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Effect of temperature on the quality of smoked Thai pangas (*Pangasius hypopthalamus*)

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ABSTRACT

This experiment was conducted to prepare and evaluate the quality and shelf-life of smoke Thai pangas (*Pangasius hypopthalmus*) prepared by using two treatments viz. Treatment 'A' at 60^{o} C temperature and treatment 'B' at 75^{o}C temperature under the laboratory condition. The smoking of the fish fillets in these treatments were done in locally made improved smoking kiln. The quality of smoked fish in both treatments were evaluated at ambient temperature and refrigerated temperature during which the sensory, biochemical, and bacterial evaluation was done. Organoleptic evaluation showed that that the smoked fish stored at ambient temperature attain a shelf- life of 05 & 06 days in treatments 'A' and 'B ' respectively. However, the products of the two treatments 'A' , ' B' , stored at refrigerated temperature (4^{o} C) showed a longer shelf - life for 60 and 66 days respectively and it was revealed that the treatment 'B' had the longer shelf-life with all its sensory attributes and quality within an acceptable condition. Biochemical assessment showed a little increasing of protein, lipid, and ash contents due to loss of moisture during smoking. There was no significant change in protein, lipid and ash contents in both the two treatments during the storage condition. TVB-N contents increased with time up to rejection level with the progress of storage period in both ambient and refrigerated storage condition. Considering all the quality parameters of the hot smoked products at 75^{o} C showed a longer shelf of 66 days.

INTRODUCTION

Smoking is a way of preserving fish that is not going to be consumed immediately and it may be stored in the refrigerator for longer than fresh fish. Any fish can be smoked, but species high in fat (oil) such as pangas, salmon, and trout are recommended because they absorb smoke faster and have better texture than lean fish, which tend to be dry and tough after curing. Smoking is used to prepare fish products with longer shelf life (Burgess and Bannerman, 1963). Smoke contains numerous substances that kill bacteria and thus helping to preserve the products. The heat from the burning of wood also partially cooks and dries the fish. There are two types of smoking viz. cold smoking and hot smoking where cold smoking is done at normal room temperature of up to 37^{o} C. This smoked product fish is used as pre-treatment for making other fishery products like canned fish. Whereas high temperature are applicable for hot smoking. Smoke has got some bacteriostatic as well as bactericidal particles. The smoked fish is then ready for consumption without further culinary treatment.

Smoking of fish in Bangladesh although a less expensive method of fish preservation with variable shelf life is not yet practiced significantly except unscientific production of only small quantities of freshwater/coastal river shrimp, sometimes small hilsha etc at different coastal districts in rainy season. A large number of potential fish such as Thai pangas (*pangasius hypopthalmus*) which is known important for its higher growth rate and good taste and tolerances of wide of environmental parameters (Bardach et. al., 1972 and Stickney , 1979) with cheaper availability which may be considered as a good raw material for using in smoke-cured method.

There is an important feasibility of smoked pangas all over the people in the country. Thai pangas (*Pangasius hypopthalmus*) fish is one of the most favorite fish throughout the subcontinent especially in Bangladesh though it is an exotic fish

species. This species has come into culture practice in farmer's level to a large extent than any other single fish species in Bangladesh in the last few years. The causes behind this are many such as easily available, relatively faster growth, high survival rate, very good food conversion ratio, comparatively low feed cost, high acceptability among consumers and good market value as well as good taste. pangas fish generally grows in ponds, reservoirs and even in small tanks.. If we can develop smoked products from pangas we can simultaneously done for preservation and for attractive smoky flavor and meet up the protein requirement nationwide.

Although it seems that there exists various potentiality of practicing such type fish preservation. In Bangladesh, different processing methods like salting, drying, fermentation, icing, freezing etc. have been practicing from a long time to preserve the fish from spoilage or to increase the shelf-life. But fish smoking is very limited in Bangladesh. Therefore, this study has been carried out to see the feasibility and suitability of fish smoking in Bangladesh.

MATERIALS AND METHODS

Collection of Sample

To conduct the study, fresh mature (average wt. 750±50g) live Thai pangas was collected from the market of "Mechwa Bazar", Mymensing sadar to the laboratory of Fisheries Technology, Bangladesh Agricultural University. A total number of sixteen fishes were selected randomly for the purpose. Among them eight fishes were selected for preparing smoked fish at 60°C and the other eight fishes to be prepared at 75°C. All fishes collected were washed in potable water, weighed and dressed.

