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QUALITY ASSESSMENT OF SALT-CURED SPOTTED SNAKEHEAD, *CHANNA PUNCTATUS*

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Abstract

A comparative study of salt curing for spotted snakehead, *Channa punctatus* was made to assess its quality under different processing and storage conditions. Condition at different types of salting (dry salting, pickle salting and brine salting) were studied after 15 days of processing and quality of processed fishes was assessed in the laboratory. In salt curing, protein (31.91%), carbohydrate (1.79%), salt (32.10%) and total volatile nitrogen (TVN, 25 mg/100g) content were increased and moisture (47.94%), fat (2.43%), ash (9.32%) and pH (6.16) were decreased at different stages. Mineral contents especially calcium (Ca) and phosphorus (P) were increased in brine and pickle salting and decreased in dry salting stages. On the other hand iron (Fe) and magnesium (Mg) were decreased but increased in dry salting stages significantly. It was also observed that dry salting process resulted highest level of protein (31.91%), carbohydrate (1.79%), energy (162 Kcal) and lowest moisture (47.94%). Minerals were highest in dry salting. Calcium (650.7 mg/100g) is less at 15 days but found higher than fresh stages (381.2 mg/100g). The TVN increasing gradually with storage period and the lowest amount found in 15 days dry salting fish products. 15 days dry salting fish have been found very good condition among other salt curing methods of different stages. The sensory score were slightly higher in pickle salting than dry salting stages and 15 days salt products are better than any other stages as like as 0 days (fresh), 2 days and 7 days. Sensory scores were determined on the basis of consumer acceptance which was dependent on the four physical parameters viz. appearance, texture, flavour and colour of the fish products. This study revealed that the salt cured *C. punctatus* products can be better processed as dry salting > pickle salting > brine salting by quality.

Key words: *Curing, storage, quality assessment, dry salting, pickling, sensory score*

Introduction

The natural ecosystem of Bangladesh includes several types of freshwater wetlands, coastal and marine types. It has many tributaries with a total length of about 24,140 km and there is a huge marine fisheries resources expanding over Exclusive Economic Zone (EEZ) (DoF, 2015). The country's water, climatic and soil conditions are highly favourable to inland fisheries and

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aquaculture (Eyo, 2001). The climate and geography of Bangladesh is well suited for diversity of fisheries resources. The ambient temperature in Bangladesh for most parts of the year is more than 25° C, which would encourage growth of spoilage by microorganisms during post harvest. Much attention is being directed at fresh water fish because of its health benefits, as a result of the presence of nutrients in the fish. Salting process is considered as one of the oldest and cheapest method of fish preservation. Salted fish products are popular in many countries around the globe as these have been proven to be safe. In developed countries the aim of salting is not only to prolong the shelf life of fresh fish but also to provide desirable sensorial changes. There are usually three types of salting of fish applied – dry salting, wet salting and a combination of the two methods. Length of salting period as well as salt concentration depends on the expected final product of fish (Bellagha *et al*, 2007). Salt has been used as a preservative since ancient times, to protect food against bacteria, mould, and spoiling. Table salt or Sodium Chloride (NaCl) is a common preservative because it is non-toxic, inexpensive, and tastes good. Basically, salting is generally aimed at reducing water activity to obstruct or destroy the growth of the microorganism as well as inactive autolytic enzymes, where in this end the fish meat gets its way to durability. A concentration of 6-10% salt in fish tissue can prevent the action of most spoilage bacteria (Horner, 1992). Common salt (NaCl) preserve when sufficient water content in fish tissue and salt penetrating into fish (Cutting, 1955; Waterman, 1965). Among the freshwater fish species spotted snakehead, *Channa punctatus* is popular to the consumers as well, delicious, nutritious and bear high market price. At present these fishes are only marketed in live as '*zeol'* fishes. A post-harvest loss been observed for dead fishes as no preservation techniques been developed specially in remote wetland areas of Bangladesh. Presently salting is low-cost, simple and popular fish processing method is being practiced extensively in our country as well as throughout the world. So it is necessary to take some steps to assure affordable preservation, guarantee quality assurance and marketing product proper quality. The purpose of the present study is to develop and assess the salt-curing of freshwater fish species *C. punctatus* for the production of high quality dry-salted, pickle-salted and brine-salted products. This may further and transfer the technology to the rural small-scale fisher folks all over Bangladesh.

Material and Methods

Collection and handling of fish: The variety of lean fishes of *C. punctatus* were collected for this comparative study of different salting processes and stages. The raw fishes were collected in the month of August, 2017 from Thatari Bazar fish market of Dhaka city in the early hours of the day where near their original habitats and the fishes were brought immediately to the BCSIR laboratory, Dhaka.

