academicresearchJournals

Vol. 2(6), pp. 88-96, October 2014
DOI: 10.14662/ARJASR2014.031
ISSN: 2360-7874©2014 Academic Research Journals
http://www.academicresearchjournals.org/ARJASR/Index.htm

Academic Research Journal of Agricultural Science and Research

Full Length Research

Effect of Dipping Time in Brine on the Quality of Smoked Silver Carp (*Hypophthalmichthys molitrix*) Stored at 23 – 26^{0}C and 4^{0}C.

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Accepted 28 October 2014

This experiment was conducted to evaluate the effect of dipping time in brine on the shelf-life of hot-smoked Silver carp (*Hypophthalmichthys molitrix*) stored at ambient (23-26ºC) and refrigeration (4ºC) temperature. The fish in two treatments named A and B were salt-dipped for 15 and 30 minutes respectively in a saturated brine solution (≈25% NaCl). The fish were then smoked at 75ºC in an improved traditional smoking kiln followed by cooling. After sealing in polythene bags the smoked products were stored separately at ambient and refrigeration temperature. Four major analysis viz. sensory assessment, initial and final proximate analysis, chemical analysis and microbial analysis were carried out on the samples. According to sensory assessment the 30 minutes brine dipped smoked fish kept at ambient temperature showed a higher shelf-life of four days. On 5th day, appearance of fungus on the product of treatment B confirmed its acceptability up to 4 days. Similarly the samples of two treatments A and B stored at refrigeration temperature showed a longer shelf-life of up to 41 and 48 days respectively. The rate of lipid deterioration and protein breakdown were found very gradual and not significant. In all cases ash content increased slightly. No appreciable changes in proximate composition in two treatments during storage condition were observed. Values of TVB-N in the samples kept at ambient temperature showed more rapid increase to 34.6 mg/100g on 4th day of observation in contrast to 35.9 mg/100g on 49th day in fish kept at refrigeration temperature. However, smoked silver carp in treatment B maintained its excellent quality up to 14 days of storage, and considered as acceptable for 41days and was just to satisfactory level for 48 days under refrigerated condition.

Key words: Smoking, *Hypophthalmichthys molitrix,* dipping time, brine, storage temperature.

Cite this article as: MOU MH, CHAKRABORTY SC (2014). Effect of Dipping Time in Brine on the Quality of Smoked Silver Carp (*Hypophthalmichthys molitrix*) Stored at 23 – 26^{0}C and 4^{0}C. Acad. Res. J. Agric. Sci. Res. pp. 88-96.

INTRODUCTION

During hot smoking, fish are generally smoked at core temperature about 60-70ºC, so that the fish are cooked to be ready-to-eat. Brining is carried out during hot smoking to ensure penetration of about 2% or more salt into the fish tissue. Salt in the muscle tissue enhance the taste of the product and prevent microbial intervention. Usually

Table 1. Yield during smoking of the experimental fish, silver carp (*Hypophthalmichthys molitrix*).

Treat-ment	Sample no.	Sample wt. (g)	Wt. of dressed fish (g)	% of yield of smoked fish from whole fish	% of yield of smoked fish from dressed fish
A	1	400	250	40.0	66.7
	2	325	215	43.1	65.1
	3	330	220	42.4	63.6
	4	305	205	45.9	68.3
	5	300	190	45.0	71.1
	6	295	180	37.3	61.1
		Mean = 325.8(±38.9)	Mean = 210 (±24.7)	Mean=42 (±3.2)	Mean=66 (±3.5)
B	7	390	235	38.5	63.8
	8	370	230	39.2	63.0
	9	365	220	36.9	61.4
	10	405	260	37.0	57.7
	11	360	225	36.1	57.8
	12	360	220	36.1	59.1
		Mean = 375.0(±18.4)	Mean = 231 (± 15.1)	Mean=37 (±1.3)	Mean=60 (±2.7)

increase of dipping time allows the penetration of salt particle inside the tissue and influence the shelf life of the product. However, the brining process can be a source of microbiological contamination. It was shown that multiple use of brine (20% salt content) may produce a source of many microorganisms including spores of *Clostridium botulinum* (Debnath *et. al*., 2009). The brine thus needs to be changed frequently.

