

## Study on the quality and safety aspect of four types of smoke-dried Chapila (*Gudusia chapra*; Hamilton-Buchanan, 1822) fish

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### Abstract

This study was carried out to know the effects of smoke-drying on the sensory characteristics, water reconstitution time, biochemical aspects and microbiological quality of freshwater SIS fish chapila, treated with four different treatments namely; Unsalted, Salted, Salt+Turmeric and Salt+Garlic. In addition, yield after processing were determined. In fresh process condition water reconstitution rate was faster in Salted products but slower in unsalted products. Biochemical composition such as moisture, protein, fat, ash salt and TVB-N value of Unsalted, Salted, Salt+Turmeric and Salt+Garlic treated smoke-dried chapila fish were in the range of 5.31±0.02%-12.36±0.04%, 45.24±0.05%-46.47±0.04%, 29.05±0.03%-32.05±0.05%, 10.83±0.02%-19.92±0.03%, 3.06±0.02%-3.75±0.02% and 4.09±0.04-6.39±0.03 mgN/100g respectively. The TVC of four types of smoke-dried chapila fish samples ranged from 1.8×10<sup>3</sup> to 3.3×10<sup>4</sup> cfu/g. The results of the studies indicated that all types of smoke-dried chapila fish products were excellent in terms of sensory characteristics and food quality aspects.

**Keywords:** Chapila, smoke-drying, water-reconstitution, bio-chemical composition, microbial-quality

### 1. Introduction

Fish is the third largest commodity consumed globally after rice and vegetables [1]. Like other countries, it contributes significantly to the livelihood baskets in Bangladesh. Fisheries items are the major protein source of Bangladesh which contributing 58% of the nation's animal protein demands [2]. Small indigenous species (SIS) which are nutrient-dense and often overlooked in developing nations abound in it together [3]. Earlier, they were said to be miscellaneous fish, but nowadays, it is admired in all classes of society. Specially, these indigenous small fish play an important role in alleviating malnutrition problem that specially existing among the poorer people of Bangladesh. In Bangladesh, large losses of fish occur due to spoilage every year. Huge losses of fish occur primarily due to rough handling and transportation which aid to heavy contaminates of fish and due to lack of refrigeration for arresting the growth of the spoilage contamination. Spoilage set in because fish is susceptible to microbial and enzymatic deterioration and quality reduction occur, if proper steps are not applied to process the fish [4]. It has become increasingly important to ensure that fish once caught is fully and efficiently utilized to avoid deterioration.

Among the several methods of long term preservation of fish, smoking is perhaps the simplest method as it does not require sophisticated equipment or highly skilled workers [5]. Smoking as a method of preservation produces commonly acceptable products since it imparts desirable color and flavor. In Bangladesh smoked fish is recent addition to the fishery products and preservation of SIS fish is a new trend or new kind of research activities in this country. Among the commercially important variety of Bangladeshi freshwater

small indigenous species (SIS) of fish, chapila (*Gudusia chapra*) fish is a table fish preferred and consumed by all the economic group of people which has been selected for the present research work. As this type of SIS fishes are mostly eaten whole with bones, they are also a very high content of bioavailability of protein, calcium, vitamin A, Iron and Zinc which can play an important role in elimination of malnutrition problem in Bangladesh. So, chapila (*Gudusia chapra*) fish would probably be good quality smoke-cured fish products to be introduced publicly in the country.

The objective of this study is to ascertain the effects of smoke-drying methods in chapila fish using four different treatments (Unsalted, Salted, Salt+Turmeric and Salt+Garlic) and their nutritional properties.

### 2. Materials and methods

#### 2.1 Sample Collection

Freshwater fish species, chapila (*Gudusia chapra*) was collected from the Meghna River early in the morning. Fresh mature fish samples were transported to laboratory in sterile polythene bag to avoid any type of microbial contamination.

#### 2.2 Place of Experiment

The whole experiment was carried out at the laboratory of Fish Technology and Food Microbiology Section of the Institute of Food Science and Technology (IFST) of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhanmondi, Dhaka.

#### 2.3 Preparation of Sample

At first, the collected chapila fish was discaled and gutted and washed properly with clean water. The dressed fish samples

were then weighed and prepared for further processing.

