



## Quality Assessment of Ethnic Fermented Product *Nga-Pi* Traditionally Produced at Cox's Bazar Region

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### Abstract

*Nga-pi*, an ethnic fermented product traditionally produced at Cox's Bazar region by Rakhine people is one of the popular food items of that area. To assess the quality of raw shrimp used for *Nga-pi* production and traditionally produced *Nga-pi* were collected. Some amount of the collected *Nga-pi* sample (from producers of both areas) were stored at refrigeration temperature (5 to 8°C) for 90 days to observe the changes in nutritive values, TVB-N and SPC during the storage. The results of proximate composition analysis for the samples showed that-the moisture content ranged from 58.29% to 61.06%, the crude protein content ranged from 25.88% to 27.12%, the crude lipid content ranged from 4.18% to 5.12% and ash content ranged from 7.30% to 8.40%. On the other hand the range for TVB-N value was found from 25.06 mg/100g to 34.02 mg/100g and SPC value from  $1.69 \times 10^5$  CFU/g to  $4.27 \times 10^6$  in *Nga-pi* samples. The result of the *Nga-pi* sample stored in air-tight polythene pack at refrigeration temperature (5 to 8°C) for 90 days showed that- the percent moisture, percent ash content, TVB-N value and SPC value increased but the percent protein and lipid content decreased with the progress of storage time.

**Key words:** Cox's Bazar, Fermented product, *Nga-pi*, Quality assessment, Traditional production

### Introduction

According to the report of BOBP (1985), traditional fish products are native to a country or culture. A large part of Bangladesh fish catch is used mainly at home to prepare a number of different processed products. In the domestic market, there are different types of traditional fish and fishery products available. Among them the most important products are dried, salted, smoked, semi-fermented and fermented fish products. For a number of reasons, these products are important, such as - these foods and food processes have survived and persisted over the centuries in developing world; they are important in the nutrition of the poor and economically deprived people and they generally involve low cost method of processing. This is why traditional fish and fishery products are very important for Bangladesh where a large number of people suffer from various chronic malnutrition, and most babies are born underweight, since their mothers are chronically malnourished (Islam, 1998). Protein malnutrition is one of the most serious problems in Bangladesh (Hossain, 1991). Due to high population growth there is an ever-increasing gap between supply and demand of fish and fisheries products in Bangladesh. The people prefer traditional products because of their taste and low cost compared with larger commercially important fish as table fish.

Among different traditional fish products, fermented products are unique. Three Chinese ideographs describing fermented fish products appear in the old Chinese work Churai, written in the third century BC. These are Hae, Ja, and Chi. Hae is fermented meat or fish made by aging in salt, occasionally with added wine, koji and nuruk, alcohol fermentation starters. Traditional fermented fish products are indigenous to

south-east Asian countries such as Laos, Kampuchea, Vietnam, Thailand, Malaysia, Indonesia and Myanmar (Martin, 1994). In Bangladesh also there are some fermented and semi fermented products like Chepashutki, Shidil, *Nga-pi* etc. which are popular in particular parts of the country. Among them *Nga-pi* is mainly produced, sold and used as popular food item at the South-East part of this country mainly by Rakhaing tribal people.

Teklemariam *et al.* (2015) stated, the quality of fish and fishery products is a major concern in fish industry worldwide. Essentially, the objective of fish and fish product assessment is to avoid the ingestion of contaminated food; to evaluate the nutritive value of food by detecting the presence of biological, chemical and physical hazards and in the end to ensure the safety of the consumer.

Alam (2007) reported different points regarding the processing of *Nga-pi* at Cox's Bazar region of Bangladesh. But information on the quality assessment of *Nga-pi* produced traditionally and marketed to the consumers are scare which are essential to ensure the safety of the product. In the present study, the team visited Chaowfalldandi and Nazirartak area of Cox's Bazar, collected relevant information, raw shrimp samples (used for *Nga-pi* production) and *Nga-pi* samples from different stakeholders of those two to assessed the quality of the collected samples using relevant methods.

### Materials and Methods

#### Collection of samples from sampling area

Raw shrimp (used for *Nga-pi* production) and traditionally produced *Nga-pi* samples were collected

form shrimp collectors, *Nga-pi* producers, wholesalers and retailers of Chaowfalldandi and Nazirarka, Cox's Bazar are (Plate 1).



