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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

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ABSTRACT

This research is the part of our research project No, 2021/1085/BAU and 2023/1948/BAU. In this part we studied the seasonal variation in nutritional composition, quality and heavy metal concentration of Giant Freshwater Prawn (*Macrobrachium rosenbergii*) available in the Mymensingh district of Bangladesh. In doing so the composition (% Protein, % lipid, % ash, % moisture, amino acid content, fatty acid profile), quality (TVBN and TMAN) and heavy metal (Cd, Cr, Pb, Cu, Zn) concentration was estimated in different seasons of the year by a series of laboratory experiments. .Noticeable change in the quantity of protein, lipid, ash in *Macrobrachium rosenbergii* in different seasons was apparent. Protein content was 18.5% in autumn, 11.75% in winter, 14.91% in spring, 15.5% in summer, 14.23% in rainy season. Lipid content was 2.15% in autumn and winter, 2.18% in spring, 2.04% in summer, 1.30% in rainy season. Ash content was 1.24% in autumn, 1.44% in winter, 0.89% in spring, 1.12% in summer, 1.59% in rainy season. Remarkable change in amino acid content in different seasons in *Macrobrachium rosenbergii* was observed from the result of laboratory experiments. Most of the essential amino acids were detected and estimated in different seasons of the year except tryptophane. Highest variation in quantity was observed in Glutamic acid which was 33.38 mg/g in winter, 133.91 mg/g in spring, 126.70 mg/g in summer. Appreciable quantities of essential amino acids are present in *Macrobrachium rosenbergii* but in general amino acid content was highest in spring season. Overall quality of *Macrobrachium rosenbergii* was assessed by the parameters TVBN and TMAN. Significant difference in TVBN was observed in different seasons but the values remained within the acceptable limit (<30 mg/100g). Similarly TMAN value was different in various seasons but remained within the acceptable limit (<10 mg/100g). Significant difference in heavy metal concentration in the flesh of *Macrobrachium rosenbergii* was observed in different seasons, some heavy metals were above maximum allowable limit. In general heavy metal concentration was less in spring and summer season. Fatty acid profile of the lipid of *Macrobrachium rosenbergii* was also studied. In general lipid contains 75.4% unsaturated fatty acids of total fatty acids. Appreciable quantity of EPA (14.82% in spring) and DHA (5.99% in spring) was estimated in the unsaturated fatty acids of *Macrobrachium rosenbergii.* Poly-phenol content and antioxidant capacity of *Macrobrachium rosenbergii* were also detected and estimated by laboratory analysis in winter season. Poly-phenol content was 32.3µmol/100g DW and antioxidant capacity was 125.9 µg/g.

KEYWORDS: Seasonal variation, nutritional composition, quality, heavy metal, amino acid content, fatty acid profile, poly-phenol, antioxidant capacity, *Macrobrachium rosenbergii.*

INTRODUCTION

Prawn and shrimp of Bangladesh water are famous food commodity for delicious taste and large size. It is a good source of protein and lipid. Both protein and lipid supply energy and provide many health benefits. Amino acids are the structural unit of protein. Amino acids contain amine group and carboxylic group. 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. Human body is unable to synthesis some amino acids but these amino acids are necessary for health. These amino acids are called essential amino acids. Lipid is also an important nutrient. Most fish and shellfish lipid contain longchain fatty acids and contain unsaturated fatty acids, DHA, EPA, □-3 PUFA which are beneficial for health.

