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Residues of Some Heavy Metals and Hormones in Fresh Water Prawn (*Macrobrachium rosenbergii)* and Marine Shrimp (*Penaeus semisulcatus*) with Reference to the Nutritive Value

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Abstract: Some heavy metals, hormonal residues (estradiol-17β, progesterone and testosterone) , proximate composition, amino acids, fatty acids (FA) and elements composition (Calcium and Phosphorus) of two shrimp species, freshwater prawn, *Macrobrachium rosenbergii* and marine shrimp, *Penaeus semisulcatus*, were determined. The obtained results indicated that heavy metal residues (Cd, Zn and Fe) were higher in fresh water prawn than marine shrimp and these levels in both species were higher than the permissible limits. Also, hormonal residues were higher ($P<0.001$) in the freshwater prawn as compared with marine shrimp. Meanwhile, protein content was higher ($P<0.05$) for marine shrimp (52.46%) than freshwater prawn (48.70%) . Moreover, calcium and phosphorous contents were high in marine shrimp. All amino acids of two species showed no significant differences except for glutamic acid. The ratio of essential to non essential amino acids for freshwater prawn and marine species was 0.65 and 0.61, respectively. The amount of polyunsaturated fatty acids (PUFA) in both species were higher than those of saturated FA. Docosahezaenoic acid (DHA) showed no significant differences between the two species, while eicosapentaenoic acid (EPA) was higher ($P<0.01$) in marine shrimp than freshwater prawn. In conclusion, although both species have a high nutritive value but marine shrimp is favorable than farmed freshwater prawn because heavy metal and hormonal residues were lower.

Key words: Freshwater prawn · Marine shrimp · Hormonal residue · Nutritive value

INTRODUCTION

Seafood products have attracted considerable attention as important sources of nutrients in the human diet. A part from their delicacy, crustacean species such as shrimp, prawn, crab and lobster consist of amino acids, protein and other useful nutrients [1].

In Egypt the giant freshwater prawn, *Macrobrachium rosenbergii* (De Man 1879) was imported from Tayland Science 1988 to Marut Fish Farming Company in Alexandria and successfully cultured. and has attracted an enormous interest as an aquaculture species in Egypt [2]. Global production of the giant freshwater prawn, *M. rosenbergii* has been increased from 17,129 to 203,903 tones between 1993 and 2003 [3]. Marine shrimp, (green tiger shrimp) *Penaeus semisulcatus* (De Haan 1789) is an Indo-Pacific species distributed along the coast of Eastern Mediterranean and is one of the most important commercial species in the world. In recent years, there has been increased interest in the culture of, *P. semisulcatus* in some countries of the Middle East, including Egypt [2], Turkey [4] as well as Kuwait and other Gulf countries [5].

Shrimp is one of the world most popular species and is a part of almost every rations traditional meal rich in protein and minerals. Shrimp and prawn have high nutritive value, both are a source of amino acids and polyunsaturated fats which have anti-inflammatory properties and stop the cartilage in joints from eroding. Additionally their muscle consists of highly unsaturated fatty acids (HUFA) such as eicosapentaenoic (20:5n-3, EPA) and docosahexaenoic (22:6n-3, DHA) acids and considered as essential provide health benefits for human, Also their meat contain linoleic acid alpha-linolenic acid that are parent compounds of omega-6 and omega-3 acid series, respectively [6].

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Shrimp and Prawn are among the most popular types of seafood. The meat has a sweet, delicate flavor and is considered to be a healthy diet choice. Both are a rich source of antioxidants like selenium [7].

Pollutants that are present in the aquatic environment and cause abnormal endocrine function in wildlife populations have been termed endocrine disrupting compounds (EDCs) . These compounds have been shown to affect reproduction and development of vertebrates as well as aquatic invertebrates [8]. Various man-made agents like pesticides, industrial chemicals and some natural substances have the potential to alter hormonal pathways that regulate reproduction processes [9].

