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Biofermentation: A Novel Method for Efficient Utilization of Shrimp Processing Waste

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Abstract A huge amount of head wastes generates from shrimp processing plants which can be used for fish feed preparation as it contains good amount of protein (40.37%) with excellent amino acid profile. In the present study fermentation of these wastes was done in two methods i.e. conventional method and in Biofermenter using *Bacillus amyloliquifaciens* (FPTB-16). The fermented shrimp head waste achieved 53.32% of protein in conventional method for 14 days fermentation whereas and 52.88% protein in biofermenter for 6 days. From the result of the present study, it can be stated that the fermentation using a biofermenter is better over conventional method primarily considering the process time.

Keywords Shrimp head waste, Fermentation, Biofermenter, *Bacillus amyloliquifaciens* (FPTB)-16) , Proximate composition.

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Introduction

Indian shrimp processing for freezing normally involves removal of head and body carapace as solid wastes. The solid shrimp waste contains head and body shell accounts approximately to 40—50% of whole shrimp weight [1]. The tropical shrimps' head generally constitutes 34—45% and body shell constitutes 10—15% [2] as a result India generates about 8.5 million tonnes of shrimp waste per year. Shrimp head waste is usually dried on the beaches that causes not only environmental pollution but also reduces the resource utilization. Continued production of the shrimp head waste resulted in waste collection, disposal and pollution problems due to the lack of technology development for proper utilization of the waste. A better economic use of the shrimp head would minimize the pollution problem and at the same time maximize the profit of the processor.

The unused shell of shrimps is a good source of protein with excellent amino acid profile, fat and minerals and can offer a potential source for exploitation

Table 1. Proximate composition of raw shrimp head waste. *NFE: Nitrogen free extract.

Parameter	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Crude fiber (%)	Nfe (%)
Value	40.37 ± 0.74	9.86 ± 0.17	17.82 ± 0.35	10.74 ± 0.34	15.78 ± 0.29	5.43

as fish feed [3]. However, the use of shrimp head meal in the formulation of fish feed is not recommended due to its high fiber (chitin) content, which results in the formation of weak pellets with poor stability in water.Bacterial fermentation could be desirable as alternative to cooking, sun drying and acid insolation [4] for reduction of this crude fiber by the breakdown of glycosidic bond between protein and chitin converting the product easily digestible. Lactic acid bacteria usually used for fermentation of shrimp waste [5] but non lactic acid bacteria also can be used for shrimp head waste fermentation [6]. The aim of the present study is to compare the fermentation of shrimp head waste using *Bacillus amyloliquifaciens* (FPTB-16) following two methods i.e. conventional method and use of biofermenter.

Materials and Methods

Raw material

Raw shrimp head waste was collected from seafood export company Nezami Rekha Seafoods, Kolkata and immediately transported to the laboratory in an ice box for experiment.

Proximate composition

The proximate composition of raw and fermented shrimp head waste were determined following the standard method [7]. For moisture content determination, the samples were heated overnight in an electric oven at 60°C. For ash content, ground dried samples were heated for 5 h in an electric oven 525°C. Total protein content was calculated by multiplying kjeldahl nitrogen with 6.25.

Inoculum preparation

Pure bacterial culture of *Bacillus amyloliquifaciens* (FPTB-16) was maintained in Man Rosoga Shrape (MRS) Broth. The inoculum was prepared by adding a loop full of cells to MRS broth incubating at 37°C for 48 h.

Fermentation in conventional method

Fermentation process was done following the method of Nwanna [8]. 500 g of blended paste prepared from thoroughly washed raw material washed raw material (shrimp head waste) was poured into a conical flask. Cane molasses (@ 150 g/kg) and 50 ml water were added to the paste and sterilized in an autoclave maintained at 121°C for 15 minutes. The material was inoculated with bacterial strain (@ 50 ml/kg) and allowed to ferment at 37°C for 14 days.

Fermentation in biofermenter

Four kg shrimp head waste paste was poured into the fermentation chamber of the biofermenter. Cane molasses and water were added to the paste in same ratio as conventional method and sterilized at 121°C for 15 minutes. 200 ml/@ 50 ml/kg bacterial strain was used to ferment for a period ranging from one to ten days at 37°C temperature in anaerobic condition in order to assess the highest protein recovery.

Amino acid compositions of all the fermented products were analyzed according to the method described by Bueno-Solano et al. [9].

Standardization of fermentation period in biofermenter

Sample was collected through the outlet of biofermenter every day to standardize the fermentation period depending upon the protein content.

Drying of fermentation product

Moisture content of the fermented product was esti-

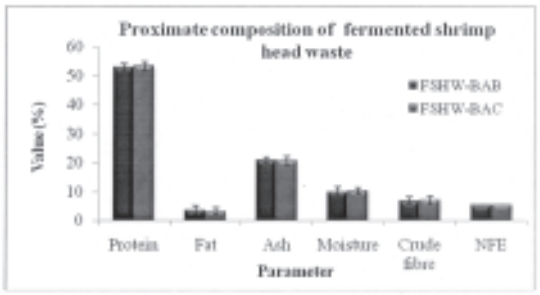

Fig. 1. Proximate composition of fermented shrimp head waste. FSHW-BAB: Fermented shrimp head waste using *Bacillus amyloliquifaciens* (FPTB-16) in biofermenter. FSHW-BAC: Fermented shrimp head waste using *Bacillus amyloliquifaciens* (FPTB-16) in conventional method.

