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Influence of salt concentration on nutritional quality of solar tunnel dried silver jewfish (*Pennahia argentata*)

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Abstract
Drying of fishery products in combination with salt treatment is practiced throughout the world to enhance drying rate and also extend product shelf life. Nutritional and eating quality of solar tunnel dried silver jewfish (*Pennahia argentata*) was determined which were treated with 0, 10, 15, 20 and 25% salt solution prior to drying. It was found that overall organoleptic qualities of all dried fish products were excellent. Reconstitution property was greatly influenced by salt treatment where lowest of 13.79 - 21.46% reconstitution was obtained for 25% salt treated solar dried fish at 80 °C indicating poor eating quality of the final product compared to those produced after 10% salt treatment. Proximate composition analysis, on the other hand, revealed that highest protein content of 68.16% on dry matter basis was obtained for 10% salt treated product with a relatively lower TVB-N value of 17.58 mgN/100g. These results suggest that for production of better quality dried silver jewfish products, treatment with 10% salt may be recommended for small-scale as well as commercial production.

Keywords: Salt concentration, nutritional quality, solar tunnel, silver jewfish

Introduction
Silver jewfish (*Pennahia argentata*) is a common marine fish species in the Bay of Bengal. This is one of the commercially important fish species and also widely popular in Bangladesh as well as foreign consumers. It has been estimated that stocks of jewfish and catfishes in the Bay of Bengal approximates about 40,000 t [16], and in total marine catch of 264,000 MT, jewfish account for 10.37% [13]. This huge amount of silver jewfish are caught every year during winter season where about 50% of the landings of this species are consumed as wet fish food for the people. Some are exported as wet fish while the rest are sun dried or salted-dehydrated also for export purpose. The salted-dehydrated products are mainly exported to Hong Kong, Singapore and other Southeast Asian countries [1]. There is also an increased demand for this species in the international market in places such as Saudi Arabia, Kuwait, Qatar and other Middle East and Arab countries. Its air bladder is dried and exported as fish maw and also for making glue and gelatin. However, dried product produced from this species is, by far, the most popular food item in Bangladesh.

The physical and organoleptic qualities of most of the traditional sun dried products deteriorate remarkably due to bad weather [17]. There are frequent complaints from the consumers about the quality of the products and the major problems associated with sun drying fish are the infestations by house fly and insect larvae, poor sanitation and improper process that often leads to contamination and spoilage and ultimately the use of pesticide to prevent those [11, 12, 14, 20, 23]. In tropical climates, under humid conditions, heavy infestation of unsalted dried fish by blow flies may cause up to 30% loss of the product [27]. A Hohnenheim type solar tunnel dryer was found very suitable for drying of fish at temperature of 35° C to 52 °C without showing any infestation, oxidative rancidity, spoilage and contamination [3, 4, 21]. The solar tunnel dryer can ensure good hygienic quality of the product. The keeping quality and wholesomeness of dried fish products are influenced by chemical composition of fish.

It has been observed that different curing treatments e.g. smoking and/or salting prior to drying have different effects on nutritional and eating quality of fish. This is because high temperature and/or exposure to high concentration of salt lead to chemical and physical changes and therefore, digestibility may change, due to protein denaturation, but the content of thermo

labile compounds and polyunsaturated fatty acids is often reduced [26]. Therefore, nutritional and eating quality of dried fish produced after treating with different concentrations of salt may not be the same. Considering the importance of dried silver jewfish in domestic as well as export market of the country, it is essential to identify appropriate drying method for production of quality silver jewfish products. In past there is little or no work done in Bangladesh on the determination of the organoleptic, physical and biochemical properties of salt treated solar tunnel dried silver jewfish. Considering the above facts the proposed experiment has been chosen to improve its quality and nutritional status.

Materials and Methods

Raw materials

Fresh fish samples of silver jewfish (*Pennahia argentata*) with an average length and weight of 18 cm and 125 g were purchased directly from the BFDC landing centre, Cox's Bazar and were transported to the Post-graduate Laboratory of the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, in an insulated box in ice (1:1). These samples are subjected to drying in solar tunnel dryer after salt treatment.