Xenobiotics, or man-made chemicals, have been shown to disrupt normal hormone function, and have received considerable attention over the last decade. Compounds evaluated as endocrine disrupting contaminants have generally concluded common environmental pollutants which have demonstrated abilities to mimic hormones, alter hormone production, or act as anti-hormones [10]. Molecularly, Xenobiotics have the ability to bind directly to steroid hormone receptors or other proteins that initiate or facilitate the transcription of genes. Compound such as polychlorinated hydrocarbon pesticides (DDT) , polychlorinated biphenyls (PCBs) and others have been shown to bind to estrogen receptors manifesting estrogenic or anti-estrogenic actions in fishes [11].

In shrimp aquaculture, many chemicals are used such as: alum, gypsum (to reduce turbidity) and fertilizers to enhance production of natural food in ponds. Also, disinfectants are widely used for the disinfection of tanks and equipment such as: chloramines T, Formalin, hypochlorite, iodophores, Ozonation and quaternary ammonium compounds. Moreover, antibacterial agents are applied in aquaculture throughout the world such as: β-lactames, Nitrofurans, Macrolides, tetracyclines and sulphonamides. Therapeutants other than antibacterials are used to affect the external protozoans and filamentous bacterial diseases such as: Acriflavine, copper compounds, Metronidazole, formalin, Hydrogen peroxide, Malachite green and Methylene blue. In addition, pesticides are used to control ectoparasitic crustacean infections such as: Ammonia, Carbaryl, Ivermectin, Nicotine, Malathion and Diazinon. Hormones addition play an important role in aquaculture industry for example: growth hormone, methyl testosterone-17β, estradiol-17 β, serotonin and ovulation-inducing drugs [12]. All of the chemicals listed above can be classified as endocrine disruptors [13].

Residues in seafood could pose a potential risk to consumers through hypersensitivity to drug residues or the emergence of antibacterial-resistant intestinal microflora. Broad use of estradiol-17β both experimentally and commercially as a means of controlling sex in cultured shrimp may reasonably be assumed to be carcinogenic, since a number of estrogenic agents, including estradiol-17β, have been shown to stimulate growth of human prostate cancer cell lines [14]. Many researches were carried on the influence of heavy metals, factory effluents and other pollutants on biochemical changes in aquatic organisms. It has been reported that the biochemical composition and protein content in muscles of *M. lamerrii* were decreased when exposed to copper [15]. The objective of this study was to evaluate the accumulation of some environmental pollutants such as heavy metals, some hormonal residues (estradiol-17β, progesterone and testosterone) and determination of the nutritive value of the freshwater prawn, *M. rosenbergii* and marine shrimp, *P. semisulcatus.*

MATERIALS AND METHODS

Animal Used: Animal used for this study were marketing size of the giant freshwater prawn, *M. rosenbergii* with an average weight (34.9±4.15 g) . Prawn was purchased from Maryot Fish Farming Company at Alexadria (El-Amria Region) . The green tiger shrimp, *Penaeus semisulcatus* (from the Suze Gulf) with an average weight (37.1±3.59g) was also purchased from fishermen at Suze city. The total number of prawn and shrimp was about 70 individuals from each species that were pooled and the shells were removed. Ten samples of the edible part of the two species were used for determination of some heavy metal (lead, cadmium, copper, zinc and Iron) and some hormonal (estradiol-17β, progesterone and testosterone) residues and were determined in the extract of muscle samples. Also, determination of the proximate composition and nutritive values (amino acids and fatty acids) were carried out in triplicate.

Estimation of Heavy Metals in the Tissues: Muscles were prepared and digested according to the technique recommended by Khan *et al.* [16]. Where one gram of each sample was macerated and put in 100 ml flask, ten ml of 7: 3 mixture of ultra pure concentrated nitric acid (HNO_3: $HClO_4$) were added to the tissue samples. The flask was tightly closed. The content was gently shaken and allowed to stand overnight at room temperature for complete digestion. The flask was warmed at 95°C until completely evaporated and then allowed to cool. The residues were redissolved into 10 ml N nitric acid. The resulting solution was filtrated through Whatman paper No. 1. The filtrate was collected in tubes and kept at room temperature until analyzed by using atomic absorption spectrophotometer (GBC 906 AA) and residue levels are expressed as ppm. according to Agemain *et al.* [17].

