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Assessment and comparison of quality of solar tunnel dried Bombay duck and Silver pomfret with traditional sun dried samples

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Abstract: Traditional sun drying methods are widely used in Bangladesh to dry fish, though the quality is not satisfactory. The aim of this study was to assess the quality of solar tunnel dried Bombay duck and Siler pomfret, and to compare it with traditional sun dried Bombay duck and Silver pomfret. Raw fish samples of Bombay duck and Silver pomfret was collected and dried using solar tunnel dryer. The quality of the dried product was analyzed measuring moisture, protein, fat, ash, peroxide value and Total Volatile Base Nitrogen (TVB-N) content and analyzing water reconstitution properties. Traditional sun dried Bombay duck and Silver pomfret were also collected from different area, and the same measurement was also performed and compared with solar tunnel dried fish samples. Microbial quality was also analyzed using standard methods. Organoleptic quality of solar tunnel dried fish samples was found very well without any objectionable flavor and odor, compared with traditional sun dried fish samples. Moisture content was also observed (15.25 % in Bombay duck and 13.43 % in Silver pomfret) within the acceptable range. Protein content of solar dried fish samples was also found higher than that of traditional sun dried samples and water reconstitution power was also found better. Peroxide and TVB-N value of the solar tunnel dried studied samples were found within the normal limit of 10-20meq/kg of oil and up to 30 mg/100gm, respectively. Aerobic Plate Count was found lower, however Salmonella and Coliform was not found in both dried samples. The quality of solar tunnel dried Bombay duck and Silver pomfret samples were of excellent compared with samples dried by traditional sun drying method.

Keywords: Bombay Duck, Silver Pomfret, Organoleptic Quality, Water Reconstitution Properties, Aerobic Plate Count, Solar Tunnel Dryer, Peroxide Value

1. Introduction

The physical and organoleptic qualities of most of the traditional sun dried products available in the market of Bangladesh 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, 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. Sun dried fish treated with insecticides creates wide spectrum of health complications. Fish drying as a means of preservation has been practiced since the time immemorial in Bangladesh. Dry fish is also considered to add delicate flavor in the menu in many region in Bangladesh. The basic principle of fish drying is that the activity of muscle enzyme and microorganism is reduced or

halted by reducing moisture content of fish. Fish drying is carried out in some selected coastal areas and inland depressions of Bangladesh where proper preservation facilities and good infrastructure and transport facilities are not available [1]. Sun drying of fish is carried out in the open air, using the energy of the sun to evaporate the water and air currents are used to carry away the vapor. During sun drying evaporation of water from fish is accomplished in two distinct phases [2]. In the first phase, when the surface of the fish is wet, the rate of evaporation depends on the relative humidity of air, air velocity, air temperature, and surface area of fish. In the second phase, when the entire surface moisture is carried away, drying of fish depends on the rate at which moisture can be brought to the surface of the fish, which is dependent on the nature of constituents of fish, thickness, temperature and water content [3].

Sun drying is one of the most important low-cost methods of fish preservation not only in Bangladesh but also in many areas of the world. However, around 20% of the artisanal catch is being dried by traditional sun drying methods and consumed in the domestic market [4], the quality of the dried fish are not good. In a view to improve the quality of dried fish products various types of drying methods has been developed. A Hohenheim type solar dryer developed in Germany in the early sixties were recently tested in field level in Bangladesh in order to assess its suitability in drying mangoes, pineapple and fish [5,6]. The quality of the dried fish produced by the Hohenheim type dryer was good in terms of organoleptic characteristics, infestation and contaminations [7,8], however, the cost of this dryer was extremely high both for small and large scale operations. Alternatively solar tunnel dryer is easy to construct with locally available material and does not require any power from electrical grid or fossil fuels. The objective of this study is to investigate the quality of solar tunnel dried fishes and to compare it with traditional sun dried fishes.