**Plate 1.** Sample collection from the sampling areas Here, a- collection of raw shrimp sample and b- collection of traditionally produced *Nga-pi*

**Carrying and Storage of the samples**

Raw shrimp (both better grade and lower grade on the basis of visual observation and fish collector's recommendation) and *Nga-pi* samples collected from different sources of Cox's Bazar region, were immediately packed in polythene packs at the collection sites and kept in ice box, covered with enough ice (ice was replaced at each 4 to 5 hours interval) to carry the samples to the laboratory of Fish Processing, Department of Fisheries technology, Bangladesh agricultural University, Mymensingh. After bringing the samples to the laboratory, were stored in a refrigerator (at 5 to 8°C) until further analysis.

A certain amount of samples (7+7 air-tight polythene packs; each pack containing about 20g *Nga-pi* sample collected from producers of two different areas of Cox's Bazar) were stored in the refrigerator separately to observe the changes in sensory, biochemical parameters and SPC of *Nga-pi* while stored at low temperature and packed in air-tight condition in polythene.

**Quality analysis**

The quality of raw shrimp and traditionally produced *Nga-pi* samples were analyzed by sensory, biochemical and microbiological analysis.

**Sensory quality assessment**

A panel of nine-persons (students, teachers and staffs of the Department of Fisheries Technology) provided the sensory quality assessments of the product. The organoleptic characteristic (general appearance, taste, flavor, texture and color) of *Nga-pi* was examined by sensory methods (through sight, touch, taste, smelling etc.). *Nga-pi* was evaluated for preference of color, flavor, odor, texture, taste and overall acceptability. Organoleptic quality of *Nga-pi* was determined on the basis of defect points as describe in Table-1 and 2.

**Table 1.** Determination of organoleptic quality according to Howgate Method (1992)

Characteristics of Nga-pi	Defect characteristics	Defect points	Quality
Appearance	Bright, shining blackish	1	Excellent
	Slight dullness	3	Acceptable
	Dullness	4	Fare
	Definite dullness, weight loss	5	Reject
Color	Gray blackish color	1	Excellent
	Brown or gray color	4	Poor
	Color become black	5	Reject
Odor	Good odor	1	Excellent
	Slight off sour odor	3	Acceptable
	Faint sour odor	4	Poor
	Strong sour odor	5	Reject
Texture	Very good	1	Excellent
	Softness	2	Acceptable
	Some loss of elasticity	3	Acceptable
	Melting, easily broken	5	Reject
Consistency of paste	Soft	1	Excellent
	Paste somewhat hard	2	Acceptable
	Paste become hard	3	Acceptable
	Loss of water absorption	4	Poor

**Table 2.** Grading of Nga-pi product

Grade	Defect point	Degree of freshness
A	<2	Excellent (E)
B	2 to <4	Acceptable (A)
C	4<5	Poor (P)
D	5	Reject (R)

**Proximate composition analysis**

Proximate composition (percent moisture, protein, lipid, ash) of all the samples were measured according to AOAC (1990) methods.

**TVB-N value**

$$SPC (CFU/g) = \frac{\text{No. of colonies on petridish} \times \text{Dilution factor} \times \text{Vol. of stock solution} \times 10}{\text{Wt. of pickle or condiment sample}}$$

**Data analysis**

After collecting various data, statistical analysis was done to know the variance between different answers and the significant level of those results. Data were processed using Microsoft Excel. Data are represented within the view of table form.

**Results and Discussion**

**Sensory quality assessment of raw shrimps and traditionally produced Nga-pi samples**

Table 3 shows the differences in sensory quality parameters of raw shrimps and traditionally produced Nga-pi samples collected from different stakeholders of Chaowfalldandi and Nazirartak, Cox’s Bazar. This table also shows the sensory quality changes in Nga-pi samples, collected from producers of two different areas and stored at 5 to 8°C in air-tight polythene pack for 90 days. The average grade point of raw shrimps (both better grade and lower grade) used for the Nga-pi production traditionally at Chaowfalldandi and Nazirartak ranged from 1.3 to 1.8 and overall quality found E (excellent) at the initial stage just after collection. The average grade point varied between 1.1 to 1,3 and overall quality also found E (excellent) for both the Nga-pi samples, either cover or not covered with mospata at the sample collection areas. On the other hand, the average grade point for Nga-pi sample collected from the producers of two different areas varied between 1.0 to 1.1 and the overall quality was observed E (excellent) whereas the average grade points varied from 2.0 to 3.4 for the Nga-pi samples collected from wholesalers and retailers of that two areas and overall quality showed A (acceptable), indicating a little quality degradation with the extension of time and steps of distribution. Alam (2010) reported, post-harvest quality loss in wet fish occurred, based on different species and seasons, from 7-19%, with an average loss encountered was 12.5%. When the fish was landed and sold to the nearer