Determination of Hormonal Residues: Ten samples of fresh water prawn and marine shrimp tissues (50g each) were prepared for steroid extraction. The extraction method was recommended by Umberger *et al.* [18]. Each sample was homogenized and extracted by chloroform: ethanol (2:1) . The organic extract was dissolved in 10ml of 95% ethanol. The steroid extracts were estimated for the levels of estradiol-17β, progesterone and testosterone using radioimmunoassay (RIA) according to the protocol of Oreczyk *et al.* [19].

Biochemical Analysis and Minerals: For each species used, the biochemical compositions such as protein, lipid, moisture and ash content were measured using the standard methods [20]. Minerals (Ca and P) were determined in the edible muscles of the two species according to APHA [21].

Analysis of Amino Acids

Fractionation of Amino Acids: Sample were ground and filtered. The residue was washed with a few ml of 75% ethanol and the volume was made up to 100 ml. Several amino acids were examined using HPLC system (HP1050) with a UV detector at 254 nm. The separation was accomplished with a APS, NH2, (5 μm. 4 ×250 mm) column. The mobile phase consists of 32% (methanol/water), 60/40 with 0.3 ml acetic acid. The flow rate was 0.9 ml/min. The temperature of column was 45°C, while the injection volume was one μl according to the method of Christian [22].

Determination of Fatty Acid Profile

Extraction of Lipids: Lipids were extracted from samples using the procedure of Folch *et al.* [23] by homogenizing them in a mechanical blender with a mixture of chloroform and methanol (2:1 v/v) . To prevent oxidation, crystals of hydroquinone were added to all samples. The chloroform extract was evaporated at 55°C under vacuum and the residue weighed.

Preparation of Methyl Esters: Following the extraction of lipids from the various tissues, methyl esters of fatty acids were prepared for subsequent use in gas-liquid chromatography. Lipid extracts were converted to their methyl esters according to Hartman and Lago [24].

Gas-liquid Chromatography: Analysis of methyl esters were performed on a CG-17 Gas Chromatography (CG Instruments, Sao Paulo, Brazil) , equipped with a flame ionization detector. A stainless steel column, 2m x 5mm, packed with chromosorb W coated with 18% (by wt) of diethylene glycol succinate (DEGS) was used. The operating conditions were as follows: column temperature, 195°C; sample vaporizer temperature, 225°C; detector temperature, 245°C. The carrier gas used was nitrogen, at a flow rate of 40 of ml/min. Injected sample size were in the rang 2.0-3.0 ml. Fatty acids were identified by comparison with the retention time of standards and by equivalent chain length [25].

Statistical Analysis: In order to test the significance of the differences between the mean values of the present two species, the student t-test was applied according to the method of Snedecor and Cochran [26].

RESULTS AND DISCUSSION

Despite the low concentrations of heavy metals in the surrounding medium, aquatic organisms take them up and accumulate them in their soft tissues to concentrations several fold higher than those of ambient level [27]. Moreover, it is of interest to note that most essential metals are toxic when supplied in concentrations in excess of the optimum levels.

Lead is known as deadly and accumulative poison even when consumed in small quantities and is capable of deadling nerve receptor in man [28]. Also, it is considered as public health problem particularly for children. The adverse toxic effect caused by lead on human was recognized [29]. Neurological defects, renal tubular dysfunction and anemia are the most characterize of lead poisoning. Also, it inhibits biosynthesis of hemerythrin and affects membrane permeability of kidney, liver and brain cells [30]. in the present results shown in Table 1 indicated that lead residues in fresh water prawn (*Macrobrachium rosenbergii*) was higher than that of marine shrimp (*Penaeus semisulcatus*) . Both levels are within the permissible limit (0.5 ppm) according to FAO/WHO [31].

