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Post-Harvest Loss and Shelf Life of Traditionally Smoked Shrimp Products Produced in Bangladesh

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Abstract: The present study was conducted to assess the post-harvest loss and shelf life of traditionally smoked shrimp produced in Southwestern region of Bangladesh. Qualitative loss in raw material shrimp was 5.8%. Most of the quantitative loss was found in storage (18.7%) and during marketing (7.9%). In combination of such losses, the total quantitative loss in smoked shrimp was calculated to be more than 30%. The moisture content and ash content of traditionally smoked shrimp was increased with the time of storage. The protein content and lipid content was significantly decreased with the time of storage. Total Volatile Basic Nitrogen (TVB-N) value of smoked shrimp exceeds 30mg TVB-N/100g after 75 days of storage which indicates the deterioration of the product. The stored shrimp in *hogla* bag had shelf life up to 2.5 months and after 2.5 months the product was rejected. Polythene or plastic bag for preservation and the appropriate training on kiln manufacturing from locally available materials for the smoked shrimp producers were recommended to improve the quality of smoked shrimp product.

Key words: Post-Harvest Loss · Smoked Shrimp · Shelf Life · Bangladesh

INTRODUCTION

The traditional low cost fish processing methods practiced in Bangladesh are sun drying, salting, semi-fermentation of barbs and smoking of small shrimps [1]. For sun drying proper intensity of light is required for producing quality dried products. Salting requires extra capital and labour. But for small shrimps in rainy season smoking is a good technique for preservation and is being used from the time immemorial due to no other alternative methods available in the rainy season [2]. Smoking is a traditional processing method of exposing fish to smoke from wood for preservation. Thermal cracking of wood under reduced oxygen supply results in smoke containing several compounds. Smoked shrimp is very tasty, nutritious and contain attractive flavor and color [3]. In Bangladesh smoked shrimp is a recent addition to the shrimp export products. Traditional smoking of small shrimps, especially in coastal region of Koyra and Paikgacha of Khulna, Chakaria and Pekua of Cox's Bazar and Patuakhali is a low cost processing of shrimp in coastal region of Bangladesh [1]. Traditional smoking method is mostly applied for the smoke curing of shrimp. However, in traditional smoking method smoked shrimps are produced in severe unhygienic and unhealthy condition. The raw shrimps are not preserved with ice before using for smoking and sometimes shrimps which are not sold in fresh market are used as raw material for the production of smoked products [4]. The raw shrimps are not washed with clean water; rather they use tidal sandy and dirty water for washing the raw shrimps. Considering the above stated fact, the current study was designed to investigate the qualitative and quantitative losses of smoked shrimp in different storage condition, to evaluate the shelf-life of traditionally smoked shrimp and to recommend appropriate means for sustainable smoked shrimp trading.

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MATERIALS AND METHODS

Sample Collection: Shrimp is smoked at several places in Bangladesh viz., Shamnagar of Satkhira, Paikgacha of Khulna and Chakaria of Cox's Bazar. For the present study, fresh smoked samples of Horina (*Metapenaeus monoceros*), Chali (*Metapaneous brevicornis*) and Chaka (*Penaeus indicus*) were collected from Batikhali, Khorule and Shibbari under Paikgacha upazila of Khulna district.

Assessment of Post-Harvest Losses in Smoked Shrimp: Assessment of Sensory Quality Loss: Quality loss of smoked shrimp in different stages of production and storage was assessed according to the modified method of Nowsad [5]. The method was based on *Fish Loss Assessment and Control Tool* originally developed by Torry Research Institute, UK [6]. At first sensory defect points (DPs) of the smoked shrimps at different steps of production and storage were determined using Table 1 and the quality of smoked shrimp was determined according to Table 2.