Preparation of smoked fish

For preparing the smoked fish, the dressed fishes were filleted and then backbone of the fishes was removed by a strong scissor. The fillets were immersed into 26% brine solution for 30 minutes and then kept lying on a clean plastic tray for air drying at room temperature for about 10 minutes. The fillets were then hung from the iron rods with the help of S-shaped hanger in the smoking chamber of each kiln for smoke-curing. Two treatments were performed separately in two smoking kilns, treatment-A at temperature of 60°C and treatment-B at 75°C.

Evaluation of smoked fish

The quality of the products was determined by organoleptic, biochemical, bacteriological evaluation and storage life.

Sensory assessment

Sensory methods were used to assess the degree of freshness based on organoleptic characteristics such as colour, odour, texture and flavour of smoked Thai pangas. The evaluation methods used in this study were based on one that is currently in use in various institution of the world (Larmond 1977). Representative samples were taken on a tray to assess the characteristics such as colour, odour and texture by organoleptic method.These characteristics were judged by five faculty members and were conducted as panel members the changes in organoleptic characteristics during storage of smoked pangas were assessed. Three of the samples from each treatment were kept in refrigerator (4°C) for organoleptic test or freshness test up to acceptable shelf-life at 2 days interval and one of the samples from each treatment were kept at ambient temperature for organoleptic test up to 14 days at every 24 hours interval.

Nutritive assessment

Chemical analysis

Proximate composition analysis of moisture, crude protein, lipid and ash were carried out according to the methods given in AOAC (1990). Salt content in the products was determined by using the following reagents viz, 0.05N Silver Nitrate (AgN03), 5% Potassium Chromate solution, and distilled water. TVB-N estimation in fish muscle was performed by using Perchloric acid (6%), NaOH (20%), Standard HC1 O.OlN, Boric acid (H3B03) 2°%), Phenolphthalein solution and Mixed indicator.

Total Plate Count

Standard plate count expressed as Colony Forming Units per gram (CFU/g) of fresh fish muscle and smoked fish fillets were determined by using consecutive decimal dilution technique using spread plates. Five (5) g sample was taken from fresh fish muscle and smoked fish products separately. The sample was homogenized in 95 ml sterile physiological saline solution (0.85% NaCl solution) in a sterile blender jar. Then blending was done for 2 minutes and the homogenate was transferred in a sterile sample bottle. One ml of the sample was transferred with a sterile micropipette to a sterile test tube containing 9.0 ml of 0.85% sterile physiological saline to a solution and test tube was shaken thoroughly on a vortex mixture machine in order to get 10^{-1} dilution of original sample solution. Using the similar process several dilutions of 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} and 10^{-}' were made. All plates in triplicates on sterile petridish were done on sterile nutrient agar media. The total plate count was determined as per methods described by (Fawole and Oso, 2001).

RESULT AND DISCUSSION

The average weight of the fish was 750±5 g which was reduced to 37 to 39 g after smoked treatment (Table 1). The appearance of smoked fish was shown in figure 1. The sensory evaluation score of two different smoked treatments at 60^{o} C and 75 ^{o} C are summarized in Table 2a and 2b. It was found that almost all panel members judges the smoked fish produce at 75^{o} C 'B' showed better in all sensory attributes and had an overall acceptability score of 8.54 in a nine point hedonic scale (Larmond, 1977).

Table 1
Treatment wise weight of whole fish, dressed fish, fish fillet, smoked fish and % of yield of whole fish.

Treatment	Mean Whole Fish wt(g)	Dressed fish wt (g)	Fillet wt (g)	Smoked fish wt(g)	Smoked fish as mean of %Yield of whole fish
A	750±5	424.75±26.40	367.5±26.90	299.37±20.94	39.00±2.0
B	750±5	412.5±32.73	363±29.89	276.87±31.5	37.00±1.0

Figure 1
Product of Treatment A and Treatment B.

Table 2a
General mean acceptability scores of smoked fish storage at refrigeration temperature at (4°C). No of samples A=6; B=6.