Table 1: Residues of some heavy metals (ppm of wet weight) of fresh water prawn and marine shrimp tissues

Parameters	Fresh water Prawn (*Macrobrachium rosenbergii*)	Marine shrimp (*Penaeus semisulcatus*)	Permissible limits
Lead (Pb)	0.46 ± 0.042	0.43± 0.10	0.5 ppm (1)
Cadmium (Cd)	2.327 ± 0.246**	1.0372 ± 0.172	0.05 ppm (1)
Copper (Cu)	8.129 ± 1.0245	6.234 ± 0.504	20 ppm (1)
Zinc (Zn)	75.614 ± 16.304	51.834 ± 5.484	50 ppm (2)
Iron (Fe)	39.276 ± 8.298	30.382 ± 03.55	30ppm (2)

Values were =Mean±SD of ten samples per group. ** Significant at P≤0.01.

(1) is the permissible limit according to FAO/WHO (1992) .

(2) is the permissible limit according to Food Stuff: Cometic and Disinfictants (1972)

Table 2: Values of extracted estradiol-17β (pg/g) , progesterone and testosterone residues (ng/g) of fresh water prawn and marine shrimp tissues

Crustacean species Parameters	Fresh water Prawn (*Macrobrachium rosenbergii*)	Marine shrimp (*Penaeus semisulcatus*)
Estradiol-17β (pg/g)	247.98±8.72***	165.73±5.20
Progesterone (ng/g)	13.84±0.28***	4.34±0.42
Testosterone (ng/g)	7.52±0.67***	3.86±0.31

Values are expressed as means ±SE of ten samples

*** Significant at P≤0.001

Cadmium, a highly toxic metal, is present throughout the environment and accumulates primarily in liver and kidney of mammals through the food chain [32]. Table 1 indicated that cadmium residues in fresh water prawn (*Macrobrachium rosenbergii*) were higher ($P \leq 0.01$) than that of marine shrimp (*Penaeus semisulcatus*) and the residues were higher than the permissible limit (0.05ppm) according to FAO/WHO [31]. Cadmium may enter into the aquatic bodies through sewage sludge and with the run off from agricultural lands as it is one of the major components of phosphate fertilizers. Also, the major sources of contamination include electroplating, paper, PVC plastic, pigments and ceramic industries, battery, mining and smoldering units and many other modern industries [33]. Meanwhile, copper concentrations were within the permissible limits reported in Table 1, (20ppm) according to FAO/WHO [31]. Copper is an essential trace metal for all living organisms, and also required by crustacean species as an essential part of their oxygen-carrying pigment heamocyanin [34]. Concentrations of copper in the body is regulated to constant level unit copper bioavaibility exceed a high threshold, when regulation breaks down and net accumulation begins e.g. *Palaemon elegans* [35], *Carcinus maenas* [27] and *Procambarus clarkii* [36]. That may explain the low level of copper in both kinds.

Zinc and iron concentrations in freshwater prawn (*Macrobrachium rosenbergii)* were higher than that of marine shrimp (*Penaeus semisulcatus)*. These levels were higher than the permissible limits (50 and 30 ppm., respectively [37]. Meanwhile the results of Hamdi and Zaghloul [38] indicated that the level of bioaccumulation of the studied heavy metals (iron, copper, zinc, lead, manganese and cadmium) in muscles of marine shrimp were within the permissible level, but higher than that of crayfish (*Procambarus clarkii)* .

Steroid hormones were identified in various tissues and in the haemolymph of several decapods crustaceans. In the ovary of *Penaeus monodon*, estrogens such as estrone and estradiol-17β were detected by means of radioimmunoassay (RIA) [39]. Additionally, progesterone and related compounds were found in several crustacean species [40]. Testosterone was detected in *Parapenaeopsis stylifera* and in the haemolymph and testis of *Homarus americanus* by means of radioimmunoassay (RIA) [41].

The hormonal residues of the edible parts of fresh water prawn and marine shrimp (Table,2) showed that estradiol-17β, progesterone and testosterone were higher ($P<0.001$) in fresh water prawn when compared with the marine shrimp. These results go hand to hand with the results of Tag El-Din *et al.* [42] who recorded high levels of progesterone and testosterone in the tissues of crayfish, *Procambarus clarkii.*

In aquaculture systems, nitrate has been neglected as a material water quality hazard. Commercial aquaculture operations have used large influxes of water to maintain water chemistry, but it is not uncommon to have water exchanges of 100% per day. As aquaculture attempts to keep pace with global demand, the growing number of aquaculture operations will be forced to utilize recirculation aquaculture technology. In recirculating

