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Comparative Analysis of nutritional composition and microbial quality of salt-smoke-dried mirror carp (*Cyprinus carpio* var. Specularis) during storage at 22-28°C and 4°C

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Abstract
The work was done to study the nutritive composition and microbial content of salt-smoke-dried Mirror carp (*Cprinus carpio* var. specularis) to compare the effect of different storage temperature. The fish in three treatments T_1 controlled fish product made by smoking & kept at ambient temperature, T_2 made as salt-smoke-dried & kept ambient temperature (22-28^{0}C) and T_3 fish product prepared as salt-smoke-dried & kept at refrigeration temperature (4^{0}C). The shelf-life in T_1 treated dried fillet was up to 6 days after preparation and T_2 treated fillet 37th whereas the shelf life in T_3 treated products was excellent up to 45 days period. It was revealed that the moisture, ash, protein and lipid, standard plate count (SPC) was 26.37%, 10.15%, 47.69%, 14.78% and 9.58×10^4 CFU/g for treatment T_1. The same parameters during 30 days observation for treatment T_2 ranged from 24.51-24.94%, 11.96-12.97%, 50.67-49.68%, 12.07-11.75% and 4.4×10^4-7.6×10^7 CFU/g respectively whereas during 45 days observation for treatment T_3 24.51-25.04%, 11.96-12.78%, 50.67-49.96%, 12.07-11.80% and 4.4×10^4-1.04×10^6 CFU/g respectively. Considering all the quality parameters of the salt-smoke-dried products it was found that the quality was still excellent and no significant quality loss occurred in products kept at refrigeration temperature (treatment T_3) during 45 days of storage.

Keywords: salt-smoke-dried, nutritional composition, microbial quality, mirror carp

1. Introduction
In Bangladesh salt-smoked-dried fish is recent addition to the fishery products. Fish is normally salted before smoking and sun drying. Different salting methods are being practiced by the smoked fish industry in different parts of the world. Moreover, smoking of fish reduces waste at times of bumper catches and permits storage for the lean season as well as increases protein availability to people throughout the year and makes fish easier to preserve, pack, transport and market (Sengor *et al*., 2004, Olokor *et al.,* 2007) [19, 16].
In more recent times fish is readily preserved by refrigeration and freezing and the smoking of fish is generally done for the unique taste and flavor imparted by the smoking process. But earlier studies show that smoking not only gives the product a desirable taste and odor, but also provides a longer shelf-life through its anti-bacterial and anti-oxidative effect, lowering of pH, imparting desirable colorations as well as accelerating the drying process and acting as antagonist to spoilage.
Smoked fish also has world- wide acceptability as processed fish food. In Bangladesh, limited of work has been done on smoked large fish species such as smoked Thai pangus, smoked Ilish, smoked Tilapia, smoked Silver Carp, smoked common carp, smoked Grass carp (Bhattacharjee, 2012) [2] but only a few researches have been reported on smoke-dried large fishes.
Moderate fatty and comparatively cheaper fish like-Mirror carp is suitable for smoking and drying. Due to high palatability, taste and rich in nutrients one commercially and nutritionally important exotic fish species Mirror carp (*Cyprinus carpio* var. specularis) have been selected for the present study. The mirror carp is a gregarious fish, mostly bottom feeder, dwelling mostly at the bottom of ponds. It is important fish because of its rapid growth, tasty flesh, and good reproductive ability. These fishes are rich in protein and fat content as well as different vitamins and minerals.
If we develop salt-smoke-dried products from Mirror carp we can simultaneously enhance the shelf life of product with attractive smoky flavor, odour, and appearance to make them a value added new product. It is essential to have a better knowledge on quality and safety of salt-smoke-dried product because a reasonable quantity of salt-smoke-dried fish may be sold to domestic market every year. Therefore, the result of the present investigation is expected to provide a clear idea on the nutritional composition and microbiological content of the smoke-dried fish under present study.

