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Comparative study of raw and boiled *Litopenaeus vannamei* of male and female species in relation to mineral concentration and proximate composition

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Abstract

Proximate composition and mineral concentration raw and boiled *L. vannamei* male and female samples from the selected farm of Visakhapatnam and were determined to gain the knowledge on the effects of raw and cooking (boiling) on trace metal and proximate composition of *L. vannamei* male and female samples were investigated. The concentration of mineral results was determined by using flame photometer and Flame atomic absorption spectrophotometer, whereas the proximate composition of the given samples was determined by using AOAC (2000) methods respectively. The consumption of boiled species is the best approach to achieve improved dietary habits, minimizing mercury exposure and increasing omega-3 fatty acid intake. This study showed that the boiled samples prior consumption will help to retain the protein, ash, and mineral contents such sodium, potassium, calcium, copper and iron and preserve it for future use.

Keywords: *Litopenaeus vannamei*; raw and boiled species; minerals; proximate composition.

Introduction

Shrimp is one of the world's most popular shellfish. It provides high quality rich protein, calcium and various extractable compounds and minerals for human body, while low in calorie and fat (Abdullah *et al*., 2009). Lipid of shrimp contains mostly polyunsaturated fatty acids (essential fatty acids). These essential fatty acids are available in shrimp provides health benefits for human e.g., eye (retina) and brain development and function (Conner *et al*., 1992). The usage of the terms "shrimp' and "prawn' varies in different parts of the world. For scientific purposes, they should be taken as synonymous. Holthuis (1980) gave a most useful discussion on the usage of the word in different countries. Food and Agricultural Organization (FAO) reported the global production of *L. vannamei* has exceeded 1,000,000 tons by 2004 exceeding that of *P. monodon* (FAO, 2009). Ma *et al*. (2013) reported that global production of *L. vannamei* had reached 2,328,000 tons equalling a profit of 9218 million US dollars. In Mexico, it represents greater than 70% of aquaculture production and the revenue provides over 80% of total economic aquaculture resource to the population (Ramirez-Guerra *et al*., 2012). It has been shown that the sensory quality of many products, particularly flesh foods actually improve for short periods of time post-mortem. However, the quality of shrimp obtained immediately after harvest is recommended for consumption, as it is healthier compared with during post-mortem storage where it undergoes physicochemical deteriorations (Vatana, P. and Del Rosario, 1983; Boonsumrej *et al*., 2007; Nirmal and Benjakul, 2009, 2012).

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India is witnessing a phenomenal growth in *Litopenaeus vannamei* farming in recent years and is poised to attain further heights in production, particularly in Andhra Pradesh. The total *vannamei* shrimp production in India increased from 1,731 t in 2009-10 (MPEDA, 2010) to 10,000 t in 2010-11 (MPEDA, 2011). Phenomenal growth in the export of *Litopenaeus vannamei* was witnessed during 2012-13 to 2013-14 and the quantity exported increased from 91,171 t to 1,75,071 t (www. mpeda.com). The main shrimp cultivated is the Pacific white *Litopenaeus vannamei*, White shrimp (*Litopenaeus vannamei* Boone, 1931) is one of the world's most popular shellfish and is mainly consumed in the North, Latin America, Europe and Asian countries. The shrimp is an excellent source of protein and essential high-Unsaturated Fatty Acids (HUFA) such as eicosapentaenoic (20:5n3, EPA) and docosahexaenoic (22:6n3, DHA) (Feliz *et al*., 2002; Yanar and Celik, 2006, Rao *et al*., 2016; Rushinadha Rao, and Sreedhar, 2017).

Although reports are available on the composition of *Litopenaeus vannamei*, studies to assess the chemical composition of raw and cooked *Litopenaeus vannamei* are scanty. In addition, there is no much information on the role of different methods on the proximate composition. The aim of the present study was to determine proximate composition of raw and cooked *Litopenaeus vannamei*. Normal household cooking, appropriate for each type, was employed and differences in nutrient composition of cooked fish are presented. The investigation provides data of representative mean values of nutrients in the species of *Litopenaeus vannamei*, both raw and cooked, which can supplement the information in the food composition.