The TVB-N value was determined according to the methods given in AOAC (1980) with certain modification using the following formula-

Amount of TVB-N (mg/100 g sample)

$$= \frac{\text{ml titrant} \times 0.014 \times \text{normality of acid}}{\text{Sample wt.}} \times 100$$

**Standard plate count**

The SPC was calculated in terms of colony forming units (CFU) after counting the colonies of the agar plate under a Quebec dark field colony counter (Leica, Buffalo, NY, USA) equipped with a guide plate ruled in square centimeters. Plates containing 30-300 colonies were used to calculate bacterial load using the following formula:

consumers within a few hours of harvest, the post-harvest loss was negligible. Longer the distance, higher was the loss.

The sensory quality parameter result for the Nga-pi sample collected from the producers of two different areas and stored in air-tight polythene packs at refrigerator (5 to 8°C) for 90 days showed that, the average grade point varied from 1.0 to 2.2 and overall quality little decreased, i. e at the initial stage of storage the overall quality of Nga-pi sample was E (excellent), after 90 days storage which lost some quality though they were found A (acceptable). Maheshwara *et al.* (2017) carried out a study on the biochemical and shelf life of fish sausage in ambient and refrigerated storage. The overall acceptability scores of sausage stored under refrigerated temperature was found to be higher when compared to ambient temperature. The quality of sausage stored in ambient condition deteriorated beyond 2 days whereas the refrigerated stored sausage was acceptable up to 25 days storage conditions. Hossain *et al.* (2019) studied the changes in sensory attributes of condiment prepared from Thai pangus (*Pangasianodon hypophthalmus*) during storage at different temperatures. The study revealed that the sensory attributes of fish condiment decrease throughout the storage period irrespective of storage temperatures (room temperature, 28°C to 32°C; refrigeration temperature, 5°C to 8°C and frozen temperature, -18°C to -20°C). At low temperatures, the product remained in acceptable condition for more than 120 days. The above mentioned findings are more or less in agreement with the findings of present study that, even at low temperature though the prepared food products may remain acceptable condition for comparatively duration than room/ambient temperature but the quality gradually deteriorates with the lapse of time.

**Table 3.** Sensory quality parameters of raw shrimps, traditionally produced Nga-pi samples collected from different stakeholders of Chaowfalldandi and Nazirartak, Cox’s Bazar and Nga-pi sample collected from producers and stored at 5 to 8°C in air-tight polythene pack for 90 days

Sample name	Average grade point				Overall quality			
	Chaowfalldandi		Nazirartak		Chaowfalldandi		Nazirartak	
	Initial	After 90 days storage	Initial	After 90 days storage	Initial	After 90 days storage	Initial	After 90 days storage
Better grade raw shrimp	1.4	-	1.3	-	E	-	E	
Lower grade raw shrimp	1.7	-	1.8	-	E	-	E	
Nga-pi (covered with mospata)	1.1	-	1.1	-	E	-	E	
Nga-pi (not covered with mospata)	1.3	-	1.2	-	E	-	E	
Nga-pi (collected from producer)	1.0	-	1.1	-	E	-	E	
Nga-pi (collected from wholesaler)	2.2	-	2.0	-	A	-	A	
Nga-pi (collected from retailer)	3.4	-	3.1	-	A	-	A	
Nga-pi (collected from producer and stored 5 to 8°C in air-tight polythene pack)	1.0	2.1	1.1	2.2	E	A	E	A