**2.4 Preparation of Samples for Processing**

Four treatments were conducted on the dressed fish samples. In the 1<sup>st</sup> treatment, Unsalted (US) fish were used in the preparation of the smoked product. In the 2<sup>nd</sup> treatment, brine containing 30% salt was used (S), whereas the 3<sup>rd</sup> and 4<sup>th</sup> treatment contained brine 30% Salt with 10% Turmeric solution (S+T) and brine containing 30% Salt with 30% Garlic solution (S+G) respectively. After that the fish samples in treatments 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> were kept immersed into solution for each experiment in separate plastic buckets for 20 minutes.

**2.5 Fish Smoke-Drying**

The fishes were smoked in improved traditional type of smoking kiln [6]. The fish smoking kiln was operated by first loading tamarind wood chips and rice-husk into the heat chamber, preheating for some minutes and then loading the fish-samples onto removable wire mesh trays in its central chamber for the smoking process. The desired temperature (70-75°C) was maintained manually. Smoking was done approximately for 4 hours. During the smoking fish samples were turned upside down in the middle period, to make the sample smooth and steady in texture and appearance. The smoked fishes showed characteristic attractive golden brown color and acceptable texture with smoky flavor, which was followed by cooling for 20-30 minutes at ambient temperature to make fish muscle compressed and facilitate to prevent breaking of smoked products. After that cooled chapila fish samples at room temperature were weighed for getting the amount of yield.

**2.6 Sampling Procedure**

3 or 4 slice of experimental fishes was taken randomly which represented the parts from whole body of the fish. Then the slices were chopped with skin and bone and finally ground with an electric blender to make a homogenous sample before being sampled for analysis. Triplicate experiments were conducted for analysis.

**2.7 Water Reconstitution Behavior**

Accurately weighed 5 g of smoke-dried fish samples were taken and weighted by analytical balance and then immersed in water at 30°C and 60°C respectively. The fish samples were kept under water for 15, 30, 45 and 60 minutes. Any

loose muscle that attached to sample was removed before dipping in water. After every 15 minutes the fish sample were removed from water and the surface water was removed with blotting paper and reweighed and dipped into water of the respected beaker. During the soaking time, the fish muscle could reabsorb maximum amount of water.

The percentage of water uptake in smoke-dried fish samples was calculated as follows

$$\% \text{ Water reconstitution} = (W_r - W_i) / W_i \times 100$$

Initial weight of the dry fish =  $W_i$ , Weight of dry fish after reconstitution =  $W_r$ ,

$$\text{Water reconstitute} = W_r - W_i,$$

**2.8 Biochemical Analysis**

The analytical methods are given below:

- Physical changes were assessed by the sensory method as described by Larmond [7].
- Moisture, fat, ash and salt contents of the fish were determined by AOAC method [8].
- The crude protein of the fish was determined by Micro-Kjeldahl method [9].
- TVB-N using Conway modified micro-diffusion technique [10].
- Microbiological analysis was done according to the standard methods of AOAC [11].

**2.9 Statistical Analysis**

Data were analyzed by using SPSS for windows-20 statistical programme.

**3. Results & Discussion**

**3.1 Physical proportions of four types (US, S, S+T & S+G) of smoke-dried chapila fish and their different yield during smoke-drying:** In present experiment percent of yield from total weight of Unsalted (US), Salted (S), Salt+Turmeric (S+T) and Salt+Garlic (S+G) treated smoke-dried chapila fish was 24.08, 26.31, 27.01 and 26.49% whereas percent of yield from dressed fish was 32.27, 32.42, 32.23 and 31.54% respectively (Table-1). Similar experiment done by Debnath with thai pangas (*Pangasius hypophthalmus*); Hossain with Tilapia (*Oreochromis niloticus*); Hossain with Silver Carp (*Hypophthalmichthys molitrix*) and Rayhan with Thai Pangas (*Pangasius hypophthalmus*) obtained an yield of 37.56%, 36.22%, 39.5% and 38% smoked fish from whole fish respectively which is more or less similar with the present findings [12, 13, 14, 15].