Salt treatment and drying of fish

The fish were washed, scaled and gutted following hygienic condition. After gutting, they were washed with tap water to remove blood, slime and other undesirable substances and split longitudinally using sharp knife. Then they were brined for 12 hr in different salt concentration (10, 15, 20 and 25%) which were prepared using food grade solar salt. After overnight salt treatment the fishes were then ready for drying. The drying procedure was started after completion of loading, usually at 8 am, and the drying was discontinued at 4 pm for each day. The drying time was 34 to 38 hours in solar tunnel dyer.

Sample preparation for analysis

For organoleptic analysis, whole dried silver jewfish samples were used and for chemical analysis, samples were ground in an electric blender to produce a homogenous one before being sampled for analysis. Samples of each treatment were packed in polythene bags tightly by using a sealer and kept for further analysis.

Determination of organoleptic characteristics

A sensory evaluation of flavor, color, texture, insect infestation, presence of broken pieces and overall acceptance of dried fishes was performed using 9 point hedonic scale (1 = extremely dislike to 9 = extremely like) by a trained panel of expert members as done previously [14].

Determination of rehydration ability/water reconstitution properties

The dried samples were rehydrated by immersing them in water bath at constant temperature, which was agitated at constant speed (100 rpm). The samples were taken from the bath at different immersion periods and were weighted after being blotted with tissue paper in order to remove excess solution and its volume was measured. The effect of water temperature was investigated using three temperatures, namely 40, 60 and 80 ºC up to 60 minutes. By the given soaking time, percentage of rehydration was calculated according to [19]. All tests were performed in triplicates.

Proximate composition analysis

Moisture content was determined by air drying of a given sample in a thermostat oven (Gallenkamp, HOTBOX, Manchester, UK) at 105 ºC for 24 hours until constant weight. Ash content was determined by igniting the sample in a muffle furnace at a temperature of 550 ºC for 6 h. Crude protein was determined by the Macro Kjeldahl method by determining total nitrogen and applying the protein conversion factor of 6.25 to the results to convert total nitrogen into total protein, assuming that fish protein contained 16% nitrogen, and lipid content was determined by extracting required quantity of samples with petroleum ether for 16 to 18 hours in a ground joint Soxhlet apparatus. The oil obtained by evaporation of the solvent on a steam bath was weighed in a sensitive balance and percent lipid was calculated.

Chemical analysis

TVB-N (mg N/100g) values for dried silver jewfish samples were determined as described by [2].

Statistical analysis

Data from different parameters were subjected to t - test ($p < 0.05$). The statistical analysis package in MSExcel 2002 (Microsoft Corporation, Redmond, WA) was used to explore the statistical significance of results.

Results and Discussion

Organoleptic characteristics

The organoleptic parameters such as color, odor, texture, insect infestation, presence of broken pieces and overall quality of salt treated solar tunnel dried silver jewfish were examined and results summarized in Table 1. The color of 0%, 10%, 15%, 20%, 25% salt treated solar tunnel dried silver jewfish was slightly brown, silvery, slight whitish, whitish, and whitish, respectively. Whitish color of the dried products indicates that the fish was treated with high salt concentration. Texture was firm and flexible with characteristic odor. No infestation or broken pieces were found around the products and the overall qualities of all the five dried fish products were excellent. The overall acceptance score for 10% salt treated samples, however, was slightly higher compared to other treatments, indicating slight preferability by the panelists towards that type of product. The products produced at 45-50 ºC range were found organoleptically excellent quality [22].

