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Quality assessments of traditional and solar tunnel dried SIS (Small Indigenous Fish Species) products

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Abstract

Studies were conducted to assessment the quality of traditional and solar tunnel dried SIS products. The moisture content of the solar products ranged from 14.38 to 18.48% with the lowest in batashi and the highest value in tengra. The moisture content of the traditional products was in the range of 23.26 to 26.42%. The range of protein contents on moisture free basis was from 67.57 to 71.90% in solar dried fishes with highest value obtained in dhela and lowest value in batashi. These values were more or less similar to those of traditional dried SIS products which were in the range of 68.02 to 73.54% on dry weight basis. Lipid contents of solar dried SIS varied from 14.10 to 16.26% and on moisture free basis the in the range of 11.73 to 21.98 with highest value found in tengra and lowest in puti. These values were more or less similar to those found for traditional dried products on dry weight basis and ranged from were 12.37 to 22. 43%.

Maximum reconstitution of solar dried products was obtained at 80°C in all samples and was in the range of 65.26 to 70.51% where the percentage of reconstitution increases with the increase of socking time and reach maximum at the end of up to 60 min. The TVB-N content of solar dried fish is low compared with traditional one ranging from 20.30 to 28.40mg/100g and peroxide value in the range of 12. 54 to 19.20meq./kg oil. The TVB-N of traditionally dried products were in the range of 32.50 to 45.45mg/100g and PO values of the traditionally dried products were in the range of 30.00 to 36.00meq./kg oil. The bacterial load of the solar dried products wase in the range of 4.0×10^3/g to 3.6×10^5CFU/g and of the traditionally dried products ranged from 1.45×10^5 to 2.52×10^6 CFU/g.

Key words : Traditional dried, Solar tunnel dried, SIS

Introduction

The physical and organoleptic qualities of most of the traditional sun dried products available in the market are not satisfactory for human consumption due to various reasons. There are frequent complaints from the consumers about the quality of the products and the major problems associated with sun drying of fish are the infestations of the products by house fly and insect larvae and poor handling and sanitation and improper processing that often lead to contamination and spoilage. One of the problems markedly evident is indiscriminate use of various types of insecticides such as DDT, Nogos, Rubral, etc. in the raw material or products to prevent infestations. Sun dried fish treated with insecticides may create wide spectrum of health hazards in this country. The present-day consumers have become more health conscious and interested in convenient food. The changing pattern of the life style and increasing number of households in the rural area have an impact on market demand since consumers now-a-days insist that the product should be acceptable in terms of both quality and safety. For the products of required quality a solar fish drying could be an alternative to the traditional sun drying.

The chemical composition is an important aspect of fish quality and influences both the keeping quality and the technological characteristics of the fish. Since composition may vary considerably with season and catching areas, it is often necessary to make repeated analyses. The main chemical components of fish meat, e.g., water, crude protein, lipids and ash, have the largest impact on the nutritive value, the functional properties, the sensory quality and the storage stability of meat. The other constituents, i.e. carbohydrates, vitamins and minerals, though minor quantity, also play a significant part in biochemical process taking place in tissue post-mortem. They are co-responsible for sensory properties, nutritive value, and wholesomeness of the product. Little or no work has been done in the past on the nutritional aspects of dried SIS products.

The present investigation reports the proximate composition, determination of water reconstitution properties, total volatile base nitrogen (TVB-N), peroxide value (PO), and aerobic plate count (APC) of traditional and solar tunnel dried products.

Materials and methods

Raw materials

Traditionally dried SIS products were collected from local fish market and fresh samples of mola, dhela, batashi, puti, chapila, tengra, chela were dried in a solar tunnel drier in the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh and ground into powder in an electric blender. The samples were packed in polythene bags tightly for chemical analysis.

Proximate composition

Biochemical analyses such as moisture, ash, lipid and crude protein, were carried out according to the methods given in AOAC (1980). Muscle protein fraction was determined according to the method described by Hashimoto *et al.* (1979). All determinations were done at least in triplicate and the mean value was reported.