Storage days	Sensory parameters											
	Color		Flavor/odor		Texture		General appearance		Test		Mean of general acceptability	
	A	B	A	B	A	B	A	B	A	B	A	B
0	8.46	8.55	8.25	8.34	8.55	8.60	8.35	8.50	8.58	8.75	8.41	8.54
15	7.54	7.82	7.56	7.85	7.50	7.74	7.44	7.83	7.44	7.78	7.49	7.75
30	6.55	6.76	6.47	6.66	6.55	6.67	6.57	6.75	6.38	6.65	6.48	6.69
45	5.45	5.82	5.62	5.78	5.54	5.72	5.37	5.80	5.54	5.76	5.58	5.77
60	*3.9	4.78	*3.7	4.80	*3.3	4.70	*3.5	4.78	*3.6	4.78	*3.4	4.76
65	.....	*3.7	.....	*3.9	.....	*3.9	.....	*3.9	.....	*3.9	.....	*3.8

*Considered as rejected

Table 2b
General mean acceptability scores of smoked fish storage at ambient temperature (15-22°C); No of samples A=2; B=2.

Days of observation	Sensory parameters											
	Color		Flavor/odor		Texture		General appearance		Test		Mean of general acceptability	
	A	B	A	B	A	B	A	B	A	B	A	B
0	7.46	7.56	7.15	7.35	7.25	7.72	7.32	7.75	7.44	7.54	7.32	7.54
02	6.70	6.76	6.15	6.41	6.35	6.63	6.56	6.68	6.15	6.35	6.32	6.06
04	5.45	5.62	5.40	5.80	5.15	5.70	5.38	5.54	5.15	5.50	5.40	5.52
05	*3.0	4.85	*3.26	4.56	*3.25	4.55	*3.30	4.52	*3.25	4.56	4.27	4.59
06	.....	*3.65	.....	*3.46	.....	*3.75	.....	*3.50	.....	*3.46	.....	*3.56

*Considered as rejected

Two samples from each treatment (A &B) were kept at ambient temperature (15-22 °C) and rest of them stored at refrigeration temperature (4°C), for shelf life study. At 7 days of interval smoked sample were taken out from the refrigerator and their sensory quality was evaluated by panel members. Table 2a showing the changes in sensory quality on hedonic scale during 0 to 66 days of storage at refrigeration temperature (4°C). The overall acceptability of both samples showed significance changes up to 66 days of observation. However, after 66 days of storage all the sensory attribute were more or less changed and sign of quality deterioration were observed and overall acceptability scores of A& B products reduce and these values were regarded as rejected of the products due to fungal growth was observed.

Smoked sample were taken out from the polythene bags stored the ambient temperature and the sensory quality was evaluated by panel members table 2b showing the changes in sensory quality on a hedonic scale during 0 to 06 days of storage. After 06 days of observation the fungal growth was observed on all the treatment of smoked fish at ambient temperature and the flesh surface was covered with thick yellow slime. Therefore all the samples of smoked fish were rejected by the panelists.

Modern smoked products need to be stored at ambient temperature of 0-5 °C, where they can be kept for 1-4 weeks, can be kept frozen and -20 °C until needed (Philip, 1981). Smoked product in this study were prepared at moderate (60 °C) and at high temperature 75 °C and result of the present

study indicated that the product could be stored at refrigerated temperature for six to ten weeks.

Proximate composition

The initial proximate composition of pangas was estimated (data not shown). In this case, the edible fish flesh from the fresh pangas showed the value of 71.25, 16.75, 10.55 and 1.45% for moisture, protein, lipid and ash respectively.

Table 3
Analysis of proximate composition of smoked fish at different days of storage at ambient temperature.

Days of observation	Sample no	Proximate composition			
		Moisture%	Protein%	Lipid%	Ash%
00	A	68.85	18.55	9.55	1.52
	B	67.80	19.40	10.25	1.58
02	A	67.65	19.55	10.15	1.64
	B	67.10	19.90	10.56	1.60
06	A	67.51	19.46	10.90	2.85
	B	67.65	18.84	10.65	2.12

Table 4
Analysis of proximate composition of smoked fish at different days of storage at refrigeration temperature (4^{o}C).