Silver carp (*Hypophthalmichthys molitrix*) is one of the exotic but popular fish throughout the Bangladesh. It is seen that during the last few years, this species has come into culture practice in farmer's level at a significant extent. Moreover it is easily available, bearing relatively faster growth, high survival rate, very good food conversion ratio, comparatively low feed cost, higher acceptability among general consumers and good market value as well as good taste. Silver carp (*H. molitrix*) generally grows in ponds, reservoirs and even in small tanks.

Smoking of fish should be popularized in Bangladesh. In this view an experiment was designed to study the effect of dipping time of silver carp (*H. molitrix*) in brine to observe the shelf life and the quality at ambient and refrigeration temperature.

MATERIALS AND METHODS

For the smoking purpose a smoking kiln (Debnath *et. al.*, 2009) was used. Fresh silver carp was collected from local K. R. market of BAU campus and was taken to the laboratory of fisheries technology department, BAU. The fishes were washed, dressed, filleted and their weights were recorded (Table 1). A total of 12 fishes (each 6 for one treatment equally divided at ambient and refrigeration temperature) were used for the experiment. Two different treatments both for ambient and refrigeration temperature were selected as 15 minutes (Treatment A) and 30 minutes (Treatment B) dip time of fish in saturated brine (25% NaCl). After dewatering for 10 minutes the brined fillets were hanged with hooks in the smoking kiln. Smoking is done at about 75°C for 2 hours until the colour and texture of the fish became satisfactory. After air cooling the products in separate treatments for ambient (23-26°C) refrigeration (4°C) storage were sealed in airtight polythene bag and evaluated for quality at different storage condition.

Sensory assessment were used to determine the degree of freshness based on color, odour, texture, general appearance and flavor of smoked fish. Analysis for proximate composition of moisture, crude protein, lipid and ash were carried out according to the methods given in AOAC, 1990 with certain modifications. Microbiological analysis during shelf life study of fish was done by applying consecutive decimal dilution technique using peptone diluents (0.2%) and plate count agar as per method given in Cowan and Steel's Manual for. identification of medical bacteria (edited by Barrow and Feltham, 1993).

Determination of salt content % and TVB-N mg/100g of

smoked fish during storage as well as microbial analysis were done for the samples kept at refrigeration temperature and ambient temperature until it was considered as in acceptable condition. The grading scale for quality analysis for shelf life study of the product was followed on the basis of Larmond, 1977.

RESULTS AND DISCUSSION

The mean weight of whole fish, dressed portion and % of yield of smoked fish from whole fish is presented in Table 1.

The shelf-life of the brine treated smoked silver carp was found to be related to the temperature. The sensory assessments of two different smoked samples are summarized in Table 2 and 3. At the beginning of storage all the organoleptic parameters of the samples were rated as good based on the grading scale, the best mean acceptability level was found in 30 minute brine treated sample while the mean acceptability level decreased as storage duration increased (Figure 1).

In a similar experiment, fungal growth on smoked tilapia fish was observed at ambient temperature. In that case, the samples of smoked fish were considered to be rejected on 5^{th}, 6^{th} and 7^{th} day in fish having various salt concentrations (Shakhawat, 2010). Hence, in this experiment the smoked silver carp fish under such ambient condition were considered to be rejected on 4^{th} and 5^{th} day in treatment A and B respectively (Table 2). The quality of the fish was found acceptable for 4 days 4^0C.

