. By analysing the quality, nutritional composition and presence of amino acids from our research we can suggest that researchers can make informed dietary recommendations and promote the aquaculture production and consumption of healthier prawn and shrimp products.

ACKNOWLEDGMENT

This research was conducted as MS thesis research supervised by Professor Dr. Md. Abul Mansur in the Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. Amino acid profile was detected and estimated in the laboratory of BCSIR (Bangladesh Council of Scientific and Industrial Research). This research was conducted by the financial support of National Science and Technology (NST) Fellowship, Government of Bangladesh. Partial support of Bangladesh Agricultural University Research System (BAURES, project no. 2023/1948/BAU) is also acknowledged.

REFERENCES

1. Michael Bernard New, W. C. (2000). Freshwater Prawn Culture: The Farming of *Macrobrachium rosenbergii*. In W. C. Michael Bernard New, *Freshwater Prawn Culture: The Farming of Macrobrachium rosenbergii* (p. 1). USA: wiley online libtrary.
2. Nirmal, N. P., Santivarangkna, C., Rajput, M. S., & Benjakul, S. Trends in shrimp processing waste utilization: An industrial prospective. *Trends in Food Science & Technology*, 2020; *103:* 20–35. https://doi.org/10.1016/j.tifs.2020.07.001
3. DOF. 2023, *Yearbook of Fisheries Statistics of Bangladesh, 2022-23.* Fisheries Resource Survey System (FRSS), Department of Fisheries; Ministry of Fisheries and Livestock, 2023; 40: 138.
4. Ferdose, A., & Hossain, M. Nutritional value of wild, cultured and frozen prawn, *Macrobrachium rosenbergii*; (De Man, 1879). *International Journal of Natural Sciences*, 1970; *1*(2): 52–55. https://doi.org/10.3329/ijns.v1i2.8821
5. Connell, J. J. Methods of assessing and selecting for Quality. In: “Control of Fish Quality”. (2nd edition) Fishing News Books Ltd. Farnham, Surrey, England, 1980; 116-143.
6. Ahmed, I., Jan, K., Fatma, S., & Dawood, M. A. Muscle proximate composition of various food fish species and their nutritional significance: A review. *Journal of Animal Physiology and Animal Nutrition*, 2022; *106*(3): 690-719.
7. Usydus, Z., Szlinder-Richert, J., Adamczyk, M., & Szatkowska, U. Marine and farmed fish in the Polish market: Comparison of the nutritional value. *Food Chemistry*, 2011; *126*(1): 78–84. https://doi.org/10.1016/j.foodchem.2010.10.080
8. Islam, A., Mondal, S., Bhowmik, S., Islam, S., & Begum, M. A comparative analysis of the proximate composition of wild and cultured prawn (*Macrobrachium rosenbergii*) and shrimp (*Penaeus monodon*). *International Journal of Fisheries and Aquatic Studies*, 2017; *5*(4): 59-62.
9. Mansur, M.A. FISHERIES STUDIES. Part-Ⅲ. Published by Selim Mahmud, Botomul, Uttara, Dhaka, 2015; 448. ISBN: 978-984-8796-34-4
10. Bhavan, P. S., Radhakrishnan, S., Seenivasan, C., Shanthi, R., Poongodi, R., & Kannan, S. Proximate composition and profiles of amino acids and fatty acids in the muscle of adult males and females of commercially viable prawn species *Macrobrachium rosenbergii* collected from natural culture environments. *International Journal of Biology*, 2010; *2*(2): 107.
11. Anzani, C., Boukid, F., Drummond, L., Mullen, A. M., & Álvarez, C. Optimising the use of proteins from rich meat co-products and non-meat alternatives: Nutritional, technological and allergenicity challenges. *Food Research International*, 2020; *137:* 109575. https://doi.org/10.1016/j.foodres.2020.109575
12. Babsky, E.B., Khodorov, B.I., Kositsky, G.I., & Zubkov, A.A. (1989). In Babsky, E.B. (Ed.), Human Physiology, Mir Publishers, Moscow.
13. Liu, Z.; Liu, Q.; Zhang, D.; Wei, S.; Sun, Q.; Xia, Q.; Shi, W.; Ji, H.; Liu, S. Comparison of

the Proximate Composition and Nutritional Profile of Byproducts and Edible Parts of Five Species of Shrimp. Foods, 2021; 10: 2603. https://doi.org/10.3390/ foods10112603