**Biochemical analysis of raw shrimps and traditionally produced Nga-pi samples**

**Proximate composition**

Proximate composition for raw shrimps (traditionally used for Nga-pi production), traditionally produced Nga-pi samples collected from different stakeholders of two different areas of Cox’s are presented in Table 4. For better comparison data have been recalculated on moisture free basis. In this study, the moisture content of raw shrimps (traditionally used for Nga-pi production) and traditionally produced Nga-pi samples collected from Chowfalldandi were as follows- 78.40% (better grade raw shrimp), 80.10% (lower grade raw shrimp), 60.29% (Nga-pi covered with mospata) and 61.06% (Nga-pi not covered with mospata), 59.29% (Nga-pi collected from producer), 59.33% (Nga-pi collected from wholesaler) and 60.26% (Nga-pi collected from retailers). The percent moisture content of raw shrimp samples and traditionally produced Nga-pi samples collected from Nazirartak were nearer to these values. In raw shrimp samples the percent moisture contents were found 77.29 (better grade) and 78.37 (lower grade) and for traditionally produced different Nga-pi samples the range varied from 58.29% to 60.70%. In case of percent protein content the values were obtained for raw shrimp samples 15.22 (better grade) and 12.51 (lower grade) whereas the protein content varied between 25.88% to 26.89% for different Nga-pi samples collected from Chaowfalldandi and 26.10% to 27.12% Nga-pi samples collected from Nazirartak. The percent lipid content of raw shrimp samples (traditionally used in Nga-pi production) were found 4.36 (better grade) and 3.28 (lower grade) collected from Nazirartak. Lipid content of different Nga-pi samples collected from the same area varied between 4.18% to 4.93% whereas the range of percent lipid content in different Nga-pi samples found from 4.81 to 5.12 collected from Chaowfalldandi. Though percent ash content varied between 0.99 to 1.98 in raw shrimp samples but while Nga-pi was produced the ash content varied from 7.33 to 8.40 collected from

Chaowfalldandi and 7.30 to 8.29 collected from Nazirartak. Nayeem *et al.* (2010) carried out a similar type of study on quality assessment of traditional semi-fermented fishery product (Chepa Shutki) of Bangladesh collected from the value chain. They examined the proximate composition of semi-fermented fish products (locally known as Chepa shutki) obtained from producer, wholesaler and retailer. Results of their study showed that- moisture content varied from 39.62 to 46.89% with the highest value recorded in the products obtained from retailer and lowest in that obtained from producer. Protein, the most important component among the chemical composition, ranged from 32.46 to 33.83% with highest value recorded in product obtained from producer and lowest value in those obtained from retailer. Lipid content, on the other hand, varied from 19.25 to 24.97% with highest value recorded for the products obtained from producer and lowest value in products obtained from retailer. Similar trend was also observed when the values of protein and lipid were recalculated on dry weight basis. Ash content varied from 0.81 to 1.01% with highest value observed in product obtained from wholesaler and retailer and lowest values in product obtained from producer. Lower levels of protein and lipid content in the products obtained from retailers and wholesalers were probably related to the losses occurring at different stages of marketing chain during handling, transportation and preservation. Sabikon *et al.* (2017) carried out another study on the nutritional and microbiological quality of chepashutki from haor Areas of Bangladesh. In their study, lower levels of protein, lipid, fiber and nitrogen free extract content in the product obtained from the retailers, probably related to the losses occurring at different stages of marketing chain during handling, transportation and preservation. A similar trend in the proximate composition of traditionally produced Nga-pi samples collected from different stakeholders in the present study was observed as the other researchers reported.

**Table 4.** Differences in the biochemical parameters and standard plate count (SPC) of *Nga-pi* samples collected from different stakeholders of Chaowfalldandi and Nazirartak, Cox’s Bazar

Sample name	Chaowfalldandi						Nazirartak					
	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	TVB-N (mg/100g)	SPC (CFU/g)	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	TVB-N (mg/100g)	SPC (CFU/g)
Better grade raw shrimp	78.40	15.22	3.59	0.99	15.03	$2.03 \times 10^5$	77.29	15.29	4.36	1.98	17.04	$3.35 \times 10^5$
Lower grade raw shrimp	80.10	12.51	5.00	0.99	19.06	$3.91 \times 10^6$	78.37	15.45	3.28	1.48	23.03	$4.91 \times 10^6$
<i>Nga-pi</i> (covered with mospata)	60.29	25.88	4.99	7.73	25.06	$2.01 \times 10^5$	58.29	27.09	4.93	8.00	25.17	$1.69 \times 10^5$
<i>Nga-pi</i> (not covered with mospata)	61.06	26.30	4.81	7.33	27.08	$3.91 \times 10^5$	60.70	26.18	4.70	7.30	26.15	$2.13 \times 10^5$
<i>Nga-pi</i> (collected from producer)	59.29	26.89	5.12	7.60	25.26	$2.01 \times 10^5$	59.28	27.12	4.92	7.68	24.13	$2.41 \times 10^5$
<i>Nga-pi</i> (collected from wholesaler)	59.33	26.23	5.08	8.02	28.03	$3.92 \times 10^5$	60.00	26.70	4.53	7.91	28.77	$4.08 \times 10^5$
<i>Nga-pi</i> (collected from retailer)	60.26	26.06	4.88	8.40	34.02	$4.02 \times 10^6$	60.61	26.10	4.18	8.29	33.92	$4.27 \times 10^6$

