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Shrimp Waste Powder – Potential as Protein Supplement

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ABSTRACT

Seafood industries produce huge amount of wastes in the form of shrimp head and shell. These waste causing environmental problems as a result of uncontrolled dumping of the bio wastes. The aim of this study is the development of low cost and environment friendly techniques to utilize the shrimp waste. Shrimps waste powder is good sources of protein, fat and minerals. It can offer a potential source for exploitation as human consumption as well as animal feed. The results of biochemical composition show that the percentage of protein in the shrimp waste powder was higher (32.06 %) than that of fresh waste (22.85 %). The lipid (9.70 %) and ash (21.36 %) composition in shrimp waste powder forced us to determine its mineral composition. Minerals concentration such as sodium, potassium, phosphorus, calcium, magnesium, iron, and manganese was found to be 53.2 mg/g, 47.5 mg/g, 21.8 mg/g, 89.1 mg/g, 27.1 mg/g, 39.4 mg/g, 17.4 mg/g respectively in the shrimp waste powder. The powder of shrimp waste was found to be microbiologically safe and acceptable to the trained panelists on overall sensory evaluation.

Key words: *Shrimp waste powder, Mineral composition, Sensory evaluation, Biochemical composition*

INTRODUCTION

Seafood processing industry is the highly developing industry in recent years. On a global basis; the shrimp processing industry produces over 700000 million tons of shell wastes[23]. These wastes create heavy bad odours and pollute the environment to great extent. In India, shrimps are processed mainly into frozen and dried forms and exported to several countries. The shrimp processing industries mainly based on species like *Litopenaeus vannamei*, *Penaeus monodon*, *Penaeus semisulcatus*, *Metapenaeus dobsoni*, *Metapenaeus affinis*. Shrimp processing industries generate large amounts of shrimp waste during processing; approximately 45 - 55% of the weight of the raw shrimp was discarded as waste during processing.

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The sea food processing industry in India generates 8.5 million tons of shell waste per year[8] and it is increasing nowadays as the requirement is increased. Processing industries generates solid waste that can be high as 50 - 80% of the original raw material[2]. Continued production of the shrimp waste without corresponding development of technology to utilizing these wastes has resulted in environment pollution problems[15]. Recycling of shrimp wastes can prove an answer, however, it can be achieved at considerable cost to the industry; alternatively it can be utilized by extracting useful components and incorporating them into desirable seafood products. A better economic use of the shell fish offal would minimize the pollution problem and at the same time maximize the profits of the processor[14].

Shrimp head and shell are a good source for proteins and also contains several dietary minerals such as Ca, Fe, Mg, Na etc. which are beneficial to human and animals. Jacquot[17] reported that shrimp powder may be utilized in soup bases, dips, and sauces. The natural shrimp powder is produced without additives, or artificial flavor. There is dearth of study in the region about shrimp waste with nutrition point of view. The aim of this research is the development of low cost and environment friendly techniques to utilize the shrimp waste and to determine proximate composition and major minerals.

MATERIAL AND METHODS

Collection of raw materials

Commercial raw shrimp (*Penaeus* spp.) wastes (head or shell) were obtained from Fish Processing plant of Faculty of Fishery Sciences Kolkata, West Bengal, India. The waste was washed several times with tap water. The shrimp's waste samples were dried in mechanical drier at 60^0C for 2 h, and then the drying was continued for another 20 h at 40^0C. Dried shrimp's waste samples (Figure 1) were fine milled, packed in glass bottles and stored at room temperature.

Figure-1: dried shrimp waste (head and shell)

Quality evaluation of fresh and shrimp waste powder

Protein, ash, and total lipid analysis of shrimp waste powder was carried out using standard procedures of AOAC[3]. Total volatile basic nitrogen (TVBN) was determined by using Conway's micro-diffusion method[9]. Peroxide value (PV) was determined on chloroform extracts of tissues according to the methods suggested by Jacobs[16].

In the present study, Mineral composition analysis was performed according to A.O.A.C. method; within which Sodium (Na), Potassium (K) and Calcium (Ca) contents were determined by flame photometric method and Iron (Fe), Magnesium (Mg) and Manganese (Mn) were determined quantitatively by atomic absorption spectrophotometer. Phosphorus (P) was determined calorimetrically according to A.O.A.C. method[3].