Experimental on curing process: Fish processing experiments, biochemical and sensory analysis were carried out at the 'Fish Technology Section' of the Institute of Food Science and Technology (IFST) of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka.

Pure common salt (NaCl), plastic box, freshwater small fishes were used as raw material for the present research study.

Preparation of fishes: Fishes were carefully washed with cooled tap water. Scales, fins, gills and viscera were removed and again washed with tap water to remove blood, slime and unnecessary flesh. Then weighed and enrolled with different salting methods with plastic box.

Quality assessment: Fish samples from different salting stages were randomly taken for quality assessment and were chopped with skin to make a homogenous sample. Before analysis, salt crystals if there any were carefully removed from fish. Quality assessment procedure was continued until the fish became inedible by checking its TVN and finally organoleptic test for public acceptance.

Methods applied for the present experiment: An experiment to observe the quality of fishes through three different salting processes with control and raw applied on fishes to experience a comparative study among different stages.

Raw: During this process of raw fishes, change in weight, salt content, moisture content and physiological acceptance of the fishes have been determined and observed. Its quality was also observed by chemical methods.

Dry salting: During this experiment the raw fishes were eviscerated, cleaned, washed, weighed and had been enrolled by dry salt (fish weight : salt weight ∷ 3:1), stocked in containers and remain always dry at room temperature.

Pickle salting: Weighed and had been enrolled by dry salt (fish weight : salt weight ∷ 3:1) in containers at room temperature and fishes are always allowed to remain in such solution.

Brine salting: 30% salt solution is prepared and the fish are kept at this brine solution stocked in containers at room temperature for 2 days, 7 days and 15 days for different samples.

Control: 5% salt solution is prepared and kept fishes at this solution and used as control condition.

Parameters of quality assessment: (i) Moisture, fat, ash contents of the sun-dried salted fishes were determined by AOAC method (AOAC, 1975).

$$\text{Moisture (\%)} = \frac{Loss\ in\ weight\ of\ sample}{Weight\ of\ sample} \times 100$$

The lipid contents were determined by Soxhlet apparatus. Ash contents of the head and scale samples were measured by burning the samples in electric furnace. The ash contents were calculated using following formula:

$$\text{Ash (\%)} = \frac{Weight\ of\ ash}{Weight\ of\ sample} \times 100$$

(ii) The protein contents were determined by using the Kjeldhal's Method (Pearson, 1962) involving the chemical digestion, distillation and titration. Amount of nitrogen thus determined and was converted into the percent crude protein by applying the following formula: Crude protein (%) = N % × 6.25

(iii) Total carbohydrates were estimated by using this formula:

Carbohydrate (%) = 100 – ($P + M + F + A$)
Where P is percentage of protein, M is percentage of moisture, F is percentage of fat,
A is percentage of ash.
(iv) Four types of minerals were estimated in this study following AOAC guideline (AOAC, 1975).
(v) TVN was determined by Conway modified micro-diffusion technique as described by Conway and Byrne (1993).
(vi) pH was determined using a pH meter (Vyncke, 1981).
(vii) Sensory test was done using hedonic scales. The Hedonic scale used to justify the level of sensory score: high acceptability (5.00), very much acceptability (4.00), moderate acceptability (3.00), board line of acceptability (2.50), slightly unacceptable (2.00) and very much unacceptability (1.00).
Statistical analysis: Data were analyzed by using Microsoft Office Excel 2010.

Results and Discussion

Biochemical composition of fish

Biochemical composition of salt cured *C. punctatus* with fresh stages during different processes and stages are shown in Table 1. Salt cured fish showed that moisture content ranged from 47.94 to 63.69% where highest amount was in 2 days brining and lowest was in 15 days dry salting. In salted condition protein ranged from 18.23 to 31.91% and the highest was in 15 days dry salting and lowest was in 2 days brining. Fat content recorded from the 2.43 to 3.91% where the highest was in 2 days dry salting and lowest was in 15 days brining. Ash value recorded from 9.32 to 17.84% where the highest was in 2 days dry salting and lowest was in 15 days brining. Carbohydrate ranged from 0.7 to 1.79% where the highest was 15 days dry salting and lowest was in 2 days pickle salting. Energy was recorded ranging from 106 to 162 Kcal where the highest was in 15 days dry salting and lowest was in 2 days pickle salting respectively.
The moisture content of fresh raw fish resembles with the finding of Clucas and Ward (1996). They observed the moisture content of fresh water fishes ranges from 70 to 80%. The protein content of the fish in stage of raw condition is similar with the finding of (Govindan, 1985) who observed that fresh water fishes contains protein content ranged from 16 to 20%. Fat content of the fish in stage of fresh raw condition also similar with the findings of Srivastava (1985) and Balachandran (2001) who has got fat ranging from 1 to 7%. Ash was higher and ranged from 0.4 to 2% in fresh fishes. Carbohydrate content in fish is very low and particularly considered zero (Anthony *et al.,* 2000). In comparison with fresh fish, the salting process resulted in a significant decrease ($P < 0.05$) of moisture, fat and ash content and a significant increase ($P < 0.05$) in protein content of dry-salted, pickle-salted and brine-salted fish samples. This findings supports the results of Abraham-Olukayode *et al.*, (2012).