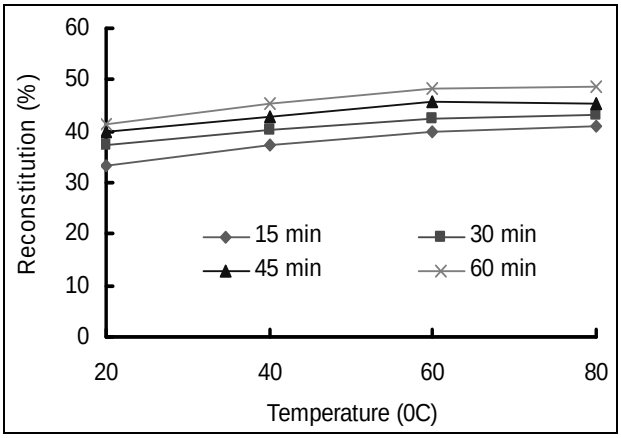
Rehydration ability/water reconstitution properties

The reconstitution properties of salt treated solar tunnel dried silver jewfish muscles was assessed at a wide range of temperature after soaking for maximum 60 min and the results have been presented in Fig. 1. The samples of salt treated solar tunnel dried silver jewfish were individually soaked in water bath at room temperature (20 °C), 40 °C, 60 °C and 80 °C temperature with time interval for one hour and the ability of the samples to absorb moisture was investigated every 15 min intervals. For salt treated solar tunnel dried fish, at room temp. (20 °C), reconstitution level was 6.56 to 33.33% after 15 min of soaking with minimum in 25% salt treated samples and maximum in 0% salt treated samples. After soaking for 60 min, reconstitution properties were in the range of 13.64 to 41.33% with minimum in 25% salt treated samples and maximum in 0% salt treated samples. On the other hand, after 60 min soaking, the highest reconstitution of

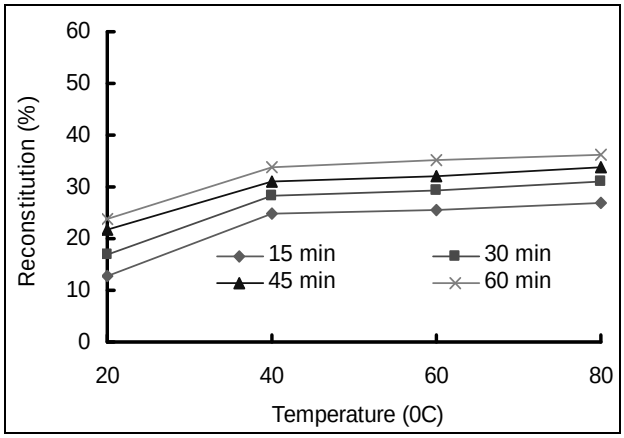
45.26% was found in 0% salt treated samples and the lowest of 16.18% in 0% salt treated samples. Reconstitution capacity increased with increase of temperature and time. At 80 °C, the reconstitution capacity ranged from 13.79 to 40.80% with maximum in 0% salt treated samples and minimum in 25% salt treated samples after 15 min of soaking whereas 60 min of soaking the minimum reconstitution value of 21.46% was found for 25% salt treated samples and the maximum value was 48.49% for 0% salt treated samples. The reconstitution of the samples increased as the temperature of the soaking water increased and maximum reconstitution of 62.72 to 78.09% was obtained in different species after one hour of soaking [18], which is more than the present study. A close relationship was observed between the reconstitution capacity and physical properties of the samples. The quality of the dried fish is related to final water activity (a_w). At low values, water uptake proceeds more quickly. In properly dried fish the water uptake is reported to complete in 3-15 min [25]. In the present study, salt treated solar dried products exhibited slightly less rehydration properties compared to control dried fish products which might be due to the denaturation of protein that took place during brining process and cause some sort of damage to the cellular structure in an irreversible manner. With a tough and rubbery tissue, water penetrates mostly to the center of large pieces by diffusion through the protein of the fiber itself and the process is very slow [6, 15, 24]. On the other hand, without salt treated dried fish products exhibited an enormously rapid initial rehydration rate due to water being carried deep into the pieces by porous structure which absorbed and retained sufficient water by capillary [10]. Considering the reconstitution ability, it can be stated that control and 10% salt treated dried jewfish products were comparatively better quality compared to other dried products.

