Fundamental and Applied Agriculture
Vol. 5(2), pp. 270–280: 2020
doi: 10.5455/faa.75035

Fisheries
ORIGINAL ARTICLE

Improved *Nga-pi*: preparation and changes in it's quality parameters under various storage conditions

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ARTICLE INFORMATION

Article History
Submitted: 23 Nov 2019
Accepted: 11 May 2020
First online: 06 Jun 2020

Academic Editor
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ABSTRACT

The study was conducted to observe the shelf life *Nga-pi*, produced with improved method, under various storage conditions. Acetes and Mysid shrimps collected from Chowfalldandi fish-landing center of Cox's Bazar were subjected to improved processing technique for 15 days and *Nga-pi* was prepared. Then it was srored for 180 days in three packing conditions (locally available mospata which is used to cover *Nga-pi* at Cox's Bazar region, open polythene pack and air-tight plastic pack) at three storage temperatures (room, refrigeration and frozen temperature). Initial moisture content of *Nga-pi* was 57.18% which reached to 63.03% in air-tight polythene pack at frozen temperature (−18±0.1 °C) at the end of storage. The initial value of protein content was 29.78% which decreased to 15.86% in open polythene pack at frozen temperature and lipid content decreased to 4.0% in open polythene pack at refrigeration temperature (5±0.5 °C) from initial value of 5.05% at the end of storage. Initial value of TVB-N was 18.0 mg $100g^{-1}$; at the end of storage the highest value was found 36.3 mg $100g^{-1}$ in mospata at room temperature (28±2 °C) and the initial value of NPN 2.12 mg $100g^{-1}$ increased to 4.0 mg $100g^{-1}$ at room temperature in open polythene pack at the end of the storage. The pH value of *Nga-pi* was 8.1 at initial stage; which declined to 5.42 in mospata at room temperature at the end of storage period. For aerobic plate count the initial value was 2.11×10^3 (CFU g^{-1}); which reached to 8.60×10^9 (CFU g^{-1}) in mospata at room temperature at the end of storage.The results showed that the moisture content, TVB-N value and bacterial load increased during 180 days of storage at all the storage temperatures but quite slowly at frozen temperature in improved *Nga-pi* and air-tight polythene pack was better for it's storage than mospata or open polythene pack.

Keywords: Improved *Nga-pi*, packing method, storage temperature, quality parameters

Cite this article: Shikha FH, Hossain MI, Das BK. 2020. Improved *Nga-pi*: preparation and changes in it's quality parameters under various storage conditions. Fundamental and Applied Agriculture 5(2): 270–280. doi: 10.5455/faa.75035

1 Introduction

Food fermentation is a technique used to preserve perishable food products which includes fruits, cereals, vegetables, milk, meat and fish, for centuries (Hui et al., 2004). In many countries of the world, particularly in the less developed countries, fermented fish products are important traditional foods. They are nutritious and available for the consumers at an affordable price. Fermented small fishes, fish eggs and intestines are widely consumed, in Asia (Lee et al., 1993). Fish paste is an indigenous fermented food in the Philippines and locally known as bagoong. It is also called kapi in Thailand, mam in Vietnam, ngapi in Burma, padec in Laos, prahoc in Cambodia, jeotkal in Korea, trassi in Indonesia and shiokara in Japan (Sanchez, 2008).

Nga-pi is usually made from the fermentation of salted ground fish or shrimp in Myanmar, which is

then sun dried before being matured in an air-free container. For *Nga-pi* production specially *Acetes* and *Mysid* spp of shrimps are used. *Nga-pi* is a main ingredient of Lower Burmese [Lower Burma referred to the part of Burma annexed by the British Empire after the end of the Second Anglo-Burmese War in 1852; (Than, 1992)] cooking, used as a condiment and additive in most dishes. This product is a very valuable source of protein for the people of that region who are underprivileged and economically deprived. In the South-East part of Bangladesh (specially at Cox's Bazar region) also a number of people from different tribes live who are also underprivileged. They get less opportunity to take animal protein in daily meals due to their poverty. Therefore, a product like *Nga-pi* might acts as a good source of animal protein for the people of that area and they can get economic benefit by selling the surplus of their product to other areas, even exporting it to other countries.

In the Rakhaing villages, mainly, Chawfaldandi and nearby localities under Cox's Bazar district of Bangladesh, the whole process is done under a very unhygienic condition where lies lots of chances of contaminations and deteriorations of the raw materials as well as the final product. It is necessary to review the whole process from raw material collection to transportation and marketing. At the same time it is also important to determine the changes in keeping quality of the raw material and the final product under different storage conditions for better understanding the handling, transportation, storage and marketing of *Nga-pi*. Therefore, the objectives of the study were to establish an improved model for *Nga-pi* preparation (by maintaining hygienic condition in each step of *Nga-pi* preparation, using different packing materials and storing in varying temperature conditions) and to find out the changes in quality parameters during storage.