Determination of water reconstitution properties

Five grams of fish sample were kept soaked in one liter of water at temperatures of 40°C, 60°C and 80°C up to 60 minutes with occasional stirring. Water was drained off through a coarse nylon net. All the flesh was then transferred to the strainer and extraneous water was wiped off by a piece of blotting paper and flesh was weighed again. By the given soaking time, flesh could reabsorb maximum mount of water. Results in this respect have been expressed in terms of weight of water absorbed by the sample.

Total volatile base nitrogen (TVB-N)

Dried samples were obtained with time intervals for evaluation of TVB-N value. Exactly 10 g of the ground sample were weighed in to a suitable container and mixed with 90 ml of 6% perchloric acid. The samples were homogenized for two minutes with a blender. This was done under cooled condition (2-6°C).

Steam distillation

One hundred milliliter of the extract was taken in Kjeldahl flask. Twenty ml of 20% sodium hydroxide (NaOH) solution and few glass beads were added into the flask. The distillation outflow tube was submerged in a conical flask with 50 ml 3% boric acid solution containing 1-2 drops of mixed indicator. After 15-20 minutes boiling in the flask the distillate accumulated in conical flask was titrated with 0.01 N hydrochloric acid (HCl). The TVB-N is calculated by the following formula :

$$TVB - N \text{ (mg/100 gms Sample)} = \frac{\text{ml of titrant} \times 0.14 \times 1 \times 100}{\text{Sample Wt.}} \quad \text{(gm)}$$

Method for peroxide value estimation

The method used for the determination of peroxide value was described by Egan *et. al.* (1981) and adopted from wood and Aurand (1977).

One gram of sample oil was weighed accurately into a Stoppard 250 ml conical flask and 20 ml of chloroform was then added to dissolve the lipid. The flask was then shaken for 30 seconds. A volume of 50 ml of a mixture of acetic acid and chloroform in the ratio of 3:2 was added. One ml of saturated aqueous potassium iodide solution was added and the flask was swirled for about 20 seconds and kept in the dark for 30 minutes. After that period, 100 ml of distilled water was added and liberated iodine was titrated against 0.002 M $Na_2\ S_2\ O_3\ 5H_2\ O$. Freshly prepared 1% starch solution was used as an indicator. The peroxide value was calculated as follows:

Peroxide value = 2 (S-B)/W, meq. /kg. of oil.

Where,

'S' is sample titre. 'B' is blank titre. 'W' is weight of sample oil in g.

Study on total bacterial count (APC) and coliform count

First 0.1 ml of diluted sample was transferred to prepare agar plates using micropipette. Samples were pipetted and transferred aseptically to the plates by raising the upper lids sufficiently enough to admit the tip of the pipette. The aliquot of the samples was then spreading over the whole surface of the media by using L-shaped glass rods until the samples were dried completely. All the plates were inoculated in duplicate. Then the plates were incubated at 30°C in an inverted position. After 48 hrs of incubation, colonies developed were counted.

Results and discussion

Proximate composition

Chemical composition i.e. moisture, protein, lipid and ash of the solar tunnel dried products and traditionally dried products is shown in Table 1. The moisture content of the products ranged from 14.38 to 18.48% with the lowest in batashi and the highest in tengra. The moisture content of the solar dried SIS is much lower than those found in the traditional products and was in the range of 23.26 to 26.42%. It is to be noted that there is a tendency in our country for fish processors and retailers sometimes allow more moisture in dried fish products to gain weight for economic benefit. The other reason is that the died products used for selling in the wholesale and retail market and during storage normally are not kept in suitable packaging material. In a tropical country like Bangladesh where relative humidity is always high, there is a chance of moisture uptake from the environment. Excessive moisture uptake increases the water activity which facilitates the growth of micro-organisms, loss of nutrients and reduction shelf-life of dried products.

