Effect of Storage Temperature on the Quality and Microbial Content of Salt-Smoke-Dried shoal (*Ophiocephalus striatus*)

Chakroborty T and Chakraborty SC

Department of Fisheries Technology, Bangladesh Agricultural University, Bangladesh

**Abstract**

The research was carried out to evaluate the comparative changes of quality and microbial content of salt-smoke-dried Shoal (*Ophiocephalus striatus*) kept under different condition using standard method of analyses. The fish in three treatments T1, T2, and T3 were denoted controlled, ambient (22-28°C) and refrigeration (4°C) condition respectively. The controlled fillets were only sun-dried without salting and smoking and kept at ambient temperature whereas, T1 and T2 represented the fish at ambient and refrigeration storage respectively. The shelf-life in T1, treated dried fillet was up to 5 days after preparation and T2, treated fillet 30th whereas the shelf life in T3 treated products was excellent up to 45 days period. It was found that the moisture, ash, protein and lipid, standard plate count (SPC) was 27.05%, 11.81%, 50.09%, 0.59% and 2.96 × 10^4 CFU/g for treatment T1. The same parameters during 30 days observation for treatment T2 ranged from 25.09%-25.41%, 13.92-15.98%, 54.07-51.74%, 5.94-5.81% and 2.12 × 10^4 - 1.04 × 10^5 CFU/g respectively whereas during 45 days observation for treatment T3 25.09-25.57%, 13.92-15.98%, 54.07-52.49%, 5.94-5.82% and 2.12 × 10^4 - 2.8 × 10^5 CFU/g respectively. Analyzing all the quality parameters of the salt-smoke-dried Shoal it was revealed that the quality was still excellent and no indicative quality reduction occurred in Shoal kept at refrigeration temperature (treatment T3) during 45 days of storage.

**Keywords:** Quality; Microbial content; Shoal; Salt-smoke-dried

**Introduction**

The causes of fish spoilage are bacterial activity, autolysis, oxidation and most commonly by combination of these which bring about very noticeable changes in the texture, flavor, odor and general appearance of the product. To enhance the shelf life of fish different fish curing methods has been practiced in Bangladesh for a long time. Drying as a fish preservation technique had been practiced perhaps longer than any other food preservation technique. However, drying together with salt-smoking is another method of fish preservation. Salt-smoke-drying of fish provides the product a desirable taste, odor, flavor, color, longer shelf-life, and also prevents spoilage of product by reducing the water activity. Therefore, salt-smoke-drying may be considered another important aspect of fish preservation.

Shoal (*Ophiocephalus striatus*) is a popular air breathing fresh water snake head fish and an important food fish in its entire native range, and has considerable economic importance. Cream extracts of Shoal fish tissues contain high levels of arachidonic acid, a precursor of prostaglandin, essential amino acids (particularly glycine), and polyunsaturated fatty acids necessary to promote prostaglandin synthesis. This fish also contains polyunsaturated fatty acids (PUFA), which play important roles in cardiovascular system to reduce the risk of heart attack.

Lean fish like - Shoal is suitable for sun-drying. For this reason, the fish Shoal was chosen for the preparation of salt-smoke-dried products due to high palatability and marketability of traditional dried products of Shoal and in future it would be a very popular food item among the people of Bangladesh. Therefore, in the present study the biochemical and microbiological analysis were carried out to assess the qualities of smoke-dried products of Shoal.

**Materials and Methods**

Fresh Shoal (*Ophiocephalus striatus*) collected from the local market for preparation of salt-smoke-dried products. The fishes for salt-smoke - drying divided into three treatments viz. T1, T2 and T3. For T1 the fishes were considered as controlled where no salt-smoke was treated and the product was kept at ambient temperature. In treatment T2 and T3 the salt-smoke-dried fish was kept at ambient and refrigeration temperature for studying shelf-life at varying length of times. After collection the fresh fish were weighed, dressed, filleted followed by washing. The fillets for T2, T3 were brined (=25% brine) followed by air drying, partial smoking (30 minutes at 53°C), sun drying (21 h in the ring tunnel) and packaged for shelf-life study. Two fishes were kept for control condition (T1). For treatments T2 and T3 a total of 6 fishes were selected randomly for salt-smoke-drying.

For biochemical analysis AOAC (1990) method was followed for determination of fresh fish and salt-smoke-dried fish composition. Microbiological analysis during shelf life study of fish was done by applying consecutive decimal dilution technique using spread plates [1].

**Results and Discussion**

**Changes in moisture content**

The moisture content of fresh Shoal was 78.51% while partial smoking slightly decreased the moisture content to 74.50%. The moisture content of sun dried controlled fillet (treatment T1) where the fillet was not salted and smoked, was 27.05% and salt-smoke-dried (treatment T2 and T3) fillet was 25.09% - 24.51% respectively. The moisture content of the product at ambient temperature (treatment T2) was 25.41% during 30 days storage and refrigerated temperature...
Changes in ash content

The ash content of fresh Shoal fillet was 0.89% whereas smoking of fish was slightly increased the ash content to 2.83%. After sun drying the ash of controlled shoal fillet (treatment T1) was 13.92% (18.59%) whereas the ash content of salt-smoke-dried (treatment T2 and T3) fillet was significantly increased 11.81% (16.88%) on the 1st day before storage. The values in the parenthesis are the weight in dry wt. basis. On the 30th day observation the ash content Shoal was 15.98% (21.42%) for treatment T2. On the other hand, during 45 days the ash content of Shoal was 14.98% (20.12%) for treatment T3. In this experiment it was observed the ash content increased after salt-smoke-drying because the salt increased from raw fishes had large amount of inorganic salt compared to fresh samples (Figure 2).