2 Materials and Methods

2.1 *Nga-pi* preparation

An improved technique was used to prepare *Nga-pi* in the Department of Fisheries Technology at Bangladesh Agricultural University, Mymensingh. The design of *Nga-pi* production realizes the demand for better hygienic condition and better moisture removal. Therefore, the *Nga-pi* was produced using pure salt. Fresh raw shrimp (*Asetes* sp. and *Mysid* sp.) was used in *Nga-pi* processing. During sorting, large shrimps, fish, mollusks, arthropods etc. was removed very carefully. Drying of shrimp was done on elevated rack made of synthetic polythene to protect from dust or animal. Mat used for drying was kept always clean. The ceramic tub and mortar were used for grounding the shrimp. Care was taken all-time to keep the area protected from animal like dog or cat. Mats were washed after each operation. No pesticide was used for *Nga-pi* production. To protect the raw shrimp from fly infestation protective net was used during drying process. The raw materials were crushed and minced into fine paste with repeated pounding for uniform fermentation and for obtaining good quality and improved flavor of the final product (Fig. 1). The final paste had got a deep-grayish appearance. This paste was shaped into round and wrapped by clean large leaves of a wild tree called mospata, those were collected from Cox's Bazar at Chowfalldandi. Wrapped up *Nga-pi* were kept for 7-10 days for aging.

2.2 Storage of *Nga-pi*

Nga-pi was packed in mospata, open polythene pack and air-tight polythene pack. All packed samples were stored at room temperature (28±2 °C), refrigeration temperature (5±0.5 °C) and frozen temperature (−18±0.1 °C) for 180 days (6 months). Biochemical and microbiological analyses of the samples were conducted at 30 days interval.

2.3 Quality analyses

2.3.1 Sensory evaluation

A panel of nine-persons (students, teachers and staffs of the Department of Fisheries Technology) provided the sensory 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 Tables 1 and 2.

2.3.2 Biochemical analyses

Proximate composition (percent moisture, protein, lipid, ash) of *Nga-pi* was determined according to the methods given in AOAC (1990). The TVB-N and NPN values were determined following the methods suggested in AOAC (1980). The pH was measured following the method described by AOAC (2005). At first accurately 5 g sample was taken and mixed homogeneously in 50 mL distilled water. Then pH was measured using an electronic pH meter (HANNA pH 211 Microprocessor pH Meter) with a glass electrode using an expandable scale.

2.3.3 Aerobic plate count

The APC was calculated in terms of colony forming units (CFU g^{-1}) after counting the colonies of the agar

Figure 1. Different steps of improved method of *Nga-pi* preparation. (a) Raw materials (shrimp) in boat, (b) Carrying to the ghat, (c) Fresh shrimp in insulated box, (d) Washing and storing, (e) Dewatering, (f) Sun drying, (g) Fish covered with net, (h) Mixing salt, (i) Grinding, (j) Sun drying, (k) Grinding, (l) *Nga-pi* covered with Mospata and kept for aging

Table 1. Determination of organoleptic quality according to Howgate (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 to <5	Poor (P)
D	5	Reject (R)

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

3 Results

3.1 Sensory quality parameters

3.1.1 Room temperature condition

Changes in sensory quality parameters of the samples stored at room temperature (28±2 °C) for 180 days at different temperatures under various packing conditions is shown in Table 3. It was observed that-bright, shining, grayish appearance of *Nga-pi* on 0 day turned to dull appearance in mospata and slight dull in air-tight polythene pack on 180 days of storage. Good characteristic odor and soft texture of *Nga-pi* changed with the progress of storage time; in open polythene pack the sample emitted faint sour odor and showed loss of elasticity. On 0 day whereas *Nga-pi* was soft and fine pound, after 180 day of storage in mospata loss of water absorption capacity was found. Defect point results showed that-with the lapse of time defect point increased to 5 for sample stored at mospata whereas the point was 3 for samples stored at air-tight polythene pack. Grade of *Nga-pi* also decreased with the extension of storage period from A to C in mospata, average grade point achieved 4 and overall quality was poor (P) after 180 days of storage.

3.1.2 Refrigeration temperature condition

During the observation it was found that the defect characteristics of *Nga-pi* was in good condition with fresh texture, natural odor and shinning appearance. At refrigeration temperature the keeping quality of *Nga-pi* was higher than that of at room temperature. The organoleptic quality was good in refrigeration temperature irrespective of packing conditions. After 180 days of storage it was found that- bright, shining grayish *Nga-pi* showed slight dullness in mospata and open polythene pack; color turned to gray blackish; emitted faint sour odor; the texture found lymph and floppy; loss of water absorption capacity also

observed (Table 3). At this temperature also defect points increased but were lower than those of room temperature. Here, in open polythene pack the grade of *Nga-pi* was obtained B for appearance and C for texture, average grade point found 4.3 and overall quality was acceptable (A).