2. Materials and Methods

2.1. Organoleptic Quality Assessment of Solar Dried Fish

Sensory methods were used to assess the degree of freshness based on organoleptic characteristics such as color, odor, appearance, eyes, slime and consistency of flesh. The organoleptic quality characteristics was judged by seven panel members and the grading of fish using score on the characteristics has been followed by EC freshness grade for fishery product with slight modification [9,10,11] to judge the quality of the fish.

2.2. Proximate Analysis

Proximate analysis of two dried fish samples, Bombay duck and Silver pomfret, dried at solar tunnel drier were done. Moreover, these two fish samples dried with traditional sun drying system were also collected from different places and proximate composition was analyzed for each collection sample. Moisture content of samples was determined according to the methods of FAO (1994) and expressed as percentage of moisture [12]. Protein content was determined by the Micro-Kjeldahl method described by AOAC [13]. Ash content was determined using a muffle furnace at 600±2°C for 8 hrs by AOAC method [14]. The total lipid in the fish was extracted using chloroform methanol phase separation and determined by the method described by Lima *et al.* [15]. Nutrient content on dry weight basis was calculated by dividing the reported amount of nutrient by total amount of dry matter and then the result was multiplied by 100. Peroxide value was determined by the methods as described by Ergan *et al.* [16] and adopted from Wood & Aurand [17]. Trichloro acetic acid extract was prepared as per FAO [12] and Total Volatile Base Nitrogen (TVB-N) content of the dried fish sample was determined by the micro diffusion method as described by Martin [18]. All determination was done in triplicate.

2.3. Analysis of Water Reconstitution Behavior

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 [19]. Two pieces of dried fish (20 gm each) sample were taken and weighted by analytical balance (Mettler H18) and then immerged in water at 40^0C, 60^0C and 80^0C, respectively. The fish samples were kept under water for 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. The results were expressed as, ml of reconstitution media absorbed per 100 g of dried fish samples.

Calculation:

The percentage of water uptake in rehydrated fish samples was calculated as follows:

% Water reconstitution = (Wr – Wi) / Wi X 100

Initial weight of the dry fish = Wi, Weight of dry fish after reconstitution = Wr, Water reconstitute = Wr – Wi,

2.4. Microbiological Analysis

In this study, bacterial content of total aerobic plate count (APC) was performed for traditional and solar tunnel dried products of Bombay duck and Silver pomfret fish. For bacterial enumeration the US FDA [20] recommended method was followed. Aerobic plate count (APC) was performed by pour plate method using plate count agar (PCA). 1 ml of desired dilution of sample was pipetted out and transferred aseptically to the agar plates. The sample were spread by L-shaped glass rod throughout the surface

of the media until the sample were dried out. The plates were incubated at 30^0 C in inverted position. After 48 hrs of incubation, the plates having 30 to 300 colonies developed were counted in order to get the cfu/g [21]. Lauryl sulphate tryptose (LST) broth was used for isolation of Escherichia coli. After incubation at 35±1°C for 48±2 hrs the broth tubes that showed gas production was selected and a loop-full of the broth culture was transferred to EC broth that was further incubated at 45.5±0.2°C for 48±2 hrs. Gassing tube was selected for E. coli enumeration using most probable number (MPN) method. For isolation and enumeration of Salmonella, Rappaport Vassiliadis (RV), tetrathioate (TT) broth, Hektoen enteric agar (HEA), bismuth sulphite agar (BSA) and xylose lysine desoxycholate (XLD) agar media were used [20].

3. Results

3.1. Organoleptic Characteristics of Dried Fish Products

The result of the organoleptic observation is given in Table 1. Organoleptic characteristics of the dried fish products produced from emergency solar tunnel dryer were investigated in determining color, odor, texture, insects' infestation, presence of broken pieces and overall quality. The color of solar dried Bombay duck and Silver pomfret fish became whitish to yellowish with little difference among fish species in traditional dryers. Texture was firm and flexible and color was very natural in all samples. No insects' infestation or broken pieces were found around the products. The overall quality of the products obtained from emergency solar tunnel dryer was excellent than traditional dryer for fish species.