Mansur, et al. [6] reported that the moisture content of dried Indian major carps ranged from 19.17 to 23.99%. Similarly, Flowra, et al. [7] showed that the moisture content of dried fishes ranging from 14.06 to 24.58%. However, the present results of salt-smoke-dried products in Shoal also agreed with the above studies.

Changes in protein content

The protein content of fresh Shoal was 17.39% and after partial smoking the protein was little increased to 18.26%. Besides, sun drying of Shoal in T1 treated showed a significantly increased value of the protein content of was 50.09% (68.67%) whereas, for salt-smoke dried (treatment T2 and T3) fish the protein content was 54.07% (72.18%) during the 1st day before storage. The values in the parenthesis are the weight in dry wt. basis. On the 30th day observation the protein content of Shoal was 51.74% (69.37%) for treatment T2. On the other hand, during 45 days the protein content of Shoal was 52.49% (70.52%) for treatment T3.

Thus, no significant changes were found in protein content of salt-smoke-dried Shoal during different storage time (Figure 3).

In an experiment on sun dried salted Hilsa products Chakraborty, et al. [9] reported that in protein content increased from 17.06% to 35.00%. This was due to a significant loss of moisture and high uptake of salt by fish muscle. Likewise, Nketsia and Sefa-Dedeh [13] determined the protein content of the smoked fish products ranging from 71.5% to 4.5%. Study conducted by Kosygin [3] found that protein content on dry basis ranged from 74.75% to 79.25% in six smoked hill stream fishes. In another experiment with Thai Pangas (Pangasius hypophthalmus), Deb Nath, et al. [10] reported that initial protein content values of smoke product was 17.27% and found the protein content values of smoked product ranging from 20.27-22.01% during different storage condition.

Besides, Mansur, et al. [14] reported that the protein content of tent dried fishes ranged from 60.07 to 72.51%. Similarly, Islam [12]...
showed that the protein content of solar tunnel dried products ranging from 58.13 to 68.49%. Likewise, Reza [4] found that the lipid content of dried products ranged from 42.51 to 56.58%. Similarly, Hasan [15] determined the protein content of solar tunnel dried products was in the range of 49.32%–65.30%. Thus, the present study of salt-smoke-dried Shoal showed no significant changes in protein content which was more or less similar to the studies with other authors.

### Changes in lipid content

The lipid content of fresh Shoal was 1.72% while smoking of fish was slightly increased the lipid content to 2.67% whereas sun drying increased the lipid content of controlled fish (treatment T1) which was 8.63% (11.85%) and salt-smoke-dried (treatment T2 and T3) was 5.94% (7.93%) on the 1st day before storage. The values in the parenthesis are the weight in dry wt. basis. On the 30th day observation the lipid content Shoal Shool was 5.81% (7.68%) for treatment T1. On the other hand, during 45 days the lipid content was 5.82% (7.82%) for treatment T2. However, no significant change in lipid content was observed during the storage period (Figure 4).

This small change might be due to oxidation and hydrolysis of some of the lipid fraction to other components. Study done by Nketsia and Sefa-Dedeh on smoked fish products and determined the lipid content of the ranged from 7.2% to 19%. Similarly, Debnath, et al. [10] reported that initial lipid content of pangas fillet was 10.64% and found the lipid content values of smoked product ranging from 9.26-10.60% during different storage condition.

Besides, Mansur, et al. [14] reported that the lipid content of tent dried fishes ranged from 6.43 to 14.99%. In an another experiment, Islam [12] showed that the lipid content of solar tunnel dried products ranging from 5.63 to 10.08%. Similarly, Reza [16] found that the lipid content of dried products ranged from 1.97 to 8.08%. Likewise, Hasan [15] determined the lipid content of solar tunnel dried products in the range of 11.96%-18.07%. The present study of salt-smoke-dried with Shoal also agreed with the above reports.

### Microbial analysis

The bacterial load of fresh Shoal fillet was 7.5 × 10⁴ CFU/g whereas, smoking of fish slightly decreased the bacterial load to 6.00 × 10⁴ CFU/g. After sun drying the bacterial load of salt-smoke-dried (treatment T1 and T3) was 2.12 × 10⁴ CFU/g and controlled fillet (treatment T2) was 2.96 × 10⁴ CFU/g, for during the 1st day of storage. On the 30th day observation the bacterial load was 1.04 × 10⁵ CFU/g for treatment T1. On the other hand, during 45 days the bacterial load was 2.8 × 10⁵ CFU/g for treatment T2.