3.1.3 Frozen temperature condition

At frozen temperature the keeping quality of *Nga-pi* found higher than other storage temperatures. Defect characteristics of *Nga-pi* on 180th day at frozen temperature (−18±0.1 °C) in mospata, open polythene pack and airtight polythene pack is shown (Table 3). The result showed that-even after 180 days of storage the odor of *Nga-pi* remained good (near to natural in air-tight polythene pack and paste remained soft. The defect point obtained 1 for appearance of *Nga-pi* stored in open polythene pack; grade B for color' average grade point 2.80 and overall quality acceptable (A) on 189th day of storage.

3.2 Proximate components and biochemical parameters

3.2.1 Room temperature condition

The initial moisture content of *Nga-pi* in mospata, open polythene pack and airtight polythene pack were 57.18% at room temperature. The initial moisture content of sample in mosapata and the airtight polythene pack increased slightly with the lapse of storage time at room temperature but the moisture content of the sample in open polythene pack increased gradually (Fig. 2). At the end of 180 days of storage, the moisture content reached to 68.41% in mospata, 68.11% in open polythene pack and 63.78% in airtight polythene pack. In this study, the lowest percent moisture content for the sample was found in airtight polythene pack. At this temperature, the initial protein content was found 29.78%. The protein content of the sample in mospata gradually decreased from 29.78% to 16.36%. During 180 days of storage the final protein contents in different packs range between 16.01% to 18.76% at wet matter basis and among them highest content was found for the sample in airtight polythene pack and the lowest amount in open polythene pack (Fig. 2). Here, the initial lipid content obtained 5.05% at room temperature. The initial lipid content of *Nga-pi* on wet weight basis decreased gradually with lapse of storage time at room temperature. After storage for 180 days, the lipid content of the sample in mospata, open polythene pack and airtight polythene pack were 3.73%, 3.98% and 3.74%, respectively. The highest lipid content was found for the sample in open polythene pack and the lowest was in mospata (Fig. 2). The lipid content decreased. This is might be due to the oxidation and rancidity of oil in *Nga-pi*. In this study, the initial ash content was found 7.99% at room temperature which gradually increased irrespective of packing condition with the progress in storage time. At this temperature percent ash content ranged between 7.65 to 11.90. The highest value (11.92) was obtained for percent ash content in air-tight polythene pack sample and lowest value (11.50) in sample stored at mospata.

At room temperature (28±2 °C), the initial TVB-N (mg $100g^{-1}$) value of the sample in mospata, open polythene pack and airtight polythene pack were found 18.0 mg $100g^{-1}$. The lowest TVB-N (mg $100g^{-1}$) value was found for the sample packed with air-tight polythene pack and highest value was for sample packed in mospata. The initial TVB-N (mg $100g^{-1}$) values of these three samples (Fig. 3) increased with the lapse of storage time. After 180 days of storage the TVB-N (mg $100g^{-1}$) values reached to 44.0, 40.3 and 37.9 (mg $100g^{-1}$), respectively, in the samples stored at mospata, open polythene pack and air-tight polythene packs. In the samples packed in mospata, open polythene pack and air-tight polythene pack the initial NPN (mg $100g^{-1}$) values were found 2.12 (mg $100g^{-1}$). The NPN (mg $100g^{-1}$) values of three samples (Fig. 3) increased with the lapse of storage time in room temperature.The highest NPN (mg $100g^{-1}$) value (4.0) was found for the sample packed in mospata and lowest value (3.96) was found for the sample packed in air-tight polythene pack. At the initial stage, pH value of the samples in mospata, open polythene pack and airtight polythene pack was found 8.10. The lowest pH value (5.61) was found for the sample in mospata and the highest value (6.01) for the sample stored in air-tight polythene pack. The initial pH values of these samples (Fig. 3) decreased with the lapse of storage time at room temperature during storage period of 180 days.

The changes in the total aerobic count expressed as colony forming unit in one gram of sample (CFU g^{-1}). Table 4 shows the changes in bacterial count of laboratory produced *Nga-pi* during 180 days of storage at room temperature under different packing conditions. The bacterial load of these samples on 0 day was 2.11×10^3 (CFU g^{-1}) which reached to 8.60×10^9 (CFU g^{-1}), 4.32×10^9 (CFU g^{-1}) and 9.95×10^8 (CFU g^{-1}) in mospata, open polythene pack and air-tight polythene pack, respectively In the present study, the bacterial load of the samples gradually increased with the lapse of storage time up to 180 days at this temperature.