In this study it was found that 30 minute brine treated smoked silver carp could be stored as suitably accepted at refrigerated temperature for 35 days (Table 3) having moderately smoky, yellowish brown with less elastic and firm texture. In contrast, the fish in treatment A had the acceptability level as “just satisfactory” on 35^{th} days of observation kept at 4ºC. Similar experiment reveals that modern smoked products need to be stored at temperature of 0-5ºC where they can be kept for 4 weeks (Philip, 1981).

The moisture content of fresh silver carp fillet was 76.40% while after smoking moisture content was found to decrease to 69.2% and 68.9% in the treatment A and B respectively. Significant reduction of moisture content in treatment A and B was revealed with initial moisture of the fresh fish (Table 4 & 5). However insignificant but lower value of moisture content was found in treatment B than A.

Experiment conducted by Gopal (2005) with thai pangas (*Pangasius hypophthalmus*) showed that medium hot smoked (about 55ºC) pangas for 3.0 hours smoking had moisture content of 64.3% on 1^{st} day to 63.2% on 21^{st} day of observation with the product prepared by dipping in saturated brine. This changes of moisture during storage period also shows a similar trend of reduction with this experiment.

Nketsia and Sefa-Dedeh (2000) determined the moisture content of the different smoked fish products ranged between 11.7% and 69.2%. The lower moisture value in smoked fish took long time for smoking and had longer shelf life whereas, the higher moisture value of fish prepared at short time had small length of shelf life. This experiment with silver carp also showed small length of shelf life since it was prepared within few hours of smoking.

The ash content of fresh silver carp fillet was 0.63% which was found to increase to 1.89 and 1.9% in treatment A and B respectively after smoking. There was no significant change in ash content between treatment A and B (Table 4 and 5).

Kosygin *et. al*., (2001) found that ash content on dry basis ranged from 5.0-7.0% in smoked hill stream fishes. Study done by Gopal (2005) with Pangas (*Pangasius hypophthalmus*) showed that medium hot smoked pangas fish found the ash content values ranging 1.4-1.60% in different days of observation of the product in refrigeration storage. Mohsin (2008) reported that the initial ash content of pangas fish fillet was 1.25%. Chakraborty (2007) found that in smoking process, the ash content was found to be 1.4, 1.4 and 1.5% in three different treatments. The protein content of fresh silver carp was found 15.85% and after smoking, protein content increased to 21.3 and 21.3% in treatment A and B respectively before storage. But insignificant changes in protein content were found in treatment A and B during storage Figure 2.

In an experiment with thai pangas (*Pangasius hypophthalmus*), Debnath *et. al.* (2009) reported that initial protein content of pangas fish fillet was 17.27% and found the protein content values of smoked product ranging from 20.3-22.0% during different storage condition. Similarly, study done by Shakhawat (2010) with smoked tilapia showed protein content as 28.2, 28.2 and 28.3% on 1^{st} day in three different treatments whereas, the protein content of fresh tilapia fillet was 17.3%. Likewise, Gopal (2005) showed that hot smoked pangas had protein content of 20.1% on 1^{st} day and an insignificant change to 20.5% on 21^{st} day of observation with the product prepared by dipping in saturated brine. In another study, Mohsin (2008) reported that the initial protein content of pangas fish fillet was 16.5% whereas after the 3 hours smoking process the protein content was found to be 20.5, 21.1 and 21.2% on three different treatments having a dip of 10% salt, 25% salt and 25% spice treated saturated salt solution respectively during 30 days of observation. The mean weight reduction of whole fish in to yield of smoked fish was found to be 42% and 37% respectively in fishes of treatment A and B respectively (Table 1).

The lipid content of fresh silver carp fillet was found

Table 2. Sensory evaluation of smoked silver carp on different days of storage at 23-26ºC.