Quality loss index (QLI) model was used to estimate the percent quality loss of smoked shrimp at any stage of distribution channel. The following formula [5] was used to calculate percent quality loss of fish.

$$L(\%) = \frac{Pi}{N} \times 100$$

L = Percent quality loss
N = Number of observed lots
Pi = Total number of calculated DP those crossed DP 3.6

$$P = \frac{p1}{n1} + \frac{p2}{n2} + \frac{p3}{n3} + \frac{px}{nx} + \ldots$$

Where 'p' is the number of DP crossed 3.6 in fishes in 'x' number of lots and 'n' is the number of observations in each lot.

Proximate Composition Analysis: Different parameters like moisture, protein, lipid, ash and TVBN were determined to find out the chemical quality loss of smoked shrimp. Proximate composition (the percentage of moisture, protein, lipid and ash) of collected samples was analyzed according to AOAC [7] method. Total volatile basic nitrogen (TVB-N) was determined according to Conway [8] micro-diffusion technique. Slight modification was done to meet the requirement of the present investigation.

Table 1: Defect Points (DP) for assessment of quality loss of smoked shrimp

			Observations									
Characteristics	Defects	DP	1	2	3	4	5	6	7	8	9	10
Colour of smoked shrimp	Bright red color	1										
	Dark red color	2										
	Reddish	3										
	Whitish	5										
Odour	Smoky sweet odour	1										
	Mild smoky odour	2										
	Neutral odour	3										
	Rancid off odour	5										
Texture	Crispy fragile texture	1										
	Fragile texture	2										
	Less fragile but some elastic	3										
	Soften and elastic texture	5										
Total DP												
Average DP												

Table 2: Quality grade of smoked shrimp with Defect Points (DP)

Grade	DP	Grade Characteristics
A	<2	Excellent, highly acceptable
B	2 to 3	Good and acceptable
C	> 3 to < 4	Deteriorating, not acceptable
D	4 to 5	Rejected

Determination of Total Bacterial Count: SPC, total coliform, faecal coliform, *Salmonella* and *Vibrio cholera* were assessed on the basis of International Commission on Microbiological Specifications for Foods [9] method.

RESULTS AND DISCUSSION

Post-Harvest Loss in Smoked Shrimp: Qualitative loss in raw material shrimp was 5.8% (Table 3). Other qualitative losses (pre-process and in-process loss) were also very little. Therefore, this type of loss in final product was also very less (10%). Most of the quantitative loss was found in storage (18.7%) and during marketing (7.9%). Simultaneous drying and smoking process made shrimp fragile and susceptible to breakage. Rostrum, legs and appendages were found to be broken down and lost during storage and marketing. One of the major losses encountered during storage was the discard due to mold infestation caused by reabsorption of water from air. This also happened during marketing, because both production and marketing of smoked shrimp were done in monsoon months. In combination of such losses, the total quantitative loss in smoked shrimp was calculated to be more than 30% (Table 3).

Changes in Proximate Composition During Storage: Moisture Content: The initial moisture content in smoked Horina, Chali and Chaka were 18.412±0.064, 14.54±0.032 and 17.296±0.038% respectively. The moisture content of the smoked shrimp was increased with the time of storage (Fig. 1), which may be due to hydroscopic nature of smoked products. In the beginning the moisture absorbance rate was higher but it reduced gradually with the passage of time. After 105 days storage period, the moisture content was found to be 32.348±0.041, 30.428±0.041 and 30.2±0.032% in Horina, Chali and Chaka respectively. Hoq *et al*. [10] reported that the moisture level at 90 days interval of mixed species smoked shrimp increased to 24% from initial 13%. The increasing moisture content of this study is in accordance with the report of Hoq *et al*. [10].