**Table 1:** Physical proportions of the experimental chapila fish treated with four (US, S, S+T, S+G) different treatments during smoke-drying

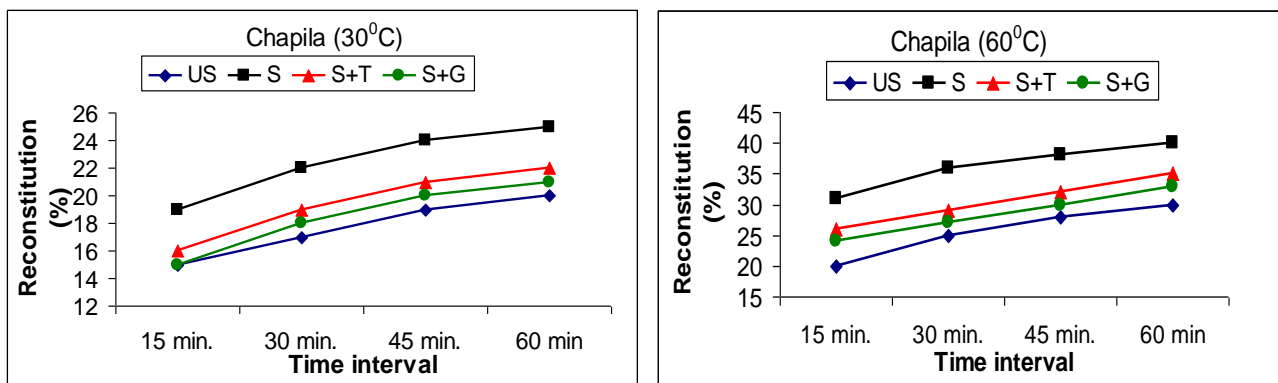
Treatment	Total weight of fish (g)	Dressed fish weight (g)	Weight after dip in 30% salt solution for 20 minutes (g)	Weight after dip in Salt(30%)+ Turmeric (10%) solution for 20 minutes (g)	Weight after dip in Salt(30%)+ Garlic(30%) solution for 20 minutes (g)	Weight after smoke drying (g)	Weight loss during smoke-drying (%)	% of yield from total weight of fish	% of yield from dressed fish
Unsalted	10000g (10 kg)	7462	-	-	-	2408	67.73	24.08	32.27
Salted	10000g (10 kg)	8115	7678	-	-	2631.1	65.73	26.31	32.42
Salt+ Turmeric	10000g (10 kg)	8379	-	8118	-	2701	66.73	27.01	32.23
Salt+ Garlic	10000g (10 kg)	8399	-	-	8177	2649.2	67.60	26.49	31.54

**3.2 Water reconstitution behavior of Unsalted (US), Salted (S), Salt-Turmeric (S+T) and Salt-Garlic (S+G) treated smoke-dried chapila fish in fresh process condition:** Percentage of water absorbed by dried fish at a certain temperature and time is called water reconstitution. It is one of the most important physical parameters to assess the quality of the dried products [16]. For this reason, reconstitution properties of any processed fish food are used to monitor of its ability to go to its original form by absorbing water. In practice, the processed fish food samples which absorb maximum percent of water in the same period of reconstitution are considered to be the best possessed fish product.

Water reconstitution behavior of four (US, S, S+T and S+G) types of freshly processed smoke-dried chapila fishes soaked in water temperature at 30°C and 60°C for 15, 30, 45 and 60 minutes are presented in Figure -1 respectively. It can be observed from this Figure that as the temperature of the soaking water increased, the rate of reconstitution also

increased. This is might be due to the fact that increased temperature of soaking water opens the structure of fish products which favor the rapid reconstitution. This is an agreement with the findings of Saha and Hossain who worked with dried sword fish (*Lepturacanthus savala*) [17]. Besides, initial uptake of 60°C water was comparatively higher than that of the 30°C water. This is because heat help in easy absorption of water in fish fiber [16]. In present study, comparatively slower reconstitution rate was observed in the later stage of reconstitution period of all four types of freshly processed smoke-dried chapila fish samples. Similar trend of slower reconstitution rate in the later stage was observed by Ituen *et al.*; Mansur *et al.*; Haque *et al* in dried products [18, 19, 20].

Present findings showed that among the four types (US, S, S+T, S+G) of freshly processed smoke-dried chapila fishes, reconstitution rate was faster in Salted smoke-dried fish samples whereas slow in Unsalted (US) smoke-dried fish samples.