Nutritional composition e.g. protein, lipid, ash/minerals, amino acid, fatty acid content of prawn and shrimp vary in different season. Average quantity as well as average percentage of these components also vary with season. 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.[1] Seasonal, cyclical changes in composition are observed in many species though less noticeable in some shell fish. So it is necessary to elucidate the seasonal variation of the stated components in prawn and shrimp of Bangladesh. Heavy metal pollution in aquatic environment is a great concern throughout the world. Water in ponds and lakes, river and sea of Bangladesh is also getting polluted day by day due to heavy metal pollution in water. Prawn and fish are capable of absorbing heavy metal in the flesh and internal organs by a process known as bio-accumulation. If the heavy metal content in prawn flesh exceeds the recommended maximum allowable limit then it is not safe for health of the consumers. Almost all heavy metals are harmful for the health of the consumers if regularly eaten heavy metal polluted (above maximum allowable limit) prawn and fish. So it is better to know in which season heavy metal is within the acceptable limit in prawn muscle. Heavy metal level in fish varies with season, sometimes it exceeds the maximum allowable limit in fish of Bangladesh which we have reported in our previous publications (Mansur *et. al*., 2018, 2019, 2021, 2023).[2,6] So seasonal variation in heavy metal content in prawn is also included in the present research.

In Bangladesh data on seasonal variation in nutritional composition particularlyamino acid content, fatty acid composition, proportion of saturated and unsaturated fatty acids in the fat/lipid of prawn and shrimp are very scarce. The same is true for heavy metal too. Some research studies have been conducted in the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2292, Bangladesh on proximate composition of prawn and shrimp (Mansur *et. al.* 2016; Shafiul *et. al*. 2013; Mukta *et. al*. 2016).[7,9] but research on seasonal variation of nutritional composition, particularly amino acid content, fatty acid composition of prawn and shrimp are very rare in Bangladesh. Enough reliable data on seasonal variation in nutritional composition, amino acid composition, fatty acid composition, quality, heavy metal safety are necessary for awareness of consumers. This is important for the Processing Industries too because safe and high quality value-added product can only be produced from high quality safe raw material. Such research is also important because it influence (composition, safety) acceptability in the International market, it influence price, shelf life of prawn and shrimp. We have included the study on poly-phenol and antioxidant capacity of the flesh of *Macrobrachium rosenbergii* in winter season. Poly-phenol is active against cancer. Antioxidants are active against free radicals. Free radicals are formed in the human body through different life processes. These processes are important for life but free radicals are harmful for health. The free radicals cause oxidative damage to biomolecules, react rapidly with lipid, protein, DNA to induce membrane damage, denaturation of protein, inactivation of enzymes, breakage of strand and base modification of DNA. Such interactions are involved in some diseases e.g. atherosclerosis, aging, cancer, cardiovascular diseases and various chronic diseases. So the result of the present research will be important for processors and consumers at home and abroad. Such information is important for export of prawn and shrimp to the International market. Greater Mymensingh district of Bangladesh is rich in fish production from rivers, beels and pond, farms etc. A large number of fish farms have been established in Greater Mymensingh district where it is a good trade with desirable profit. Similarly, considering the profitability a good number of freshwater prawn farms have been established in Mymensingh district. In general the freshwater prawn is also liked by the consumers at home and abroad. Giant freshwater prawn (*Macrobrachium rosenbergii*) is a good exportable item of Bangladesh.The contribution of prawn and shrimp in export earning of Bangladesh is nearly 75-85% og Fisheries export earnings. *Macrobrachium rosenbergii* is the most desirable exportable prawn species among the 14 freshwater prawn species of Bangladesh.

MATERIALS AND METHOD

Collection of raw material

Raw Giant freshwater prawn (*Macrobrachium rosenbergii*) was purchased from a fisherman (supplier) of KR Market within the Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. Samples were supplied in chilled condition inpolyethylene bag in a Styrofoam box with sufficient ice (1:1 to 1:2). Giant freshwater prawn (*Macrobrachium rosenbergii*) was harvested from prawn farm of Mymensingh district and brought to the KR Market within Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. The raw species were taken in a polyethylene bag and immediately brought to the laboratory of the Department

of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. It took only 10-15 minutes. On arrival to the laboratory the Giant freshwater prawn (*Macrobrachium rosenbergii*) were subjected to laboratory analysis e.g. TVBN, TMAN, Protein, Lipid, Ash and Moisture. A portion of the raw Giant freshwater prawn (*Macrobrachium rosenbergii*) was subjected to amino acid analysis and fatty acid analysis in the BCSIR (Bangladesh Council of Scientific and Industrial Research), Dhaka. Another portion of Giant freshwater prawn (*Macrobrachium rosenbergii*) was frozen stored at -20°C in a freezer in the laboratory for subsequent laboratory analysise.g. heavy metal. Raw Giant freshwater prawn (*Macrobrachium rosenbergii*) species were purchased from the same fisherman (supplier) in everyseasons during this research. Experimental protocol was almost same in all seasons of the current research.