Table 1. *Organoleptic observation of traditional sun dried and solar tunnel dried fish sample collected from various places.*

Dried fish sample	Collection source	Storage duration	Use of chemicals	Color	Odor	Texture	Infestation	Broken pieces	Overall quality
				Dried by traditional sun drying method					
Bombay duck	Kutubdia	7-10 days	Nogos, DDT	Off white and clear	Characteristic odor	Firm and flexible	No infestation	Nil	Good
	Shaparirdip	6-7 months	Nothing	Yellowish	sour	soft	Infested by insects and their eggs	Broken	Not good
	Cox'bazar	6-7 months	Nothing	Brownish to yellowish	sour	soft	Infested by insects	Broken	Bad
Silver pomfret	Cox'bazar	5-7 days	Nothing	Reddish	Natural	Firm and flexible	No infestation	Nil	Good
	Chakti	6-7 months	Nothing	Brownish in outer and reddish in inside	Slightly sour	Soft	Slightly infestation by flies	Slightly broken	Not so good
	Kazidewry	8-9 months	Nothing	Brownish in outer and reddish in inside	Sour	Soft and damp	Infested by flies and insects	Broken	Very bad
				Dried by solar tunnel drier					
Bombay duck	Cox'bazar	1-4 days	Nothing	Whitish	Character-istic odor	Firm and flexible	Nil	Nil	Very good
Silver pomfret	Cox'bazar	1-4 days	Nothing	Yellowish and shining	Character-istic odor	Firm and flexible	Nil	Nil	excellent

The color of collected traditional sun dried fish samples were ranged from silvery to white with wide variations in different species and that of all the products were characteristics with firm and flexible texture. No broken pieces were found. The overall quality of all the products from producer source was good though the sum of the color score was not so attractive. The same products collected from wholesale market were of markedly deteriorative quality. They were stored 5 to 7 months, which lead to deterioration in color and texture compared to those of the original products. Slightly sour to sour odor was developed in many products. Infestation by flies, insects and their eggs and larvae were very common in most of them. Broken pieces were noticed some of the products. On the other hand, most of the samples from retail market were of bad quality. In contrast, the color and texture of the solar tunnel dried products were of better compared to traditional sun dried products of the same species. No broken pieces and infestation was present.

3.2. Proximate Composition

Proximate composition of two marine fishes and their traditional sun dried and solar tunnel dried product are

reported in Table 2. Raw Bombay duck (88.31%) were found to contain more moisture than Silver pomfret (76.16%). Protein content was found more in Silver pomfret (18.65) than in Bombay duck (8.75%). Similarly, lipid (3.41% and 1.88%) and ash (1.51% and 0.71%) content was also found more in Silver pomfret than in Bombay duck. The moisture content of the traditional sun dried product of the two studied sample collected from different area were found in the range of 19.08% to 25.86%. The protein content of traditional sun dried Silver pomfret and Bombay duck was found from 41.16% to 54.58%. The range of lipid and ash content were 5.16% to 7.18% and 16.95% to 21.41%, respectively.

Table 2. *Proximate composition of Raw, Traditional and Solar tunnel dried fish sample*

