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Influence of salt and herbal substance on the drying and reconstitution performance of Bombay duck, *Harpodon nehereus*

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Abstract

Effects of salt, chili and turmeric powder on the production of high quality dried fish products from Bombay duck (*Harpodon nehereus*) under open sun drying was investigated. Five different types of dried products (T_1-T_5) were produced and studied. Moisture content in T_3 decreased more rapidly to below 16% within 28 hrs of drying compared to those treated with other treatments (temperature varies from 24.6°C to 34°C and relative humidity varies between 60% and 48%) . Drying process was very slow in control samples where it took 32 hrs for reaching the moisture level to 18.75%. Both turmeric and chili powders had strong repellency effect against insect infestation. Bombay duck treated with salt and herbal products were less infested by the blowfly whereas samples dried under control treatment were severely infested by blowfly.

Keywords: Herbal treatment, blowfly, Bombay duck, *Harpodon nehereus*, infestation

INTRODUCTION

Dry fish (*shutki* in Bengali) is one of the popular food items in Bangladesh. It is the staple source of protein in many areas of Bangladesh. About 20% of total fish caught are sun dried and mostly consumed in the domestic market annually (BBS 2005). Traditionally, drying of fish is carried out by spreading fish on the mat made of split bamboo, concrete floor or raised platform or fish are hanged over bamboo pole and bar. The physical and organoleptic qualities of most of the traditional sun-dried products available in the domestic market are not satisfactory for human consumption. One of the major problems associated with the sun-drying of fish is the infestation of the products by the blowfly and beetle larvae. Under warm and humid condition, sun-dried fish rapidly become infested by blowfly larvae (Kordyl 1976). In tropical climates under highly humid condition, heavy infestation of unsalted dry fish by beetles may cause quality deterioration in dried fish also takes place due to enzymatic reactions, microorganism growth and mycotoxin development (Nowsad 2005). To avoid such insect infestation and microbial continuations commercial dry fish processors often apply several harmful insecticides in fish (Bala and Hossain 1998). To reduce the loss of dry fish caused by insect infestation (beetle, blowfly and mites) commercial processors often take many preventive actions. The most popular and commonly practiced preventive and curative control measure is the use of harmful chemical pesticides, in spite of having serious lethal effects on consumer's body. Most commonly used pesticides are DDT and nogos (1 kg Dichlorovos in 1 liter) (Nowsad *et al.* 2010, Nowsad 2007). Studies on the conservation of dry fish showed that a mixture of organochlorine (DDT and heptachlor) is used in dry fish in Bangladesh (Bhuiyan *et al.* 2008). Many people call DDT as white powder. These chemical control

methods are usually effective, but there are serious health and environmental problems associated with chemical pesticides (Reza *et al.* 2005). The commercial processors have no knowledge on pesticide action, limit of dose, residual and health hazard effect. The processors generally use insecticides in three steps: (i) just after washing the fish before spreading on the rack; (ii) during the half-way of drying of fish on the rack and (iii) During storage of dried fish in gunny bag or *gola* (a container made of wooden/bamboo mat) (Nowsad 2005). In field level application during processing nogos, nuvacron, endrin, malathion, dimacron, etc. are popularly used, while in storage of product DDT, basudin and malathion are preferred ones. Due to harmful effect on human health most of the pesticides are banned in Bangladesh for any type of use (Reza *et al.* 2005). For the protection of human health and production of safe dried fish, alternative additives such as salt, different herbal products such as chili, turmeric, neem powder have been suggested by many scientists. The suitability of herbal pesticides including turmeric and neem in repelling dry fish insect (Lithi *et al.* 2012). However, there is no study conducted so far about the effect of these herbal products on the quality of dried fish. Studies, were, therefore, conducted to find out the influence of salt and two herbal pesticides *viz.* chili and turmeric on drying of a popular marine fish Bombay duck (*Harpodon nehereus*) under open air drying condition by assessing drying performance and reconstitution property.

METHODOLOGY

The experiment was conducted in the Faculty of Fisheries of Bangladesh Agricultural University (BAU), Mymensingh, during the period March to July 2012. Fresh Bombay duck samples (*H. nehereus*) were obtained directly from the BFDC landing centre at Cox's Bazar where the fish was preserved in flake ice then transported to the laboratory of Department of Fisheries Technology, BAU, in an insulated box with ice (1:1). Approximately 16-20 hrs required to reach in the laboratory from harvesting time.