Table 1: Organoleptic characteristics of salt treated solar tunnel dried silver jewfish products

Dried fish sample	Organoleptic characteristics of solar tunnel dried fish	Overall acceptance	Overall quality
0% Salt treated	Slightly Brown color, characteristic odor, firm and flexible texture, no infestation and no broken pieces	5.25	Excellent
10% Salt treated	Silvery color, characteristic odor, firm and flexible texture, no insect infestation and no broken pieces	7.18	Excellent
15% Salt treated	Slightly whitish color, characteristic odor, firm and flexible texture, no insect infestation and no broken pieces	6.55	Excellent
20% Salt treated	Whitish color, characteristic odor, firm and flexible texture, no insect infestation and no broken pieces	6.45	Excellent
25% Salt treated	Whitish color, characteristic odor, firm and flexible texture, no insect infestation and no broken pieces	6.02	Excellent



A



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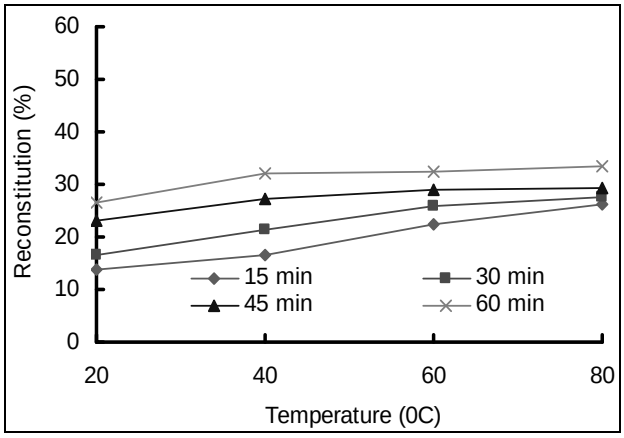

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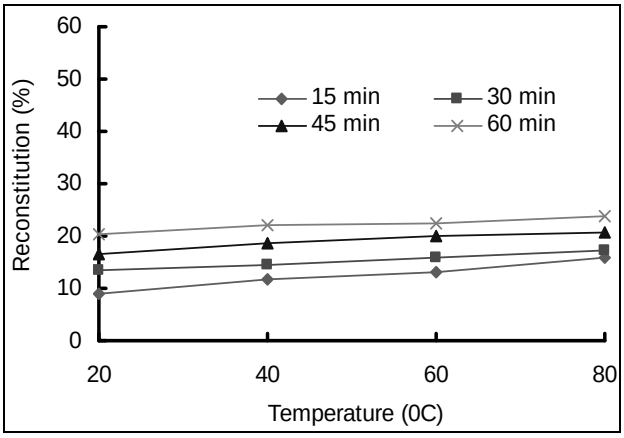

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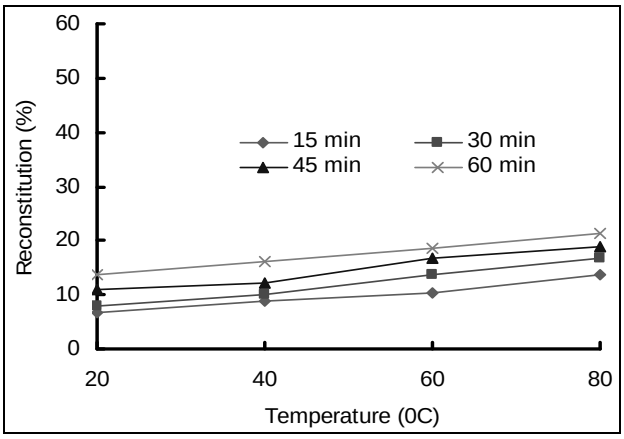

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Fig 1: Reconstitution behavior of solar tunnel dried silver jewfish produced after (A) 0%, (B) 10%, (C) 15%, (D) 20%, (E) 25% salt treatment at different temperature and time