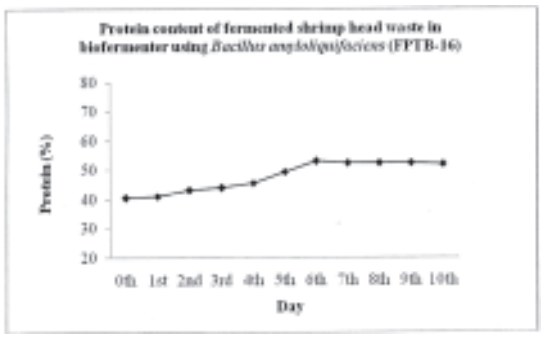

Fig. 2. Protein content of fermented shrimp head waste in biofermenter using *Bacillus amyloliquifaciens* (FPTB-16).

mated by drying in hot air oven at 60°C taking the sample at an interval of two hours.

Statistical analyses

Data generated from the experiment were subjected to one way of analysis of variance using the SPSS (Statistical Package Computer, Software 1988 version Chicago Illinois, (USA).

Results and Discussion

Proximate composition of
raw shrimp head waste

It is revealed from the present study (Table 1) that raw shrimp head waste contains 40.37% crude protein on dry weight basis which is in agreement with the result of Sachindra and Bhaskara [10]. Shrimp head waste contains 19.82% ash duly supported by the result of Tarafder et al. [11]. 15.78% crude fiber was obtained from shrimp head waste in the present study.

Proximate composition of fermented
shrimp head waste

Nutritional value considerably increases with the increase of protein for fermented products. Fermented shrimp head waste in conventional method by using *Bacillus amyloliquifaciens* (FPTB-16) contains 53.32% protein (Fig. 1) which was supported by Amar et al. [12].

The high protein and low fiber content are the indications of high digestibility. In the present study, protein content has increased by 32.08% and decrease in crude fiber was to the extent 55.51%. Hydrolyzing chitin in shrimp waste by using crude chitinase extracellular from *Serrata marcescens* (shrimp waste hydrolysate) could decrease chitin content by 61.07% and increased the protein content by 26.09% which is in concurrence with the findings of the present study [13]. It might be due to production of amylase which can break glycosidic bond between protein and chitin by hydrolysation.

Fermented shrimp waste using *Bacillus amyloliquifaciens*)FPTB-16) in biofermenter (at 37°C for 6 days) contains 52.88% protein (Fig. 1). Cira et al. [14] obtained protein content of 46.1% in fermented shrimp waste using *Lactobacillus* sp. in column reactor at 30°C after the fermentation period of 6 days. In the present study, raw shrimp head waste contains 17.82% ash which has increased by 20.63% and 20.95% after fermentation in conventional method and using biofermenter respectively. Demineralization of shrimp waste during the fermentation process could be the reason for the increase in ash content in the samples.

Table 2. Amino acid composition of fermented shrimp head waste.

Name	FSHW-BAC	FSHW-BAB
Arginine	2.03	2.30
Histidine	0.55	0.56
Isoleucine	1.42	1.5
Leucine	2.46	2.57
Lysine	1.73	2.40
Methionine	1.50	1.50
Phenyialanine	6.09	5.41
Threonine	2.76	2.56
Tryyptophan	0.39	0.53
valine	1.83	1.72

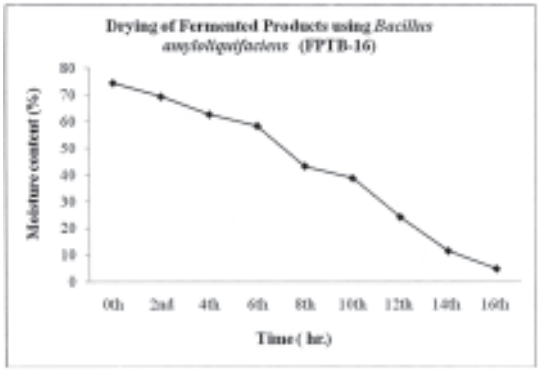

Fig. 3. Drying of fermented products (in 2 h. interval, in % of moisture).

There was no significant difference in protein content in both the methods followed. However, the time taken for fermentation in conventional method was 14 days as compared to 6 days in biofermenter, therefore the fermentation process following biofermenter may be considered better over conventional method.

Essential amino acid composition of fermented shrimp head waste

In order to fully evaluate the nutritive value of fermented shrimp head waste, it is desirable to establish its amino acid composition. This experiment was carried out to quantify the amino acid content in fermented shrimp head waste following conventional method and biofermenter (Table 2). The phenylalanine content was found to be more followed by the availability of other essential amino acids in lesser quantity which are in concurrence with the findings of Nwanna [8] working on fermented shrimp head waste meal. In amino acid composition, these was no significant (p>0.05) difference in both the fermentation methods.

Standardization of fermentation period

Because of inadequate information available pertaining to the process an attempt was made to standardise the process of fermentation using biofermenter. Standardisation of the fermentation process was done considering the protein content by drawing sample at one day interval. The result shows (Fig. 2) that the protein content was highest on 6th day which is at par with the finding of Cira et al. [14]. In the present experiment protein percentage was highest on 6th day with marginal reduction in the subsequent days of fermentation. Hence, period of fermentation for 6 days may be considered as ideal for biofermenter.

Drying of fermented products

Fermented products need to be dried for its use as fish feed. In the present experiment, moisture content of 74.36% was found in fermented shrimp head waste necessitating to reduce it to an acceptable level. In order to standardise the process, the material was subjected to drying at 60^{o}C and sample was drawn at 2 h interval (Fig. 3) to determine the moisture content. It was observed that drying period of 14 h at given temperature was most ideal for the product duly supported by the findings of Amar et al. [12].

From the present study it can be concluded that use of biofermenter is the perfect method for fermentation of shrimp head waste as conventional method usually needs long processing time. This fermented product can be utilized for fish feed preparation by replacing the expensive fish meal which would help to minimize the pollution problem and at the same time maximum the profits of the processor.

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