



Biofermentation: An Efficient Way to Utilize Shrimp Head Waste

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ABSTRACT

Shrimp head waste (SHW) is rich in protein (40.37%) with excellent amount of amino acid which can easily be incorporated in fish feed preparation by replacing fish meal. The utilization of SHW is limited due to the presence of crude fiber (chitin) which interferes in digestibility of fish. This problem may be overcome through bio-fermentation using *Bacillus subtilis* (FPTB-13) which can reduce this crude fiber by the breakdown of glycosidic bond between protein and chitin converting the product easily digestible. Fermentation of shrimp head waste in biofermenter increases the amount of available protein with proper proportion of amino acid and reduces the fermentation time substantially as compared to conventional method.

Key Words: Amino acid, *Bacillus subtilis*, Biofermentation, Drying Shrimp head waste.

INTRODUCTION

Several crustacean species are commercially harvested in India and processed for export. During the financial year 2017-18, India has exported 13,77,244 MT of seafood worth US\$ 7.08 billion. Frozen Shrimp remained the major export item followed by frozen fish. Frozen shrimp continued to be the major item of export in terms of quantity and value, accounting for a share of 41.10 per cent in quantity and 68.46 per cent of the total USD earnings (MPEDA, 2018). Shrimp processing for freezing normally involves removal of head carapace and body shell. Shrimp contains only 40 per cent as edible part, remaining 60 per cent contributed by head and body shell simply be discarded as solid waste (Sindhu and Sherief, 2011) which not only diverse environmental problems but also reduces the recoverable components in this bio-waste due to marine dumping. A better economic use of shrimp waste can minimize the pollution problem as well as maximize the profits of the processor. Shrimp waste can be considered as a potential feedstuff due its good quality protein, minerals, pigments, lipid, and flavors contents. This waste can be utilized

in various ways. Continue production of shrimp head waste without corresponding development of technology utilizing the waste had result in waste collection, disposal and pollution problem (Amar *et al*, 2006) and effort was made to put the shrimp head waste collected from plant to be processed using three different bacteria and to put use for preparation of fish feed. The main objectives of the present study to recover protein and analyze essential amino acid present in shrimp head waste which may be incorporated in fish feed manufacture. Lactic acid bacteria usually used for fermentation of shrimp waste (Jung *et al*, 2005) but non lactic acid bacteria also can be used for shrimp head waste fermentation (Simi *et al*, 2007). The aim of the present study is to compare the fermentation of shrimp head waste using *Bacillus subtilis* (FPTB-13) following two methods i.e. conventional method and use of biofermenter.

MATERIALS AND METHODS

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.

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Fermentation of SHW in conventional method

Paste of thoroughly washed SHW was taken in a conical flask for fermentation according to the method of Nwanna, (2003). Cane molasses (@ 150 g/kg) and water (10 ml/100gm) were added prior to sterilize in autoclave maintaining 121°C for 15 min. The material was inoculated with pure bacterial culture of *Bacillus subtilis*(FPTB-13) @ 50 ml/kg and allowed to ferment at 37°C for 14 d.

Fermentation in biofermenter

Four kg shrimp head waste paste was poured in 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 1 to 10d at 37°C temperature in continuous stirring condition in order to assess the highest protein recovery. The proximate composition (moisture, ash, fat, protein) of shrimp head waste are determined according to the Association of Official Analytical Chemists (AOAC, 2012). Amino acid compositions of all the fermented products were analyzed according to the method described by Bueno-Solano *et al* (2009). Sample was collected through the outlet of biofermenter every day to standardize the fermentation period depending upon the protein content.

Moisture content of the fermented product was estimated by drying in hot air oven at 60°C taking the sample at an interval of two hr. 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

Standardization of fermentation period in Biofermenter

The main intension of this study is to maximize the available protein content in fermented shrimp head waste by breaking down the bond between chitin and protein. To standardize the fermentation

period in biofermenter, sample was collected in regular interval of one day for analysis of protein up to 10 days. In the present investigation it had shown highest value (55.17%) of protein on 6th day of fermentation using *Bacillus subtilis* (FPTB-13) after that it was started to decrease slowly. According to days the fluctuation of protein value of fermented product were presented in Fig. 1. The similar type of result obtained by Cira *et al* (2001) *i.e.* 46.1% protein in fermented shrimp waste using *Lactobacillus* sp. in column reactor in 6 d fermentation.

