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Proximate composition, quality and flavor components of shrimp (*Penaeus monodon, Penaeus orientalis* and *Pandalus hypsinotus*)

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Abstract. The present work was conducted to determine the proximate composition, quality and volatile flavor components of shrimps from two different origins. In *Penaeus monodon* from Bangladesh the protein was 18.2 %, lipid was 6.0 %, and moisture content was 74.93 %. TVB-N and TMA-N values in *P. monodon* were 27.51 mg/100 g and 2.11 mg/100 g, respectively. Heavy metals i.e. Cd, Zn were within the Maximum Allowable Limit (MAL), but Cr, Pb, Cu were above MAL. Acetone, Dimethyl sulfide and Hexane were identified as 30, 11.3 and 6.2 ($x10^5$), respectively in *Penaeus orientalis*, whereas the values were 18.6, 3.7 and 5.7 ($x10^5$), respectively in *Pandalus hypsinotus*.

Keywords: Proximate composition, TVB-N, TMA-N, Heavy metals, Flavour components

Introduction

The contribution of prawn to the export earning in Fisheries sector of Bangladesh is praiseworthy which is nearly 75–85% (DoF 2018). The main export earning species of shrimp harvested in Bangladesh is *Penaeus monodon*. The major causes of quality deterioration after death are the effects of bacteria, enzymes, wrong handling, use of inadequate ice, ambient temperature etc. These are the processes that must be controlled or slowed down to protect quality of the prawn. The freezing process and frozen storage is needed to be standardized because improper freezing and a long time of storage may deteriorate the quality of prawn. Recently the pollution by heavy metal is the great concern in many countries including Bangladesh. The common heavy metals that contaminate prawn and fish are Mercury (Hg), Lead (Pb), Cadmium (Cd), Chromium (Cr), Arsenic (As), Copper (Cu), Zinc (Zn) and Selenium (Se). All heavy metals are harmful above certain level and cause health risk. In the International Market consumers put more importance on the quality of raw material rather than the quality of finished product.

The quality of finished product depends on the quality of raw materials. Importance is now given on the qualitative improvement through value addition ensuring maximum food safety as per requirement of the consumers. Good quality raw material supply is

essential for the development of value-added product for domestic consumption as well as for export. It needs proper research support to produce safe and quality product for domestic consumption as well as for export. In Japan shrimp is a delicious food and liked by the consumers. Ever year Japan imports a sizeable quantity of prawn from different countries of Asia. The objectives of this study are the analysis of proximate composition, TVB-N and TMA-N and heavy metals of marine shrimp *Penaeus monodon*, determination of volatile flavor components of marine prawn, *Penaeus orientalis* and *Pandalus hypsinotus*

Materials and method

Source of shrimp: Marine shrimp (*Penaeus monodon*) was purchased from a fish processing plant located at Cox's Bazar. After purchase the marine prawn was immediately quick frozen in that freezing plant and transported to the Laboratory of the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh. Transportation was done by motor vehicle which took nearly 12 hours to reach the Laboratory. The raw material (shrimp) was purchased from the same source in each batch. It was known from the Processing Industry that the prawn species was caught from the Bay of Bengal along the Cox's Bazar coast of Bay of Bengal. However, raw material for volatile flavor components was purchased from a fish shop at Nara City of Japan because the volatile flavor component research was conducted in the Laboratory of Food Chemistry, Department of Food Science and Nutrition, Nara Women's University, Japan. It was not possible to collect *P. monodon* from Bangladesh. So the flavor component part of this research was conducted on *Penaeus orientalis* and *Pandalus hypsinotus*.

Freshness test: Freshness test (sensory quality i.e. SDP value) was conducted by organoleptic method which was adopted from the method followed in European Union (Howgate *et al.* 1992).

Biochemical analysis: TVB-N and TMA-N were estimated by AMC method (1979). The rest of the samples were subjected to laboratory analysis for the estimation of protein, lipid, ash and moisture according to the method of AOAC (1980).