Material and methods

All the *Litopenaeus vannamei* samples were brought from the cultured farms of Visakhapatnam. The species were collected and immediately dipped in ice box along with transported in sterile polystyrene boxes to sustain freshness. Then the samples transferred to the laboratory for further analysis. On arrival at the laboratory, samples were washed with tap water several times to remove adhering particles. They were then prepared using common household practices. The edible portions of samples were prepared and cooked by boiling, steaming, frying, roasting or grilling according to common household methods. Soybean oil was used as the medium for pan-frying. Fresh and cooked samples were homogenized in a stainless-steel meat mincer and blender and kept at -20°C. Prior to analysis, composite samples of fresh and cooked species were prepared by combining the same weight from each of four single samples. Well-homogenized composite samples were used for all determinations.

The percentage of moisture was analyzed by the standard AOAC method (AOAC, 2000) for which a known weight (10 ± 0.5 g) of sample was placed individually in a moisture dish and dried in a hot air oven set at 105˚C until constant weights were obtained. The protein content of the fish was determined by micro Kjeldahl method (AOAC, 2000). It involves the conversion of organic nitrogen to ammonium sulphate by digestion of flesh with concentrated sulphuric acid in a micro Kjeldahl flask. The digest was diluted, made alkaline with sodium hydroxide and distilled. The liberated ammonia was collected in a boric acid solution and total nitrogen was determined titrimetrically. The percentage of protein in the sample was calculated. For the estimation of fat content, the dried samples left after moisture determinations were finely grinded and the fat was extracted with

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chloroform and methanol mixture (AOAC, 2005). After extraction, the solvent was evaporated and the extracted materials were weighed. The percentage of the fat content was calculated. The ash content of a sample is residue left after ashing in a muffle furnace at about 550-600°C till the residue become white. The percentage of ash was calculated by subtracting the ash weight from initial weight.

Sodium, potassium and Calcium were quantified by flame photometry in the ash hydrochloric solution, using lithium solution as an ionization buffer (AOAC, 2005). Copper and iron were analyzed with the help of flame atomic absorption spectrophotometer in the ash hydrochloric solution (AOAC, 2000). All results were done in triplicates and expressed as 100 g of edible part.

Results

Proximate composition

The results of moisture content, total protein, total fat and total ash contents of the fresh and boiled muscle of *L. vannamei* male and female samples of Visakhapatnam farms which were shown in table 1. The more quantity of moisture and protein content was accumulated in males than females whereas total fat and total ash percentage was found more in females than males respectively. While the percentage of moisture content was found more in raw samples than boiled samples whereas the total protein, total fat and total ash contents observed highest values in boiled samples of *L. vannamei* than raw samples.

Table 1. Proximate composition of raw and boiled male and female *L. vannamei* samples

	Male		Female	
	Raw	Boiled	Raw	Boiled
Moisture (%)	77.19±0.59	73.49±0.62	76.34±0.83	72.53±0.69
Protein (%)	20.43±0.41	22.98±0.26	19.36±0.51	22.36±0.48
Fat (%)	1.43±0.09	2.12±0.15	1.89±0.24	2.68±0.19
Ash (%)	1.03±0.11	1.41±0.04	2.43±0.13	2.44±0.21

Mineral composition of raw and boiled samples of L. vannamei male and females

Data on sodium, potassium, calcium, copper and iron were expressed in mg % of raw and boiled male and female *L. vannamei* samples represented in table 2. The content of sodium and calcium was found more in males of raw samples, whereas the percentage of potassium, copper and iron content observed more in females of raw samples, while all the minerals like sodium, potassium,

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calcium, copper and iron content in the study accumulated more in both males and females of *L. vannamei* boiled samples.