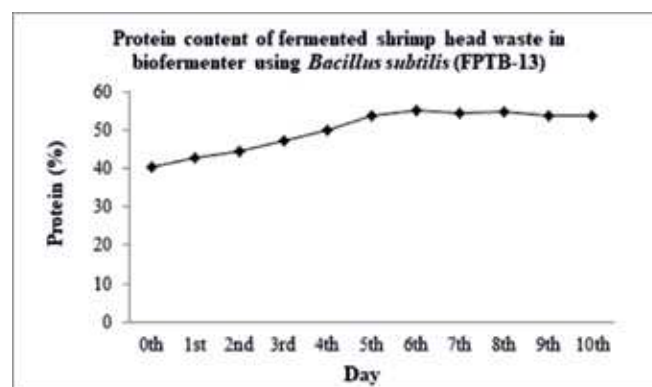


Figure 1: Protein Content of Fermented Products in Biofermenter

Proximate Composition of Fermented Shrimp Head Waste

Considerable increase in nutrient content was noted in terms of the protein for fermented products. Fermented shrimp head waste in conventional method by using *Bacillus subtilis* (FPTB-13) 52.52% protein content achieved in present investigation (Fig. 2). In the support of these results, Nwanna (2003) reported that fermented shrimp head waste (comprising mainly heads of *P. enaeusnotialis*, *P. duorarum*, *P. kerathurus* and *Parapepaeus longirostris*) by *Lactobacillus planterum* contain 58.96 per cent protein whereas Tarafder *et al* (2010) reported that fermented shrimp head waste by *Lactobacillus planterum* content 58.64 per cent protein. Amar *et al* (2006) reported that fermented shrimp waste by *Bacillus* strain contain 449 g/kg protein. Shrimp head silage using acetic acid content 39.9 per cent protein (Cavalheiro *et al*,

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2007). Percentage of the protein was varying in the present study from Nwanna (2003), Tarafder *et al* (2010), Amar *et al* (2006) and Cavalheiro *et al* (2007) might be due to different shrimp head used as raw material, different strain used for fermentation and difference in fermentation process. In the present experiment it was reported that shrimp head waste fermented by *Bacillus subtilis* (FPTB-13) content 7.15 per cent crude fiber. According to Nwanna (2003) fermented shrimp head waste by *Lactobacillus planterum* comprise of 3.35 per cent crude fiber. This difference of fiber content of fermented products might be due to different shrimp head used as raw material and different strain used for fermentation. Proliferation of bacteria in the chitinous substrate might have contributed to the enrichment of protein because of biomass buildup and or hydrolysis of chitin and certain extent of the protein hydrolysis might have enhanced the nutritional value. Microbial protein is also believed to contribute significantly to the protein content of the fermentation products.

Fermented shrimp waste using *Bacillus subtilis* (FPTB-13) in biofermenter (at 37°C, for 6 days) contain 55.17 per cent protein Cira *et al* (2002) obtained the result of 46.1 per cent protein in fermented shrimp waste using *Lactobacillus* sp. in column reactor at 30°C in 6d fermentation. The percentage of protein of fermented products in present investigation was varying from Cira *et al* (2002) might be depending upon the bacterial strain used in fermentation and incubation temperature.