**Fig 1:** Water reconstitution behavior of freshly processed Unsalted (US), Salted (S), Salt-Turmeric (S+T) and Salt-Garlic (S+G) treated smoke-dried chapila fish soaked in water at 30°C and 60°C during different time intervals

**3.3 Sensory Evaluation:** The sensory characters of four types (Unsalted-US, Salted-S, Salt+Turmeric-S+T and Salt+Garlic-S+G) of smoke-dried chapila (*G. chapra*) fish were evaluated on the basis of the color, odor, texture and remarks which are presented in Table 2. The smoke determines the color which is one of the qualities

that attracts consumers. Clucas stated that the color ranges from black, dark brown, golden brown or light brown to dirty white [21]. In fresh process condition the remarks of all the smoke-dried products were considered excellent. Moreover, there was found no broken parts of the experimental fish after four types (US, S, S+T and S+G) of smoke-drying process.

**Table 2:** Sensory evaluation of four types (US, S, S+T, S+G) of smoke-dried chapila (*G. chapra*) in fresh process condition

Product	Color	Flavor/Odor	Texture	Remarks
US	Bright golden brown	Fresh smoky flavor	Firm & semi-elastic	Excellent
S	Bright golden brown	Fresh smoky flavor	Firm & semi-elastic	Excellent
S+T	Bright yellowish brown	Fresh smoky turmeric flavor	Firm & semi-elastic	Excellent
S+G	Bright golden brown	Fresh smoky garlic flavor	Moderately firm & semi-elastic	Excellent

**3.4 Bio-chemical Composition:** Biochemical composition of fresh and freshly processed Unsalted (US), Salted (S),

Salt+Turmeric (S+T) and Salt+Garlic (S+G) treated smoke-dried chapila (*G. chapra*) fish products are given in Table 3.

**Table 3:** Biochemical composition of fresh and freshly processed Unsalted (US), Salted (S), Salt+Turmeric (S+T) and Salt+Garlic (S+G) treated smoke-dried chapila (*G. chapra*) fish products

Experimental fishes	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Salt (%)	TVB-N mgN/100g
Fresh fish	76.41±0.02	10.53±0.03	11.62±0.03	1.50±0.03	*	2.40±0.03
US	12.36±0.04	45.25±0.03	32.05±0.05	10.83±0.02	*	6.39±0.03
S	5.31±0.02	46.47±0.04	29.05±0.03	19.92±0.03	3.75±0.02	4.29±0.03
S+T	6.21±0.03	45.93±0.04	30.81±0.03	18.95±0.04	3.06±0.02	4.65±0.03
S+G	6.77±0.08	45.24±0.05	30.52±0.02	18.71±0.03	3.11±0.02	4.09±0.04