Table 3:Proximate composition and some minerals of the freshwater prawn, *M. rosenbergii* and marine shrimp, *P. semisulcatus* meats

Composition % dry weight	Freshwater prawn	Marine shrimp
Protein	48.79±4.3	52.46±3.7
Lipid	1.55±0.36	1.75±0.04
Moisture	75.9±4.8	82.5±7.2*
Ash inerals	1.1±0.02	1.56±0.03
Ca (g/Kg dry weight)	25.00±4.9	33.00±7.10*
Ph (g/Kg dry weight)	6.79±1.22	7.53±1.21

*= Significance at $P \leq 0.05$

aquaculture systems with limited water exchange, nitrate can rise to concentrations far in excess of those of natural environment [43].

The high level of steroids may be due to: first, nitrate triggered an up-regulating of steroidogenic function resulting in increased gonadal synthesis of sex steroids. Second, nitrate induced alterations to transport proteins hamper transport to the liver and affect clearance. And lastly, elevated nitrate may impair liver function, thereby reducing its ability to clear these steroids from blood [44]. The elevated level of estradiol-17β and testosterone in fresh water prawn may be due to the use of organic fertilizers as chicken manure in shrimp ponds or the inorganic fertilizers such as a combination of ammonium phosphate and urea [45]. Moreover, the increase of progesterone level ($P \leq 0.001$) in the fresh water prawn muscles may be due to the inactivation of some enzymes such as 17β-hydroxylase, C_{17}-C_{20} lyase, 17β-hydroxysteroid dehyddrogenase (HSD) and aromatase of the hepatopancrease. These enzymes under the effect of pollution can't convert progesterone to estradiol-17β [46].

The high level of testosterone in fresh water prawn (Table, 2) may be due to heavy metals and the organometallic compound that have been reported to be a strong endocrine-disrupting compounds (EDCs), probably by interfering with more than one mechanism, i.e. by inhibiting P_{450}-dependant aromatase that converts endogenous testosterone to estradiol, as well as by inhibiting testosterone excretion, therefore giving rise to a phenotype known as imposex [47].

There is no official reference for the permissible limits of hormonal,, specially the natural hormone as estradiol-17β, progesterone and testosterone in fish or crustacean tissues. Meanwhile, the results of Gale *et al.* [48] indicated that the estimated residual steroid of <5 ng/g fish tissue is too low to be a hazard to human health. So, the high level of testosterone and progesterone in fresh water prawn tissues may represent a risk hazard for human health due to their genotoxic and carcinogenic effects [49].

Proximate Composition: The results in Table (3) show protein, moisture, lipid and ash contents of the meat of both the freshwater prawn, *M. rosenbergii* and marine shrimp, *P. semisulcatus*. Generally, the proximate composition depending upon season, age, maturity, sex, aviability of food and pollutants in the aquatic environment [50, 15]. Protein was found as the major constitute indicating that shrimp meat can be a good source of amino acids. In this study, both species, the freshwater prawn, *M. rosenbergii* and green tiger shrimp,*P. semisulcatus* had high percentage of protein, but the marine shrimp had a higher value represented by 52.46% while for freshwater prawn it was represented by 48.79%. This may be due to stress conditions caused by toxicity of heavy metals on protein metabolism or due to enhanced proteolytic activity as a consequence of increased metabolic demands following exposure to toxic pollutants in freshwater environment [15]. This finding disagree with the previous studies by Yanar and Celik [51] who reported the protein content of green tiger shrimp varies from 20.44% to 21.70% and this variation depending upon season. However, in the studies on red and pink shrimps species, the protein content did not change between winter and summer [52]. Oksuz *et al.*[7] reported that, shrimp is considered as a high-range protein containing nutrient like fish. It has reported that protein content of shrimp ranged between 17-21% depending on shrimp species[51, 1]. According to the study of Silva and Chamul [53], the protein content of crustaceans and mollusks were indicated around 20% comparing these previous studies with the present study, finding disagree and this may be due to the difference in analytical methods. No significant differences in lipid content between two species which represented by 1.75% for marine species, while for freshwater prawn represented by 1.55%,this finding in agreement with reported by Oksuz *et al.* [7] who reported that lipid content of edible part of deep seawater rose shrimp (*Parapenaeus longirostris*) and red shrimp (*Plesionika martia*) were about 1.1and2.61% respectively. Huidobro *et al.* [54]