In this study the highest protein was 31.91% in 2 day dry salting and lowest was fat 2.43% in 15 days dry salting condition fish products. Significant increase in protein levels ($p<0.05$) in all salted fish-products when compared with the fresh fish, suggested that protein nitrogen was not losing during salting (Nahid *et al.,* 2014). The findings in the protein content were similar but ash and lipid contents were not similar with related studies by Thorarinsdottir *et al.* (2004) where quite related trends were observed with indications that the amount of protein was a function of salt concentration and water content. The higher value of total ash content in freshly processed dry-salted, pickle-salted and brine-salted spotted snakehead fish than fresh fish was attributed to high salt content which added more ash components to the products. These results were in accordance with El-Bassir *et al.* (2015).

Mineral composition

Mineral composition of salt cured *C. punctatus* with fresh stages during different processes and stages are shown in Table 2 and Figure 1, 2, 3 and 4. The result shows that calcium found from the ranged 526.5 to 1737.2 mg/100g where the highest was in 15 days brining and lowest was in 2 days pickle. Magnesium (Mg) ranged from 66 to 118 mg/100g where the highest was in 15 days dry salting and lowest was in 15 days brining. Phosphorus (P) recorded from 72.5 to 252.1 mg/100g where the highest was in 15 days dry salting and lowest was in 2 days pickle. Iron (Fe) recorded 11.2to 15.9 mg/100g where the highest was in 2 days brining and lowest was in 15 days pickle.

Present findings of minerals showed similarities with Zaman *et al.* (2014) who observed the calcium (Ca) content range from 76.59 to 1984.32 mg/100g, magnesium (Mg) 81.55 to 148.16 mg/100g and iron (Fe) 0.31 to 15.95 mg/100g. According to Stansby (1954) and Jacquot (1961) variation in nutrient composition of fish flesh may vary with species variation, season, age and the feeding habit of fish. Present experimental showed that three types of salting methods increased the mineral composition in fish products except iron (Fe) and dry salting calcium (Ca) which was decreasing in trend. Iron (Fe) content was gradually decreased with increasing days and dry salting calcium (Ca) were similarities with iron (Fe) content. The present results are comparable with the results reported for some dry freshwater fish reported by Ahmed *et al.* (2011). According to Begum *et al.* (2012), freshly processed salted-dried punti (*Puintius sophore*) contain calcium (Ca) and iron (Fe) 320-330 mg/100g and 3.1-3.9mg/100g respectively.

pH and Salt content

pH value and salt content were 6.72 and 4.00% in raw stages and 7.25 and 3.50 (%) in stage of control 2 days condition. pH were ranging from 6.53 to 6.95 where the highest was in 2 days dry salting and lowest in 15 days pickle. Salt content were 14.75 to 32.10 % where the highest was in pickle 15 days and lowest in 2 days brining (Table 3). It showed in the present investigation that pH value decreasing gradually with increasing the storage periods and lowest was in 15 days brining. The pH value in fish muscle was due to storage period which was also associated with the state of rapid spoilage of fish (Kyrana and Lougovois, 2002). Reduced pH may be caused by

reduction or cessation of microbial growth (Widayaka *et al.,* 2001). Post mortem pH can vary from 6.0 to 7.1 depending on season, species and other factors (Church, 1998). According to Hernandez-Herrero *et al.* (1999) after salting of anchovies that salt content increased from 0.32 to 19.3% and pH decreased from 6.13 to 5.72 which are in harmony with present finding. Salt content was the highest in stage of pickling 15 days (32.1%) in this fish among three types of salting methods and stages.