Values are shown as mean ± standard deviation of triplicate measurements

In present study, fresh and freshly processed US, S, S+T and S+G treated smoke-dried chapila (*G. chapra*) fish products moisture (%) content were  $76.41 \pm 0.02\%$ ,  $12.36 \pm 0.04\%$ ,  $5.31 \pm 0.02\%$ ,  $6.21 \pm 0.03\%$  and  $6.77 \pm 0.08\%$ ; protein (%) content were  $10.53 \pm 0.03$ ,  $45.25 \pm 0.03\%$ ,  $46.47 \pm 0.04\%$ ,  $45.93 \pm 0.04\%$  and  $45.24 \pm 0.05\%$ ; fat (%) content were  $11.62 \pm 0.03\%$ ,  $32.05 \pm 0.05\%$ ,  $29.05 \pm 0.03\%$ ,  $30.81 \pm 0.03\%$ , and  $30.52 \pm 0.02\%$ ; ash (%) content were  $1.50 \pm 0.03\%$ ,  $10.83 \pm 0.02\%$ ,  $19.92 \pm 0.03\%$ ,  $18.95 \pm 0.04\%$  and  $18.71 \pm 0.03\%$ ; TVB-N content were  $2.40 \pm 0.03$ ,  $6.39 \pm 0.03$ ,  $4.29 \pm 0.03$ ,  $4.65 \pm 0.03$  and  $4.09 \pm 0.04$  mgN/100g of fish respectively. On the other hand, salt (%) content of S, S+T and S+G treated smoke-dried chapila (*G. chapra*) fish products were  $3.75 \pm 0.02\%$ ,  $3.06 \pm 0.02\%$  and  $3.11 \pm 0.02\%$  respectively. Borgstrom reported that salt content was 2-3% in hot smoked herring [22]. Kabir investigated that freshly processed salted smoke dried Kajuli (*Ailia coila*) fish had salt content of 4.9% [23]. Nketsia and Sefa-Dedeh determined the salt content of the smoked fish products ranging between 0.4 to 1.2% which is more or less similar with the present findings [24]. In comparison of fresh fish, four types of smoke-drying process resulted in a significant decrease in moisture (%) content and a significant increase in protein, fat, ash and TVB-N content in smoke-dried chapila (*G. chapra*) fish products. The moisture levels in all the smoke-dried fishes examined were below 20% (Table-3) which is good or acceptable for smoke-dried fishes suggested by Lilabati and similar result was also found by Hei and Sarojnalini in some smoke-dried hill stream fishes ( $9.36 \pm 0.01$ - $15.77 \pm 0.02\%$ ) and Akinwumi in smoked *Clarias gariepinus* ( $5.885 \pm 0.034$ ) [25-27]. Fapohunda and Ogunkoya reported that smoke drying methods increased the protein, ash and fat contents of *C. gariepinus* which is in line with the present research work [28]. Increase in fat content could be the result of evaporation of moisture contents which is in agreement with the previous works of Chukwu and Shaba; Islam; Daramola *et al.*; Bouriga *et al.*; Bilgin *et al.*; Ezemba and Onwuka [29-34]. According to Salama and Ibrahim Unsalted smoke-dried grass carp fillets samples had ash content of 9.00% which is more or less similar with unsalted Smoke-dried chpila fish products [35]. An increase of TVB-N after smoking was most likely caused by an autolytic process which produces volatile amine compounds [36]. Similarly Vasiliadou *et al.* and Ezemba and Onwuka also observed an increase in the TVB-N value after smoking [37, 34].

**3.5 Microbiological analysis (TVC):** Total viable count (cfu/g) of fresh and freshly processed Unsalted (US), Salted (S), Salt+Turmeric (S+T) and Salt+Garlic (S+G) treated smoke-dried chapila (*G. chapra*) fish products are given in Table 4.

Total viable count (cfu/g) of fresh and freshly processed US, S, S+T and S+G treated smoke-dried chapila fish were  $3.1 \times 10^5$  cfu/g,  $3.3 \times 10^4$  cfu/g,  $3.7 \times 10^3$  cfu/g,  $1.8 \times 10^3$  cfu/g and  $2.0 \times 10^3$  cfu/g respectively. Bacterial growth is the main cause of fish spoilage; therefore it is logical to use bacterial number as an index of fish quality. Surendran *et al.* observed that the acceptable limit for bacterial count is  $5 \times 10^5$  cfu /g for fresh fish [38]. The limit for TVC is  $1 \times 10^5$  cfu/g in the dried product [39]. The total viable count (TVC) of bacteria in fresh and freshly processed US, S, S+T and S+G treated smoke-dried chapila (*G. chapra*) fish products showed the values within the range of acceptable limit.

**Table 4:** Total viable count (cfu/g) of fresh and freshly processed Unsalted (US), Salted (S), Salt+Turmeric (S+T) and Salt+Garlic (S+G) treated smoke-dried chapila (*G. chapra*) fish products

Experimental fishes	TVC(cfu/g)
Fresh fish	$3.1 \times 10^5$
US	$3.3 \times 10^4$
S	$3.7 \times 10^3$
S+T	$1.8 \times 10^3$
S+G	$2.0 \times 10^3$

#### 4. Conclusions

The present study reveals that smoke-drying process have a positive significant role on the biochemical composition of freshly processed US, S, S+T and S+G treated smoke-dried chapila (*G. chapra*) fish products and reduces bacterial load as well as makes them nutritionally suitable for all. This work has elucidated more on the importance of smoke-dried freshwater SIS fish as good sources of protein and broadened our knowledge on the nutritional value of smoke-dried fish using different treatments. Commercial traders those who produce different type of smoke-dried fishes in our country may be asked to follow the suggestions made over here on the basis of the findings of the present study.

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