Fish sample	Collection source	Moisture %	Protein %	Lipid %	Ash %
			Raw Fish Sample		
Bombay duck	Kutubdia	88.31 ± 1.63	8.75 ± 0.42 (74.85 ± 2.83)	1.88 ± 0.33 (16.08 ± 2.17)	0.71 ± 0.01 (6.07 ± 0.59)
Silver pomfret	Shaparirdip	76.16 ± 1.28	18.65 ± 0.89 (78.22 ± 3.21)	3.14 ± 0.59 (13.17 ± 0.78)	1.51 ± 0.05 (6.33 ± 0.84)
			Dried by traditional sun drying method		
Bombay duck	Kutubdia	21.39 ± 1.65	50.66 ± 2.28 (66.44 ± 2.13)	6.24 ± 0.39 (7.93 ± 0.61)	18.71 ± 1.02 (23.80 ± 1.11)
	Shaparirdip	19.08 ± 1.05	54.58 ± 2.11 (67.44 ± 3.02)	6.98 ± 0.18 (8.62 ± 0.43)	18.64 ± 0.86 (23.03 ± 0.63)
	Cox'bazar	23.61 ± 0.87	52.49 ± 1.69 (68.71 ± 1.31)	5.16 ± 0.26 (6.75 ± 0.39)	20.32 ± 0.92 (26.60 ± 0.67)
Silver pomfret	Cox'bazar	25.86 ± 0.64	41.16 ± 2.11 (55.51 ± 1.98)	5.81 ± 0.32 (7.80 ± 0.41)	21.41 ± 1.03 (28.87 ± 0.82)
	Chakti	20.42 ± 0.59	54.32 ± 1.37 (68.25 ± 3.21)	7.18 ± 0.29 (9.02 ± 0.52)	16.95 ± 1.01 (21.29 ± 1.03)
	Kazidewry	22.48 ± 1.37	49.84 ± 1.92 (64.29 ± 1.17)	6.46 ± 0.16 (8.33 ± 0.07)	19.40 ± 0.39 (25.02 ± 0.48)
			Dried by solar tunnel drier		
Bombay duck	Cox'bazar	15.25 ± 0.34	68.78 ± 3.13 (81.15 ± 2.82)	7.37 ± 0.22 (8.69 ± 0.12)	8.29 ± 0.17 (9.78 ± 1.31)
Silver pomfret	Cox'bazar	13.43 ± 0.43	68.05 ± 0.79 (78.60 ± 1.45)	8.51 ± 0.18 (9.83 ± 0.45)	9.45 ± 0.26 (10.91 ± 0.12)

*() values indicates the result on dry weight basis.

3.3. Water Reconstitution Behavior

The reconstitution properties of the dried fish muscles at 40^0C, 60^0C and 80^0C were investigated for the products obtained from both traditional sun dryer and solar tunnel dryer. The reconstitution percentages of solar tunnel dried fish produced at different temperature and time interval result are presented in Table 3. The water holding capacity of dried fish products were shown to increase with the increase in reconstitution temperature and time. At 40^0C after 60 minutes, traditional sun dried Bombay duck and Silver pomfret were shown to hold 41.45% and 38.76% moisture, whereas solar tunnel dried products were shown to have 61.78% and 64.14%, respectively. In contrast at 80^0C after 60 minutes, this percentage were 44.51 and 42.96, and 65.94 and 67.59 for Bombay duck and Silver pomfret of traditional Sun dried and solar tunnel dried products, respectively.

Table 3. *Water reconstitution properties of traditional sun dried and solar tunnel dried fish sample.*

Soaking Temperature	Soaking time (minutes)	Reconstitution percentages	
		% water holding capacity in Bombay duck	***% water holding capacity in Silver pomfret***
		Traditional sun dried fish sample	
40^0C	15	19.29 ± 1.03	17.86 ± 0.35
	30	28.61 ± 0.91	26.24 ± 0.62
	45	36.72 ± 1.18	32.59 ± 0.93
	60	41.45 ± 2.06	38.76 ± 1.53