Observation period (day)	Treatment	Sensory parameters						
		Color	Flavor/odor	Texture	General appearance	Taste	Overall quality	Comment
1st	A	Bright golden brown	Fresh smoky	Normal firm and elastic	Like extremely attractive	Like extremely salted smoky	Very good	Nice & attractive
	B	Bright golden brown	Fresh smoky	Normal firm and elastic	Like extremely attractive	Extremely salted smoky	Excellent	
2nd	A	Moderately brown	Moderately smoky	Moderately firm and elastic	Like moderately attractive	Slightly salted smoky	Good	Acceptable
	B	Moderately brown	Moderately smoky	Moderately firm and elastic	Like slightly attractive	Moderately salted smoky	Very good	
3rd	A	Light brown	Moderately smoky	Slightly firm and elastic	Slightly dull & fade	Slightly salted smoky	Moderately good	Just satisfactory
	B	Brown	Moderately smoky	Moderately firm and elastic	Slightly attractive	Slightly salted smoky	Slightly good	Acceptable
4th	A	Fade brownish	Fade smoky flavor	Loss of firm and elastic	Definitely dull	Slightly bitter	unacceptable	Rejected
	B	Normal brown	Slightly smoky	Slightly firm and elastic	Slightly dull & faded appearance	Slightly salted	Neither good nor bad	Just satisfactory
5th	A	-	-	-	-	-	-	
	B	Fade yellowish	Faded smoky flavor	Softening	Definitely dull	Slightly bitter	Very bad	Rejected

5.33% which was increased to 6.7 and 6.8% in treatment A and B respectively after smoking. The variation of moisture content between fresh fish and treatment B was much higher than between fresh fish and treatment A, which was reflected by the lipid content in the product A and B (Figure 3).

Debnath *et. al.* (2009) reported that initial lipid content of pangas fish fillet was 10.6% and found the lipid content values of smoked product ranging from 9.3-10.6% during different storage condition. Similarly,

Table 3. Sensory evaluation of smoked silver carp on different days of storage at 4ºC

Observation period (day)	Treatment	Sensory parameters						
		Color	Flavor/odor	Texture	General appearance	Taste	Overall quality	Comment
1st	A	Bright golden brown	Fresh smoky	Normal firm and elastic	Like extremely attractive	Like extremely salted smoky	Very good	Nice & attractive
	B	Bright golden brown	Fresh smoky	Normal firm and elastic	Like extremely attractive	Extremely salted smoky	Excellent	
7th	A	Moderately golden brown	Smoky flavor	Moderately firm and elastic	Like moderately attractive	Salted smoky	Moderately good	Nice & attractive
	B	Bright golden brown	Fresh smoky	Very firm and elastic	Like very much attractive	Like salted smoky	Very good	
14th	A	Golden brown	Moderately smoky	Slightly firm and elastic	Moderately nice and attractive	slightly salted smoky	Moderately good	Attractive & acceptable
	B	Bright brown	Moderately smoky	Moderately firm and elastic	Like moderately attractive	Moderately salted smoky	Moderately well	
21st	A	Yellowish brown	Slightly smoky	Slightly firm	Slightly attractive	Slightly salted smoky	Slightly well	Acceptable
	B	Golden brown	Slightly smoky flavor	Slightly firm and elastic	Like moderately attractive	Moderately salted smoky	Well	
28th	A	Normal yellowish	Slightly smoky flavor	Slightly soft	Slightly dull & fade	Slightly salted smoky	Moderately good	Acceptable
	B	Yellowish brown	Slightly smoky flavor	Loss of firm and elastic	Slightly attractive	Slightly salted smoky	Slightly good	
35th	A	Fade brownish	Slightly off flavor	Some softening	Dislike slightly	Slightly salted smoky	Dislike slightly	Just satisfactory
	B	Yellowish brown	Moderately smoky	Loss of firm and elastic	Slightly dull & faded appearance	Salted smoky	Slightly good	Acceptable
42nd	A	Dull brownish	Extremely disagreeable odor	Some softening	Definitely dull	Extremely bitter	Unacceptable	Rejected
	B	Normal yellowish	Faded smoky flavor	Slightly soft	Slightly dull and faded	Slightly bitter	Slightly bad	Just satisfactory
49th	A	-	-	-	-	-	-	-
	B	Fade yellowish	Slightly off flavor	Some softening	Definitely dull	Slightly bitter	Unacceptable	Rejected