Proximate composition

Proximate composition i.e. moisture, protein, lipid and ash contents of salt treated solar tunnel dried silver jewfish products are shown in Table 2. For better comparison data have been recalculated on moisture free basis and the average values are shown in the parentheses for each chemical component. It was found that moisture content in salt treated solar tunnel dried fish was in the range of 15.48 to 18.56% with the highest in control samples and lowest in 10% salt treated samples. Protein, the most important chemical component ranged from 45.31 to 61.38% with the lowest and highest value found in 25% salt treated samples and 0% salt treated samples, respectively. The moisture and protein contents of solar tunnel dried products were ranged in 13.71%-19.30% and 49.32%-65.30%, respectively [8], which is agreed with our present study. Protein content in 10% salt treated samples was not significantly different than those found in control samples (p>0.01). Lipid and ash contents, on the other hand, ranged from 8.45% to 9.16% and 11.43% to 29.91%, respectively, which did not vary significantly among samples (p>0.05). The lipid and ash contents varied from 5.63 to 10.08% and 11.95 to 16.58%, respectively for solar tunnel dried products [9].

Table 2: Proximate composition of salt treated solar tunnel dried silver jewfish products

Proximate composition	Solar tunnel dried silver jewfish				
	0% Salt	10% Salt	15% Salt	20% Salt	25% Salt
Protein (%)	61.38±0.12 (75.37)	57.61±0.15 (68.16)	53.37±0.22 (63.56)	48.19±0.12 (58.05)	45.31±0.10 (53.79)
Lipid (%)	8.69±0.20 (10.67)	9.13±0.12 (10.80)	8.45±0.11 (10.06)	8.72±0.12 (10.50)	9.06±0.10 (10.75)
Ash (%)	11.43±0.02 (14.03)	17.81±0.01 (21.07)	22.19±0.01 (26.43)	26.13±0.02 (31.47)	29.91±0.01 (35.51)
Moisture (%)	18.56±0.20	15.48±0.30	16.03±0.25	16.98±0.20	15.76±0.18

*Values in parenthesis indicate the average values on dry matter basis

Food Quality Analysis

Food quality of salt treated solar tunnel dried silver jewfish products were analyzed to determining the biochemical aspect like TVB-N. Although TVB-N is used for the determination of the spoilage level during the storage period [5]. In the present study, TVB-N was estimated to determine any changes due to salt treatment. The results of TVB-N of the solar tunnel dried products are shown in Table 3.

Table 3: TVB-N values of salt treated solar tunnel dried silver jewfish

Solar tunnel dried fish sample	TVB-N (mg/100g)
0% salt treatment	25.02
10% salt treatment	17.58
15% salt treatment	16.14
20% salt treatment	16.32
25% salt treatment	16.18

In the present study, TVB-N values were in the range of 16.14 to18.02 mg/100g with the lowest value in 15% salt treated samples and highest in control samples. Although the values of all the samples were found within the acceptable limit recommended for fishery products [7], significantly higher levels of TVB-N in control samples (p<0.05) indicate slightly higher rate of microbial spoilage during the processing stage. These results suggest that, to ensure better lowering of microbial activity during the processing stage, salting can serve as a useful tool to reduce growth of spoilage bacterial of the tropics. The TVB-N content of solar tunnel dried products is low compared to traditional one ranging from 14.34-15.68mg/100g, [8].

Conclusion

In conclusion, it can be stated that salting/brining is an effective tool to minimize bacterial spoilage during the drying process. Although solar tunnel dryer ensures comparatively faster drying compared to traditional and many other drying methods, it can be carried out in combination with 10% salt treatment for 12 hr to ensure better nutritional and eating quality. Already many fish processors in Cox's Bazar and Teknaf region are practicing 10% salt treatment for their dried products as the product also do not retain salt in the final product. Further studies need to be carried out to produce dried products with combination of herbal products like chilli

powder, turmeric so that better shelf life during storage can be obtained.

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