Days of observation	Proximate composition							
	Moisture%		Protein%		Lipid%		Ash%	
	A	B	A	B	A	B	A	B
0	69.85	69.05	18.27	18.85	10.15	10.30	1.65	1.38
07	69.65	68.74	18.35	18.98	10.25	10.15	1.56	1.56
15	68.25	69.93	18.85	18.68	10.89	10.86	1.54	1.64
30	68.55	69.75	18.76	19.04	10.76	10.56	1.76	1.86
45	68.10	69.05	19.05	19.15	10.64	10.34	1.88	1.98
60	67.45	68.84	19.14	19.07	10.08	9.98	2.06	2.36
65	.....	67.10	.....	19.04	.....	9.95	.....	2.15

Moisture content

The initial moisture content of fresh pangas fish was 72.82%. The changes in moisture content of smoked pangas fish tissues of the two different types of products during storage at ambient and refigeration temperature are presented in table 3 and 4 where the moisture content was found to show no significant change during the six days of storage period. During the 45^{h} days of observation the moisture content was 68.10%, and 67.05% in A and B respectively. However, there was only a small change of moisture content observed during the storage in refrigeration condition on different days of observation. This study is in accordance with the findings of Gopal (2005). Nketsia and Sefa-Dedeh (2000) determined the moisture content of the smoked fish products ranged from 11.70% to 69.20% which is within the range of the present study. The present study of smoked pangas agrees with the moisture content with the other reports (Borgstrom, 1965; Kosygin, 2001) with some difference which might be due to variation of smoke temperature and storage condition.

Protein content

The initial protein content of fresh pangas fish was 16.85%. During the 45th days of observation the protein contents were 19.05 and 19.05% in A & B respectively. However, there was found no significance change of protein content during the storage at refrigeration condition on different days of observation in both treatment A and B. Chakraborty et al., (1997) 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. Kosygin (2001) found that protein content on dry basis ranged from 74.75%

to 79.25% in six smoked hill stream fishes. The present study showed smoked pangas having a reasonable protein content which was similar to the studies with other authors. A study by Gopal (2005) with pangas *(Pangasius hypophthalmus)* showed that medium hot smoked pangas had protein content of 20.18% on l^{st} day and 20.45% on 21^{st} day of observation with the product prepared by dipping in saturated brine. This study with pangas also agrees with the findings of the above study. In another study, Mohsin (2008) reported that the initial protein content of pangas fish fillet was 16.58% whereas after the smoking process the protein content was found to be 20.50%, 21.07% and 21.20% on three different treatments having a dip of 10% salt, 25% salt and 25% spice treated saturated salt solution during 30 days of observation.

Lipid content

The initial lipid content of fresh pangas fish was 8.88%. During the 45^{th} days of observation the lipid content was 10.64 and 10.34.10 in A and B respectively (Table 3 & 4). This small variation of lipid content might be due to the complex biochemical process of salting in and out during this small ripening period. The presence of higher amount of lipid in the smoked products might be one of the reasons of such small shelf-life of fish. Borgstrom, (1965) also reported that lipid content of hot smoked herring was 15.20%. Nketsia and Sefa-Dedeh (2000) determined the fat content of the smoked fish and obtained the values between 7.20-19.00% which shows the similar values of this study. Kosygin, et al., (2001) found that lipid content ranged from 9.00-14.50% in six smoked hill stream fishes.

Ash content

The initial ash content of fresh pangas fish was 1.45%. During the 45^{ffi} days of observation the ash content was 1.88% & 1.98% in A& B respectively (Table 3 & 4). Kosygin, et al., (2001) in his experiment found that ash content on dry basis ranged from 5.02-7.00% in six 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 1.39-1.60% in different days of observation of the product in refrigeration storage. Rahman (1997) reported that the ash content in raw fish was 1.68% which increased up to 18.92% on 14^{th} days, 15.48% on 49^{th} days and 18.97% on 56^{th} days of observation in a salted hilsa.

Salt content

The salt content values were 5.37% in treatment `A' and 6.80 % in treatment `B' (Table 5). The initial salt content of fresh pangas fish was 0.01%. During the 45^{nd} days of observation the salt content was found to be 5.34% and 6.91 % in A & B respectively. Borgstrom, (1965) reported that sat content was 2-3% in hot smoked herring which is in agreement with the present study. Study done by Gopal (2005) with pangas *(Pangasius hypophthalmus)* showed that medium hot smoked pangas fish had the salt content values ranging between 2.22% and 2.38% in different days of observation of the smoked product in refrigerator storage.