2. Materials and Methods
Fresh Mirror carp (*Cyprinus carpio* var. specularis) collected from K.R. market, Bangladesh Agricultural University, Mymensingh for preparation of salt-smoke-dried products. The collected fishes for salt-smoke-drying were divided into three treatments viz. T_1, T_2 and T_3. For T_1 the fishes were considered as controlled where no salt-smoke was treated and the product was kept at ambient temperature. In treatment T_2 and T_3 the salt-smoke-dried fish was kept at ambient (22-28 ^{0}C) and refrigeration temperature (4 ^{0}C) for studying shelf-life at varying length of times. After collection the fresh fish were weighed, dressed, filleted followed by washing. The fillets for T_2,T_3 were brined (≈25% brine) followed by air drying, partial smoking (30 minutes at 53 ^{0}C), sun drying (21hrs. in the ring tunnel) and packaged for shelf-life study. Two fishes were kept for control condition (T_1). For treatments T_2 and T_3 a total of 6 fishes were selected randomly for salt-smoke-drying.
For biochemical analysis of fresh fish and salt-smoke-dried fish composition AOAC (1990) [1] method was followed. Microbiological analysis during shelf life study of fish was

done by applying standard method of consecutive decimal dilution technique using spread plates.

3. Results and discussions

3.1 Changes in moisture content

The moisture content of fresh Mirror carp fillet was 79.87% respectively while partial smoking slightly decreased the moisture content to 75.62%. The moisture content of sun dried controlled fillet (treatment T_1) where the fillet was not salted and smoked was 26.37% and salt-smoke-dried (treatment T_2 & T_3) fillet had 24.51% moisture during the 1st day of storage.

The moisture content of the product at ambient temperature (treatment T_2) was 24.94% during 30 days storage and refrigerated temperature (treatment T_3) product had 25.04 % during 45 days storage.

However, there was no significant increase observed during different storage treatment. (Figure 1)

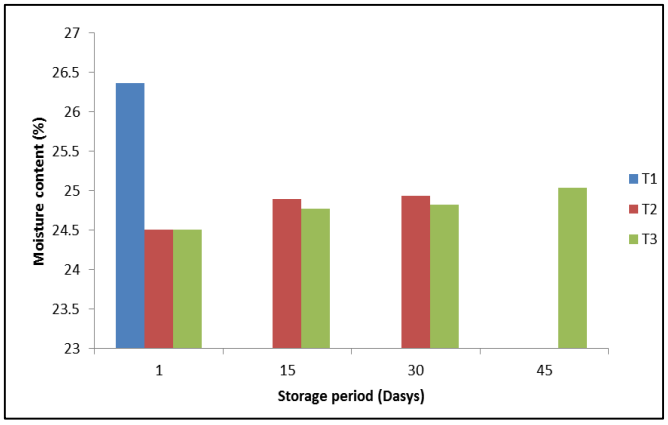

Fig 1: Changing pattern of moisture content of the salt-smoke-dried Mirror carp with different treatments during different days of storage (T_1, T_2 rejected on day after 6 and 37 respectively).

Increases in moisture content could be attributed to the difference in the moisture of the salt-smoke-dried fish relative to the surroundings. Nketsia and Sefa-Dedh (2000) [14] determined the moisture content of the smoked fish products range from 11.70% to 69.20%. Kosygin (2001) [10] found that moisture content ranged from 10.30-29.90% in six hot smoked hill fishes.

Likewise, Reza (2002) [17] found that the moisture content of dried products ranged from 18.0 to 29.8%. In another experiment with marine dried fishes Siddique *et al*., (2011) [20] determined the moisture content of dried fish was in the range of 13.81%-34.99%.

Experiment conducted by Mansur *et al.*, (2013) [12] with Indian major carps reported that the moisture content of dried fishes ranged from 19.17 to 23.99%. Similarly, Flowra *et al*., (2012) [6] showed that the moisture content of dried fishes ranging from 14.06 to 24.58%. However, the present results of salt-smoke-dried products Mirror carp also agreed with the above studies.

3.2 Changes in Ash content

The ash content of fresh Mirror carp fillet was 0.92 % respectively whereas smoking of fish was slightly increased the ash content to 2.91%. After sun drying the ash of controlled Mirror carp fillet (treatment T_1) was 15.86% respectively whereas the ash content of salt-smoke-dried (treatment T_2 and T_3) fillet was significantly increased 13.82% during the 1st day before storage.

On the 30th day observation the ash content Mirror carp was 17.30%for treatment T_2. On the other hand, during 45 days the ash content of Mirror carp was 17.06% for treatment T_3. The values in the parenthesis are the weight in dry wt. basis.