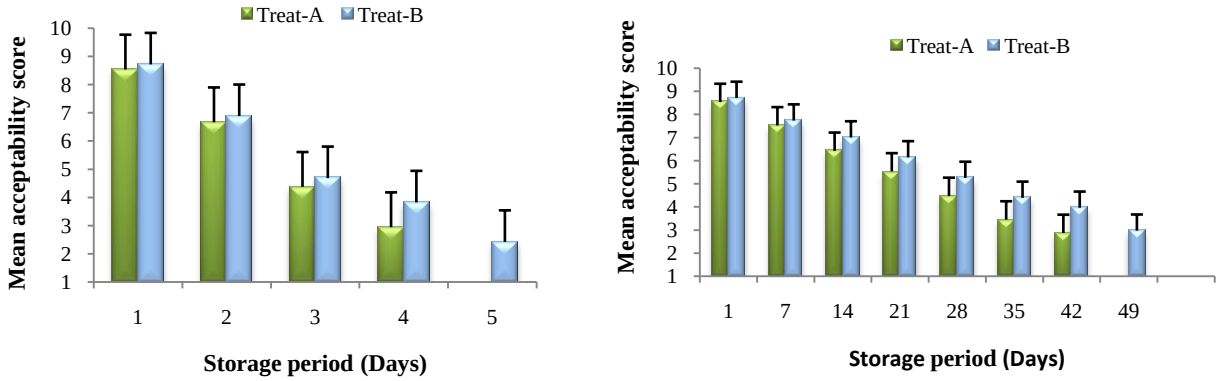

Figure 1. Changes in sensory evaluation score (mean acceptability) of different brine treated smoked silver carp fillets stored at ambient and refrigeration temperature

Table 4. Results of proximate analysis for smoked silver carp fillets with different treatments stored at 23-26ºC.

Storage period (day)	Moisture (%)		Ash (%)		Protein (%)		Lipid (%)	
	Treat-A	Treat-B	Treat-A	Treat-B	Treat-A	Treat-B	Treat-A	Treat-B
1st	69.3 (±0.04)	68.9 (±0.05)	1.8 (±0.12)	1.9 (±0.19)	21.3 (±0.16)	21.3 (±0.17)	6.7 (±0.03)	6.8 (±0.05)
4th	69.6 (±0.05)	69.0 (±0.07)	1.8 (±0.21)	1.9 (±0.20)	21.1 (±0.19)	21.2 (±0.20)	6.6 (±0.08)	6.7 (±0.07)
5th	-	69.2 (±0.06)	-	1.9 (±0.15)	-	21.1 (±0.23)	-	6.7 (±0.13)

Table 5. Results of proximate analysis for smoked silver carp fillets with different treatments stored at 4^0C

Storage period (day)	Moisture (%)		Ash (%)		Protein (%)		Lipid (%)	
	Treat-A	Treat-B	Treat-A	Treat-B	Treat-A	Treat-B	Treat-A	Treat-B
1st	69.3 (±0.04)	68.9 (±0.02)	1.8 (±0.10)	2.0 (±0.14)	21.3 (±0.16)	21.3 (±0.18)	6.7 (±0.04)	6.8 (±0.06)
14th	69.4 (±0.07)	69.1 (±0.04)	1.8 (±0.10)	2.0 (±0.13)	21.2 (±0.18)	21.3 (±0.17)	6.6 (±0.03)	6.8 (±0.05)
28th	69.5 (±0.03)	69.2 (±0.07)	1.8 (±0.11)	2.0 (±0.10)	21.2 (±0.21)	21.2 (±0.15)	6.6 (±0.08)	6.7 (±0.08)
42nd	69.5 (±0.05)	69.2 (±0.06)	1.8 (±0.12)	1.9 (±0.12)	21.1 (±0.19)	21.2 (±0.20)	6.6 (±0.07)	6.7 (±0.02)
49th	-	69.3 (±0.06)	-	2.0 (±0.10)	-	21.1 (±0.23)	-	6.7 (±0.04)