Laboratory analyses

Proximate composition e.g. Protein, Lipid, Ash and Moisture was estimated by A. O. A. C. (1990) method.[10] TVBN and TMAN were estimated by AMC (1979) method.[11]

Amino acid analysis was conducted by Acid Hydrolysis Method (Sykam AAAS433-D Amino acid Analyzer): The method used for this assay was based on chromatographic technique which we used in our previous experiment (Mansur *et. al*. 2000)[12] the method is described below.

Samplepreparation

200 to 250 mg of sample (prawn flesh) was taken first. 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 mlHydrolysis Solution). After soaking and mixing, the samples were kept at 120^0C for 24 hours. After that the pH has 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. 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.

Fatty acid analysis

GC (Gas Chromatography) method was followed for fatty acid analysis.

Heavy metal analysis

Heavy metal (Cd, Cr, Pb, Cu, Zn) of prawn flesh was estimated by Spectrophotometric analysis. Sample preparation was done according to our previous experiment. Sample digestion was done according to the method described by Eboh et. al.[13] The digested sample was filtered and subjected to analysis by Atomic Absorption Spectrophotometer (HG-AAS, PG-990, PG Instruments, UK) according to Clesceri et. al.[14] The method is briefly described below.

Sample preparation:Six prawn were selected from the supplied specimens and the shell, appendage, head were removed by forceps and scissor. Only the prawn flesh was taken. Accurately weighed 5 g homogenized prawn flesh was taken in a crucible and dried at 105°C for 24 hours in a hot air oven. This oven dried sample was used for heavy metal analysis (estimation/determination).

Analysis by Atomic Absorption Spectrophotometer: The digested and diluted sample was then subjected to analysis by Atomic Absorption Spectrophotometer. That means the absorbance of colourof solutions was measured by Atomic Absorption Spectrophotometer at a specific wavelength. The wavelength for such measurement is for As, Cr and Cd is 193.7 nm, 127 nm and 217 nm respectively. The absorbance and corresponding concentration of heavy metal was observed or determined from a standard graph which was previously prepared by standard compound of heavy metal.

Calculation: The actual concentration of heavy metal was calculated by the following formula

$$\text{Heavy metal (ppm)} = \frac{\text{ppm concentration observed x Final volume of sample (ml)}}{\text{Weight of sample in g}}$$

Poly-phenol and antioxidant capacity

Sample preparation: First the appendages, head, shell of chilled Giant freshwater prawn (*Macrobrachium rosenbergii*) were removed by forceps, scissors and knife. Only the flesh was collected. Then the flesh of prawn was chopped finely by a sharp knife. The chopped flesh of the prawn was taken in the crucibles. Each crucible contained 10 g chopped prawn flesh. Then the crucibles with flesh were kept in a hot air oven at 105℃ for 24 hours. Then the crucibles were cooled within a desiccator to the room temperature. At this stage the cooled crucibles were taken out of the desiccator and the dried flesh was taken in plastic sample bottle. These samples were brought to Japan and used for laboratory analysis.