Table 2. Mineral concentration of raw and boiled male and female *L. vannamei* samples

	Male		Female	
	Raw	Boiled	Raw	Boiled
Sodium (mg %)	356±0.56	369±1.23	351±1.54	382±0.68
Potassium (mg %)	1128±0.12	1356±2.56	1264±1.63	1548±1.86
Calcium (mg %)	159.5±0.38	162.55±0.98	152.5±1.28	169.83±1.05
Copper (mg %)	3.26±0.06	4.93±0.24	4.83±0.64	5.47±0.39
Iron (mg %)	6.35±0.11	8.49±0.35	8.96±0.72	10.58±0.45

Discussion

All the results were expressed in wet weight basis. The results showed that there was a significant difference in the moisture ($P < 0.05$) content between males and females of raw and boiled *L. vannamei* samples. The percentage of moisture in the composition of shrimp is a good indicator of the relative energy, protein and fat contents (Barua *et al*., 2012). The proportion of moisture in shrimp varies widely between 65-90 % although it is normally in the range of 72-77 %. The existence of an inverse relationship between moisture and fat contents has been reported by several workers. It has been reported that low moisture content is usually associated with the relatively high-fat content and vice-versa (Yanar and Celik, 2006).

Shrimp is considered as a high-range protein containing nutrient, which contain 8 to 20% protein. It has been reported that protein content of shrimp ranged between 17 and 21% based on the shrimp species (Yanar and Celik, 2006). The high protein content in the lowest size groups may be attributed to increased protein synthesis during the active growth phase as it has been observed elsewhere in shrimps (Achuthan Kutty and Parulekar, 1984; Ajith kumar, 1990; Tanuja, 1996; Pedrazzoli *et al*., 1998). High level of protein was obtained in all the raw and boiled samples of male and female *L. vannamei* with the highest level were found in the (19.36±0.51, 20.43±0.41, 22.36±0.48 and 22.98±0.26) in edible portion. Similar to our results has been reported the protein level in edible portions by Silva and Chamul (2000), Sriraman (1978), Nair and Prabhu (1990), Reddy and Shanbhogue (1994), Ravichandran (2000).

Shrimp is considered as a high-range protein containing nutrient like fish. It has been reported that protein content of shrimp varies depending on shrimp species (Sriket *et al*., 2007).

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Protein and fat contents of the edible part of our shrimp were slightly different from those found by Sriket *et al*. (2007). Proximate compositions in shrimp muscle are affected by several factors such as species, growth stage, feed and season (Karakoltsidis *et al*., 1995). The ash content was higher in this study than from shrimp farmed in Songkhla and Suratthani provinces (Sriket *et al*., 2007). However, non-significant difference in terms of origin and place of samples had been reported. In our study, the proximate contents found for L. vannamei was within the range of other shrimp species (Diler and Ata, 2003; Oksuz *et al*., 2009; Turan *et al*., 2011).

The water loss and the higher contents of the other constituents in the boiled species are in accordance with the findings of other studies (Gall *et al*., 1983; García-Arias *et al*., 2003; Gokoglu *et al*., 2004; Kalogeropoulos *et al*., 2004; Rosa *et al*., 2007). Limited changes in the fat content occurred during processing, probably due to the preferential location of lipids in membranes. This is particularly evidenced by the higher level of PUFAs, especially DHA (an important structural fatty acid), which were not lost during grilling. The water lost during and frying were also reflected in the relative increase in cholesterol level in the cooked products. This effect was also particularly evident in other species and has been reported for other shrimp species (Ewaida, 1993; Echarte *et al*., 2001).