Total Volatile Nitrogen (TVN)

TVN content was 15 mg/100g in stage of raw condition and 21 mg/100g in stage of control 2 days condition (Table 3). Among different salt curing processes and stages TVN content were 9.25 to 25 mg/100g where the highest was 15 days dry salting and lowest was 2 days dry salting. The result of present showed that 15 days dry salting stage fish contained 15mg/100g among three salted methods and stages. The TVN measurement can be used as a parameter for the determination of microbiological and enzymatic spoilage of fish product. The product of volatile nitrogen bases increase in concentration during spoilage of fish. Their collective measurement could therefore be used as means determination of the level of microbiological and enzymatic determination of fish. TVN has been widely used as an index for freshness of fish (Stanby *et al.,* 1954). The limiting level for rejection of TVN is 20 mg/100g for storage at refrigerator temperature (Connell, 1990). The level of 35mg has been considered the upper limit, above which fishery products are considered spoiled (Schormuller, 1969). In case of long term storage the TVN value will be higher (Siddique *et al.,* 2011). In present investigation, TVN values of the products stored at room temperature showed linearly increasing pattern throughout storage period but neither of the value exceeded their recommended value set by different researchers for various fish and fish products as acceptable condition. In the present study, increase in TVN throughout the storage period may be due to microbial activity, absorption of moisture. Increase in TVN value is related to bacterial spoilage.

Quality assessment

Acceptability scores according to Hedonic Scale of salt cured fish showed that pickling fish are in the high quality followed by dry salting and brining (Figure 5). Appearance, texture, flavour and taste score was the highest in pickling fish and the lowest was the brining fish. Dry salting fish was average in these criteria. Texture of fish was scored the lowest in brining condition. Appearance got the highest score both in pickling and dry salting fish (Figure 5). Evaluation of the sensory score had been performed using the basis of consumer acceptance which was dependent on the four physical parameters those were appearance, texture, flavour and colour of the fish products. The sensory scores of salt cured fish products had been determined by a panel of judges by following a sensory method. The TVN value which helps to measure the level of fish spoilage, had been found to have inverse relationship with the sensory score of salt cure fish product.

Table 1. Showing variation in proximate composition of *C. punctatus* at different salt curing process and stages.

Types	Stages (days)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Energy (Kcal)
Raw	0 (fresh)	74.14	17.75	2.8	2.89	0.73	101
Control	2	71.44	18.16	2.81	4.79	0.65	103
Brine salting	2	63.69	18.23	3.50	14.83	0.74	110
	7	61.95	20.25	3.00	12.89	0.81	114
	15	55.10	29.78	2.43	9.32	1.54	151
Dry salting	2	56.70	19.01	3.91	17.84	0.90	117
	7	53.36	24.29	2.89	16.53	1.14	131
	15	47.94	31.91	2.65	14.77	1.79	162
Pickle salting	2	60.63	18.58	3.01	14.82	0.70	106
	7	56.81	23.09	2.72	13.99	1.09	124
	15	49.88	30.82	2.56	12.89	1.46	156

Table 2. Showing variation in mineral composition of *C. punctatus* at different salt curing processes and stages.

Types	Stages (days)	Calcium (mg/100g)	Magnesium (mg/100 g)	Phosphorus (mg/100g)	Iron (mg/100g)
Raw	0 (fresh)	381.2	105	68.6	11.4
Control	2	450.2	84.2	71.3	10.9
Brine salting	2	783.0	100	75.1	15.9
	7	1083.9	96.2	115	12.3
	15	1737.2	66	184.3	11.7
Dry salting	2	1160.7	96	96.2	12.9
	7	765.4	106	113.1	12.1
	15	650.7	118	252.1	11.7
Pickle salting	2	526.5	102	72.5	11.5
	7	909.3	94	110.1	11.4
	15	1326.4	69	116.2	11.2

Table 3. pH, salt and TVN content in *C. punctatus* at different salt curing processes and stages.

Types	Stages (days)	pH	Salt content (%)	TVN (mg/100 g)
Raw	0 (fresh)	6.72	4.00	15
Control	2	7.25	3.50	21
Brine salting	2	6.63	14.75	11
	7	6.61	20.00	17
	15	6.16	25.50	20
Pickle salting	2	6.90	11.00	11
	7	6.59	21.50	19
	15	6.53	32.10	12.5
Dry salting	2	6.95	16.00	9.25
	7	6.66	19.75	12.5
	15	6.59	31.50	25

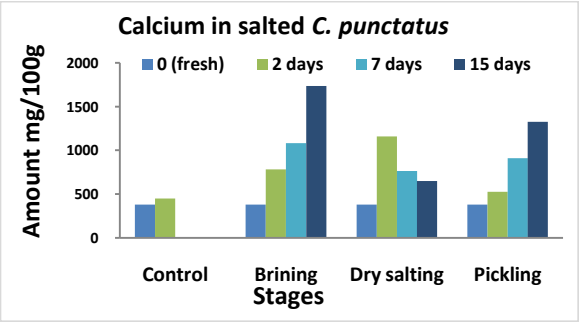

Figure 1. Calcium content in *C. punctatus* at different salt curing processes and stages.