Description of drying condition

A triangular simple bamboo made frame was made in open air for drying purposes. Viscera of the fish samples were removed and cleaned. Then the samples were washed with potable water. After draining out of water from fish samples, they were divided into five groups/treatments (Table 1). Then the treated samples were hanged in a bamboo pole in such a way that the all body surfaces of the samples were exposed to surrounding air until drying in a natural condition.

Table 1: Treatments used in the present study

Treatment	*Description*
T_1	Control, use of no herbal material or salt
T_2	Fish samples treated with 2% salt
T_3	Fish samples treated with 4% salt
T_4	Fish samples treated with 1% turmeric + 1% chili powder
T_5	Fish samples treated with 2% turmeric + 2% chili powder

Dressing/evisceration and washing: Fishes were simply gutted using knives and scissors and removed entire viscera. Then the raw materials were washed with potable tap water to remove blood, slime and other undesirable substances.

Salt treatment: After draining out water from washed raw materials, they were split longitudinally and soaked for 12 hrs using turmeric, chili and salt solutions except control one as described in above.

Drying: After overnight salt and herbal treatment the samples were then dried in the bamboo made frame. It took 32 to 34 hrs for drying.

Packaging: After drying, individual item-wise processed products were packed in polyethylene bag using sealer to prevent moisture absorption.

Temperature and humidity measurement: Air temperature was measured by thermometers. The relative humidity was also measured at various locations using relative humidity meter recorded by a data logger. Temperature and humidity data of fish samples were collected every two hour interval.

Determination of moisture content: Initially three fresh fish samples; collected every two hour interval from the drying yard, ground together in a blender and taken 2-5 g muscles in triplicate in pre-weighted crucibles and placed the samples in thermostat oven (Gallenkamp, HOTBOX, Model OVB-306) at 105°C for about 24 hrs until constant weight was obtained before drying.

Moisture content was determined by placing an accurately weighed known amount of ground sample (2-5 g) in a pre-weighed porcelain crucible in thermostat oven (Gallenkamp, HOTBOX, Model OVB-306) at 105°C for about 24 hrs until constant weight was obtained. The loss of moisture was calculated as percent moisture.

Data analysis: To find out the mean percentage and standard deviation Statistical Package for Social Sciences (SPSS version 16.0) was used in this study.

RESULTS AND DISCUSSIONS

Temperature and humidity conditions: Temperature and relative humidity conditions in the open air drying of fish samples are shown in Figure 1. In the air, temperature varied from 24.6°C to 34°C and humidity varied from 48-60% from morning 8:30 am to 4:30 pm during the drying period with higher temperature and lower humidity in the afternoon and lower in the morning. There was an inverse relationship between temperature and humidity, where relative humidity was low at higher temperature and *vice-versa*.

Moisture reduction pattern: In T_1 (control) initial moisture content was 89.53±1.50% and it was reduced very slowly during the first 3-4 hrs of drying (Figure 2). After 4 hrs it was found 85.86±1.20%. Then in the second phase, moisture content declined rapidly with the extension of drying period and after 6 hrs it was 75.6±1.30%, after 20 hrs of drying the moisture content was found 36.10±1.10%. In the last phase, drying process slowed down until the samples were dried after 32 hrs of drying the moisture content was found 18.75±1.00% (Table 2).

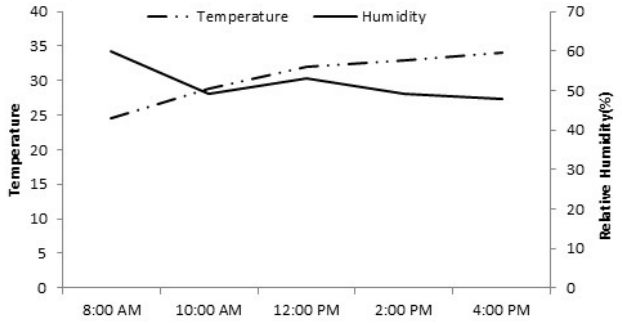

Figure 1: Relationship between temperature and humidity with time during period of drying in open air