Detection and quantification of heavy metal: Heavy metal detection and quantification was conducted by analysis of acid digested sample which was diluted and filtered through Whatman No. 1 filter paper. The colour of the solutions was measured by Atomic Absorption Spectrophotometer at a specific wave length and concentration was calculated according to the methods of Clesceri *et al.* (1989) and Eboh *et al.* (2006).

Identification of volatile flavour components: Volatile flavor components of shrimp (*Penaeus orientalis* and *Pandalus hypsinotus*) was conducted in the Laboratory of Food Chemistry, Department of Food Science and Nutrition, Nara Women's University, Nara, Japan. A method was followed which was adopted, developed and improved by Mansur and reported subsequently (Mansur *et al*. 2001, Mansur *et al*. 2003 and Mansur *et al*. 2015).

Results and Discussion

Proximate composition of shrimp is presented in Table I. Proximate composition of prawn and fish depends on various factors among which species, size, spawning period, water temperature, geographical variation etc. are important. Seasonal, cyclical changes in composition usually occurs though less noticeable in some shellfish (Connell 1980).

Table I. Proximate composition of *Penaeus monodon*

Parameter	*Penaeus monodon*
Protein (%)	18.2
Lipid (%)	6.00
Ash (%)	2.10
Moisture (%)	74.93

In Bangladesh some research have been conducted on nutritional composition of *P. monodon* (Mustafa *et al*. 2014; Islam *et al*. 2017). This will help to take quality control measure or action, which will keep the bio factors of fish unchanged, will save the bulk catch from spoilage, will help to continue the export of prawn for export earning, for new product development will keep the prawn safe for human consumption. Protein and lipid supply energy in our health. Protein from aquatic source is better for health compared to other protein. Apart from protein prawn contains lipid, minerals, vitamins, antioxidants etc. Lipid contains omega-3 polyunsaturated fatty acids which is effective against coronary heart disease. DHA, EPA and overall bio-factors are excellent which place the prawn as a very good food. Prawn of Bangladesh water area is famous for delicious taste and large size. International consumers purchase prawn with confidence.

Result of quality assessment of *P. monodon* is stated in Table II. Sensory quality of prawn was excellent (SDP$<$2; Grade A). The other two parameters for quality assessment were TVB-N and TMA-N value. TVB-N value was 27.51 mg/100g and TMA-N value was 2.11 mg/100g. This result indicates that the prawn samples were in good conditions. TVB-N value and TMA-N value remained in excellent condition. The recommended usual range of TVB-N value for frozen fish and shrimp is 32–40 mg/100g fish.

Table II. Quality (SDP Value, TVB-N Value, TMA-N Value) of *Penaeus monodon*

Parameter	*Penaeus monodon*	Maximum Allowable Limit
SDP	1.62	<5
TVB-N (mg/100g)	27.51	40
TMA-N (mg/100g)	2.11	8

In the present research TCA extract of the samples was prepared for steam distillation. TVB-N and TMA-N are two parameters generally used to measure the degree of spoilage in fish and prawn. TVB-N indicates spoilage caused by bacteria and self enzyme whereas TMA-N indicates spoilage caused by bacteria only. Considerable attention has been given to the TVB-N and TMA-N of fish and shrimp and a Maximum Allowable Limit (MAL) is set. This MAL determines the acceptability and safety of fish and shrimp, processed fish and shrimp, fishery products on the basis of freshness and quality (Pearson and Muslemuddin 1969). Prawn muscle and fish muscle contain a little TMAO but the major portion of the TVB-N is considered to be ammonia. In well preserved prawn and fish ammonia originates from amino acids mainly from glutamine and asparagine (Haaland and Njaa 1988). Selection of appropriate method for the accurate estimation of TVB-N is important. A number of methods for TVB-N estimation had been proposed by many researchers (Ritskes 1975; Ruiter and Weseman 1976; Parris 1984). In this research extraction with TCA and steam distillation was selected because sophisticated methods were considered to be expensive and unsuitable for routine monitoring.