The total bacterial load in treatment T1, T2 and T3 both for Shoal and Mirror carp were found to be increased significantly with the lapse of time and reached maximum at unacceptable limit and then it was considered as spoiled. In this study it was observed that the total bacterial load of salt-smoke-dried products were increased with increase in the duration of storage due to growth and multiplication of the microbes. As the duration of storage increased processed fish samples may absorb small amounts of moisture from surrounding atmosphere providing enabling environment for microbial growth. Smoking inhibits microbial growth in stored fish products.

Experiment conducted by Debnath, et al. [10] on smoked pangas and reported that initial bacterial loads of fresh pangas fillets 1.5 × 10³ CFU/g and found that the bacterial load of smoked product ranging from 1.8 × 10⁴–4.10 × 10⁴ CFU/g during different storage condition. The bacterial counts are generally lower for smoked fish compared to fresh fish [13]. Salan, et al. [4] reported that the fish with microbial load >10⁵ CFU/g is likely to be at the stage of being unacceptable from the microbiological point of view and unit for consumption which agrees with the present research work. Study conducted by Mansur, et al. [6] on sun-dried samples and revealed that the total bacterial count (TBC) ranged from 1.84 × 10⁴ to 5.3 × 10⁴ CFU/g and also highly varied among the species probably indicating the different degrees of spoilage by bacteria. Similarly, Nahid, et al. [17] found that smoke-dried freshwater small fish, Chapila (Gudiusa chapra) and Baim (Mastacembelus puncatus) during storage at room temperature (26-31°C) the (Total viable count) TVC ranged from 1.8 × 10³-2.3 × 10⁹ CFU/g and 1.1 × 10⁶-2.0 × 10⁹ CFU/g respectively. This experiment with Shoal agreed with the findings of the above study.

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### References

1. AOAC (1990) Official method of analysis. In: Horwitz W (ed.) Association of Official Analytical Chemists (12thedn) Washington DC.
2. Nketsia T, Sefa-Dedeh S (2000) Quality attributes of cured fish in Ghana. Journal of Applied Science and Technologi (JAST), Vol. 5 (1&2): 148-155.
3. Kosygin L, Lilabati H and Viswanath W (2001) Proximate composition of commercially important hill stream fishes of Manipur. India J of Fisheries 48: 111-114.
4. Salan OE, Juliana AG, Marilia O (2006) Use of smoking to add value to salmonoid trout. Barch Arch Biol Techon 49: 57-62.
5. Siddique MAM, Akter M (2011) Changes of nutritional value of three marine dry fishes (Johniuis dussumierii, Harpodon neheerus and Lepturacanthus savala) during storage. Food and Nutrition Sciences 2: 1082-1087.
6. Mansur MA, Rahman S, Khan MNA, Reza MS, Kamrunnahar et al. (2013) Study on the quality and safety aspect of three sun-dried fish. African Journal of Agricultural Research 8: 5149-5155.
7. Flowra FA, Nahar, DG, Tumpa AN, Islam MT (2012) Biochemical analysis of Five Dried Fish species of Bangladesh. J zoil Rajshahi Univ 31: 9-11
8. Mohsin A (2008) Study of hot smoke curing Thai pangas (Pangasius hupphalimus) at different coditions M. S. Thesis, submitted in the Department of Fisheries Technology, Bangladesh Agricultural University.
9. Chakraborty SC (2003) A Study on proximate composition fresh water fishes of Bangladesh. Bangladesh J Fish 66: 23-26.
10. Debnath SK, Chakraborty SC, Sharmin R, Nath PCD (2009) A study on the improved technique for the production of smoked Thai pangas (Pangasius hupphalmus). Int J Biore 2: 47-50.
11. Gopal S (2005) A study on the shelf life of smoked Thai pangas (Pangasius hupphalmus) MS, Thesis, submitted in the Department of Fisheries Technology, Bangladesh Agricultural University, Mnsinings, p. 71.
12. Islam S (2001) A comparitive study on the nutritional and food quality aspects of some traditional sun dried and solar tunnel dried marine fish products.
13. Oku, Ikpeivie, Amakoromo, Rebecca, E (2013) Microflora of fresh and smoke-dried fish in Yenagoa metropolis, Nigeria. African Journal of Microbiology Research 7: 4451-4456.

14. Mansur MA, Islam MN, Chakraborty SC, Chalraborty FA (1990) A comparative study in the traditional and solar tent dried fish. Bangladesh Journal of Fisheries 13: 33-39.

15. Hasan MM (2006) Improvement of food quality of traditional dried small indigenous fish products using rotary dryer and solar tunnel dryer, MS Thesis, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh, p: 126.

16. Reza MS (2002) Improvement of food quality of traditional marine dried fishery products using solar tunnel drier. M. Sc. Thesis, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh, p: 136.

17. Nahid MN, Latifa, GA, Farid, FB and Begum M (2014) Proximate composition of salted smoke-dried and salt-garlic treated smoke-dried chapila (gudusia chapra; hamiltonbuchanan, 1822) fish stored at room temperature. Bangladesh J Zool 42: 205-209.