Table 4: Amino acid composition (G/100g dry weight) of the giant freshwater prawn, *M. rosenbergii* and green tiger shrimp, *P. semisulcatus*

Amino acid	*M. rosenbergii*	*P. semisulcatus*
Aspartic acid N	7.92±0.959	8.9±0.5
Threonine E	2.53±0.23	2.94±0.411
Serine N	2.45±0.42	3.11±0.35
Glutamic acid N	8.66±1.92	11.45±2.10*
Proline N	1.63±0.035	2.63±0.29
Glycine N	4.03±0.925	3.42±0.49
Alanine N	3.19±0.875	4.14±0.55
Valine E	3.12±0.658	3.01±0.190
Methionine E	2.79±0.521	1.92±0.210
Isoleucine E	2.69±0.601	3.18±0.39
Leucine E	4.65±1.003	5.46±1.10
Tyrosine N	2.70±0.490	2.89±0.59
Phenylalanine E	3.08±0.890	3.41±0.61
Lysine E	7.46±1.92*	5.8±1.05
Histidine N	3.92±0.598*	1.65±0.30
Arginine N	5.82±0.955	5.63±0.99
Total Amino acids	66.64	69.55
NEAAs	40.32	43.82
EAAs	26.32	26.73
EAAs/NEAAs	0.65	0.61

*=significant at $P<0.05$

E= Essential amino acids N=Non-essential amino acids Mean values ±SD

and Cadun *et al.*[55] found that the lipid content of frozen and shrimp covered with liquid ice were 0.35 and 0.31%, respectively. Moisture of fresh shrimp is generally reported as 75-80 % [1, 51]. The moisture of the freshwater prawn and marine shrimp in this study were in parallel with previously reported findings (Table 3) . The ash content of freshwater prawn and marine shrimp was reported as 1.1% and 1.56%, respectively. The amount of ash shows the richness of the food in terms of element composition. Ash content of shrimp is generally 1-1.5% Sriket *et al.* [1] calculated the amount of ash of black tiger and white shrimp 0.95 and 1.47%, respectively. While Oksuz *et al.* [7] found the ash content of the rose shrimp and red shrimp was calculated as 1.55 and 1.01%, respectively. These previously reported findings are very close to the findings in this study. The recorded high values of phosphorus (6.79, 7.53 g/Kg dry wt) and calcium (25, 33 g/Kg dry wt) in muscles of both freshwater prawn and marine shrimp,respectively are in accordance with the corresponding values reported by Hamdi and Zaghloul [38].

The amino acids profile of the two species, *M. rosenbergii* and marine shrimp, *P. semisulcatus* were presented in Table 4. There were no significant differences in concentration of most amino acids. The most significant amino acids was glutamic acid, which represented by 8.66 (g/100g dry wt) for freshwater prawn and 11.45 (g/100g dry wt) for marine shrimp. The most abundant amino acids in both species were, glutamic acid, aspartic acid, lysine, arginine and leucine. These amino acid constitute about 50% of the total amino acids.Glycine, alanine, serine and threonine give tasty sweet, while arginine, leucine, valine, methionine, phenylalanine, histidine and isoleucine give bitter taste [56]. Sriket *et al* [1] reported a higher glycine content (3.10%) in black tiger shrimp (*P.monodon*) than in white shrimp (*P.vannamei*) which represented by 2.99%. These previously reported findings were very close to the findings in this study. The ratios of essential amino acids (EAA) to non essential amino acids (NEAA) in the giant freshwater prawn and green tiger shrimp were 0.65 and 0.61, respectively. These obtained ratio are in agreement with that reported by Yanar and Celik [51] with green tiger shrimp, *P. semisulcatus* and Speckled shrimp (*Metapenaeus monoceros)* . Iwasaki andHarada [57] explained that EAA/NEAA ratio of many fish species is 0.70 on average, whereas this ratio was reported to be 0.59 in crab (*Partunus trituberculatus*) and squid (*Doryteusthis bleekeri)* . Thus, the different amino acids might be associated with the varying tastes as well as textural properties of meat of the two species.