Laboratory analysis: Detection and estimation of Poly-phenol, amti-oxidant was conducted according to the DPPH method.[15]

RESULT AND DISCUSSION

Result of seasonal variation in composition (% Protein, % lipid, % ash, % moisture, amino acid content mg/g, fatty acid profile %), quality (TVBN mg/100g and TMAN mg/100g) and heavy metal (Cd, Cr, Pb, Cu, Zn) concentration in ppm are reported in Tables 1 – 5. Table 1 shows the content (%) of protein, lipid, ash and moisture in freshwater prawn flesh (*Macrobrachium rosenbergii* in autumn, winter, spring, summer and in rainy season. Most noticeable change was observed in protein in different season. Protein percentage was 18.5% in autumn, 11.75% in winter, 14.91% in spring, 15.5% in summer and 14.23% in rainy season. Lipid percentage also showed a significant variation in freshwater prawn flesh in different seasons of the year. Lipid percentage was 2.1% in both autumn and winter season, 2.18% in spring season, 2.04% in summer and only 1.3% in the rainy season.Ash content (total minerals) showed significant difference in different seasons. Ash content was 1.24% in autumn, 1.44% in winter, 0.89% in spring, 1.12% in summer and 1.59% in rainy season (Table 1). We have studied the seasonal variation in composition of some freshwater fishes and marine fishes which we have reported in our previous publications (Mansur *et. al*., 2018, Mansur *et. al*, 2019, Mansur *et. al*. 2020).[16,18] Seasonal variation in composition of aquatic animals particularly fish and prawn is influenced by many factors of which Intrinsic nature bearing upon genetics, morphology, physiology, environment relating to the living conditions particularly feed are important. Among the factors the difference between species, individual variation, anatomical difference, sex difference and the mostimportant one is seasonal change affect the chemical composition of fish and shellfish including prawn and shrimp.

Table 1: Seasonal variation in composition of *Macrobrachium rosenbergii* flesh.

Parameter	Autumn	Winter	Spring	Summer	Rainy
Protein (%)	18.5	11.75	14.91	15.5	14.23
Lipid (%)	2.15	2.15	2.18	2.04	1.30
Ash (%)	1.24	1.44	0.89	1.12	1.59
Moisture (%)	79.65	79.45	80.66	80.03	78.84

It is very difficult to confirm between the effects of the many factors which play a part in seasonal variation of composition. The principal ones are the stage of sexual development and feeding condition. Appreciable variations are sometimes encountered. Mansur (1995) stated that British coast North Sea herring (*Clupea harengus*) contain 17% lipid in pre-spawning condition and 9% lipid in post-spawning condition. In this fish the pre-spawning samples contained 63% moisture while the post-spawning samples contained 69% moisture.[19] The Atlantic sardine contains 2% lipid in the spring and 8.6% lipid in the fall. Protein content in this species i.e. Atlantic sardine varies between 16% in March and 20.6% in July.

Gonadal (Sexual) development stage influences the composition of fish and shell-fish including prawn and shrimp. During the first two years of life, when the sardine is immature, its fat content remains around 3%, while at the end of the third year, when it spawns, it oscillates between 5 and 15% depending upon the season. In the female of horse mackerel, the protein content falls regularly from 18 to 16% during the sexual cycle. But it is not encountered in the male fish of that species. Connell (1980) explained the cause of seasonal variation in body constituents of fish and shellfish in most understandable way. He stated that in all species of fish, seasonal changes in certain bodily characteristics occur. At certain time ordinary fish appear thinner, flabbier and less lively than at others, the flesh being more watery and softer and containing less protein and fat. Fish in this condition is called in 'poor condition' or out of season'; usually such fish have poor appeal and gives lower yield. Poor condition occurs immediately after spawning. For instance, in the case of many species in temperate or arctic waters this is the spring. Immediately before spawning and during spawning energy reserved in the flesh, and in some species in the liver, is transformed for the development of the gonads (eggs and sperms). During spawning and some period afterwards most fish do not eat. As a consequence of both effects the flesh after spawning becomes severely depleted of protein, carbohydrate and fat.Similar poor conditions can arise, however, when for some reasons the fish do not eat or eat at an abnormally low level. Once fish start eating again, they normally recover their good condition. Seasonal, cyclical changes in flesh composition take place in all species of fish though less noticeable in some shellfish. In white fish, fatty pelagic fish, prawn and shrimp, shellfish such changes in flesh composition have on sensory quality (sensory appeal) of fish, prawn and shrimp after cooking. Fish, prawn and shrimp in poor condition is not desirable. In the present research the proximate composition i.e. protein, lipid, ash and moisture of *Macrobrachium rosenbergii* varied considerably in different seasons of the year. Certainly the cause of such variation/changein proximate composition in *Macrobrachium rosenbergii* is seasonal (seasonal variation). It may be related to the availability of natural feed in water (aquatic environment) the quantity of which is changed in different seasons. The second reason may be the effect of spawning of *Macrobrachium rosenbergii* of the present research.