Total Volatile Base Nitrogen (TVB-N)

The TVB-N (mg/100g) values at different days were found to be changed in an increasing rate at ambient temperature on 6 days of storage period (Table 7). The TVB-N value of fresh fish was found to be 4.14 mg/ 100g fillet. During the 45th days of observation the TVB-N values increased up to 27.65 and 25.55 (mg/100g) in A & B respectively (Table 6). Study conducted by Gopal (2005) with pangas *(Pangasius hypophthalmus)* showed that medium hot smoked pangas had TVB-N (mg/100g) values ranging 6.04-18.12 in 21 days of observation of the product in refrigerator storage. This study with pangas also agrees with the findings of the above study.

Bacterial load of smoked products

On 0 day bacterial load in smoked fish fillets of Treatment A was found $1.5x\ 10^4$ CFU/g and Treatment B was $1.50\ x10^1$ whereas, the smoked fillets in A and B on the 5^{th} and 6^{h} day at ambient temperature was $3.5\ X\ 10^7$, and $2.80X\ 10^3$ CFU/g respectively (Table 8, 9). The total bacterial load on 5^{th} and 6^{th} day of observation in treatment A and B was found to be increased significantly with the lapse of time and reached maximum at

unacceptable limit and than it was considered as spoiled. During storage of smoked fish at refrigeration temperature (4°C) the bacterial load on the 42nd days of observation was 2.98 X 10^5 and 4.10 X 10^3 CFU/g in the treatments A & B respectively. However, it is observed that the increase of bacterial population in all the treatments with the increases of time at refrigeration temperature (4°C). A study by Kolodziejska et al., (2002), on determination of microbial status the aerobic plate count after smoking, chilling and packing in bags was observed at I st week as 1.66x 10^3 CFU/g in the fresh fish and 1.25 X 10^5 CFU/g in flesh which remained as such for 3 weeks at 2°C, while after 14 days at 8°C, the bacterial population of the fresh flesh was 1.86X 10^7 CFU/g. Microbial count of the fish flesh did not increase up to 21 days at 2 and 8°C. Salim (2005) reported that fresh pangas had initial bacterial load of 1.56 X 10^5 CFU/g and after smoking the bacterial load increased to about 2.92x108 CFU/g during 21 days of storage at refrigeration temperature (4°C).

Table 5
Changes in salt content of smoked pangas in the treatment A and B during storage at refrigeration temperature (4°C).

Days of observation	Salt content (Nacl %)	
	A	B
0	5.37	6.80
15	5.30	6.88
45	5.34	6.91
60	5.40	6.87

Table 6
Changes in Volatile Base Nitrogen (TVB-N) content of smoked pangas in the treatment A and B during storage at refrigeration temperature (4°C).

Days of observation	TVB-N(mg/100g)	
	A	B
0	4.29	5.21
15	16.58	15.52
45	27.65	25.55
60	30.95	27.85
66	.....	32.05

Table 7
Changes in Volatile Base Nitrogen (TVB-N) content of smoked pangas in the treatment A and B during storage at ambient temperature

Days of observation	TVB-N(mg/100g)	
	A	B
0	4.14	5.31
02	16.58	15.72
03	27.65	24.55
04	30.95	28.85
06	-------	32.05

Smoked pangas prepared from different concentration of temperature showed a shelf-life of less than 10 days at ambient temperature. The smoked fish stored at refrigerated temperature had longer shelf-life of 50, 56, 60, 66 days in treatments G, E, F, A, C and B respectively showing the best `B' which had 66 days of shelf-life with all its sensory qualities as g.

Table 8
Changes in Total Bacterial count (APC) of smoked Thai Pangas *(Pangasius hypopthalmaus*) during storage at ambient temperature.

Days of Observation	Treatment A		Treatment B	
	CFU/g	Log CFU/g	CFU/g	Log CFU/g
0	1.50 x10^4	4.18	1.50 x10^1	1.18
5	2.98 x10^5	5.47	1.95 x 10^2	2.29
6	3.50 x10^7	7.54	2.80 x10^3	3.45

Table 9
Changes in Total Bacterial count (APC) of smoked Thai Pangas (*Pangasius hypopthalmaus*) during storage at refrigeration temperature.

Days of Observation	Treatment A		Treatment B	
	CFU/g	Log CFU/g	CFU/g	Log CFU/g
0	1.50E+04	4.18	1.50E+01	1.18
14	2.10E+04	4.32	3.10E+02	2.49
42	2.98E+05	5.47	4.10E+03	3.61

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