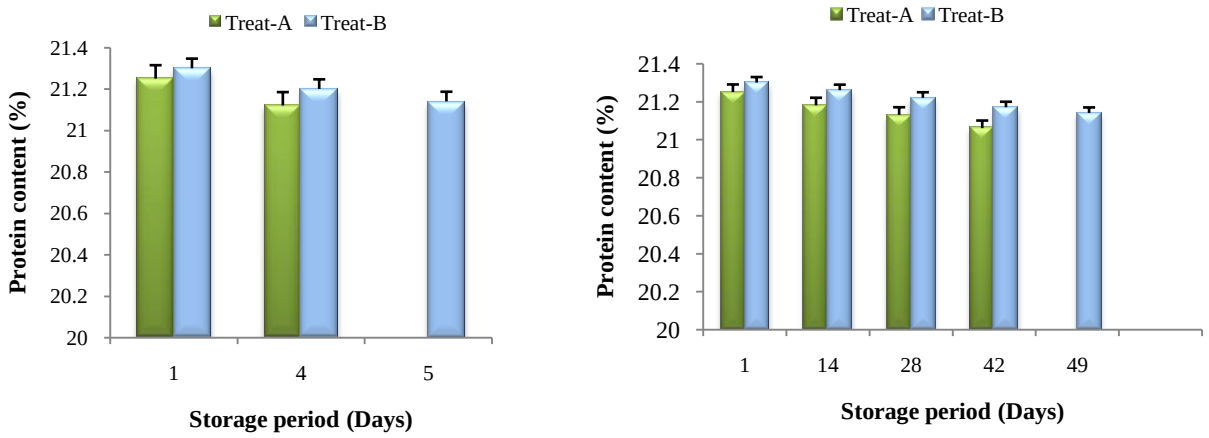

Figure 2. Changes in protein content (%) of the smoked silver carp fillets with different treatments stored at ambient and refrigeration temperature

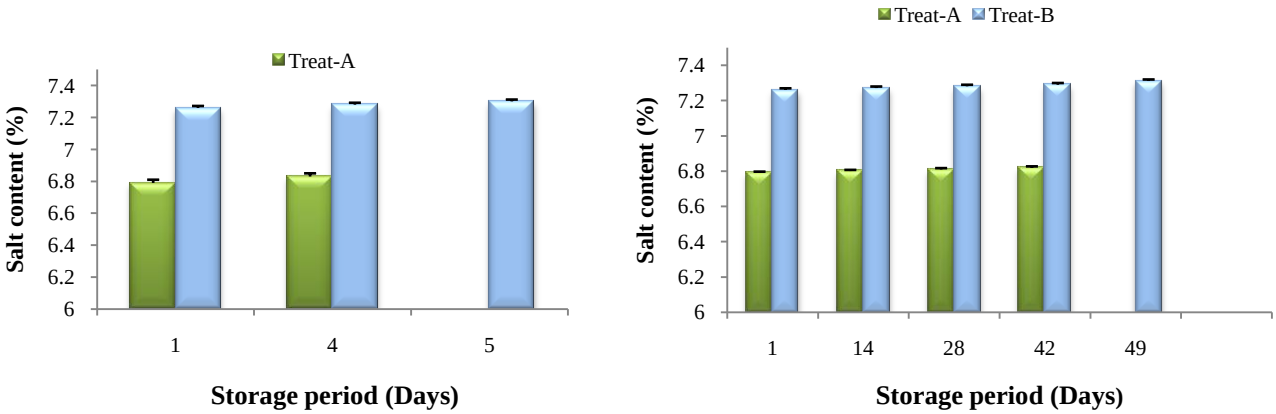

Figure 3. Changes in salt content (%) of the smoked silver carp fillets with different treatments stored at ambient and refrigeration temperature.