In this experiment it was observed that the ash content slightly increased after salt-smoke-drying because the salt increased from raw fishes had large uptake of inorganic salt compared to fresh samples. (Figure 2)

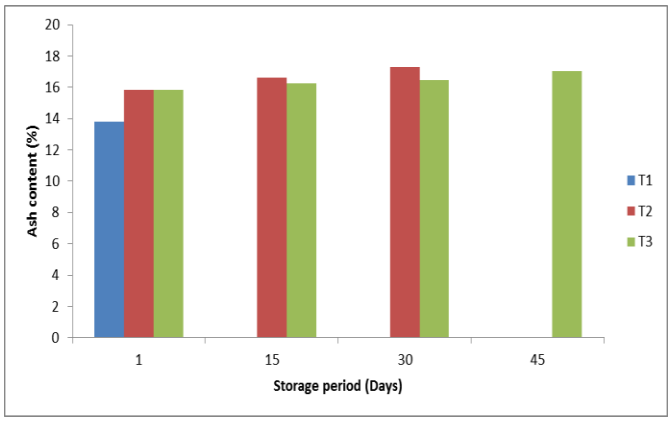

Fig 2: Changing pattern of ash content (% dry weight basis) of the salt-smoke-dried Mirror carp with different treatments during different days of storage (T_1, T_2 rejected on day after 6 and 37 respectively)

Stansby (1962) [21] reported that the ash content of fresh fishes ranged from 0.4 to 1.5%. Similarly, Mohsin (2008) [13] reported that the initial ash content of Pangas fillet was 1.25%. Likewise, Chakraborty (2003) [3] found that in smoking process, the ash content was found to be 1.43, 1.45 and 1.50%. In another experiment Debnath *et al.*, (2009) [5] reported that initial ash content of Pangas fish fillet was 1.02% and found the ash content values of smoked product ranging from 1.15-1.91% during different storage condition. Study done by Gopal (2005) [7] showed that the medium hot smoked Pangus (*Pangus hypophthalmus*) fish had ash content values ranging between 1.39% and 1.60% in different days of observation of the smoked product in refrigeration storage.

3.3 Changes in protein content

The protein content of fresh Mirror carp was 15.18% and after partial smoking the protein was little increased to 16.03%. Besides, sun drying of Mirror carp in T_1 treated showed a significantly increased value of the protein content of was 64.82% respectively whereas, for salt-smoke dried (treatment T_2 and T_3) fish the protein content was 67.14% 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 Mirror carp was 66.62% for treatment T_2. On the other hand, during 45 days the protein content Mirror carp was 66.72% respectively for treatment T_3.

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

Chakraborty *et al.*, (1997) [4] reported that in sun dried salted Hilsa products, 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.
Nketsia and Sefa-Dedeh (2000) [14] determined the protein content of the smoked fish products ranging from 71.5% to 4.5%.

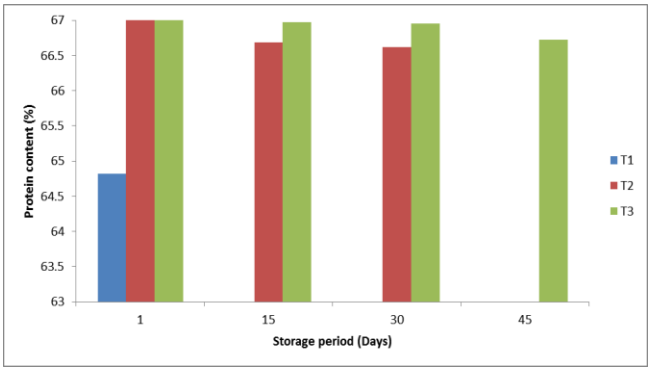

Fig 3: Changing pattern of protein content (% dry weight basis) of the salt-smoke-dried Mirror carp with different treatments during different days of storage (T_1, T_2 rejected on day after 6 and 37 respectively).

In another experiment Debnath *et al.*, (2009) [5] with Thai Pangas (*Pangasius hypothalamus*), showed that initial protein content values of smoke product was 17.27% and found the lipid content values of smoked product ranging from 20.27-22.01% during different storage condition.
Besides, Mansur *et al.*, (1990) [11] reported that the protein content of tent dried fishes ranged from 60.07 to 72.51%. Similarly, Islam (2001) [9] showed that the protein content of solar tunnel dried products ranging from 58.13 to 68.49% Likewise, Reza (2002) [17] found that the lipid content of dried products ranged from 42.51 to 56.58%. Similarly, Hasan (2006) [8] 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 Mirror carp having no significant changes in protein content which was more or less similar to the studied with other authors.