Table 2: Overall quality of chilled *Macrobrachium rosenbergii* flesh.

Parameter (mg/100g)	Autumn	Winter	Spring	Summer	Rainy	MAL (mg/100g)
TVB-N	3.85	9.65	9.43	21.06	17.10	30.00
TMA-N	2.26	3.19	2.27	3.32	3.18	10.00

The overall quality of chilled *Macrobrachium rosenbergii* collected in different seasons is stated in Table 2. Two universally accepted parameters TVB-N and TMA-N were used the assess the overall quality of chilled *Macrobrachium rosenbergii*. Between these two parameters TVB-N indicates spoilage caused by autolytic enzymes and by bacterial activity. 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. On the other hand TMA-N is the measure of spoilage caused by bacterial activity in fish and prawn, fishery products etc. Both the parameters are used as quality indicator of fish, prawn, fishery products in many countries including EU. Connell et. al. (1976)[20] mentioned that TVB-N and TMA-N are useful tests for measuring spoilage in fish and fishery products including prawn and shrimp.These two tests are applicable for the chilled, frozen, salted, dried, fermented, canned fish and prawn.They also mentioned the normal or acceptable range of TVB-N and TMA-N in chilled, frozen, salted, dried, canned, fermented 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. 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, 1976; Burt *et. al*., 1976).[21,22] Table 2 expresses the TVB-N and TMA-N values in different season of *Macrobrachium rosenbergii* of current research. In all seasons the TVB-N remained within maximu7m allowable limit. Similarly TMA-N value also remained within the maximum allowable limit. TVB-N value varied significantly among the seasons. TMA-N value also varied among the seasons. But both TVB-N and TMA-N remained within the maximum allowable limit (for TVB-N 30 mg/100 g; for TMA-N 10 mg/100 g). The highest value of TVB-N was obtained in summer (21.00 mg/100g) and the lowest value was obtained in autumn (3.85 mg/100g). In winter TVB-N was 9.65 mg/100 g, in spring TVB-N was 9.43 mg/100 g, in rainy season TVB-N was 17.1 mg/100 g as the maximum allowable limit. The reason behind such variation may be the autolytic enzyme activity and bacterial activity in prawn flesh was different in various seasons. On the other hand the highest TMA-N value was obtained in summer (3.32 mg/100 g) and lowest value was obtained in autumn (2.26 mg/100 g). Both values were within the maximum allowable limit (>10.00 mg/100 g). TMA-N value in winter 3.19 mg/100 g, spring was 2.27 mg/100 g, and in rainy season 3.18 mg/100 g. The reason of such difference in TMA-N in different seasons is the difference in the rate of bacterial activity. Result stated in Table 2 proves that the quality of chilled *Macrobrachium rosenbergii* was excellent.

Table 3: Heavy metal concentration in *Macrobrachium rosenbergii* flesh in different seasons.

Heavy metal (ppm)	Autumn	Winter	Spring	Summer	Rainy	MAL (ppm)
Cd	0.474	0.526	0.1	1.00	0.24	1.0
Cr	29.53	11.82	4.6	0.01	0.11	0.05
Pb	4.23	5.30	0.001	6.00	5.50	2.0
Cu	22.24	18.00	13.88	14.10	14.33	10.00
Zn	67.44	58.00	63.20	26.6	15.44	100.00