3.2.2 Refrigeration temperature condition

Shelf life of *Nga-pi* at room temperature is not more than three months. But the *Nga-pi* samples may be kept in good conditions applying chilling and freezing temperatures. Chilling increases shelf life of the products than those are preserved at room temperature. The initial moisture content of *Nga-pi* in mospata

Table 3. Changes in sensory quality parameters of the samples stored for 180 days at different temperatures under various packing conditions

Storage condition	Average grade points				Overall quality			
	Initial	After 180 d storage			Initial	After 180 d storage		
		Mospata	OPP	APP		Mospata	OPP	APP
Room temp. (28±2 °C)	1	4.4	4.2	4.0	E	P	P	P
Refriger. temp. (5±0.5 °C)	1	3.4	4.2	2.0	E	A	A	A
Frozen temp. (−18±0.1 °C)	1	3.0	2.8	1.6	E	A	A	E

OPP = open polythene pack, APP = airtight polythene pack; E = Excellent, P =Poor, A = Acceptable

Table 4. Changes in bacterial counts (CFU g^{-1}) of the samples stored for 180 days at different temperatures under various packing conditions

Days	Room temp. (28±2 °C)			Refrigeration temp. (5±0.5 °C)			Frozen temp. (−18±0.1 °C)		
	Mospata	OPP	APP	Mospata	OPP	APP	Mospata	OPP	APP
0	2.11×10^3	2.11×10^3	2.11×10^3	2.11×10^3	2.11×10^3	2.11×10^3	2.11×10^3	2.11×10^3	2.11×10^3
30	2.70×10^5	2.60×10^4	2.50×10^3	2.50×10^3	2.45×10^3	2.50×10^3	2.45×10^3	2.40×10^3	2.39×10^3
60	4.02×10^5	5.32×10^5	3.20×10^5	4.63×10^5	4.30×10^5	2.91×10^5	4.36×10^5	4.19×10^5	5.98×10^4
90	5.89×10^7	4.32×10^6	4.22×10^6	4.60×10^6	4.21×10^6	4.10×10^6	2.10×10^6	2.11×10^6	5.80×10^5
120	2.10×10^8	2.35×10^7	2.50×10^7	3.20×10^7	3.30×10^7	2.50×10^7	2.40×10^7	2.50×10^7	5.90×10^6
150	2.01×10^9	5.55×10^7	4.60×10^8	6.55×10^7	5.30×10^8	4.90×10^8	2.25×10^8	2.55×10^8	2.10×10^8
180	8.60×10^9	4.32×10^9	9.95×10^8	5.75×10^9	9.13×10^8	8.35×10^7	8.86×10^8	7.01×10^8	6.21×10^7

OPP = open polythene pack, APP = airtight polythene pack

and air-tight polythene pack increased slightly with the lapse of storage time at refrigeration temperature but the moisture content in open polythene pack increased gradually and continued up to 90 days and then begins to decrease from 120 days up to 180 days storage. At the end of 180 days, the moisture content reached from 57.18% to 67.91% in mospata, 69.0% in open polythene pack and 64.73% in air-tight polythene pack (Fig. 2). At this temperature the initial percent protein content was found 29.78%. With the progress in storage period, the protein content of *Nga-pi* in mospata, open polythene pack and airtight polythene pack gradually decreased to 18.36%, 16.50%, 20.76%, respectively. During 180 days of storage, the highest value was obtained for sample stored in the air-tight polythene pack and lowest value in the sample stored in open polythene pack (Fig. 2). On wet weight basis, the initial value of lipid content (4.95%) of *Nga-pi* decreased gradually with lapse of storage time at refrigeration temperature. On 180th day of storage, the lipid content of the sample in mospata, open polythene pack and air-tight polythene packs were obtained 3.72%, 4.0% and 3.95%, respectively. The highest lipid content was found for the sample in open polythene pack and the lowest was in mospata (Fig. 2). For all the samples, the initial percent ash was found 7.99% at refrigeration temperature. On 180th day of storage the samples in mospata, open polythene pack and air-tight polythene packs the ash content values reached to 10.31%, 11.50% and 11.56%, respectively (Fig. 2).