3.4 Changes in lipid content

The lipid content of fresh Mirror carp fillet was 3.54 % while smoking of fish was slightly increased the lipid content to 5.33% whereas sun drying increased the lipid content of controlled fish (treatment T_1) which was 20.11% and salt-smoke-dried (T_2 & T_3 treated) was 15.98% on the 1st day before storage. On the 30th day observation the lipid content Mirror carp was 15.67% for treatment T_1. On the other hand, during 45 days the lipid content Mirror carp was 15.78% for treatment T_3. The values in the parenthesis are the weight in dry wt. basis. However, no significant change of lipid content in Mirror carp was observed during the storage period. (Figure. 4)

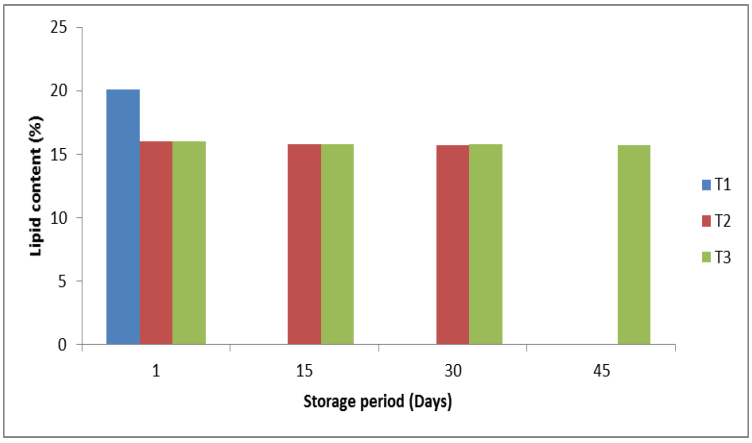

Fig 4: Changing pattern of Lipid content (% dry weight basis) of the salt-smoke-dried Mirror carp with different treatments during different days of storage (T_1, T_2 rejected on day after 6 and 37 respectively).

Mansur *et al.*, (1990) [11] reported that the lipid content of tent dried fishes ranged from 6.43 to 14.99%. Similarly, Islam (2001) [9] showed that the lipid content of solar tunnel dried products ranging from 5.63 to 10.08%. The present study of salt-smoke-dried with Mirror carp agreed with the above reports.

3.5 Microbial analysis

The bacterial load of fresh Mirror carp fillet was 7.5×10^5 CFU/g whereas, smoking of fish slightly decreased the bacterial load to 1.32×10^5 CFU/g. After sun drying the bacterial load of salt-smoke-dried (treatment T_2 & T_3) was 4.4×10^4 CFU/g and controlled fillet (treatment T_1) was 9.58×10^4 CFU/g during the 1st day of storage.
On the 30th day of observation the bacterial load of Mirror carp was 7.6×10^7 CFU/g for treatment T_2. On the other hand, during 45 days the bacterial load of Mirror carp was 1.04×10^6 CFU/g for treatment T_3.
The total bacterial load in treatment T_2 and T_3 for Mirror carp was found to be increased significantly with the lapse of time and reached maximum at unacceptable limit when it was considered as spoiled. In this study it was observed that the total bacterial load of salt-smoke-dried Mirror carp fish samples were increased with increase in the duration of storage due to growth and multiplication of the microbes.
Debnath *et al.*, (2009) [5] reported that initial bacterial loads of fresh pangas fillets was 1.5×10^5 CFU/g and found that the bacterial load of smoked product ranging from 1.8×10^3-4.10×10^9CFU/g during different storage condition. The bacterial counts are generally lower for smoked fish compared to fresh fish. (Oku *et al*., 2013) [15]. It is generally accepted that fish with microbial load >10 ^{6}c CFU/g is likely to be at the stage of being unacceptable from the microbiological point of view and unfit for consumption which agrees with the present research work. (Salan *et al*., 2005).

4. Conclusions

The result of the study revealed that the refrigeration storage (4 ^{0}C) of salt-smoke-dried Mirror carp (*Cprinus carpio* var. specularris) had the longer period of shelf-life and acceptability than the products kept at ambient temperature (22-28 ^{0}C) and that prepared only by sun drying with no salt and smoke as in the control (T1) one. The shelf-life of salt-smoke-dried fish was affected by storage condition. At lower temperatures in refrigeration temperature there was a longer shelf-life, while at ambient temperature there was rapid deterioration. The level of salt concentration in fish slightly affected the level of lipid oxidation although smoking exhibited greater antioxidant activity. Changes in protein content were found insignificant but very small as effected in various storage treatments. Microbial content of the products increased due to increasing of the storage period and retaining moisture from surrounding. In all cases refrigeration storage treated samples retain high protein, lipid, ash, lower moisture content and microbial content. In comparison to the different storage treated samples in T3 showed longer shelf-life.

