Effect of Salt and Garlic on the Quality and Microbial Content of Smoked Catfish *(Pangasianodon hypophthalmus)*

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Abstract

The purpose of this research was to determine quality and microbial content of smoked catfish (*Pangasianodon hypophthalmus*) using salt and garlic in two treatments—T_1 (10% salt) and T_2 (10% salt and 10% garlic). Smoked catfish samples subjected to bio-chemical and microbiological analysis were observed by changes in moisture, protein, fat, ash, total volatile nitrogen (TVN) value, total viable count (TVC), and total coliform, *E. coli* and *Salmonella*. Protein, fat, ash, TVN percentage of T_2 was 53.71±0.35, 17.67±0.40, 7.87±0.13 and 7.57±0.13, respectively which was higher than T_1 (48.65±0.67, 14.39±0.62, 7.56±0.92 and 6.47±0.65, respectively). Besides, moisture percentage and TVC of T_2 (24.59±0.82 and 50 cfu g^{-1}) was lower than T_1 (42.91±1.02 and 60 cfu g^{-1}). Total coliform, *E. coli* was <3 MPN g^{-1} and *Salmonella* was absent in both the treatments. As a result , moisture and fat content shows inverse relationship which is similar to T_2 and was the best

1. Introduction

In Bangladesh, about 63% animal protein of meal comes from fish resources (Ahmed, 2005) which is composed of 260 freshwater native species, 12 species of exotic fish, 24 species of freshwater prawn, 475 marine fish species and 36 species of marine shrimp Haque et al., 2005). Fish proteins containing all of the essential amino acids (EAA) in right proportion and is needed for proper growth and development of the animal body. Fish tissue is characterized by rich in protein substance but low in carbohydrate resulting in high post-mortem pH (<6). Further the pelagic fatty fish have a high content in lipid consisting mainly of triglycerides with long chain fatty acid which are highly unsaturated. Also the phospholipids are highly unsaturated and these circumstances have important consequence for spoilage process under aerobic storage condition. Fish have rich source of essential nutrients required for supplementing both infant and adult diets (Abdullahi et al., 2001). Fish also contain many vitamins and minerals. It is an extremely perishable food. Quality loss can also occur very rapidly after catch (Zakhia, 2002). Processing is carried out with the aim of either to supply distant markets or to produce a range of products with different flavor and texture. Of all food preservation methods, drying has received the most widespread and enthusiastic publicity in recent years (Calicioglu et al, 2002). Smoking is a method of preserving fish which involves cooking, drying, and smoking (Clucas and Ward, 1996). This method combines six important effects in fish and shrimp muscle. Fire producing smoke can generate heat and dry the fish and thus reduce the water activity so that the microorganisms cannot survive. Hot smoking cooks the flesh and thus destroys enzymes and kills the bacteria. Wood smoke contains compound like phenol which kills bacteria. Wood smoke contains compound that acts as antioxidant. Smoking makes the product highly acceptable bright brown and reddish color. Besides, wood smoke gives highly relished characteristic smoke flavor (Horner, 1992). One-third of the cured fish is smoked and about 20% of the smoked fish goes into international market. Smoking of fish and/or meat products is one of the most ancient processing technologies. It has been used for preservation and is still widely used by several communities in the third world where up to 70% of the catch is smoked for preservation. In industrialized countries, however, smoking of fish is done for enhancement

of flavor and texture; often producing value added products whose preservation is achieved by other means. Nutritionally, fish proteins are noted for a high degree of digestibility and as a rich source of lysine and sulfur containing amino acids. Much attention is being directed at fresh water fish because of its health benefits, as a result of the presence of omega-3-fatty acids in the fish oil (Vileg and Body, 1988; Negbenebor, 1990). The reduction of these losses can only be achieved by systematic improvements in handling, processing, storage and distribution (FAO, 1992). *Pangasianodon hypophthalmus* is commonly known as *Pangas* in Bangladesh, belonging to the family Pangasiidae, under the order Siluriformes. According to Roberts and Vidthayanon (1991), the origin of *P. hypophthalmus* is the Mekong river of Vietnam to the Chao Phraya River to Thailand; subsequently it was spread over other countries such as Malaysia, Indonesia and China. According to David (1962) *Pangasius* sp. is highly tolerant to salinity, pH, dissolved oxygen, temperature or even pollution. *P. hypophthalmus* is well accepted by a wide range of people and therefore, it has been a good source of protein and calorie for poor, medium and better-off people in rural as well as urban areas. Any fish can be smoked, but species with high fat content such as catfish is most suitable because they absorb smoke faster and have better texture than lean fish, which tend to be dry and tough after smoking (Swastawati, 2008). In Bangladesh, a lot of works were done on drying (Ahmed, 1979; Akter, 2009), salting (Islam, 2007) and freezing (Mazumder, 2008) of fish but a few works were done on smoke curing and that too on catfish. On the other hand, smoke curing is a method which is not affected by climatic condition as well as the smoke cured product has a special taste and color. It also has worldwide acceptability as processed fish. Therefore, the purpose of this research was to determine the effects of salt and garlic on the quality of smoked Pangus.