**Total volatile base nitrogen (TVB-N) value**

Table 4 also shows the changes in total volatile base nitrogen (TVB-N) values of raw shrimp (traditionally used in the production of *Nga-pi*) and traditionally produced *Nga-pi* samples collected from different sources of the study area. The initial TVB-N values of raw shrimps ranged between 15.03 to 23.03 but in the traditional *Nga-pi* samples collected from Chaowfalldandi the range was 25.06 to 34.02 and 24.17 to 33.92 in the *Nga-pi* samples collected from Nazirartak. Samples collected from both places showed that, the TVB-N value was slightly higher in the *Nga-pi* samples not covered with mospata than the samples covered with mospata. On the other hand, another observation was that, TVB-N values found higher in the *Nga-pi* samples collected from retailers than the samples collected from wholesalers from both places of the study area. Nayeem *et al.* (2010) found that TVB-N value was 1.12 mg/100g in products obtained from producer whereas that value increased with the increase of intermediaries in the value chain. TVB-N value in product obtained from retailer was 3.12mg/100g, in their study. Sabikon *et al.* (2017) also found that, total volatile base nitrogen (TVB-N) values were the highest in retailer and the lowest in control samples (samples prepared in laboratory condition). Though the TVB-N values found little higher in the case of raw shrimps and traditionally prepared *Nga-pi* samples than “chepashutki” samples but the values were within the suggested value for the fishery products. The trend of increase in value of TVB-N for the collected *Nga-pi* samples from producer level to retailer level was similar as found for the mentioned studies above.

**Standard plate count (SPC) of bacteria**

The standard plate count (SPC) of bacteria found higher in the shrimp samples of lower grade ( $3.91 \times 10^6$ ;

Chaowfalldandi and  $4.91 \times 10^6$ ; Nazirartak) than in the shrimps of better grade ( $2.03 \times 10^5$ ; Chaowfalldandi and  $3.35 \times 10^5$ ; Nazirartak). In the case of traditionally prepared *Nga-pi* samples, the standard plate count (SPC) of bacteria were found  $2.01 \times 10^5$ ,  $1.69 \times 10^5$  (covered with mospata) and  $3.91 \times 10^5$ ,  $2.13 \times 10^5$  (not covered with mospata), respectively collected from Chaowfalldandi and Nazirartak. While the intermediaries in the value chain is considered, the highest values were observed at the *Nga-pi* samples collected from retailers ( $4.02 \times 10^6$ ; Chaowfalldandi and  $4.27 \times 10^6$ ; Nazirartak) than the values found at the samples collected from producers ( $2.01 \times 10^5$ ; Chaowfalldandi and  $2.41 \times 10^5$ ; Nazirartak) of both places of the study areas. Microbiological analysis revealed that, the total bacterial count of samples ranged from  $6.01 \pm 0.28$  to  $8.10 \pm 0.18$  log cfu g-1 (Sabikon *et al.*, 2017). Higher moisture content along with higher microbial load in the retailer’s samples reflected poor quality, whereas those obtained from producer’s and control samples (prepared at the laboratory condition) were within the acceptable limit. Chandrashekhar (1979) reported TBC in prawn pickle in the range of  $10^3$  to  $10^5$  g-1. But Erichson (1967) reported that pickled fish, unless spoiled, normally carry low level of bacteria in the range of  $10^1$  to  $10^3$  g-1. All these reports are more or less in agreement with the findings of present study.