Heavy metal concentration in the flesh of *Macrobrachium rosenbergii*in different seasons is stated in Table 3. Five metals and elements were included in this study. Cadmium (Cd), Chromium (Cr), Lead (Pb), Copper (Cu) and Zinc (Zn) were included in this research. From the Table 3 it is seen that most of the heavy metals were within the maximum allowable limit with a few exceptions. Cr, Pb and Cu were above maximum allowable limit in some seasons. The observed difference in heavy metal concentration in the flesh of *Macrobrachium rosenbergii* may be due to the difference in the extent of water pollution.Same type of result on heavy metal concentration in marine (salt water) prawn which we have reported in our previous publication (Mansur *et. al*., 2023).[23] Heavy metal present in the source normally cause water pollution. The main sources of heavy metal in water bodies are industrial effluent, waste dump and waste dumping stations, lagoons and sewerage disposal, large drains of big cities, slaughter house waste, lowgrade feed ingredients in farmed prawn and fish etc. Fish, prawn and other aquatic animals are capable of absorbing heavy metal from water and

accumulates in the flesh by a process called bioaccumulation. Continuous accumulat5ion of heavy metal in prawn flesh and fish flesh makes it unsafe for human consumption. Almost all heavy metals are harmful for human health. Most common problem of the heavy metals is that it cause renal problem, abnormality in stomach, retarded growth in children, toxicological problem etc. Heavy metals above certain level s cause health risk. Severity varies depending on on the type and concentration of heavy metal although there is a maximum allowable limit. It should be kept in mind that presence of such poisonous substance is not always harmful as they present in only trace quantities in prawn, fish and other aquatic animals. But care should be taken about eating heavy metal polluted fish and prawn. Because repeated eating of trace quantities may accumulate in stomach, and once they exceed the defect action level, would be detrimental to health.The elements of most concern are cumulative poisons, that is those that cause injury to health through progressive and irreversible accumulation in the body as a result of ingestion of repeated small amounts. Cadmium (Cd) and lead (Pb) are the example of two of such poisonous heavy metals. Heavy metal pollution in aquatic food is a major problem throughout the world. Aquatic environment is getting polluted day by day from different sources cause heavy metal pollution in prawn and fish. There is a growing concern throughout the world about the impact of pollution, particularly heavy metal, on the quality and safety of prawn and fish i.e. food from aquatic sources. Heavy metal polluted prawn and fish if eaten continuously, consumers are affected by different health injury.

Table 4 states the amino acid content of *Macrobrachium rosenbergii* in winter, spring and summer. Amino acids are the structural unit or basic unit of protein. Amino acids contain amine group and carboxylic group. Both Essential amino acids (except tryptophane) and other common amino acids were detected and estimated in this research. Essential amino acids are those amino acids which human body is unable to synthesis but essential for human life. We should get essential amino acids from dietary source. Other amino acids listed in Table 4 also have specific function. Examples of Essential amino acids for human are Methionine, threonine, tryptophane, valine, isoleucine, leucine, lysine. Non-essential amino acids possess different properties of which taste is an important or mentionable property. Sweet, tasteless, bitter, meaty flavor 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 flavor. Table 4 states the quantity of each amino acids and percentage of each amino acids to total amino acids of *Macrobrachium rosenbergii* in winter, spring and summer. Result expresses, hat there is a significant difference in the quantity of each amino acid among the seasons. The content of Glutamic acid in winter is 33.38 mg/g, in spring 133.91 mg/g, in summer 126.79 mg/g. Same type of difference was obtained in different seasons in this research. *Macrobrachium rosenbergii* possesses different types of taste in different seasons due the difference of glutamic acid. Almost all amino acids quantity is different in winter, spring and summer.

It has already been mentioned that amino acids are the structural unit or basic unit of protein. Amino acid content in protein is important while considering protein quality, protein characteristics, taste etc. Protein of fish and prawn have some significant function in human body which is related to amino acids. In general, amino acids possess radical scavenging activity, essential amino acids possess the capacity to help many biological functions in cell e.g. antimutagenicity, antiaging, anticarcinogenicity etc. From the results it is evident that the amount of amino acids is highest in spring season which is decreased in summer and least in winter season.