Result of heavy metal detection and quantification of the prawn muscle is presented in Table III. Five heavy metals were included in the present research i.e. Cr, Cd, Pb, Cu, Zn. Among these heavy metals Cd and Zn were within the Maximum Allowable Limit as recommended by World Health Organization (WHO) and Food and Agricultural Organization (FAO) of the United nations. The other three heavy metals e.g. Cr, Pb and Cu were above the Maximum Allowable Limit.

Table III. Heavy metal concentration (Cr, Cd, Pb, Cu, Zn) in *Penaeus monodon*

Heavy Metal	Concentration ppm	MAL (WHO/FAO) ppm
Cr	7.47	0.05
Cd	0.58	1.00
Pb	4.51	2.00
Cu	33.17	10.00
Zn	84.89	100.00

The reason behind the high concentration is water pollution by waste material dumping, industrial effluent discharge, lagoon and finally climate change or environmental change which reduce water depth and thus heavy metal in water is more concentrated which easily accumulated in muscle of aquatic animals e.g. prawn and fish through food chain. Considering the affect of heavy metal on prawn/fish quality and safety the food regulatory and health authorities in some developed countries have taken serious view and adopted Maximum Allowable Limit of metal and element. Usually heavy metal cause pollution to raw material (prawn), in this way the concentration of harmful metal and element is also at danger level in processed products. In Bangladesh aquatic environment is getting polluted by heavy metals. Three main sources of such pollution are: Industrial effluent discharge, waste dump, and lagoon and sewerage disposal. Control of water pollution in Bangladesh was not adequate which is now affecting its aquatic resources. About 20 years ago heavy metal concentration was undetectable in the prawn and fish of Bangladesh, but now-a-days the aquatic animals e.g. prawn and fish usually contain heavy metal (Mansur 2015).

Volatile flavor components of two prawn species (*Penaeus orientalis* and *Pandalus hypsinotus*) of Japan were detected and quantified (Table IV). Corresponding chromatograms are shown in Fig. 1. It is seen from Table IV that the volatile flavor components of *Penaeus orientalis* and *Pandalus hypsinotus* are almost similar but concentration is different. Flavour components were acetone, dimethyl sulfide, hexane. Concentration in terms of peak area was 30 x 10^5, 11.3 x 10^5, 6.2 x 10^5, respectively in *P. orientalis*. But concentration of flavor components was less in *P. hypsinotus*. Concentration of acetone, dimethyl sulfide, hexane in *P. hypsinotus* was 18.6x 10^5, 3.7x 10^5, 5.7 x 10^5 respectively. This part of research was conducted in Japan. During purchase the raw shrimp were in chilled condition for more than 8 hours. So it is possible that a part of the volatile flavor components was lost due to condensation (due to low temperature) and leached out from the samples. Most of the flavor components were of low molecular weight same as the flavor components of fin fish.

Table IV. Volatile flavor components identified in *Penaeus orientalis* and *Pandalus hypsinotus*

Component	Peak area (x10^5)	
	Penaeus orientalis	*Pandalus hypsinotus*
Acetone	30	18.6
Dimethyl sulfide	11.3	3.7
Hexane	6.2	5.7

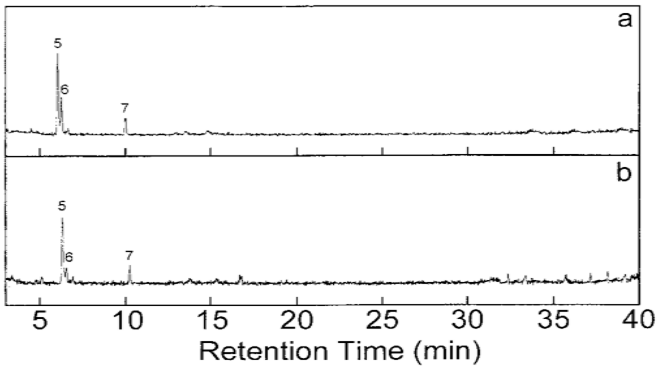

Fig. 1. Chromatogram of volatile flavor components identification by GC-MS
(a) *Penaeus orientalis* (b) *Pandalushypsinotus*

In this research we have attempted to create data and information which will be helpful for the consumers of domestic market as well as for foreign buyers. Such data are also helpful for producing a quality product and a safe product. Such data are also helpful to develop awareness as well as to formulate quality control and quality assurance programme.