At the initial stage, the TVB-N (mg $100g^{-1}$) value of the *Nga-pi* samples found 18.0. This TVB-N (mg $100g^{-1}$) value increased with the lapse of storage time at refrigeration temperature. On 180th day of storage the TVB-N (mg $100g^{-1}$) values reached to 44.80, 40.30 and 37.90, respectively, in mospata, open polythene pack and air-tight polythene pack (Fig. 3). The result of NPN (mg $100g^{-1}$) values showed a similar increasing trend with the progress of storage time irrespective of packing condition. Here, the initial NPN (mg $100g^{-1}$) value of *Nga-pi* sample was found 2.12 which increased to 4.00, 3.97 and 3.96 at refrigeration temperature. after 180 days of storage in mospata, open polythene pack and air-tight polythene pack, respectively (Fig. 3). Here the pH value was found 8.10 of *Nga-pi* sample at the initial stage. During 180 days of storage at refrigeration temperature the pH values of the samples decreased (Fig. 3). After the storage for 180 days, the pH values found 5.50, 6.00 and 5.78 in mospata, open polythene pack and air-tight polythene pack, respectively.

Table 4 shows the changes in bacterial count of *Nga-pi* samples during 180 days of storage at refrigeration temperature (5±0.5 °C) under different packing conditions. The bacterial load of the sample ranged between of 2.11×10^3 (CFU g^{-1}) to 5.75×10^9 (CFU g^{-1}). After 180 days of storage, the highest value

of aerobic plate count was found 5.75×10^9 CFU g^{-1} in mospata and lowest value 8.35×10^7 CFU g^{-1} in air-tight polythene pack.

3.2.3 Frozen temperature condition

The initial moisture content of *Nga-pi* sample was found 57.18% at frozen temperature. The moisture content of samples in mospata and in air-tight polythene pack increased slightly with the lapse of storage time at frozen temperature, but the moisture content of the sample in open polythene pack increased gradually and continued up to 90 days and then began to decrease from 120 days up to 180 days of storage. At the end of 180 days, the moisture content reached to the range of 57.18% to 66.45% in mospata, 57.18% to 63.03% in air-tight polythene pack and 57.18% to 67.66% in open polythene pack with highest value of moisture content (70.0%) on 90 days (Fig. 2). Here, the protein content of the samples at initial stage was found 29.78%. Irrespective of packing condition percent protein content decreased with the progress in storage period. On 180th day of storage percent protein content values were obtained 17.31, 15.86 and 20.76 in mospata, open polythene pack and air-tight polythene pack (Fig. 2). The lipid content of *Nga-pi* sample was obtained 4,67% on 0 day which decreased later on with extension of storage period. The highest percent lipid content was found for the sample in open polythene pack and lowest lipid content was found for the sample in the mospata. During storage for 180 days, the lipid content of the sample in mospata, open polythene pack and air-tight polythene packs were 3.74%, 3.88% and 2.49%, respectively (Fig. 2). At this temperature also an increasing trend in percent ash content was observed irrespective of packing condition. At the initial stage, ash content of *Nga-pi* was found 7.99%. The highest ash content was found in air-tight polythene pack sample and lowest ash content was found in the sample stored in mospata. On 180th day of storage, the ash content in mospata, open polythene pack, air-tight polythene packs were obtained 12.65, 11.60 and 12.72, respectively (Fig. 2) during storage at frozen temperature.

TVB-N (mg/100 g) value of *Nga-pi* sample at the initial stage was obtained 18.0. The lowest TVB-N (mg $100g^{-1}$) value was found in the sample in packed air-tight polythene pack and highest value was found in the sample packed in mospata. The initial TVB-N (mg $100g^{-1}$) values of the samples increased with the lapse of storage time at frozen temperature. The obtained values for TVB-N in mospata, open polythene pack and air-tight polythene packs were 33.65, 33.25 and 33.17, respectively (Fig. 3). Irrespective of storage conditions NPN value of *Nga-pi* samples increased at frozen temperature. The initial NPN (mg $100g^{-1}$) value was found 2.12, during 180 days of storage which increased to the values 3.88, 3.86 and 3.84 in mospata, open polythene pack and air-tight polythene pack, respectively. pH value of *Nga-pi* sample obtained 8.1 on o day of storage at this temperature with decreased during 180 days of storage to 5.6, 5.55 and 5.7 in mospata, open polythene pack and air-tight polythene pack (Fig. 3).

Total viable count is an important criterion for quality evaluation. On 0 day of storage of *Nga-pi* the microbial load was found 2.11×10^3 (CFU g^{-1}) which increased to 8.86×10^8 (CFU g^{-1}) in mospata, to 7.01×10^8 (CFU g^{-1}) in open polythene pack and to 6.21×10^7 (CFU g^{-1}) in air-tight polythene pack after 180 days of storage. The values observed at frozen temperature were much lower than those obtained for other two temperatures.

4 Discussion

Production of shrimp paste is seasonal, with most production taking place from November to May. Production during the rainy season is greatly reduced and processing is difficult due to the unfavourable drying conditions (ILO, 2016). Therefore, it was necessary to study the production procedure of the product in laboratory condition maintaining hygienic condition and to search for a suitable way to store the prepared product for longer duration safely which could be used even in off season.