Table 1. Proximate composition of solar dried (SD) and traditionally dried (TD) SIS

Fish species with scientific & local name	Moisture (%)		Protein (%)		Lipid (%)		Ash (%)	
	SD	TD	SD	TD	SD	TD	SD	TD
Amblypharyngodon mola (mola)	16.00	26.02	59.60 (70.95)	49.20 (66.50)	14.86 (17.69)	10.76 (14.54)	11.33 (13.48)	19.32 (26.11)
Osteobrama cotio cotio (dhela)	15.86	23.26	60.40 (71.90)	52.20 (68.02)	14.10 (16.78)	9.50 (12.37)	9.00 (10.71)	16.00 (20.84)
Barbides sarana (puti)	17.12	24.14	57.90 (70.60)	50.38 (66.99)	15.36 (11.73)	11.52 (15.31)	10.32 (12.58)	14.00 (18.61)
Pseudotropius atherinoides (batashi)	14.38	26.26	57.44 (67.57)	48.60 (68.45)	16.26 (21.83)	8.40 (22.43)	11.00 (12.94)	17.80 (23.98)
Mystus vitatus (tengra)	18.48	26.42	58.00 (71.60)	51.23 (69.98)	15.92 (21.98)	10.58 (14.45)	12.13 (14.97)	12.20 (16.48)
Gudusia chapra (chapila)	17.02	26.24	57.24 (69.80)	51.48 (73.54)	14.50 (17.68)	9.21 (21.39)	10.45 (12.74)	13.45 (19.21)

* Values within parenthesis indicate the results on dry weight basis

The protein contents varied from 57.24 to 60.40% on fresh weight basis. The range of protein contents on moisture free basis was 67.57 to 71.90% with highest value obtained in dhela and lowest value in batashi. These values are more or less similar to those of traditional dried SIS products which were in the range of 68.45 to 73.54 on dry weight basis. It is possible that the total nitrogen content in most traditional dried samples obtained from various market sources increased compared to that in solar dried samples due to the growth of microorganisms and release of metabolites during drying. Lipid contents of solar dried SIS varied from 14.10 to 16.26% and on moisture free basis the lipid contents were in the range of 11.73 to 21.98% with highest value found in tengra and lowest in puti. These values were more or less similar to those found in traditional dried products on dry weight basis which were 12.37 to 22.43% although among the chemical composition, the lipid contents were reported to vary greatly even within the species according to age, sex, season, feeding habit and habitat (Stansby 1962). Ash contents of solar dried SIS varied from 10.71 to 14.97% with highest value obtained in tengra and lowest in dhela on moisture free basis. On the other hand, ash content in traditionally dried products on moisture free basis were in the range of 16.48 to 26.11% with highest value obtained in mola and lowest in tengra. The high level of ash content in traditional dried SIS products might be associated with the contamination of sands and filth during drying. It is well known that traditional drying of fish are often done in the open field or on the sand particularly when large quantity of fishes are caught at a time during peak season.

The results of proximate analysis of traditionally and solar tunnel dried fish products indicate some variations in their composition. The most important and significant variation was observed in moisture and ash content. The moisture and ash content of market and producers samples of dried fish were much higher than the solar tunnel dried product samples. The results obtained on proximate composition in the present study is more or less similar as previously reported for freshwater fishes of this region (Qudrat-I-Khuda 1962, De 1967, Chaity 1992). Ahmed *et al.* (1979) reported that fishes dried by a solar drier contained higher percentage of protein and fat over the traditional sun dried products. This phenomenon was also observed in the present study. Cutting (1962) stated that the chief alteration caused by drying was the loss of water resulting in an increase in protein, fat and mineral contents and thereby an increase in food value per unit weight of dried fish. This means food value per unit weight of tent dried fish must be higher than that of traditionally dried market samples.