2. Materials and Methods

Fresh Pangus fish were collected from the aquarium of the Fish Technology Laboratory, Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research, Dhaka. Fish were in the aquarium for two years from December, 2009 to December, 2011 which were grown up by aquarium feed. Average weight of the fish was 11 inches. After cleaning and cutting fish were dipped in the solution for about two hours and were made ready for smoking . 750 g fish were taken for two treatments and were soaked in 300 ml of distilled water with the associated ingredients. Temperature and relative humidity (RH) inside and outside the drying box were recorded carefully by thermometer and Hare Hygrometer, respectively. Fish were arranged on S-shape hooks, through gills by rods, split, and simply laid on rock. Regular nails, eight or 10 gauge steel wires, S -shaped iron hooks or round wooden sticks were used for curing the fish. Non -resinous (hickory, oak, maple, etc.) wood chip or saw dust was fired to produce constant volume of smoke on the ground. Danger of fire was minimized through ventilation that was controlled to promote smoke rather than flames. Alternative method was that fire may be built in covered pit or trench outside the chamber. Smoke was generated into the bottom of smoking chamber via tile on stove pipe. The sample was cut into very small pieces to test various examinations. One cluster was composed of 10% salt as treatment-1 (T_1) and another cluster was composed of 10% salt and 10% garlic as treatment-2 (T_2). The following observations were made for assessment of bio-chemical composition and microbiological parameters of smoked Pangus (*Pangasianodon hypophthalmus*).

- Moisture and ash contents of the fish were determined by AOAC method (1975).
- Crude protein was assessed by micro-Kjeldhal method (Pearson, 1999).
- Fat content was determined by Bligh and Dryer method (1959).
- TVN value was determined by the modified Conway micro-diffusion technique (Conway and Byrne, 1933). The volatile base produced during post-mortem changes in fish and their increase in concentrations indicate fish spoilage.
- Microbiological quality assessment was done by the standard plate count obtained by pour plate method (ICMSF, Thailand, 1988).

3. Results and Discussion

Comparative studies of qualities between three treatments were done by several parameters, such as bio-chemical composition (Table 1), TVN, amount of calcium and microbial aspects, i.e. TVC, total coliform, *E. coli*, *Salmonella*, etc.

From Table 1 it can be observed that T_2 has the highest amount of fat, protein, ash percentage due to water loss during smoking. In addition the least amount of moisture percentage was found in T_2. Besides, T_1 contains highest amount of Ca but lowest amount of TVN value when compared with T_2. Smoking reduced the protein content of fish while simultaneously increased the fat content. Audrey Morris et al. (2006) observed that smoking has been known to cause nutrient loss due to associated heat flow of gases and interaction of the smoke components with protein. Similar findings were reported by Bhuiyan et al. (1986) in Atlantic mackerel and Unlusayin et al. (2001) in European eel, pike perch and rainbow trout. For industrial specifications for ''smoked finished products'' generally it is recommended with water content in

Table 1: Bio-chemical composition of two treatments in smoked fish

Treatment	Moisture g (%)	Fat g (%)	Protein g (%)	Ash g (%)	Calcium mg (%)	TVN N 100 g^{-1}
T_1	42.91±1.02	14.39±0.62	48.35±0.67	7.56±0.92	1.70±0.19	6.47±0.65
T_2	24.59±0.82	17.67±0.40	53.71±0.35	7.81±0.35	1.45±0.14	7.57±0.13

the fish flesh of less than 65% (Cardinal et al., 2001). Goulas and Kontominos (2005) reported that the moisture content of smoked chum Mackerel samples were 58.1 and 59%. Lowest moisture content in T_2 indicates that it was resistant to enzymatic and microbial activities and qualities which might have lengthened the shelf life. According to BSTI (1982), the increased moisture content of dried fish above 15% favors the growth of mould and insect infestations which in turn accelerate the spoilage. According to Waterman (1976), bacterial action stops at 25% water content and mould action increased at 15% water content. TVN value which helps to measure the level of fish spoilage is used widely to explore the shelf life of fish. It clearly indicates that T_1 had the qualities that supported a longer shelf life to the products. More salt was penetrated into T_1. Table 2 gives an account of microbial content.

From Table 2 it is observed that TVC was less in T_2 than T_1. In case of total coliform and *E. coli* the result was same and *Salmonella* was absent in both of them. Hood et al. (1983) reported that microbial load increases with duration of storage and temperature. Salan et al. (2006) observed that smoking inhibits microbial growth in stored fish products. Results reveal that use of salt and garlic together yielded best outcome compared to the salt alone as it retained the more useful nutrient property, lower moisture, higher fat, ash and protein. Salt removed water from fish body and thus helped through smoking, whereas the salt and garlic not only removed water from fish but also added some nutrients that prevented the growth of moulds and bacteria due to the creation of an unfavorable expansion medium retaining the good taste. So, Treatment-2 (T_2) may be suggested for table use as a good eminent ready food item after conducing some field trials.

Table 2: Microbial conditions of three treatments of smoked fish

Parameters	T_1	T_2
TVC (cfu g^{-1})	60	50
Total coliform (MPN 100 g^{-1})	<3	<3
E. coli (MPN 100 g^{-1})	<3	<3
Salmonella (25 g^{-1})	Absent	Absent

TVC=Total volatile count; MPN= Most probable number

4. Conclusion

It can be concluded that dipping in a concentration of salt and garlic before smoking improves overall quality and shelf life of catfish.

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