Gopal (2005) showed that medium hot smoked pangas had lipid content of 13.3% on 1st day and 13.3% on 21st day of observation with the product prepared by dipping in saturated brine. The higher lipid value in pangas than silver carp of this experiment might be due to the initial oil content of two fish species.

The initial salt content of fresh silver carp was 0.02%. After smoking, salt content were found to 6.8 and 7.26% in treatment A and B respectively just before storage. There was greater variation in salt content between fresh fish and treatment A, B which was due to the penetration of salt particle inside the tissue with different dipping time in brine. In this study, the salt content varied in the treatments depending on the dipping time in salt. However, very little increase of salt content was observed during the storage period.

Mohsin (2008) reported that the initial salt content of pangas fish fillet was 0.01% and after the smoking process the salt content was found to be 5.4, 7.9 and 7.7% on three different treatments of 30 days of observation which also revealed the effect of increased salt concentration at different treatments in this experiment with silver carp.

Borgstrom, (1965) reported that salt content was 2-3% in hot smoked herring. Nketsia and Sefa-Dedeh (2000) determined the salt content of the smoked fish products ranging between 0.4 to 1.2%. However, this experiment with silver carp showed a much higher salt content (Fig. 3) because of the long lasting dipping time of fish in to salt solution in both treatments.

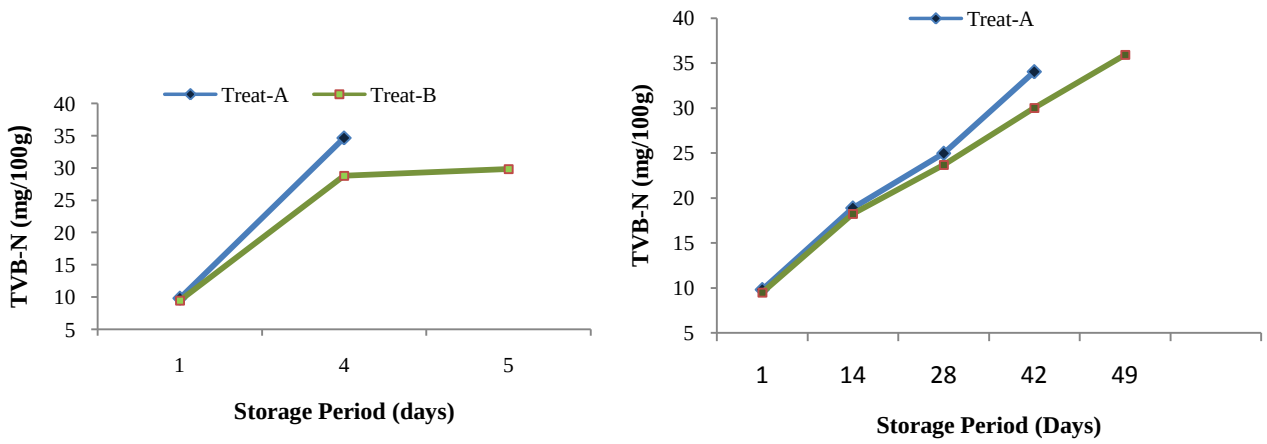

Figure 4. Changes in TVB-N (mg/100g) of the smoked silver carp fillets with different treatments stored at ambient and refrigeration temperature.