Table 4: Major amino acid (mg/g) content of *Macrobrachium rosenbergii* flesh in different seasons.

Prawn	**Analysis**	**Season**		
Species	**Amino acid**	**Winter (mg/g)**	**Spring (mg/g)**	**Summer (mg/g)**
Macrobrachium rosenbergii	Aspartic acid	20.39 (12.90%)	102.912 (14.2%)	77.427 (11.89%)
	Threonine	6.02 (3.81%)	28.458 (3.9%)	26.150 (3.85%)
	Serine	8.61 (5.45%)	32.856 (4.5%)	30.776 (4.53%)
	Glutamic acid	33.38 (21.11%)	133.918 (18.4%)	126.707 (18.64%)
	Glycine	10.21 (6.46%)	35.903 (4.9%)	38.634 (5.68)
	Alanine	12.09 (7.65%)	47.052 (6.5%)	49.856 (7.33)
	Cystine	2.89 (1.83%)	2.423 (0.3%)	8.224 (1.21%)
	Valine	6.17 (3.90%)	52.156 (7.2%)	21.878 (3.22%)
	Methionine	3.49 (2.21%)	16.832 (2.3%)	20.033 (2.95%)
	Isoleucine	3.65 (2.31%)	17.978 (2.5%)	20.522 (3.02%)
	Leucine	10.64 (6.73%)	50.683 (7.0%)	50.197 (7.38%)
	Tyrosine	3.66 (2.31%)	25.731 (3.5%)	23.084 (3.40%)
	Phenylalanine	4.42 (2.80%)	28.019 (3.9%)	25.681 (3.78%)
	Histidine	1.83 (1.16%)	17.189 (2.4%)	18.505 (2.72%)
	Lysine	11.17 (7.06%)	63.049 (8.7%)	55.270 (8.13%)
	Arginine	14.63 (9.26%)	70.857 (9.8%)	59.309 (8.72%)
	Proline	4.86 ---------	22.182 --------	27.521 (4.05%)

Table 5 states the Fatty acid profile of the lipid of *Macrobrachium rosenbergii*. The lipid of the flesh of *Macrobrachium rosenbergii* contains 75.4% unsaturated fatty acids of total fatty acids. Among the unsaturated fatty acids the essential fatty acids, EPA and DHA were been detected and estimated in the lipid of prawn flesh. Remarkable variation in the percentage of saturated and unsaturated fatty acids in winter, spring and summer was observed by laboratory analysis. Aquatic animal lipid particularly fish and prawn has important function in human life. It is health beneficial and effective against some diseases. In general unsaturated fatty acids are beneficial for health.Essential fatty acids supply energy in human cell, lowers cholesterol level in human body. DHA and EPA are essential for human cell. DHA and EPA have anti-stress effect and increase learning capacityas well as memory capacity in human. Unsaturated fatty acids are rich source of energy in human cell. They perform cardiac health beneficial function and similar type of lifestyle related disease. It is believed that unsaturated fatty acids help brain maturity in children. Our study period was winter, spring and summer. Among these three seasons DHA and EPA were highest in spring season. Other unsaturated fatty acids were also in appreciable percent in spring season. The reason behind the significant variation in the percentage of unsaturated and saturated fatty acids of *Macrobrachium rosenbergi*imay be related to feed they consume. Also during winter fish and prawn usually take a little feed because of cold weather they do not feel much hungry. But in spring with the rise of ambient temperature prawn take comparatively more feed in spring. It may cause a difference in fat content and fatty acid quantity and composition.

Table 5: Fatty acid profile *of Macrobrachium rosenbergii* fat extracted from flesh.