Tokur et al. (2004) investigated the changes in quality of tilapia burger during frozen storage at (-18 ± 0.1 °C) for over 8 months. They found that the sensory quality attributes were decreased gradually throughout the storage period but none of the sensory quality attributes were considered as unacceptable. Hossain et al. (2019a) studied the changes in sensory attributes of condiment prepared from Thai pangus (*Pangasianodon hypophthalmus*) during storage at room temperature (28 °C to 32 °C), refrigeration temperature (5 °C to 8 °C) and frozen temperature (-20 °C to -18 °C). Throughout the storage period the sensory attributes did not change significantly ($p>0.05$). With the lapse of storage period, the initial sensory scores of fish condiment decreased but none of them were considered as significant. Kameník et al. (2012) determined the influence of different storage temperatures (5 °C and 15 °C) on the quality of vacuum-packed dry fermented sausage Poličan. The salami mixture, finished salamis (the maturing period of 30 days), and salamis stored for 30, 60, 90, and 120 days were analyzed. The analyses performed (physical/chemical, sensory, microbiological) found no differences in sensory properties during storage of 120 days. Mahanta and Muzaddadi (2013) carried out an experiment on the extension of shelf life of the fermented fish product, shidal by packaging in glass bottle and low temperature storage. Microbiological, biochemical and sensory changes during storage period of 120

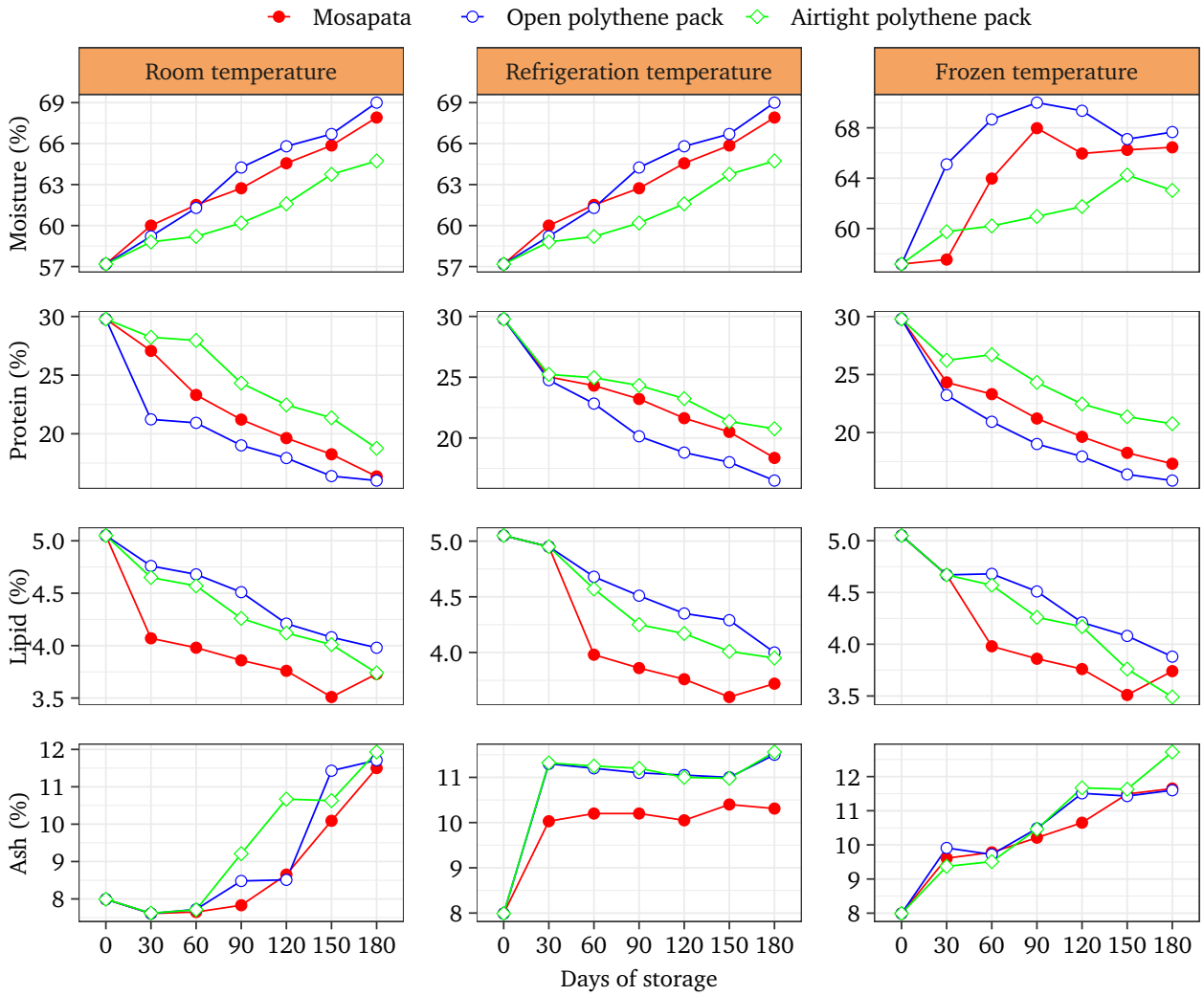

Figure 2. Changes in proximate composition of improved *Nga-pi* samples at different storage conditions. Room temperature = 28±2 °C, refrigeration temperature = 5±0.5 °C, and frozen temperature = −18±0.1 °C