Table 5: Fatty acid composition (mg/100g) of the freshwater prawn, *M. rosenbergii* and marine shrimp, *P. semisulcatus*

Fatty acids	*M. rosenbergii*	*P. semisulcatus*
Saturated fatty acids		
Myristic acid C14:0	5.2±1.1	11±2.5*
Palmitic acid C16:0	130±5	106±7.3*
Stearic acid C18:0	75±7.5	48±5.3**
Unsaturated fatty acids		
Palmiololeic acid C16:1n-7	21±3	61±7**
Vaccenic acid C18:1n-7	21±2.5	25±3.1*
Oleic acid C18:1n9	79±6*	62±5
Linolenic acid C18:3n-3	5.9±1.1*	2.7±0.45
Linoleic acid C18:2n-6	61±9**	8.6±0.35
Eicosenoic acid C20:1n-9	9.5±2*	3±0.5
Eicosadienoic acidC20:2n-6	1.0±0.2	1.10.05
Arachidonic acid C20:4n-6	0.9±0.3	1.5±0.4
Eicosapenlaenoic acid (EPA) C20:5n-3	97±9	120±15**
Docosapentaenoic acid C22:5n-3	7.0±1.6	10±0.6 *
Docosahexaenoic acid (DHA) C22:6n-3	70±6.5	71±6
Total fatty acids	583.5	530.9
Total saturated fatty acids	210.2 (36%)	165 (31.1%)
Total unsaturated fatty acids	373.3 (64%)	365.9 (68.9%)
Unsaturated/ saturated	1.78	2.2
Total monounsaturated	130.5 (22.4%)	151 (28.4%)
Total polyunsaturated	242.8 (41.6%)	214.9 (40.5%)
Polyunsaturated/saturated	1.2	1.3
∑EPA and DHA	167	191
∑ n-3	179.9 (30.8%)	203.7 (38.4%)
∑n-6	62.9 (10.8%)	11.2 (2.1%)
n-3/n-6	2.9	18.2
n-6/n-3	0.35	0.055

*= Signifecant at P≤ 0.05 **= Signifecant at P≤ 0.01 Mean values ±SD

Total fatty acid composition of freshwater and green tiger shrimp are shown in Table (5) . The major fatty acids in the freshwater prawn were as follow: C16:0 (130mg/100g), EPA (C20:5n-3) (97mg/100g), C18:1n-9 (79 mg/100g) , C18:0 (75 mg/100g) , DHA (C22:6n-3) (70mg/100g) and C18:2n-6 (61mg/100g). The sum of major fatty acids concentrations was approximately 85% of the total. The pattern was approximately similar in marine shrimp in which major fatty acids were C20:5n-3 (120mg/100g) , C16:0 (106 mg/100g) , C22:6n-3 (71mg/100g) , C18:1n-9 (62mg/100g) and C16:1n-7 (61mg/100g) , which constitute about 78%of the total fatty acids and C16:0 and C20:5n-3 were also the first two fatty acids. Some variations in the concentrations of the minor fatty acids could also observed. *M. rosenbergii* differed the most presenting significantly lower values of C14:0, C16:1n-7, C22:5n-3 and significantly higher level of C18:3n-3 and C20:1n-9 than marine shrimp. Marine shrimp significantly higher ($P \leq 0.05$) in both C14:0, C18:1n-7and C22:5n-3 and most higher significant ($P \leq 0.01$) for C16:1n-7 and C20:5n-3 than freshwater prawn.