Species	Fatty acid type	Fatty acid	Winter %	Spring %	Summer %
Macrobrachium rosenbergii	Saturated	Myristic acid (C14:0)	0.868	1.2	0.38
		Pentadecylic acid (C15:0)	0.175	0.49	
		Palmitic acid (C16:0)	19.129	15.45	15.98
		Heptadecanoic acid (C17:0)	0.314	1.04	
		Stearic acid (C18:0)	12.416	7.20	11.14
		Arachidic acid (C20:0)	0.416	0.46	0.30
	Unsaturated	Palmitoleic acid (C16:1)	4.871	1.85	
		Cis-9-Oleic acid (C18:1)	26.02	18.76	16.85
		Linoleic acid (C18:2)	13.67	6.06	13.92
		Alpha linoleic acid (C18:3)	0.942	1.65	2.93
		Eicosadienoic acid (C20:2)	0.631	0.57	
		Eicosatetraenoic acid (C20:4)	4.445	15.75	
		Eicosapentaenoic acid (C20:5)	5.465	14.82	7.54
		Docosadienoic acid (C22:2)		0.48	
		Docosapentaenoic acid (C22:5)	0.452	1.33	1.3
		Docosahexaenoic acid (C22:6)	1.283	5.99	5.63

*In *Macrobrachium rosenbergi*i a saturated fatty acid has been detected in spring season named Lignoceric acid (C24:4) which was nearly 0.43%.

Poly-phenol and anti oxidant capacity

In winter season we conducted another experiment on poly-phenol and antioxidant capacity of *Macrobrachium rosenbergii*flesh. Result is presented in Table 6. The Table 6 states that poly-phenol of *Macrobrachium rosenbergii* flesh was 32.3 µmol/100g DW whereas the anti-oxidant capacity was 125.8 µg/g. Both poly-phenol and anti-oxidants are effective against many diseases including cancer. Poly-phenols are directly active against cancer. Anti-oxidants are effective against free-radicals i.e. active oxygen in human body. Free radicals are formed in human body as a result of some biological phenomena which are necessary for life but free radicals are harmful. Human body has self-defensive mechanism to protect against free radicals or active oxygen. But if we get more poly-phenols and antioxidants from dietary source then it is better to protect our health from many diseases. Because formation of free radicals, active oxygen in human body and accumulation of such unwanted compounds cause some diseases in human body.

Table 6: Poly-phenol and Antioxidant capacity of *Macrobrachium rosenbergii* in winter season.

Species	Parameter	Result
Macrobrachium rosenbergii	Poly-phenol	32.3 µmol/100g DW
	Antioxidant capacity	125.9 µg/g

Anti-oxidants inhibit the generation of free radicals from oxidation of other molecules by inhibiting the initiation or propagation phase of oxidizing chain reaction. Living tissues protect themselves from the oxidative damage cause the free radicals by a number of ways, including the scavenging actions of some natural antioxidants.[24,25]

In addition to endogenous defenses, consumption of dietary antioxidants plays an important role in protecting against free radicals.[26,27] Antioxidant capacity is a fundamental property for human life.[28,29] A good number of research has been conducted on the antioxidant capacity of plant origin food and on soft drinks.[30,31] But very little is known about the flesh food (animal origin food) particularly prawn and fish. Khanum et. al. (1998) conducted a research study on the radical scavenging activity of some fishes of Japan and Bangladesh.[32] Mansur et. al. (2002) conducted some research on the effectof processing and storage on the radical scavenging activity of horse mackerel and sardine.[33] The present research on poly-phenol and anti-oxidant capacity was conducted on the oven dried flesh of *Macrobrachium rosenbergii* which has been described previously in materials and method section.

CONCLUSION

From the result of the present research it may be concluded that the nutritional composition of Giant freshwater prawn (*Macrobrachium rosenbergii*) is excellent which vary considerably in different seasons. Quality of this species remains within acceptable level in different seasons. Flesh of *Macrobrachium rosenbergii* possesses almost all essential amino acids as well as other amino acids. Both types of amino acids vary remarkably in different seasons of the year. Lipid of *Macrobrachium rosenbergii* contains 75.4% unsaturated fatty acid. Among the unsaturated fatty acids essential fatty acids, DHA, EPA, Ω-3 PUFA present in appreciable quantity. These unsaturated fatty acids also vary considerably in different seasons. Flesh of *Macrobrachium rosenbergii* possesses poly-phenol and antioxidant property.

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