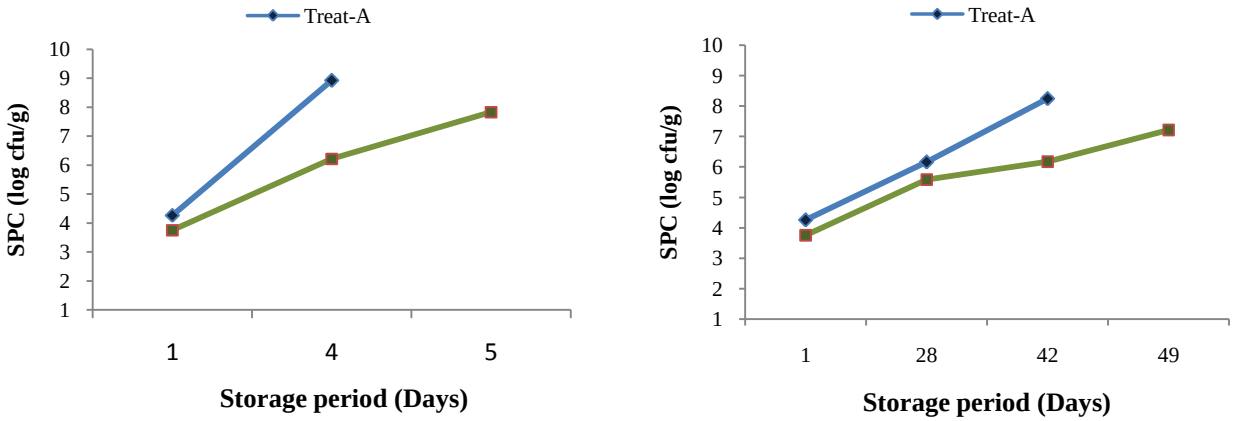

Figure 5. Changes in SPC (log CFU/g) of the smoked silver carp fillets with different treatments stored at ambient and refrigeration temperature.

The total volatile base nitrogen (TVB-N) value of fresh silver carp fillet was 9.3 mg/100g which was increased to 9.8 and 9.5 mg/100g in treatment A and B respectively after smoking. Samples kept at ambient temperature showed more rapid increase in comparison to refrigerated sample (Figure 4), this might be due to extent of protein breakdown during storage period. Samples kept at refrigeration temperature, the changes in TVB-N content in treatment A were much higher than treatment B (Figure 4).

Increase in final values of TVB-N in this study was similar to the result of Trinidad and Estrada (1986) who reported an increase in the value of TVB-N produced in smoked tilapia fish from 4.2 mg to 11.0 mg N per 100 g in less than fifteen hours. In this study with silver carp, the highest value of Total Volatile Base Nitrogen (35.9 mg/100 g) considered as unacceptable product was found in treatment B on 49th days of storage which provides similar result with the findings of the above study.

Bacterial load in fresh fish fillets was found 1.56×10^5 CFU/g. Whereas, in smoked fillets of treatment A and B were found 1.84×10^4 and 5.62×10^3 CFU/g respectively on the 1st day just before storage. The total bacterial load in treatment A and B were found to be increased significantly with the lapse of time and reached maximum at unacceptable limit and then it was considered as spoiled. However, much higher value of bacterial load was found in treatment A than B stored at refrigeration temperature (Figure 5).

Debnath *et. al.* (2009) reported that initial bacterial load of fresh pangas fish fillet was 1.5×10^5 CFU/g and found the bacterial loads of smoked product ranging from 1.80×10^3-4.10×10^9 CFU/g during different storage condition. Similarly, Salim et al. (2007) reported that fresh pangas (*Pangasius hypophthalmus*) had initial bacterial load of 1.56×10^5 CFU/g and after smoking the bacterial load increased to about 2.92×10^8 CFU/g during 21days of storage at refrigeration temperature (4ºC). Likewise, study done by Shakhawat (2010) with smoked tilapia showed bacterial load was found to be 1.68×10^4, 1.41×10^4 and 5.71×10^3 CFU/g on 1st day in three different treatments whereas, the bacterial load of fresh tilapia was 1.84×10^5 CFU/g. This experiment with silver carp agrees with the findings of the above studies. Considering the results it can be said that smoked silver carp in treatment B had an excellent quality up to 14 days of storage and as acceptable for 41 days.

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