Biochemical analysis of *Nga-pi* samples (collected from producers of two different places of the study areas) stored in air-tight polythene packs at refrigeration temperature (5 to 8°C)

**Proximate composition**

Change in proximate composition parameters of traditionally produced *Nga-pi* (collected from producers of Chaowfalldandi and Nazirartak, Cox’s

Bazar) stored for 90 days at refrigeration temperature (5 to 8°C) in air-tight polythene pack is presented in Table 5. The table shows that, with the lapse of storage period per cent moisture content of *Nga-pi* samples increased gradually. The per cent moisture content was 59.29 and 59.28 in *Nga-pi* samples collected from Chaowfalldandi and Nazirartak, respectively at the initial stage of storage which increased to 63.33 and 63.79 at the end. On the other hand, for the samples of both sources, protein content decreased from 26.89% to 19.03% and 27.12% to 19.28% within 90 days of storage. Like per cent protein content, lipid content also decreased with progress of storage period from 5.12% to 3.05% (Chaowfalldandi sample) and from 4.92% to 2.65% (Nazirartak). In case of per cent ash content a reverse pattern was followed. During storage ash content of the samples increased with the extension of storage period. While at the initial stage ash content was found 7.60% (Chaowfalldandi sample) and 7.68% (Nazirartak sample), after 90 days of storage the values reached to 13.89% and 12.99%, respectively. Rahman *et al.* (2019) carried out a study to observe the quality changes of fish pickle prepared with Thai Pangus (*Pangasianodon hypophthalmus*) at refrigeration (5°C to 8°C) and freezing (-20°C to -18°C) temperature in kitchen refrigerator. In fish pickle, moisture content (%) decreased from 58.20 ± 0.194 to 48.53 ± 0.345 and 58.67 ± 0.180 to 43.90 ± 0.245 at refrigeration and freezing storage, respectively after twelve months of storage. Likewise, protein content (%) decreased from 22.35 ± 0.385 to 18.85 ± 0.097 and 22.70 ± 0.141 to 14.69 ± 0.137, respectively throughout the storage period. Lipid content (%) increased up to five months of storage and then decreased gradually at refrigeration temperature, whereas at frozen temperature it increased gradually at the whole storage period. Ash content (%) increased from 4.08 ± 0.043 to 7.38 ± 0.081 and 4.83 ± 0.130 to 9.18 ± 0.085, respectively in refrigeration and freezer compartment. The pattern of changes in the proximate composition parameters of traditionally

produced *Nga-pi* is very much similar to the above mentioned report.

**Total volatile base nitrogen (TVB-N) value**

A gradual increase in the TVB-N values also observed for *Nga-pi* samples collected from both sources. The initial value of TVB-N was obtained 25.26 (mg/100 g) in *Nga-pi* sample collected from Chaowfalldandi, after 60 days of storage which reached to 30.91 (mg/100g) and 34.09 (mg/100g) at the end of storage. The same pattern was observed for *Nga-pi* sample collected from Nazirartak and the final value 34.39 (mg/100g) also was found closer to the other sample kept for storage in the same condition indicating that, even at low temperature also TVB-N value increase though the rate of increment is slower. Hossain *et al.* (2019) studied the effect of storage temperatures on the quality parameters of fish condiment prepared from Thai pangus (*Pangasianodon hypophthalmus*). The results of their experiment showed that-irrespective of storage temperature the TVB-N value increased progressively with the lapse of storage period. At room temperature (28°C to 32°C), the values increased very rapidly in compare to those of refrigeration (5°C to 8°C) and frozen temperature (-18°C to -20°C). The TVBN value increased from 1.63±0.01 to 3.31±0.06, 3.18±0.02 and 2.02±0.02 mg/100g on day 15<sup>th</sup> at room, 90<sup>th</sup> at refrigeration and 120<sup>th</sup> at frozen storage temperature, respectively. Shikha *et al.* (2018) also reported the changes in quality parameters of fish pickle prepared from Thai pangus (*Pangasianodon hypophthalmus*) at different temperatures. They found that, the TVB-N value increased from 1.18±0.12 to 4.29±1.05, 4.45±0.51 and 2.05±0.04 mg/100g on day 15<sup>th</sup> at room, 73<sup>rd</sup> at refrigeration and 90<sup>th</sup> at frozen storage temperature, respectively. The trend of increase in TVB-N value even at refrigeration temperature in both studies, during storage is more or less similar to the observation of the present study.