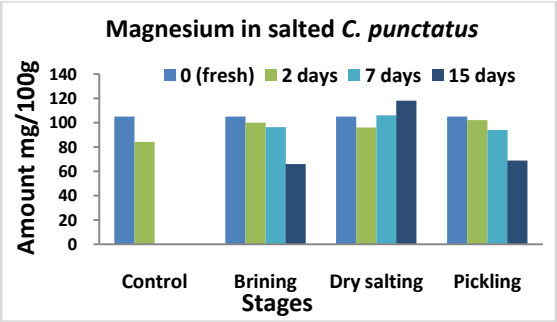

Figure 2. Magnesium content of *C. punctatus* at different salt curing processes and stages.

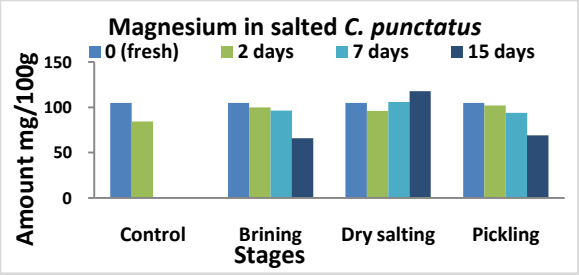

Figure 3. Phosphorus content in *C. punctatus* at different salt curing processes and stages.

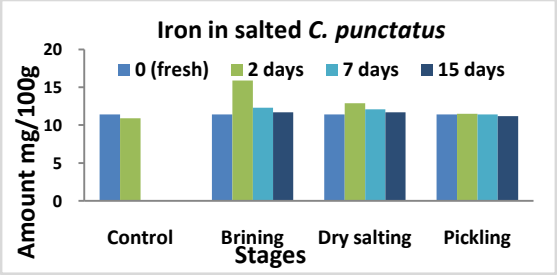

Figure 4. Iron content in *C. punctatus* at different salt curing processes and stages.

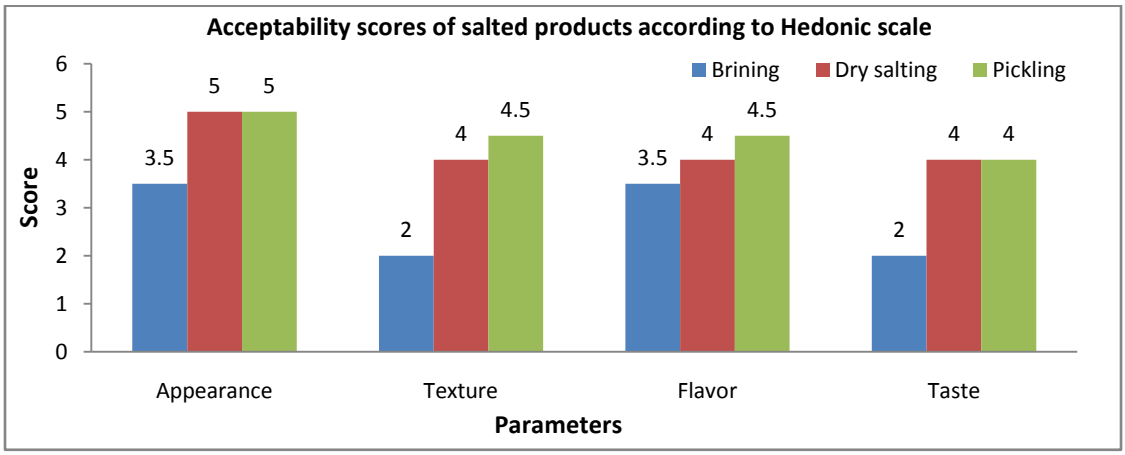

Figure 5. Acceptability scores among different salt cured fish according to Hedonic Scale.

Conclusion

Salt cured *C. punctatus* products may be a good source of fish protein when they are safe and better processed although they are not popular. It probably be a item for fish lovers as it gave a good taste with quality. The quality rank assessed in different steps after fresh fish found as dry salting followed by pickle salting and brine salting.

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