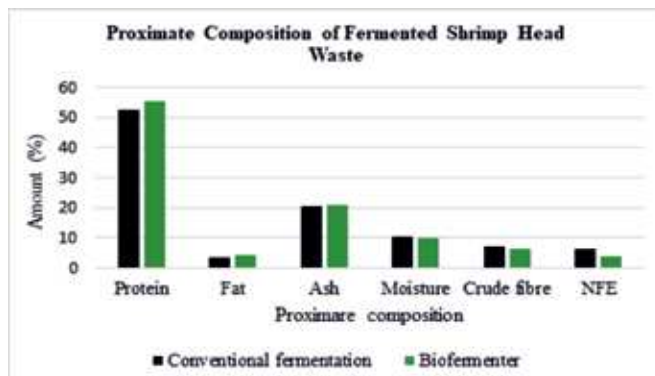


Figure 2: Proximate Composition of Fermented Shrimp Head Waste

Amino Acid Composition of Fermented Shrimp Head Waste

This experiment was carried out to quantify the amino acid in fermented shrimp head waste in both conventional method and biofermenter (Fig. 3) using three different bacteria namely *Bacillus subtilis* (FPTB-13). In conventional method, it gave maximum value of phenylalanine (5.17g/100g protein) where as other essential amino acids were shown comparatively less amount after 14d fermentation but in case of fermentation in biofermenter also shown similar result (phenylalanine 5.98g/100g protein) in 6d fermentation. Histidine (0.57g/100g protein) and tryptophan (0.53g/100g protein) were limiting essential amino acid in both fermented product. Fox *et al* (1994) and Nwanna (2003) reported a supporting result of the present study. Phenylalanine content 5.82g/100g protein in shrimp head silage meal (Nwanna, 2003). In amino acid composition there is no significant difference among both fermentation methods.

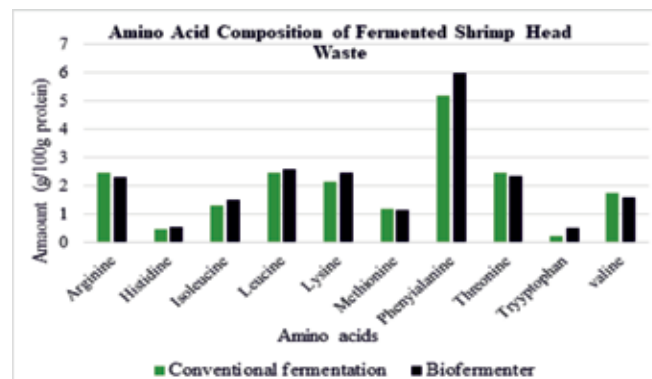


Figure 3: Amino Acid Composition of Fermented Shrimp Head Waste

Drying of fermented fish

Fermented shrimp head wastes are mainly used in dried condition for preparation of fish feed. So determination of drying period of fermented product is an important factor. In the present study it had taken 18 hr to dry each three fermented products at 60°C and reduced moisture content of each three fermented products has been recorded in 2 hr interval Fig. 4. Fermented prawn shell waste was dried at 60°C for 18 hr and used as an ingredient for feed preparation by Amar *et al* (2006).

Similar type of result also obtained by Cavalheiro *et al* (2007) where the shrimp head silage was subjected to dehydration with forced air circulation at a temperature of $65\pm 2^{\circ}\text{C}$ for 36 hr. There is no significant different among three treatment.

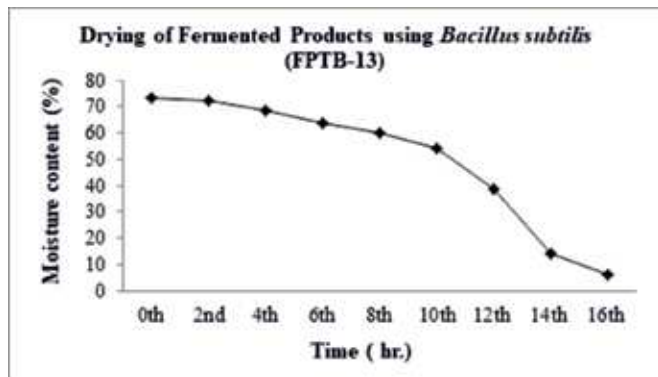


Figure 4: Drying of Fermented Products using *Bacillus subtilis* (FPTB-13)

CONCLUSION

There was no significant difference in protein value and amino acid composition among two methods i.e. fermentation in conventional method and in biofermenter. In biofermenter it had taken only 6d for fermentation to obtain more or less same result as conventional method which had taken 14d. In this circumstance it can be reported that fermentation in biofermenter may be better than conventional method as less time consuming to achieve good result.

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Received on 06/07/2020

Accepted on 10/11/2020