Protein Content: After 105 days storage in *hogla* bag, the protein content (dry matter basis) of smoked Horina, Chali and Chaka were reduced from 72.568±0.03 to 60.964±0.033, 73.912±0.041 to 66.662±0.039 and 72.296±0.033 to 62.712±0.03% respectively (Fig. 2). In storage condition, the protein content decreased significantly with the time due to water soluble protein diffused out to the

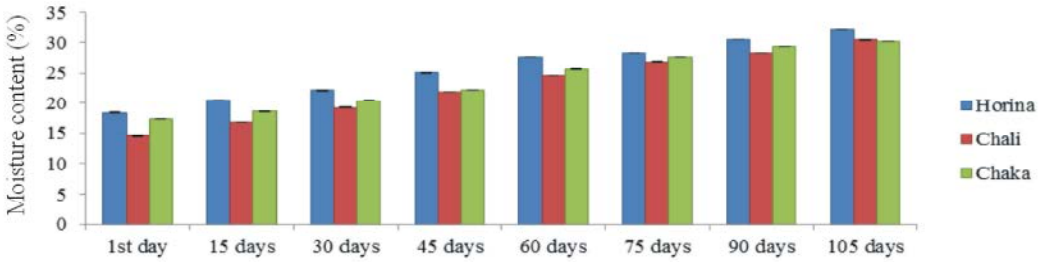

Fig. 1: Changes in moisture content of different smoked shrimps in storage condition

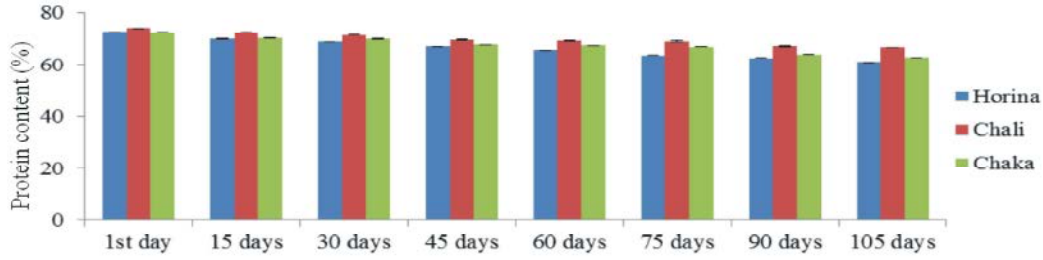

Fig. 2: Changes in protein content (dry matter basis) of different smoked shrimps in storage condition

Table 3: Post-harvest loss in Smoked shrimp

Quality loss during processing (%)				Quantitative Loss (% weight loss) during distribution and marketing				
Raw material	Pre-process	In-Process	Final product	Packaging	Transportation	Storage	Marketing	Total Quantitative Loss (%)
5.8±0.5	9.0±0.6	10.2±0.6	10.0±0.3	2.0±0.3	2.3±0.3	18.7±1.4	7.9±1.8	30.9

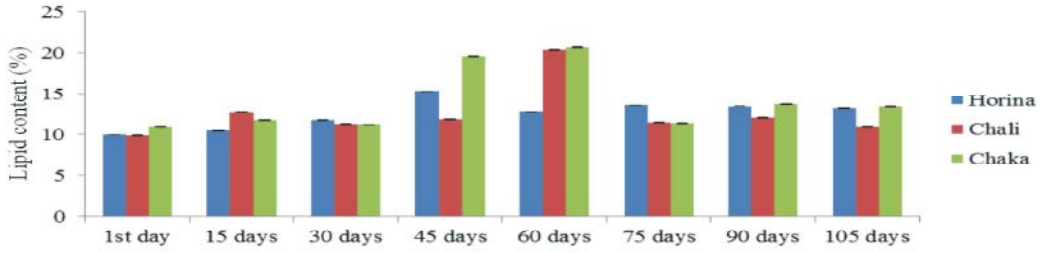

Fig. 3: Changes in lipid content of different smoked shrimps in storage condition