High levels of polyunsaturated fatty acids were found, especially of EPA and DHA, both of which are important to human health. Marine shrimp meat showed a higher values for these two essential fatty acids. The sum of these two fatty acids was higher for marine shrimp (191mg/100g) than the freshwater prawn meat which represented by 167 mg/100g. This result was in agreement with that obtained by Bragagnolo and Rodriguez-Amaya [58] who reported high levels of PUFAs found for farmed freshwater prawn *M. rosenbergii a*nd wild marine shrimp especially of EPA and DHA, both of which are important to human health. Among published work our results resemble those of Krzynowek and Panunzio [59] in *Penaeus vannanei* of Ecuador which had a higher level of C16:1n-7 and lower level of C14:0. On the other hand, our data revealed that PUSFAs were found as the major fatty acids for both species recorded by 41.6% for *M. rosenbergii* and 40.5% for *P. semisulcatus* this result was in agreement with [60] who found that PUFAs were the major fatty acids in white shrimp *P. vannamei*. Our result revealed that the content of n-3 PUFAs were greater than those of n-6 PUFAs. C22:6n-3 (DHA) and 20:5n-3 (EPA) were the dominant PUFAs in lipid from both species, this in agreement with Sriket *et al.* [1] for two species of marine shrimp (white shrimp, *P. vannamei* and black tiger shrimp, *P. monodon*) .Freshwater prawn meat had higher significant value ($P \leq 0.05$) for both oleic acid (C18:1n-9) , linolenic acid (C18:3n-3) and Eicosenoic acid (C20:1n-9) and most higher significant ($P \leq 0.01$) for linoleic acid (C18:2n-6) than had marine shrimp., while marine shrimp meat had higher significant values ($P \leq 0.01$) 0f EPA (C20:5n-3) and palmioloteic acid (C16:1n-7) than freshwater prawn.. DHA (C22:6n-3) showed about similar values for both species represented by 70 mg/100g dry weight for freshwater prawn and by 71mg/100g dry weight for marine shrimp. In this respect, Sriket *et al.* [1] reported that DHA/EPA ratio in black tiger shrimp meat was higher (2.15) than that found in white shrimp meat (1.05) . White shrimp meat had higher oleic acid (C18:1n-9) and linolenic acid (C18:3n-3) contents than black tiger shrimp meat.

The total saturated fatty acid percentage was 36% for freshwater prawn meat and 31.1% for marine shrimp. Among the saturated fatty acids C16:0 and C18:0 were the most abundant fatty acids in the lipid extracted from both species in the present study. [52, 61] reported that palmitic acid (C16:0) , Stearic acid (C18:0), DHA and EPA were the most abundant fatty acids in shrimps (*Nephrops norvegicus, Parapenaeus longirostris, Aristeus antennatus* and *P. semisulcatus, Metapenaeus monoceros*) and these previous results were completely in agreement with our finding. Also about similar percentage were observed for unsaturated fatty acids represented by 64. % for *M. rosenbergii* and 68.9. % for *P. semisulcatus.* Total monounsaturated (MUSFA) was 22.4% for freshwater prawn and 28.4% for marine shrimp meat. The percentage of n-3 fatty acid was higher (38.4%) for marine shrimp than had freshwater prawn (30.8%) . The percentage of n-6 fatty acids were 10.8% for freshwater prawn while for marine shrimp represented only by 2.1%.

About similar ratios of polyunsaturated / saturated fatty acids were observed in both species and represented by 1.2 for freshwater prawn and 1.3 for marine shrimp. These results were approximately in agreement with Bottino *et al.* [62]) who found in *Penaeus aztecus values* of 30, 29 and 41% for saturated, MUFAs and PUSFAs, respectively. The corresponding percentage obtained by Krzeczkowski [63] in *Pandalus boreolis* were 22, 31 and 47%. Similar results were reported by Hyvonen and Koivistoinen, [64] for unspecified frozen shrimp. On the other hand, Essien [65] encountered 54% saturated fatty acids and 43% unsaturated fatty acids in some Palaemonetes spp.

In conclusion, the present work revealed that meats in both the freshwater prawn, *M. rosenbergii* and marine shrimp, *P. semisulcatus* are a good source of protein and polyunsaturated fatty acids, omega-3 and omega-6, which have anti-inflammatory properties and stop the cartilage in joints from eroding. But marine shrimp is favorable due to the percentage of heavy metals in its meat is lower than that of freshwater prawn. Also, marine shrimp had a lower values of hormonal residues. While the freshwater prawn may suffered from more polluted water which led to accumulation of some heavy metals and hormonal residues in its muscles.

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