The fat and ash content was significantly higher in female samples compared to male samples ($P < 0.05$). In particular, the ash values were significantly different between female and male shrimps due to their size. The females were all larger than the male specimens; thus the ash content was determined to be higher in female samples. A corresponding result for female shrimp was also found in white shrimp (Lim *et al*., 1997). The chemical compositions of both sexes confirmed that the shrimp is an excellent food source due to its balance of nutrients and protein content. Yanar and Celik (2006) investigated the Ca, K, P, and Na mineral contents of the speckled shrimp (Metapenaeus monoceros) in different seasons. As all microelement levels were compared, only the K level was found to be higher compared to Yanar and Çelik's study (2006). For penaeid and pandalid shrimps, these values were lower compared to the study by Exler (1987). Karakoltsidis *et al*. (1995) reported nearly one-fifth of the Ca content (1210 mg/kg). Adeyeye *et al*. (2008) reported higher Ca content in another shrimp.

Conclusion

In a nutritional point of view, both male and female shrimps demonstrated acceptable quality; in particular, the female shrimps had the highest levels of lipids, and the fat content of the female and boiled shrimps was higher compared to the male and raw species. Consumers may receive some health benefits consuming the *L. vannamei* due to its proximate and mineral contents. The result of this study showed that the boiled samples prior consumption will help to retain the protein, ash, and minerals contents such sodium, potassium, calcium, copper and iron. It is however, important to conclude that boiled samples prior consumption will not only help in retaining the nutrient content and the keeping quality, but also serve as a valuable and economical means of preserving it for future use.

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References

Abdullah O, Ayse O, Mevlut A, Gozde G, Jelena M (2009). A comparative study on proximate, mineral and fatty acid compositions of deep seawater rose shrimp (Parapenaeus longirostris, Lucas, 1846) and red shrimp (Plesionika martia, A. Milne-Edwards, 1883). J. Anim. Vet. Adv. 8(1):183-189.

Achuthan Kutty CT, Parulekar AH (1984). Mahasagar-Bul, Natn. Inst. Oceanogr. 17(4):239-242

Adeyeye EI, Adubiaro HO, Olufemi J. Comparability of chemical composition and functional properties of shell and flesh of Penaeus notabilis.Pakistan J Nutr 2008; 7: 741–747.

Ajith kumar M (1990). Studies on the proximate composition of the prawn Macrobrachium idella (Hilgendorf). M. phil Thesis, Annamalai University. pp. 1-28

AOAC, 2000. Association of Official Analytical Chemists, AOAC, Washington, DC, USA, 17th edition.

AOAC. 2005. Official Methods of Analysis. 18th Edition. Association of Official Analytical Chemists, Gaithersburg, MD.

Barua P, Pervez MA, Sarkar D, Sarker S. Proximate biochemical composition of some commercial marine fishes from Bay of Bengal, Bangladesh. Mesopot. Journal of Marine Science. 2012; 27:59-66.

Boone, L. 1931. A collection of anomuran and macruran Crustacea from the Bay of Panama and the fresh waters of the Canal Zone. Bulletin of the American Museum of Natural History 63: 137-189.

Boonsumrej, S., Chaiwanichsiri, S., Tantratian, S., Suzuki, T. and Takai, R. (2007) Effects of Freezing and Thawing on the Quality Changes of Tiger Shrimp (Penaeus monodon) Frozen by Air-Blast and Cryogenic Freezing. Journal of Food Engineering, 80, 292-299.

Conner WE, Neuringer M, Reisbick S (1992). Essential fatty acids: The importance of n-3 fatty acids in the retina and brain. Nutr. Rev. 50:21- 29.

Diler, A. and S. Ata, 2003. Microbiological and chemical quality and meat yield of Penaeus semisulcatus De Haan 1884 caught from the Antalya region. Turk. J. Vet. Anim. Sci., 27: 497-503.

Echarte, M., M.A. Zulet and I. Astiasaran. – 2001. Oxidation process affecting fatty acids and cholesterol in fried and roasted salmon. J. Agr. Food Chem., 49: 5662-5667.