Determination of water reconstitution properties

The results of the reconstitution properties of the dried products of each seven species after soaking in a series of water bath for time variation at 40°C, 60°C and 80°C for maximum of 60 min are shown in Table 2, 3 and 4 respectively. Table 2 shows comparison of reconstitution behaviour between solar dried and traditionally dried SIS products at 40^{0}C. In solar dried products maximum reconstitution was attained in 15 min of socking at 40^{0}C in all the samples and was in the range of 17.64 to 23.62% with highest value was found in chapila and lowest value in batashi. Then the reconstitution of dried products increased slowly with the increasing of socking time. After 60 min the values were in the range of 33.41to 49.462% with maximum value observed in chapila and minimum in batashi. On the other hand, different reconstitution behaviour was observed with traditional dried SIS products at 40^{0}C where the reconstitution percentage was found relatively poor. During 15 min soaking the reconstitution was in the range of 15.18 to 20.75% with highest value determined with chapila and lowest with mola. Then reconstitution percentage increased with the lapse of socking time ranging between 29.00 and 45.33% after 60 min. of socking with maximum value in chapila and minimum in batashi.

Table 2. Reconstitution behaviour of solar and traditionally dried SIS products at 40^{O}C shown as percentage of water holding capacity

Fish species	Reconstitution behaviour of solar dried SIS in % water holding capacity				Reconstitution behaviour of traditionally dried SIS in % water holding capacity			
	15 min.	30 min.	45 min.	60 min.	15 min.	30 min.	45 min.	60 min.
Mola	21.60	25.42	27.69	35.62	15.18	20.22	25.56	30.17
Dhela	21.73	26.08	30.43	39.13	16.66	20.75	26.65	35.75
Puti	18.75	21.87	31.25	40.62	15.75	20.00	27.16	38.29
Bbatashi	17.64	23.41	26.72	33.41	14.19	18.66	25.33	29.00
Tengra	22.17	24.00	32.26	40.00	18.21	22.33	28.65	36.66
Chapila	23.62	27.72	36.63	49.46	20.75	25.75	35.56	45.33
Phul chela	21.05	26.31	36.66	41.10	20.15	24.75	35.64	40.75

Table 3. Reconstitution behaviour of solar and traditionally dried SIS product at 60^{O}C shown as percentage of water holding capacity

Fish species	Reconstitution behaviour solar dried SIS in % water holding capacity				Reconstitution behaviour of traditional dried SIS in % water holding capacity			
	15 min.	30 min.	45 min.	60 min.	15 min.	30 min.	45 min.	60 min.
Mola	22.58	35.48	41.93	46.16	21.66	30.24	36.74	45.24
Dhela	36.84	24.10	47.36	48.42	30.45	38.76	42.33	48.25
Puti	35.29	47.05	50.19	52.94	30.25	40.22	45.66	50.33
Bbatashi	46.66	53.33	60.00	61.23	40.35	50.55	55.84	62.04
Tengra	48.93	53.12	56.25	59.37	45.25	51.74	58.02	60.25
Chapila	33.33	50.00	52.52	54.16	30.00	45.00	50.66	53.77
Phul chela	27.77	38.88	44.46	48.75	25.33	35.22	42.56	45.79

Tables 3 and 4 show the reconstitution of solar dried and traditionally dried SIS products at 60 and 80^{0}C respectively. The reconstitution phenomenon indicates that the re-hydration increased as the socking temperature increased where maximum reconstitution of 22.58 to 48.93% in solar dried products was achieved during 15 min. socking at 60^{0}C with highest value in tengra and lowest value in mola (Table 3). The rehydration of the products increased slowly with the increase of soaking time where maximum reconstitution was attained at after 60 min. with maximum value of 61.23 for batashi and minimum of 46.16% for mola. The Table also shows that the reconstitution properties of the traditional dried products were comparatively less than those of solar dried products. During 15 min. socking at the same temperature the maximum reconstitution was 45.25% for tengra and minimum of 21.66% for mola. It is interesting to see that the reconstitution behaviour of traditionally dried SIS products increased rapidly with the increasing socking time and after 60 min. of socking the reconstitution was found in the range of 45.24 to 62.04% with maximum value obtained for batashi and minimum for mola.