Sensory evaluation

The method described by Kramer and Twigg[20] was followed for sensory analysis of shrimp waste powder using the following rating system out of 10 marks; for fancy 10-9-8, for extra-standard 7-6-5, for standard 4-3-2 and for sub-standard 1.

Microbial evaluation

The microbiological characteristics such as Total plate count (TPC) were enumerated by using plate count agar and Total fungal count (TFC) were enumerated using potato dextrose agar by following the procedure of Flowers *et al.*[12]. The pathogenic bacteria Coliforms and *Salmonella* were enumerated by following the method of USFDA[1].

Statistical analyses

Data resulting from the experiment were subjected to one way of analysis of variance using the SPSS.

RESULTS AND DISCUSSION

The aim of this research is the development of low cost and environment friendly techniques to utilize the shrimp waste powder for food product. So far no attempt has been taken to formulate and develop this edible product or other value added products from shrimp head waste in this region. Considering the above facts, shrimp waste powder was developed from unutilized shrimp head and shell waste.

Table-1: Biochemical composition of fresh shrimp waste and Shrimp waste Powder

Parameter	Fresh waste	Shrimp waste Powder
	Mean ±Std. Deviation	
Protein %	22.85 ±1.535	32.06±1.072
Lipid %	5.20±0.566	9.70±0.540
Ash %	8.29±0.665	21.36±0.758
TVBN mgN/100gm	8.50±1.065	0.37±0.085
PV meq O_2/kg	5.87±0.621	7.21±0.883

The biochemical composition of the *Penaeus spp.* waste Powder and fresh waste is presented in (Table 1).The percentage of protein in the Shrimp waste Powder was significantly higher (32.06±1.072) than that of fresh waste protein (22.85 ±1.535). Significant higher crude protein in the Shrimp waste Powder than fresh waste is attributed to more concentrated protein due to moisture loss while drying. Jeyasanta *et al.*[18], and Balogun & Akegbejo[5] reported 18.4% and 16.08% of crude protein in fresh head waste of *Penaeus spp.* respectively. In present study, finding of bit higher protein percentage may be due to inclusion of fresh shell along with head of *Penaeus spp*. As far as protein percentage in dried shell waste is concerned, due to effect of regional difference Ibrahim *et al.*[14], has reported 47% protein content in dried shell waste of *Penaeus spp* which is higher than our result (32.06%). The higher value of (21.36±0.758) of ash was noticed in the shrimp waste powder than that of fresh waste (8.29±0.665). Experimental data shows that after the processing ash content was increased in the dried powder[7]. Ash content of shrim waste powder was near to the result of Assunção & Pena[4] who reported in dry *Pandalus borealis* head residue contain 22.01% ash. Fernandes *et al.*[11], also acknowledged that ash content of shrimp cephalothorax flour was 20.97%. Likewise the lipid content of the shrimp waste powder was significantly higher (9.70±0.540) than fresh waste (5.20±0.566). This is because fat content is inversely proportional to moisture content. Our finding of fat content (9%) in shrimp waste powder is in agreement with Jeyasanta *et al*[18], and Ravichandran *et al.*[24], who reported similar fat content in *Peneaus spp*. from India.

The spoilage indicator TVB-N content was significantly lower (0.37±0.085) in shrimp waste powder than fresh waste (8.50±1.065). This lower TVB-N may be because of no sufficient microbes left after drying to give rise to TVB-N. Microbial quality of the shrimp waste powder has been presented in Table 5. TVB-N of the shrimp waste was less than 20mg N/100g, thus the raw material was considered fresh[13]. Unlikely, PV was higher in shrimp waste powder (7.21±0.883) than fresh waste. No sufficient data has been found to compare our result for PV. Higher PV in shrimp waste powder than fresh waste may be attributed to first stage oxidation of fat present in the head due to heat during drying.