days were analyzed at 15 days interval. The sensory scores showed significant differences ($p<0.05$) during the storage period. Shidal retained good quality up to 60 days at room temperature whereas 90 days at refrigerated temperature showing significantly high sensory scores in the treatment. The results of the above mentioned studies are quite similar to the obtained results in the present study. In the studies, the sensory quality of the fish products deteriorated might be due to formation of some volatile low molecular weight compounds, lipid oxidation and protein degradation during chilled and frozen storage (Undeland and Lingnert, 1999).

Kilinc et al. (2005) studied the chemical, microbiological and sensory changes associated with fish sauce processing. Fish sauce were produced by incubating mixtures of sardine (*Sardina pilchardus*) at different concentrations of sodium chloride and glucose at 37 °C for 57 days. There were some significant differences in moisture and fat values of the first day and last day of the study. The moisture increased over 10% in all groups and decrease in the fat values was observed. In the same experiment the raw material pH was 6.39±0.01. During 57 days of fermentation process pH values gradually decreased irrespective of samples. Shikha et al. (2019a) studied the effect of low temperature on quality of mola (*Amblypharyngodon mola*) fish pickle during storage and consumer preference towards. It was revealed that during refrigeration and frozen storage the percent moisture, protein and lipid contents decreased but ash content increased with the progress in storage period. At these temperatures, pH value of the pickle decreased very slowly but the TVB-N value and bacterial load increased slowly throughout the storage period. A. mola pickle may remain in acceptable condition until 120 days at refrigeration and about 300 days at frozen temperatures. In the same experiment, the bacterial load of fish pickle (Sealed Pack) increased during storage at refrigeration and frozen temperatures. Aerobic