Ewaida, E.H. – 1993. Cholesterol, fat and food energy content of selected raw and cooked commercial fish species from the Ara- bian Gulf. Ecol. Food Nutr., 30: 283-292.

Exler J. Composition of foods: finfish and shellfish products, raw, processed, prepared. Agriculture Handbook Number 8–15. Washington, DC, USA: US Department of Agriculture, Human Nutrition Information Service; 1987.

FAO (2009) Online Query Panel: Global Aquaculture Production 1950-2007. Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Department. Accessed April 2009. www.fao.org

Feliz GLA, Gatlin MD, Lawrence LA, Velazquez PM (2002). Effect of dietary phospholipid on essential fatty acid requirements and tissue lipid composition of Litopenaeus vannamei juveniles. Aquacult. 207:151-167.

Gall, K. L., Otwell, W. S., Kobverger, J. A. and Appledorf, H. (1983). Effect of four cooking methods on the proximate, minerals and fatty acid composition of fish fillets. J. Food Sci. 48, 1068—1074.

García-Arias, M.T., E.A. Pontes, M.C. García-Linares, M.C. García-Fernández and F.J. Sánchez-Muniz. – 2003. Cookingfreezing-reheating (CFR) of sardine (Sardina pilchardus) effect of different cooking and reheating procedures on the proximate and fatty acid compositions. Food Chem., 83: 349-356.

Gokoglu, N., P. Yerlikaya and E. Cengiz. – 2004. Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (Oncorhynchus mykiss). Food Chem., 84: 19-22.

Holthuis LB. Shrimps and prawns of the world. In: FAO Species Catalogue Vol. 1. Annotated Catalogue of Species of Interest to Fisheries. Rome, Italy: FAO; 1980. p. 1161.

Kalogeropoulos, N., N.K. Andrikopoulos and M. Hassapidou. – 2004. Dietary evaluation of Mediterranean fish and molluscs pan-fried in virgin olive oil. J. Sci. Food Agric., 84: 1750-1758.

Karakoltsidis PA, Zotos A, Constantinides SM. 1995. Composition of the commercially important Mediterranean finfish, crustaceans and mollusks. J. Food Comp. Anal. 8: 258-273.

Lim C, Ako H, Brown CL, Hahn K. Growth response and fatty acid composition of juvenile Penaeus vannamei fed different sources of dietary lipid. Aquacult 1997; 151: 143–153.

Ma, Z., Wan, R., Song, X. and Gao, L. (2013) The Effect of Three Culture Methods on Intensive Culture System of Pacific White Shrimp (Litopenaeus vannamei). Journal of Ocean University of China, 12, 434-440.

MPEDA 2010. Annual report 2009-10, The Marine Products Export Development Authority, Kochi, 27 pp.

MPEDA 2011. MPEDA Newsletter, The Marine Products Export Development Authority, Kochi.

Nair AL, Prabhu PV (1990). Protein concentrates from tiny prawns. J. Mar. boil. Assoc. India 32(1-2):198-200.

Nirmal, N.P. and Benjakul, S. (2009) Melanosis and Quality Changes of Pacific White Shrimp (Litopenaeus vannamei) Treated with Catechin during Iced Storage. Journal of Agricultural and Food Chemistry, 57, 3578-3586

Nirmal, N.P. and Benjakul, S. (2012) Inhibition Kinetics of Catechin and Ferulic Acid on Polyphenoloxidase from Cephalothorax of Pacific White Shrimp (Litopenaeus vannamei). Food Chemistry, 131, 569-573.

Oksuz, A., A. Ozyilmaz, M. Aktas, G. Gercek and J. Motte, 2009. A comparative study on proximate, mineral and fatty acid compositions of deep seawater rose shrimp (Parapenaeus longirostris, Lucas 1846) and red shrimp (Plesionikamartia, A. Milne-Edwards, 1883). J. Anim. Vet. Adv., 8(1): 183-189.