Table-2: Microbial quality of the of the shrimp waste powder

Microbial parameter	Storage temperature	Storage day	Shrimp waste powder
TPC (CFU/g)	30^0C	0	$1.36x10^2$
		15	$1.51x10^2$
		30	$1.79x10^2$
TFC (No. of colonies/g)		0	Nil
		15	Nil
		30	Nil
Salmonella		0	Absent
		15	Absent
		30	Absent
Coliform MPN/100g		0	Nil
		15	Nil
		30	Nil

The shrimp waste powder stored in at room temperature (30^0C) for 30 days. Total plate counts (1.36×10^2CFU/g) in the shrimp waste powder were within acceptable limit may be because of significant lowering of water activity as result of drying and milling. Bacterial growth at room temperature rapidly increased with the progress of storage time. Although, overall bacterial count is within acceptable limit which was below the microbiological quality parameter of 5, 00,000 TPC/g in sea foods[26] it is intuitive to speculate this increase in TPC count at ambient temperature of bacterial growth in normal storage environment. Jeyasanta, *et al.*[18], Khan and Nowsad[19] observations is in same line with our result.

Fungal colonies and pathogens like *Salmonella* and Coliforms were absent in the same indicates no fecal contamination. Moisture is the main parameter for the growth of above mentioned microbes. Moisture content of shrimp waste powder was low enough to adequately prevent the growth of fungal colonies, Salmonella and Coliforms. Coliforms acceptable limit in food products is 20/g[26] and in the present study coliforms was completely absent in shrimp waste powder. The absence of *Salmonella* was reported in squid *Sepioteuthis lessoniana* soup powder by Chacko, Seafood safety does not approve the presence of pathogens in fish and fishery products.

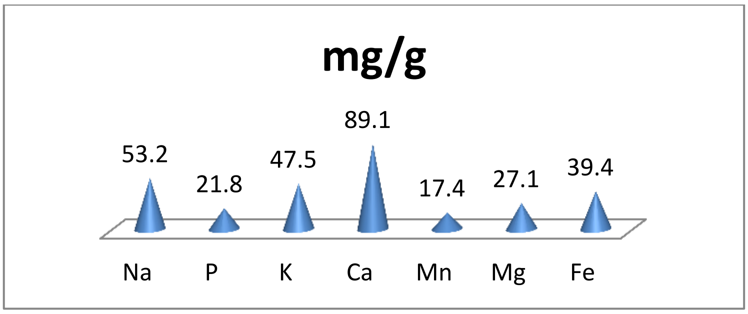

Figure-2: Mineral composition of shrimp waste powder

Minerals such as sodium, potassium, calcium, magnesium, iron, phosphorus and manganese were assessed in the shrimp waste powder and the results are presented in Figure-2. The sodium content was 53.2 mg/g. Iron was found to be 39.4 mg/g. Potassium was 47.5 mg/g. High values were also recorded for calcium 89.1 mg/g and magnesium 27.1mg/g. This high level of minerals was expected for the investigated samples because these minerals are one of the major ingredients which form crustacean structures. Among the seven minerals Phosphorus and manganese concentration was lower.

Fanimo *et al.*[10], found 157.7mg/g calcium content in shrimp cephalothorax flour, which is higher than that found in the present investigation. Beaney *et al.*[6], reported that calcium was abundantly present in prawn shell which is 17 times more than the magnesium. Mahmoud *et al.*[21], reported the amount of iron present in the *Penaeus semisulcatus* shells was 39.7mg/g and it is in agreement with our results. Nargis *et al.*[22], reported that the concentration of sodium was consistently higher in shrimp shell and this is in agreement with our result in the present study.

Table-3: Overall quality of Shrimp waste powder sample tested parameters in 10 units

Tested parameters	Shrimp waste powder	Overall quality
Colour	7.88	Extra standard
Aroma	7.63	Extra standard
Taste	7.75	Extra standard
Texture	7.92	Extra standard
Appearance	7.95	Extra standard

Application of the shrimp waste powder is tried in wafers from our processing plant. Interestingly, the value-added powdered wafer was accepted by all experts panel. The results of organoleptic characteristics are revealed in Table-3. The colour, aroma, taste, texture and appearance were of extra standard.

CONCLUSION

In the present study shrimp waste powder was developed. It can be said strongly that shrimp dried powder can be used as nutrient supplement in the formulation of ingredients or food products for humans and its utilization can be extended to animal diet also. Utilization of the shrimp wastes could minimize the cost of waste disposal that would realize substantial savings.

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