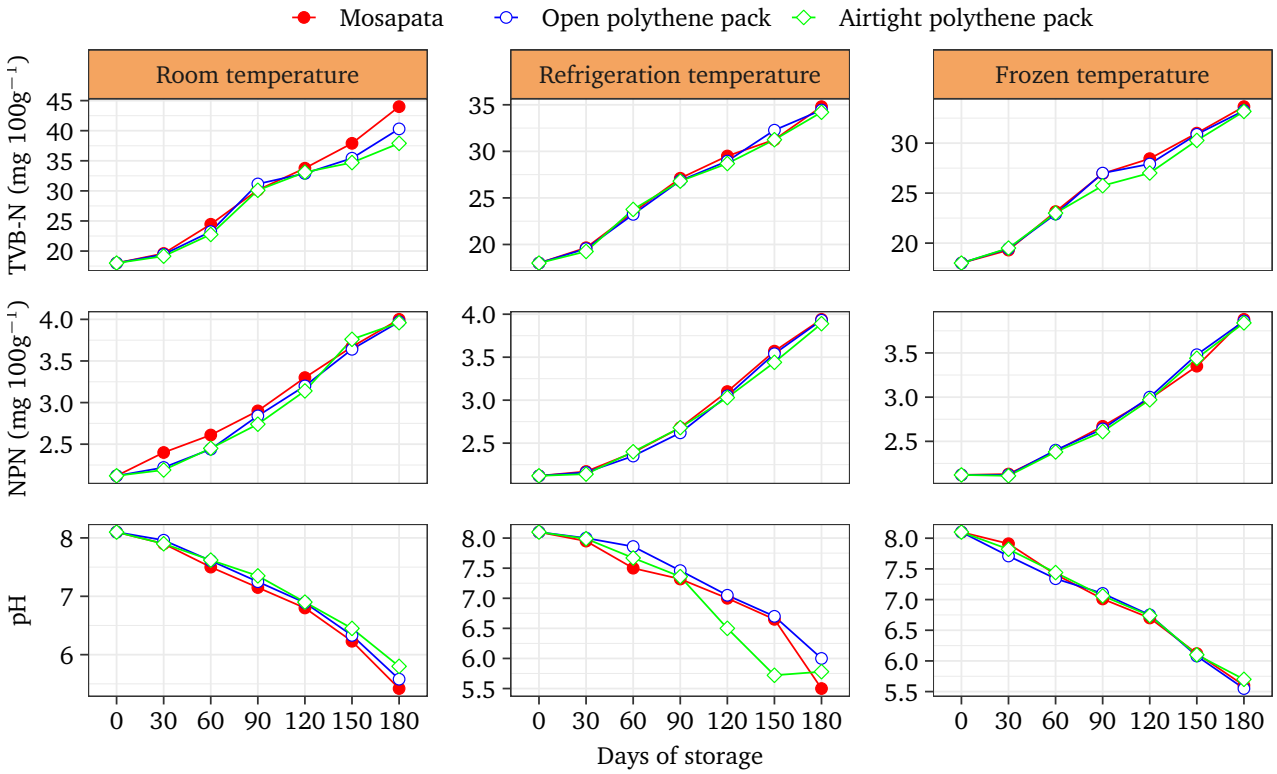

Figure 3. Changes in TVB-N, NPN and pH values of improved *Nga-pi* samples at different storage conditions. Room temperature = 28±2 °C, refrigeration temperature = 5±0.5 °C, and frozen temperature = −18±0.1 °C

Plate Count (APC) for bacterial load showed inverse relation at frozen temperature storage. At refrigeration temperature bacterial load increased with the lapse of storage period. On the contrary bacterial load decreased at frozen temperature within 0 to 300 days storage. On 0 day of storage APC was 2.1×10^4 CFU g^{-1} in room, refrigeration and frozen storage respectively. After 150 days of storage at refrigeration temperature, APC was found 6.6×10^5 CFU g^{-1}. On the other hand at frozen storage APC was fond 3.6×10^2 after 300 days of storage. Results of another study conducted by Shikha et al. (2019b) on the changes in the nutritional composition of fish condiment prepared from Thai Pangus (*Pangasianodon hypophthalmus*) during storage at low temperature for longer period showed that- moisture content (%) decreased at refrigeration and frozen temperature from 53.57 to 43.56 and 54.11 to 42.33, respectively from initial month of storage to final month of storage. Similarly, protein content (%) decreased from 24.05 to 18.31 and 23.96 to 16.97, respectively throughout the storage period might be due to leaching out process. Lipid content (%) increased up to seven month of storage and then decreased gradually at refrigeration temperature while at freezing temperature it increased gradually during the whole storage period. Ash content (%) increased from 4.53 to 7.91 and 4.34 to 8.25 at refrigeration and frozen storage, respectively. Aerobic plate count (APC) increased to 4.5×10^7 CFU $^{-1}$ from 4.8×10^4 CFU $^{-1}$ at refrigeration temperature whereas at frozen storage it decreased to 6.9×10^2 CFU $^{-1}$ from 4.5×10^4 CFU g^{-1}. In a study on the effect of storage temperatures on the quality parameters of fish condiment prepared from Thai pangus. Hossain et al. (2019b) observed that irrespective of storage temperature the TVB-N value increased progressively with the lapse of storage period. On the other hand, the peroxide values increased from 2.80±0.10 to 6.08±0.10, 6.97±0.20 and 5.40±0.20 meq kg^{-1} of oil, on 15th at room, 90th at refrigeration and 120th at frozen storage temperature, respectively. Throughout the storage period, the pH values of fish condiment also changed at different temperatures. The bacterial load (CFU g^{-1}) in condiment was found to increase at room temperatures (from 2.2×10^4 to 2.6×10^7). However, the growth of bacteria was slower at refrigeration temperature (from 2.2×10^4 to 2.5×10^7) and at frozen temperature bacterial growth found negative (from 2.2×10^4 to 3.6×10^2). The trend in changes in proximate composition, TVB-N, NPN, pH values and aerobic plate count in the present study is more or less similar to the finds of above mentioned experiments. In the present study it was observed that irrespective of temperature and packing condition

percent moisture content increased during storage which is might be cause of absorption of moisture by the sample from surroundings. On the other hand percent protein and lipid content decreased in this experiment. According to Xiong (1997), Zamir et al. (1998) and Saeed and Howell (2002) proteins exposed to oxidizing environments are very susceptible to chemical modification, such as amino acid destruction, peptide scission and formation of protein-lipid complexes that results in decrease in protein content. Siddique et al. (2011) in *Puntius* spp found a significant loss in total lipid content when stored at low temperature and they attributed that- this loss may due to oxidation of lipid.

5 Conclusions

On the basis of obtained results and discussions this study can be concluded as- quality parameters of improved *Nga-pi* obtained better at frozen temperature among three storage temperatures and air-tight polythene pack found more suitable for storage than mospata or open polythene pack.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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The Official Journal of the **Farm to Fork Foundation**
ISSN: 2518–2021 (print)
ISSN: 2415–4474 (electronic)
http://www.f2ffoundation.org/faa