14. Cobb, B.F., Conte, F.S., & Edwards, M.A. Free amino acids and osmoregulation in penaeid shrimp. J. Agric. Food Chem., 1975; 23: 1172-1174.
15. Fang, L.S., Tang, C.K., Lee, D.L., & Chen, I.M. Free amino acid composition in muscle and hemolymph of the prawn Penaeus monodon in different salinities. Nippon Suisan Gakkaishi, 1992; 58: 1095-1102.
16. Thompson, A.B., McGill, A.S., Murray, J., Hardy, R., & Howgate, P.F. The analysis of a range of non-volatile constituents of cooked haddock (Gadus aeglefinus) and the influence of these on flavor. In J.J. Connell (Ed.), Advances in Fish Science and Technology, 1980; 484. Fishing Books, Farnham, Surrey.
17. Mullen, B.J. & Martin, R.J. The effect of dietary fat on diet selection may involve central serotonin. Am. J. Physiol. Regul. Integr. Comp. Physiol., 1992; 263: R559- R563.
18. Md. Shofiqul Islam, M. A. Mansur, M. S. Reza, M. N. Haider, Daisuke Kimura, Misa Ogushi, Seasonal variation in amino acid composition and fatty acid composition, anticancer capacity of salt water prawn (Giant Tiger Prawn, *Penaeus monodon*). *World Journal of Advance Healthcare Research*, 2024; 8(8): 250-256.
19. Kulkarni, C.; Kulkarni, K. S.; Hamsa, B. R. L-Glutamic acid and glutamine: Exciting molecules of clinical interest. Indian Journal of Pharmacology, May–Jun. 2005; 37(3): 148-154. | DOI: 10.4103/0253-7613.16210
20. A. M. C. (Analytical Methods Committee). Recommended General Methods for the Examination of Fish and Fish Products, Analyst, 1979; 104: 434-450.
21. A. O. A. C. Official Methods of Analysis. Association of Official Analytical Chemists. (18th ed.). Washington, D. C., USA, 2006.
22. Gupta, A., Sehgal, H. S., & Sehgal, G. K. Growth and carcass composition of giant freshwater prawn, Macrobrachium rosenbergii (De Man), fed different isonitrogenous and isocaloric diets. *Aquaculture Research*, 2007; *38*(13): 1355–1363. https://doi.org/10.1111/j.1365-2109.2007.01787.x
23. Dalgaard, P. Fresh and lightly preserved seafood. In C. M. D. Man, & A. A. Jones (Eds.), *Shelf-life evaluation of foods*, 2000; 110-139. Aspen Publishers.
24. Abulude, F. O., Lawal, L. O., Ehikhamen, G., Adesanya, W. O., & Ashafa, S. L. Distribution of macro minerals in four prawns from the coastal area of Ondo State, Nigeria. *Journal of Fisheries International*, 2006; *1*(2-4): 70–72.
25. Ali, S. S. R., Ramachandran, M., Chakma, S. K., & Sheriff, M. A. Proximate composition of commercially important marine fishes and shrimps from the Chennai coast, India. *International Journal of Fisheries and Aquatic Studies*, 2017; *5*(5): 113-119.
26. Ginson, J., & Bindu, J. Review on Biochemical Composition and Micro-flora of Prawns. *Fishery Technology*, 2017; *54*(2).
27. Shahidi, F. Seafood proteins and preparation of protein concentrates. In *Seafoods: Chemistry, processing technology and quality*, 1994; 3-9. Boston, MA: Springer US.
28. Dinakaran, G. K., & Soundarapandian, P. Biochemical status of edible palaemonid prawn *Macrobrachium idella idella* (Hilgendorf, 1898). *Advance Journal of Food Science and Technology*, 2009; *1*(1): 19-26.
29. Muriana, F. J. G., Ruiz-Gutierrez, V., Gallardo-Guerrero, M. L., & Mínguez- Mosquera, M. I. A Study of the Lipids and Carotenoprotein in the Prawn, Penaeus japonicus1. *The Journal of Biochemistry*, 1993; *114*(2): 223–229. https://doi.org/10.1093/oxfordjournals.jbchem.a124158
30. Md. Shofiqul Islam, M. A. Mansur, M. S. Reza, M. N. Haider, Daisuke Kimura, Misa Ogushi, A study on the seasonal variation in nutritional composition, amino acid composition, fatty acid composition, quality and heavy metal safety and anti- cancer capacity of giant freshwater prawn (*Macrobrachium rosenbergii*) available in Mymensingh district of Bangladesh. *World Journal of Advance Healthcare Research*, 2024; 8(6): 43-51.
31. Connell, J. J., Quality deterioration and extrinsic quality defects in raw materials. In: Control of fish quality. 2nd.ed. Fishing New (Books) Ltd. Surrey. England., 1975; 33-35.
32. EOS, Chilled and frozen fish. Egyptian Organization for Standardization and Quality Control, ES., 2005; 3494: 889-892.
33. Hassan, F. and Ali, M. Quality Evaluation of Some Fresh and Imported Frozen Seafood. Food Hygiene Department, Faculty of Veterinary Medicine, Beni-Suef University, 62511 Beni-Suef, Egypt. Advance J. of Food Sci. and Technol., 2011; 3(1): 83-88.
34. Pearson, D., Muslemuddin, M. The accurate determination total volatile nitrogen in meat and fish. *Journal of the Association of Public Analysts*, 1969; 7: 50-54. 22.
35. Burt, J. R., Gibson, D. M., Jason, A. C., Sanders, H. R. Comparison of methods of freshness assessment of wet fish II. *Journal of Food Technology*, 1976; 11(1): 73-89.
36. Wolfe, R.R. Branched-chain amino acids and muscle protein synthesis in humans: myth or reality? *J Int Soc Sports Nutr,* 2017; 14: 30. https://doi.org/10.1186/s12970- 017-0184-9
37. Jackman SR, Witard OC, Philp A, Wallis GA, Baar K and Tipton KD. Branched-Chain Amino Acid Ingestion Stimulates Muscle Myofibrillar Protein Synthesis following Resistance Exercise in Humans. *Front. Physiol*, 2017; 8: 390. doi:

10.3389/fphys.2017.00390
38. Wang, W., Wu, Z., Dai, Z. *et al.* Glycine metabolism in animals and humans: implications for nutrition and health. *Amino Acids*, 2013; 45: 463–477. https://doi.org/10.1007/s00726-013-1493-1
39. Young, S. N. How to increase serotonin in the human brain without drugs. *Journal of psychiatry & neuroscience: JPN*, 2007; *32*(6): 394.
40. Yoshikawa, T., Nakamura, T., Shibakusa, T., Sugita, M., Naganuma, F., Iida, T., Miura, Y., Mohsen, A., Harada, R., & Yanai, K. Insufficient Intake of L-Histidine Reduces Brain Histamine and Causes Anxiety-Like Behaviors in Male Mice. *The Journal of Nutrition*, 2014; *144*(10): 1637–1641. https://doi.org/10.3945/jn.114.196105
41. Abe, H., & Ohmama, S. Effect of starvation and sea-water acclimation on the concentration of free smallcap˜ L-histidine and related dipeptides in the muscle of eel, rainbow trout and Japanese dace, 1987.
42. Brosnan, J. T., & Brosnan, M. E. Branched-Chain Amino Acids: Enzyme and Substrate Regulation. *The Journal of Nutrition*, 2006; *136*(1): 207S-211S. https://doi.org/10.1093/jn/136.1.207S
43. Tohyama, S., Fujita, J., Hishiki, T., Matsuura, T., Hattori, F., Ohno, R., ... & Fukuda, K. Glutamine oxidation is indispensable for survival of human pluripotent stem cells. *Cell metabolism*, 2016; *23*(4): 663-674.
44. Betz, H. Structure and function of inhibitory glycine receptors. *Quarterly Reviews of Biophysics*, 1992; *25*(4): 381–394. https://doi.org/10.1017/S0033583500004340