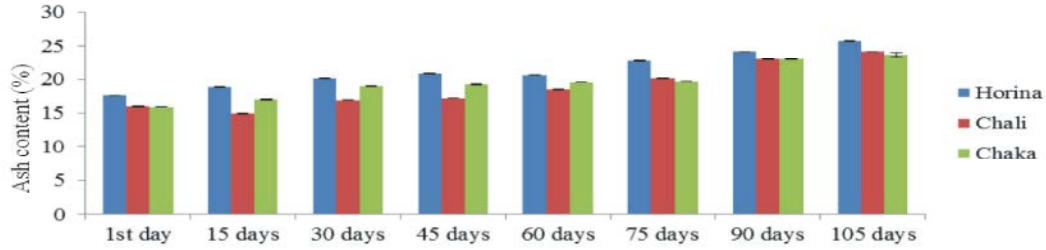

Fig. 4: Changes in ash Content of different smoked shrimps in storage condition

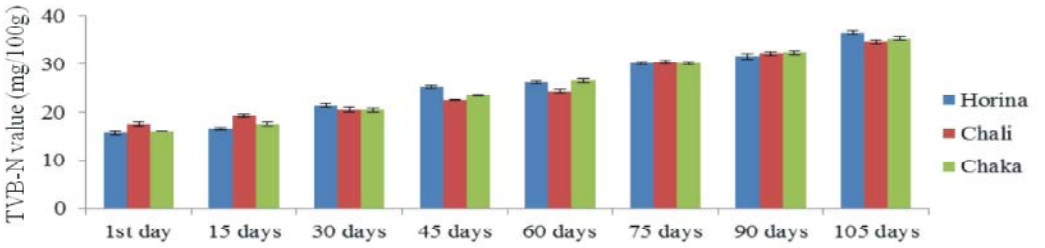

Fig. 5: Changes in TVB-N value of different smoked shrimps in storage condition

surrounding for exosmosis. Hoq *et al*. [10] showed that the protein content of mixed species smoked shrimp reduced to 64.48, 57.17 and 52.11% from initial 68.08% in 30 days, 60 days and 90 days respectively. The results of present study of the changes in protein content of smoked shrimp agree with the above report.

Lipid Content: The initial lipid content at the day of storage of smoked Horina, Chali and Chaka were 9.948±0.023, 9.9±0.032 and 11.03±0.047% respectively (Fig. 3). The highest level of lipid content of the smoked shrimp was found from 45 to 60 days of storage and after that the lipid content was decreased with the time of storage. The highest level of lipid content was found to be 15.344±0.026, 20.388±0.041 and 20.7±0.032% for Horina, Chali and Chaka respectively.

Ash Content: After 105 days storage in *hogla* bag, the ash content of smoked Horina, Chali and Chaka were reduced from 17.552 ±0.041 to 25.716±0.03, 15.94±0.04 to 24.138±0.03 and 15.876±0.038 to 23.698±0.341% respectively (Fig. 4). The ash content changes with the time of storage due to absorbance of moisture and loss of protein.

TVB-N Value: The TVB-N values of raw Harina, Chali and Chaka were 7.86 mg/100g, 11.58 mg/100g and 10.92 mg/100g respectively. The variation in the TVB-N value may be due to handling and processing method of the shrimp. The acceptable limits of TVB-N were reported as 30mg TVB-N/100g in good quality products [11]. The initial TVB-N values at the day of storage of Horina, Chali and Chaka were 15.758±0.368, 17.58±0.415 and 16.034±0.015 mg/100g respectively (Fig. 5). The TVB-N values of the smoked shrimp were increased with the time of storage. After 75 days of storage the value of TVB-N in all three species of smoked shrimp exceeds 30mg TVB-N/100g which indicates the deterioration of the product.