Table 4. Reconstitution behaviour of solar and traditionally dried product at 80^{0}C shown as percentage of water holding capacity

Fish species	Reconstitution behaviour solar dried SIS in % water holding capacity				Reconstitution behaviour of traditional dried SIS in % water holding capacity			
	15 min.	30 min.	45 min.	60 min.	15 min.	30 min.	45 min.	60 min.
Mola	43.33	50.00	53.33	60.00	35.00	42.66	50.29	55.74
Dhela	27.77	38.88	55.56	61.12	25.29	35.73	48.75	55.33
Puti	42.56	53.33	60.00	66.68	38.66	45.69	55.33	60.26
Bbatashi	40.00	44.52	56.64	61.32	35.00	40.75	52.66	58.24
Tengra	28.00	38.21	48.00	56.51	25.75	35.36	48.24	54.26
Chapila	43..47	52.17	56.38	59.16	40.00	48.15	55.26	58.16
Phul chela	30.64	38.72	42.78	54.26	25.00	32.66	40.26	50.75

As shown in the Table 4, the phenomena of reconstitution behaviour at 80^{0}C for solar and traditionally dried products were more or less similar to those obtained at 40 and 60^{0}C except that the rehydration percentage at 80°C was considerably high and was in the range of 27.77 to 43.47% with maximum for chapila and minimum for dhela after 15 min. of socking. The percentage of reconstitution increases with the increasing of socking time and at the end of 60 min. the values were in the range of 54.26 to 66.68% with maximum value in puti and minimum in phul chela. On the other hand, reconstitution of all traditionally dried SIS products of was poor and varied from 25.00 to 38.66% with maximum value obtained in puti and minimum in phul chela after 15 min. of soaking at 80^{0}C. The reconstitution increased rapidly with the lapse of socking time and at the end of 60 min. the maximum value of 60.26% was obtained for puti and minimum of 50.75% for phul chela. On the basis of the results obtained from the present study, it is clearly evident that reconstitution of solar dried products was faster compared with those of traditionally dried products.

A close relationship was observed between the reconstitution power and physical properties of the samples. The quality of dried fish is also related to final a_w. At low a_w 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). If it is more than 15 minutes the quality of fish is considered to be questionable. Protein denaturation might be the cause of a decreased ability of rehydration. The poor rehydration in traditionally dried products was probably due to the irreversible changes (denaturation) that took place during drying causing severe damage to the cellular structure. In such situation, the real reconstitution was impossible. The best way of reconstitution is to conserve a porous structure by a suitable method, which absorbs and retains sufficient water by capillary. Compressed products absorb slowly and less completely (Jason, 1965). The fibers of these sample muscles appeared to be cemented together and suffered hardly any of the separation induced by shrinkage. The samples of solar dried products exhibited an enormously rapid initial rate of rehydration, which was no doubt due to water being carried deep into the pieces by a porous structure which absorbed and retained sufficient water by capillary (Jason, 1965). The results obtained with traditionally dried products are in agreement with that which reported that with a tough rubbery tissue water penetrated mostly to the center of large pieces by diffusion through the protein of fiber itself and the process was very slow (Connell 1957, Sen *et. al.* 1961, Lahiry *et al.* 1961). According to Schewan *et al.* (1950), the most important requirements of satisfactory dried fish products are: (i) resemblance to fresh fish in flavor and texture and free from ripened flavors caused by prolonged bacterial, enzymatic, oxidative and chemical changes; (ii) compactness; (iii) ready and rapid reconstitution, and (iv) retention of good palatability for a minimum period of 6 months.

TVB-N, PO value and APC of solar tunnel and traditionally dried products

The results of the total volatile base nitrogen (TVB-N), peroxide value (PO) and aerobic plate counts (APC) of solar dried and traditionally dried products are given in Table 5. The TVB-N content of solar dried fish ranged from 20.30 to 28.40mg/100g with highest value in mola and lowest value in dhela. In traditionally dried fish the TVB-N contents ranged from 32.50 to 45.45mg/100g with highest value in katchki and lowest value in mola.