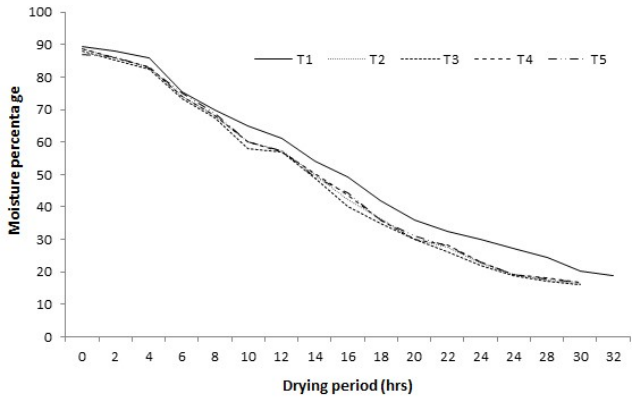

Figure 2: Changes in moisture content with time interval

Sample treated with salt was dried quickly than the controlledsamples. In T_2 the initial moisture content was 88.71±10.40% but after 2 hrs of drying the moisture content reduced to 86.10±1.00% which was much quicker than controlled fish samples as like after 6 hrs of drying it was found 74.20±1.50%. After 20 hrs of drying the moisture content in T_2 was found 30.10±1.00%. Finally they dried within 30 hrs and the last moisture content was found 16.55±1.00% (Table 2).

In T_3, samples were dried quickly than all others treatments. The initial moisture content was 87.92±1.40% and after 6 hrs of drying it was found 82.52±1.1% which is comparatively lower than any other treatment. After 20 hour of drying the moisture content was 30.01±1.0% which is almost similar to T_2 but after 30 hrs of drying moisture content was 16.08±1.10 (Table 2).

Chili and turmeric powder extracts also have positive effects on fish drying. In T_4 initial moisture content was 88.71±1.50% and after 6 hrs it was 74.10±1.00% which was comparatively lower than T_1. After 20 hrs of drying moisture content was 35.90±1.30% and after 30 hrs of drying final moisture content was 16.60±0.90% (Table 2).

In T_5 initial moisture content of 87.16±1.4%. After 6 hrs of drying moisture content was 75.13±1.3% and after 20 hrs of drying moisture content was 31.01±0.90% and finally after 30 hrs of drying moisture content was 16.65±0.80% (Table 2).

Table 2: Mean value (±SD) of moisture content of Bombay duck with various samples of salt and herbal treatments

Drying Hrs	T_1	T_2	T_3	T_4	T_5
0	89.53±1.50	88.71±1.40	87.92±1.4	88.71±1.50	87.16±1.40
2	88.07±0.90	86.10±1.00	85.25±0.9	86.05±1.10	86.31±1.30
4	85.86±1.20	83.20±1.30	82.52±1.1	83.01±1.20	82.79±1.20
6	75.60±1.30	74.20±1.50	73.21±1.2	74.10±1.00	75.13±1.30
8	70.04±1.20	68.10±1.20	67.3±1.1	68.23±1.10	68.90±1.30
10	65.12±1.30	60.20±1.10	58.15±1.3	60.10±1.20	60.20±1.10
12	61.30±1.30	57.30±1.50	56.97±1.4	57.10±1.00	57.18±1.10
14	54.10±1.20	50.07±1.10	49.05±1.0	50.25±1.10	49.28±1.00
16	49.20±1.00	42.10±1.10	40.21±1.0	43.75±1.40	44.38±0.90
18	41.80±1.20	36.20±1.20	35.07±1.3	35.90±1.30	36.01±1.00
20	36.10±1.10	30.10±1.00	30.01±1.0	30.15±0.90	31.01±0.90
22	32.40±1.00	27.50±0.90	26.35±0.9	28.31±0.80	27.95±0.90
24	30.06±1.00	22.60±1.00	22.08±1.0	23.05±0.90	23.01±0.90
24	27.10±1.00	19.23±1.10	19.01±1.1	19.12±0.90	19.27±1.00
28	24.30±1.00	17.50±1.20	17.10±1.0	18.05±1.00	17.91±0.90
30	20.10±1.00	16.55±1.00	16.08±1.1	16.60±0.90	16.65±0.80
32	18.75±1.00	-	-	-	-

In our experiment we found that there was no significant difference in T_2-T_5 but samples in these treatments were

dried quickly than T_1 (control). The moisture content of Bombay duck is higher compare to its fat content which is probably reduced due to the use of salt treatment that enhances the drying process and took less time for drying. Condition of skin and muscle may be another reason, which enhances the quick evaporation of moisture from fish body (Sultana 2008). Turmeric and chili powder also have anti-insecticidal effect, authors found in T_5 blowflies did not infest frequently where the T_1 (untreated samples) were infested by huge blowflies. It was clear that both turmeric and chili powder had strong repellency power against insects and inhibited the production of larvae. There were several factors which might be accounted for the rapid efficacy of turmeric and chili as repellent of insects. The active ingredient of turmeric having pesticidal action is curcumin (Aggarwal *et al.* 2007). All the above botanical pesticides also have extra health benefit to the man (Ascher 1993).