Table 4: Changes in bacterial content of different smoked shrimps

	SPC (CFU/g)			Total coliform (Nos)			Faecal coliform		
Storage time	Horina	Chali	Chaka	Horina	Chali	Chaka	Horina	Chali	Chaka
1st day	0.37×10^5	0.16×10^5	0.48×10^5	<3	<3	<3	<3	<3	<3
15 days	0.48×10^5	0.56×10^5	0.70×10^5	<3	<3	<3	<3	<3	<3
30 days	0.78×10^5	0.92×10^5	0.98×10^5	<3	<3	<3	<3	<3	<3
45 days	1.29×10^5	1.13×10^5	1.37×10^5	<3	<3	<3	<3	<3	<3
60 days	2.41×10^5	2.39×10^5	2.98×10^5	11	<3	210	<3	<3	<3
75 days	3.74×10^5	3.55×10^5	4.42×10^5	23	07	460	<3	<3	<3
90 days	4.42×10^5	5.20×10^5	5.46×10^5	23	240	>1100	11	93	43
105 days	6.11×10^5	5.42×10^5	6.82×10^5	<1100	>1100	>1100	93	07	93

Table 5: Condition of smoked shrimp in different stake holders

Stakeholders	Holding time (Days)	Chemicals or preservatives used	Keeping method/ Hygienic condition for storage	Organoleptic quality	Overall quality
Producers	2-15	No chemicals or preservatives used	*Hogla* plant made baskets are used for storage. The storage room is dam and insect accessible	Bright red color with Strong smoky sweet odour and Stringy, fragile texture	Good
Wholesaler	15-40	No chemicals or preservatives used	*Hogla* plant made baskets are used for storage. The storage room is dam and insect accessible	Reddish color with mild smoky odour Fragile texture	Good
Retailer	10-35	No chemicals or preservatives used	Not good, products are kept in dam and air permeable basket made of *hogla*, bamboo or gunny bag.	Dark to whitish red color with neutral odour rancid off odour and mostly soften and elastic texture	Poor

Bacterial Flora: The initial bacterial load at the day of storage of Horina, Chali and Chaka were 0.37×10^5, 0.16×10^5 and 0.48×10^5 CFU/g respectively. In this study it was observed that the bacterial load of the smoked shrimp was increased with the time of storage. At the end of 105 days the bacterial load were found to be 6.11×10^5, 5.42×10^5 and 6.82×10^5 CFU/g for Horina, Chali and Chaka (Table 4) respectively. Hoq *et al*. [10] showed the total bacterial count of smoked shrimp product increased to 1.47×10^7 from an initial of 2.46×10^4 in 90 days storage period. Total number of coliform and faecal coliform was increased with the time of storage. No *Salmonella* and *Vibrio cholerae* was found in the any stage of storage. A close relationship exists between the moisture content and the bacterial load in smoked shrimp products. In storage condition, the moisture increases as a result the bacterial load also increases.

Condition of Smoked Shrimp in Different Stakeholders: The distribution channel of smoked shrimp mainly consists of producers, wholesalers and retailers. The time of holding of the smoked shrimp at producers, wholesalers and retailers were found to be 2-15, 15-40 and 10-35 days respectively. No chemicals or preservatives were found to be used at any stage of holding. Baskets made of *Hogla* plant were used for storage. The condition of the smoked shrimp was found to be gradually decreased from producers to retailers (Table 5). The stored shrimp in *hogla* bag had shelf life up to 2.5 months. After 2.5 months all of quality factors changed to unacceptable level so the product was rejected.

CONCLUSIONS

The condition of the smoked shrimp was not satisfactory. Traditional smoked shrimp products were stored in unhygienic condition by the retailers and marketed without proper packaging. Appropriate packaging material such as polythene should be used for storing the smoked shrimp to reduce the post-harvest losses. The socio-economic condition of the smoked shrimp producers is below poverty level and they are not conscious about health, hygiene and the product quality. They are deprived of education and due to some superstition the women are not involved at all with the smoking activities. However, high quality smoked shrimp

products can be produced by using developed smoking kiln which can be constructed by using locally available materials at low production and operation cost. For this smoked shrimp producers should be given loan facilities and the appropriate training on kiln manufacturing from locally available materials.

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