Table 5. Total volatile base nitrogen (TVB-N), peroxide value (PO) and aerobic plate count (APC) of solar tunnel dried (SD) and traditionally dried (TD) SIS products

Fish species	TVB-N (mg/100g)		PO (meq/kg oil)		APC (CFU/g)	
	SD*	TD*	SD	TD	SD	TD
Mola	28.40	32.50	12.54	34.00	3.2×10^4	$1.45X10^5$
Dhela	20.30	34.20	17.30	30.00	$4.0x10^3$	$2.40X10^5$
Puti	25.50	34.45	15.30	36.00	3.6×10^5	$2.52X10^6$
Chapila	23.00	32.80	16.10	32.60	3.9×10^4	$2.44X10^5$
Tengra	24.80	41.10	19.20	35.45	$5.0x10^3$	$1.45X10^6$
Katchki	20.40	45.45	14.80	31.00	4.6×10^5	$1.80X10^5$

*SD (Solar dried), *TD (Traditionally dried)

TVB-N values were much lower than the recommended value (100-200mg/100g) for variety of salted and dried fish products. (Connell 1995). Volatile bases (ammonia, mono-di, and tri-methylamines) are of minor significance in the muscles of living fish but most important to fish handling, as they are found in the common pattern of spoilage. Volatile bases other than TMA are formed during spoilage.

Sen *et al.* (1961) reported that TVB-N value of sun-dried product varied from 32.5 to 41.0 mg/100g. Available reports suggest that in the case of fresh finfish such as cod, haddock, eel and sea pike, the upper limit of 30 mg TVB-N/100g is considered for acceptability (Kawabata 1953). The TVB-N value is a useful parameter to assess the degree of freshness for chilled and frozen products but not suitable for the dried products because most of the volatile bases escape from the body during the drying process.

As shown in the Table 5 the PO value of the solar dried products produced from fresh samples was in the range of 12. 54 to 19.20m.eq./kg oil with maximum obtained with tangra and minimum with mola. These values were, however, the range of suggested value of 10-20 (Connell 1957). Similar results were also obtained from some marine fishes where the PO values of the products produced from 1 day ice stored samples were in the range of 3.9 to 12.1 m.eq./kg oil with lowest value in Ribbon fish and highest value in Big-eye tuna (Reza 2002). On the other hand, the PO values of the traditionally dried products were in the range of 30.00 to 36.00 m.eq./kg oil with maximum in puti and minimum in dhela , the range which was much above the acceptable limit.

The bacterial loads of solar and traditionally dried samples of mola, dhela, tengra, katchki, puti, and chapila are presented in Table 5. The bacterial load of the solar dried products were in the range of 4.0×10^3/g to 4.6×10^5/g with highest value in puti and lowest value in dhela. On the other hand, APC of traditional dried products ranged from 1.45×10^5 to 2.52×10^6 CFU/g with maximum value obtained from puti and minimum in mola. No Coliform bacteria or *Salmonella* was found either in solar or traditional dried products. It is clearly evident from the results that the APC counts were higher in traditional compared to solar dried samples. The results obtained from the solar dried products of the present study is more or less similar to those of some marine dried products produced in solar dryers where APC of solar tunnel dried ribbon fish, Bombay duck, big-eye tuna, silver jew fish and Chinese pomfret were in the range of 1.88×10^3 to 3.06×10^4 CFU/g (Islam 2001). The quality of dried fish is related to the final a_w. Most bacteria do not grow and multiply at a_w values below 0.95. Frazier and Westhoft (1978) stated that generally no microorganism (yeast, mold and bacteria) could grow in a fish product of moisture content less than 15%. Moisture content in most of the solar tunnel dried products was low enough for the growth and multiplication of microorganisms. Besides, strict hygienic condition was maintained during various steps of drying. As a result the total bacterial content was within the acceptable limit and the products were safe from microbiological point of view. On the other hand, most of the traditionally sun dried product samples collected from local retail market was stored for 6-7 months in abusive condition. Enough moisture was absorbed from the air especially during the rainy season. Thus a suitable environment was created and total bacterial content exceeded the limit of acceptability. According to Sen *et al.* (1961), when water content of fish fell below 25% of wet weight, bacterial action stopped and when the water content further reduced to 15%, mold ceased to grow.

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