Reconstitution properties: The reconstitution behavior was measured at room temperature, 26°C, 40°C and 60°C temperatures. Reconstitution percentage was measured at every 15 minutes interval for each temperature (Table 3).

For dried fish samples at 26°C, reconstitution level was found to be varied from 30.00±1.20% to 39.27±0.80% after 15 minutes of soaking with minimum uptake of water in T_3 and maximum in T_1 (Table 3). After soaking for 60 minutes, the reconstitution properties were between 42.25±1.40% and 51.5±1.40% with minimum uptake of water in T_2 and maximum in T_1 (Table 3).

After soaking at 40°C, the highest reconstitution properties of 43.75±1.20% found in T_4 and the lowest of 32.14±1.3% in T_5 after 15 minutes of soaking (Table 3). On the other hand, after 60 minutes of soaking the highest reconstitution 50.00±1.3% was found in T_1 (Table 3) and the lowest of 43.75±1.30% in T_2. Reconstitution capacity of all dried samples enhanced with the increase of temperature of water and soaking time. At 60°C, highest reconstitution of 48.18±1.30% obtained in T_4 and lowest reconstitution of 38.4±1.10% in T_2 after 15 minutes of soaking and after 60 minutes of soaking the highest value of 50.00±1.30% found in T_1 and the lowest was 38.4±1.10% in T_2 (Table 3). Slightly higher reconstitution of 60.25% for Bombay duck produced in controlled air drying condition using solar tunnel dryer (Reza *et al.* 2009).

A close relationship was observed between the reconstitution capacity and physical properties of the samples. The quality of the dried fish is also related to final aw. At low values, water uptake proceeds more quickly. In properly dried fish the water uptake is reported to complete in 3-15 minutes (Sikorski *et al.* 1995). In the present study, salt and herbal treated dried products exhibited slightly less rehydration properties compared to controlled products (T_1) 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. Thus little poor reconstitution in salt and herbal treated products (T_2-T_5) compared to controlled products was due to cemented and compact structure of the muscle with few inter fibrillar spaces. 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 (Connell 1957, Sen *et al.* 1961).

Table 3: Reconstitution behavior of samples under different treatments at various temperatures and times

Temp. (°C)	*Treat-ments*	*Reconstitution Percentage (Mean±SD)*			
		15 min	*30 min*	*45 min*	*60 min*
26	T_1	39.27±0.80	47.45±1.00	50.00±1.30	51.50±1.40
	T_2	30.50±1.20	34.92±1.10	40.57±1.20	42.25±1.40
	T_3	30.00±1.20	36.30±1.10	42.80±1.50	45.10±1.60
	T_4	34.10±1.20	40.81±1.60	45.28±1.40	47.20±1.30
	T_5	30.43±1.10	38.46±1.30	45.76±1.20	47.54±1.60
40	T_1	42.8±0.90	46.60±1.10	47.54±1.10	50.00±1.30
	T_2	36.06±1.10	37.40±1.30	45.30±1.00	46.13±1.50
	T_3	34.14±1.10	37.21±1.20	41.30±1.30	43.75±1.30
	T_4	43.75±1.20	47.05±1.30	48.57±1.30	50.00±1.20
	T_5	32.14±1.30	40.62±1.40	41.53±1.30	43.10±1.30
60	T_1	40.57±0.90	42.62±1.00	45.90±1.10	45.31±1.20
	T_2	31.91±1.30	34.69±1.20	37.25±1.10	38.40±1.10
	T_3	31.03±1.10	37.50±1.00	39.02±1.20	39.57±1.40
	T_4	41.17±1.10	45.80±1.40	47.30±1.10	48.18±1.30
	T_5	30.06±1.20	37.23±1.20	42.30±1.20	44.04±1.20

On the other hand, controlled products (T_1) 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 (Jason 1965). Considering the reconstitution ability, it can be stated that controlled products (T_1) products were slightly better quality compared to that of salt and herbal treated dried products.

CONCLUSION

Dried fish treated with salt and herbal treatment (turmeric powder and chili powder) found organoleptically excellent quality. It was also found that turmeric, chili powder and salt act as a repellent against blowflies and insects which are very harmful for the fish. In tropical climates, under humid conditions, heavy infestation of unsalted dried Bombay duck. Herbal treatment as like chili and turmeric powder also increases

the acceptability of the dried product which can be commercially helpful to the fish processors. Further study as like cost benefit analysis of these products can be another good topic for research.

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