**Table 5.** Changes in biochemical parameters and standard plate count (SPC) of *Nga-pi* samples (collected from producers of Chaowfalldandi and Nazirartak, Cox’s Bazar) stored in air-tight polythene packs at refrigeration temperature (5 to 8°C)

Days of storage	Chaowfalldandi						Nazirartak					
	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	TVB-N (mg/100g)	SPC (CFU/g)	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	TVB-N (mg/100g)	SPC (CFU/g)
0	59.29	26.89	5.12	7.60	25.26	2.01×10 <sup>5</sup>	59.28	27.12	4.92	7.68	24.13	2.41×10 <sup>5</sup>
15	60.09	25.05	4.77	9.88	26.33	3.32×10 <sup>6</sup>	60.20	25.53	4.40	9.97	25.89	4.47×10 <sup>6</sup>
30	61.25	24.20	4.20	10.71	28.21	1.32×10 <sup>7</sup>	61.32	24.13	4.24	10.41	27.27	2.02×10 <sup>7</sup>
45	61.87	22.00	4.01	11.50	29.01	4.32×10 <sup>7</sup>	62.43	22.92	3.85	11.67	28.91	5.95×10 <sup>7</sup>
60	62.51	21.22	3.50	12.19	30.91	2.01×10 <sup>8</sup>	63.19	20.91	3.07	12.42	30.89	2.87×10 <sup>8</sup>
75	63.00	20.07	3.21	12.82	32.54	5.91×10 <sup>8</sup>	63.62	19.82	2.97	12.99	32.97	5.73×10 <sup>8</sup>
90	63.33	19.03	3.05	13.89	34.09	9.61×10 <sup>7</sup>	63.79	19.28	2.65	13.78	34.39	9.32×10 <sup>7</sup>

**Stander plate count (SPC) of bacteria**

Standard plate count (SPC) of bacteria was done throughout the storage period at definite time interval of the *Nga-pi* samples collected from the producers of both places of the study area. Result of standard plate count of bacteria shows that, though the no of bacteria increased in the samples of both sources with the lapse of storage time until 75 days of storage at refrigeration

temperature (5 to 8°C) but at the end of 90 days of storage the standard plate count of bacteria decreased from 5.91×10<sup>8</sup> to 9.61×10<sup>7</sup> (Chaowfalldandi sample) and from 5.73×10<sup>8</sup> to 9.32×10<sup>7</sup> (Nazirartak sample). In a study on fish pickle prepared with Thai Pangus (*Pangasianodon hypophthalmus*) by Shikha *et al.* (2018), the initial bacterial load was found 2.30×10<sup>3</sup> CFU/g which increased gradually within 15 days of

storage to  $7.20 \times 10^7$  CFU/g at room temperature. In the case of refrigeration temperature, bacterial load reached to  $9.10 \times 10^7$  from its initial value  $2.30 \times 10^3$  CFU/g within 73 days of storage. On the other hand, during frozen storage of 90 days, the bacterial load of fish Pickle found  $0.27 \times 10^2$ . In another study on pangus fish pickle carried out by Rahman *et al.* (2019) it was observed that, the aerobic plate count (APC) reached to  $6.5 \times 10^6$  CFU g<sup>-1</sup> from  $4.4 \times 10^4$  CFU g<sup>-1</sup> at refrigeration temperature, but at freezing temperature it decreases to  $6.8 \times 10^2$  CFU g<sup>-1</sup> from  $3.3 \times 10^4$  CFU g<sup>-1</sup> during 12 months of storage. The decreasing tendencies in bacterial count at low temperatures during longer storage is in agreement with findings of present study.

### Conclusion

On the basis of the obtained results the present study could be concluded as- the sensory quality, proximate composition parameters, TVB-N value and SPC of bacteria did not vary in big range among the samples collected from different stakeholders of traditionally produced *Nga-pi* of Chaowfalldandi and Nazirartak of Cox's Bazar area. Among the *Nga-pi* samples collected from producers showed comparatively better in view of grade point than the samples collected from retailers. The result of the *Nga-pi* sample which was for 90 days in air-tight polythene pack at refrigeration temperature (5 to 8°C) showed that- the percent moisture and ash content, TVB-N value and SPC value increased but the percent protein and lipid content decreased with the progress of storage time

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