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Literature Cited

AMC (Analytical Methods Committee), 1979. Recommended General Methods for the Examination of Fish and Fish Products. *Analyst*, 104: 434-450.

AOAC, 1980. Official Methods of Analysis. Association of Official Analytical Chemists. (12th ed.) Washington, D.C. USA.

Azam, S.A.K.M., M.A. Mansur, M. Asaduzzaman, M. Rahman and M.G. Sarwer, 2013. Quality and safety aspects of fresh and frozen prawn (*Macrobrachium rosenbergii*), Bangladesh. *American J. Food Sci. Technol.,* 1(4): 77-81.

Clesceri, L.S., A.E. Greenberg and R.R. Trussed, 1989. Standard method for the examination of water and waste water. 17th ed. American Public Health Association. Washington DC.

Connell, J. J., 1980. Intrinsic Quality. In: "Control of Fish Quality (2nd ed.)". Fishing News Books Ltd. Farnham, Surrey, England. 4-30.

Department of Fisheries (DoF), 2018. Fish Week 2018 Publication. Department of Fisheries. Government of Bangladesh. Matshya Bhaban. Ramna, Dhaka.

Eboh, L., H.D. Mepba and M.B. Ekpo, 2006. Heavy metal concentration and processing effects on the composition, storage stability and fatty acid profile of 5 common commercially available fish species in Oron/Local Govt. Nog. *Food. Chem*, 97: 490-497.

Haaland, H. and L.R. Njaa, 1988. Ammonia (NH_3) and Total Volatile Nitrogen (TVN) in preserved and unpreserved stored, whole fish. *J. Sci. Food and Agricul.,* 44: 335-342.

Howgate, P.A., P. Johnson, K. J. Whittle, 1992. Multilingual guide to EC freshness grades for fishery products. Torry Research Station, Aberdeen. Food Safety Directorate, Ministry of Agriculture, Fisheries and Food, UK. 9p.

Islam, A., S. Mondal, S. Bhowmik, S. Islam and M. Begum, 2017. A comparative analysis of the proximate composition of wild and cultured prawn (*Macrobrachium rosenbergii*) and shrimp (*Penaeus monodon*). Int. J. Fish. Aqua. Stu., 5(4): 59-62.

Mansur, M.A., 2001. Examination of Flavour Components in Fish, Processed fish and Fishery Products of Japan. Research Report. The JSPS Post-doctoral Fellowship for Foreign Researchers. ID No. P99117. Ministry of Education, Tokyo, Japan. 10 p.

Mansur, M.A., 2015. Chemical Composition of Fish. In: "Fisheries Studies. Part-III". Botomul, Dhaka. 410-448.

Mansur, M.A., A. Bhadra, H. Takamura and T. Matoba, 2003. Volatile flavor compounds of some sea fish and prawn species. *Fisheries Science*, 69(4): 864-866.

Mustafa, M.G., M.A. Hossain, M.J. Alam, M.M.R. Khanam, S.S. Nila and M.Z. Alam, 2014. Effects of gamma irradiation on the shelf-life of frozen tiger shrimp, *Penaeus monodon* (Fabricus, 1798). *Int. J. Nat. Sci.*, 4(1): 10-15.

Parris, N., 1984. An improved fluorometric method for the determination of ammonia and volatile amines in meat tissue by High-performance Liquid Chromatography. *J. Agricul. Food Chem.,*32: 820-831.

Pearson, D. and M. Muslemuddin, 1969. The accurate determination of total volatile nitrogen in meat and fish. *J. Assoc. Public Anal.,* 7: 50-54.

Ritskes, T.M., 1975. The gas chromatographic determination of trimethylamine and dimethylamine in fish, fishery products and other food stuffs. *J. Food Technol.,* 10: 221-228.

Ruiter, A., J.M. Weseman, 1976. The automated determination of volatile bases (trimethylamine, dimethylamine and ammonia) in fish and shrimp. *J. Food Technol.,*11: 59-68.

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