5. Acknowledgement

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6. References

1. Association of Official Agricultural Chemists (AOAC), Official method of analysis. Horwitz W (Editor) 12th Ed. Washinton DC, 1990.
2. Bhattacharjee S. Effect of salt composition on the quality of smoked common carp (*Cyprinus carpio*) stored at ambient and refrigerated temperature. M.S. Thesis submitted in the Department of Fisheries Technology, Bangladesh Agricultural University, Mmensingh, 2012; 84.
3. Chakraborty SC. A Study on proximate composition fresh water fishes of Bangladesh. Bangladesh J Fish, 2003; 26(1-2):23-26
4. Chakraborty SC, Islam MN, Khan AS. Study on the evaluation of the quality aspects of dry salted, wet salted and sun dried Hilsa fish (*Hilsa ilisha*). Bangladesh J Agri. Sci. 1997; 24(2):71-79.
5. Debnath SK, Chakraborty SC, Sharmin R, Nath PCD. A study on the improved technique for the production of smoked Thai pangas (Pangasius hpothalmus).Intl. J Biores. 2009; 2(12):47-50
6. Flowra FA, Nahar DG, Tumpa AN, Islam MT. Biochemical analysis of Five Dried Fish species of Bangladesh, Univ. j. zool. Rajshahi Univ. 2012; 31:09-11
7. Gopal S. A study on the shelf life of smoked Thai pangas (*Pangasius Hupothalmus*). M.S. Thesis, submitted in the Department of Fisheres Technology, Bangladesh Agricultral University, Mmensingh, 2005; 71.
8. Hasan MM. 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, 2006, 126.
9. Islam S. A comparative study on the nutritional and food quality aspects of some traditional sun dried and solar tunnel dried marine fish products, MS Thesis, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh, 2001, 45-60.
10. Kosygin L, Lilabati H, Viswanath W. Proximate composition of commercially important hill stream fishes of Manipur. India. J of Fisheries. 2001; 48(1):111-114.
11. Mansur MA, Islam MN, Chalraborty SC, Chaity FA. A comparative study in the traditional and solar tent dried fish. Bangladesh Journal of Fisheries, 1990; 13:33-39.
12. Mansur MA, Rahman S, Khan MNA, Reza MS, Kamrunnahar Uga S. Study on the quality and safety aspect of three sun-dried fish. African Journal of Agricultural Research. 2013; 8(41):5149-5155.
13. Mohsin A. Study of hot smoke curing Thai pangas (*Pangasius hpophthalamus)* at different coditions. M.S. Thesis, submitted in the Department of Fisheries Technology, Bangladesh Agricultural University. 2008, 74
14. Nketsia T, Sefa-Dedeh S. Quality attributes of cured fish in Ghana. Journal of Applied Science and Technlog (JAST). 2000; 5(1, 2):148-155
15. Oku, Ikpebivie, Amakoromo, Rebecca E. Microflora of fresh and smoke-dried fish in Yenagoa metropolis, Nigeria. African Journal of Microbiology Research. 2013; 7(35):4451-4456.
16. Olokor JO, Ihuahi JA, Omojowo FS, Falayi BA, Adelowo EA. Handbook of Practical Fisheries Technology. Published by Fisheries Technology Dvision, National Institute for Freshwater Fisheries Research (NIFFR), P.M.B 6006, New Bussa, Niger State. 2007, 22-29.
17. Reza MS. 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, 2002, 136.
18. Salan OE, Juliana AG, Marilia O. Use of smoking to add value to salmoned trout. Braz. Arch. Biol. Technol. 2006; 49(1):57-62.
19. Sengor GF, Kalafatoglu H, Gun H. The determination of, microbial flora, water activity and chemical analysis in smoked Mussels *(Mytilus galloprovincialis*, L.) Tunk. J Vet. Anim. Sci. 2004; 28:793-797.
20. Siddique MAM, Akter M. Changes of nutritional value of three marine dry fishes (*Johnius dussumieri, Harpodon nehereus* and *Lepturacanthus savala*) during storage. Food and Nutrition Sciences, 2011; 2:1082-1087.
21. Stansby MB. Proximate composition of fish. Fish in Nutrition. Ed. B Erik Heen and Rudlof Ercnzer. Fishing News (Books). Ltd. Ludgate, 110 Fleet Street London, E.G.4, England, 1962.