Pedrazzoli A, Molina C, Montoya N, Townsend S, Leon- Hing A, Parades Y, Calderon J (1998). Recent Advances on Nutrition Research of Penaeus vannamei in Ecuador. Rev. Fish. Sci. 6:1-2.

Ramirez-Guerra, H.E., Garcia-Sifuentes, C.O., Pacheco-Aguilar, R., Ramirez-Suarez, J.C., Lugo-Sanchez, M.E. and Scheuren-Acevedo, S.M. (2012) The Influence of Ante-Mortem Hypoxia on the Physicochemical Stability of Myofibrillar Proteins in the Muscle Tissue of White Shrimp (Litopenaeus vannamei) Exposed to Multiple Freeze-Thaw Cycles. European Food Research and Technology, 235, 37-45.

Rao, K.R*., Viji, P., Sreeramulu, K. and Sreedhar, U. (2016). Proximate Composition and Heavy Metal Accumulation in Deep-Sea Crustaceans from Selected Stations in the Indian Exclusive Economic Zone (EEZ). Fishery Technology 53 (2): 155 – 161.

Ravichandran R (2000). Biodiversity, Litter processing, Leaf preference and growth, biochemical and microbial aspects in crabs of Pichavaram mangroves. Ph.D. Thesis, Annamalai University, India.

Reddy HRV, Shanbhogue SL (1994). Biochemical changes in different tissues of the mantis shrimp, Oratosq uilla neppa (Stomato poda) during reproductive cycle. Indian J. Mar. Sci. 23:247-249.

Rosa, R., N.M. Bandarra and M.L. Nunes. – 2007. Nutritional quality of African catfish Clarias gariepinus (Burchell 1822): a positive criterion for the future development of the European production of Siluroidei. Int. J. Food Sci. Tech., 42: 342-351.

Rushinadha Rao, K. and Sreedhar, U. (2017). Proximate composition and Heavy metal accumulation in some selected Deep sea fishes along the continental slope (200m to 1200m depth) of Indian EEZ (Exclusive Economic Zone). International Journal of Multidisciplinary Educational Research. 8(2): 77 – 92.

Silva JJ, Chamul RS (2000). Composition of marine and freshwater Finfish and shellfish species and their products. In: Maritin, R.E., E.J. Carter and L.M. Davis (Eds.), Marine and freshwater product handbook, USA: Technomic Publishing Company, Inc. pp. 31-46.

Sriket S, Benjakul P, Visessanguan W, Kijroongrojana K. Comparative studies on chemical composition and thermal properties of black tiger shrimp (Penaeus monodon) and white shrimp (Penaeus vannamei) meats. Food Chemistry. 2007; 103:1199-1207

Sriraman K (1978). Biological and biochemical studies on the prawns of Portonova coast (Crustacea: Decapoda: Macrura). Ph.D. Thesis, Annamalai University, India. P. 69

Tanuja R (1996). Some aspects of biology and utilization of the mantis shrimp Oratosquilla neppa from Cochin waters. Ph.D. Thesis, Cochin University of Science and technology, India. P. 87.

Turan, H., Y. Kaya and M.E. Erdem, 2011. Proximate composition, cholesterol and fatty acid content of brown shrimp (Crangon crangon L. 1758) from sinop region, black sea. J. Aquat. Food Prod. Technol., 20: 100-107.

Vatana, P. and Del Rosario, R.R. (1983) Biochemical Changes in Fermented Rice-Shrimp (Macrobrachium idella) Mixture: Changes in Protein Fractions. Food Chemistry, 12, 33-43.

Yanar, Y. and Celik, M. (2006). Seasonal amino acid profiles and mineral content of green tiger shrimp (*Penaus semisulcatus*, De Haan, 1844) and speckled shrimp (*Metapenaus monoceros*, Fabricus 1789) from the Eastern Mediterranean sea. Food Chemistry. 94:33-36.

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