60^{0}C	15	20.77 ± 0.63	18.62 ± 0.28
	30	29.98 ± 0.97	27.89 ± 0.85
	45	38.41 ± 1.95	34.14 ± 1.17
	60	43.22 ± 1.71	40.56 ± 0.60
80^{0}C	15	22.63 ± 0.46	20.33 ± 0.52
	30	31.25 ± 0.29	30.15 ± 0.70
	45	38.72 ± 0.78	37.78 ± 0.37
	60	44.51 ± 1.42	42.69 ± 1.30
		Solar tunnel dried fish sample	
40^{0}C	15	29.30 ± 0.52	31.07 ± 0.61
	30	39.20 ± 0.73	42.62 ± 0.59
	45	52.07 ± 0.89	54.58 ± 1.59
	60	61.78 ± 1.19	64.14 ± 2.06
60^{0}C	15	31.33 ± 0.73	32.80 ± 0.69
	30	43.31 ± 0.81	43.43 ± 1.32
	45	54.49 ± 1.19	55.26 ± 0.92
	60	64.07 ± 2.13	65.20 ± 2.56
80^{0}C	15	33.26 ± 0.95	33.00 ± 0.16
	30	43.96 ± 0.69	46.32 ± 0.35
	45	55.64 ± 1.75	57.25 ± 2.13
	60	65.94 ± 1.39	67.59 ± 1.61

3.4. Peroxide Value and Total Volatile Base Nitrogen Content

The peroxide values of solar tunnel dried Silver pomfret and Bombay duck were 18.62 meq/kg oil and 21.78 meq/kg oil respectively. The peroxide value of Silver pomfret was within the acceptable limit of 20 meq/kg oil [22], whereas this value for Bombay duck was not within the acceptable limit. It was also observed that peroxide value of most of the traditional sun dried product exceeded much above acceptable recommended limit. The lowest and highest value values were 16.88 meq/kg oil and 39.22 meq/kg oil for traditionally dried fish products. Total Volatile Base Nitrogen (TVB-N) content in solar tunnel dried and traditional dried product are given in Table 4.

Table 4. *Peroxide and TVB-N value of traditional sun and solar tunnel dried products.*

		Peroxide value (meq/kg of oil)	
Dried fish samples	**Collection places**	**Traditional dried products**	**Solar tunnel dried products**
Bombay duck	Kutubdia	32.50 ± 0.89	
	Shaparirdip	39.22 ± 1.52	21.78 ± 0.83
	Cox'bazar	19.51 ± 1.37	
Silver pomfret	Cox'bazar	16.88 ± 0.26	
	Chakti	28.42 ± 2.09	18.62 ± 1. 02
	Kazidewry	35.21 ± 0.63	
		TVB-N value (mg/100g)	
Bombay duck	Kutubdia	28.00 ± 0.82	
	Shaparirdip	30.24 ± 0.59	27.30 ± 0.73
	Cox'bazar	29.15 ± 1.03	
Silver pomfret	Cox'bazar	23.11 ± 0.91	
	Chakti	31.05 ± 0.39	22.40 ± 0.39
	Kazidewry	29.25 ± 0.64	

TVB-N content of Sun dried Silver pomfret and Bombay duck sample were found 23.11 mg/100g and 29.15 mg/100g, respectively collected from cox'bazar area. The highest TVB-N value for both Bombay duck (30.24) and Silver pomfret (31.05) were shown to be highest in those collected from Shaparirdip and Chakti. Solar tunnel Silver pomfret (22.40) were shown to have lower TVB-N value than those of Bombay duck (27.30).

3.6. Bacteriological Quality

The result of Bacteriological study of raw and traditional sun and solar tunnel dried fish products are given in Table 5. Fresh fish and fishery products often have an APC of 10^4-10^5/g, although there are examples of seafoods with an APC of 10^6-10^8/g without objectionable quality changes [23]. Aerobic plate count of raw fish sample was found 3.36×10^4 and 4.30×10^3 cfu/g for Bombay duck and Silver pomfret respectively, whereas no Coliform and Salmonella were found. In traditional sun dried fish sample the total aerobic bacterial count were in the range of 2.88×10^4 to 3.37×10^5 cfu/g for both Bombay duck and Silver pomfret collected from different region. For solar tunnel dried products, bacterial load was found lower in Bombay duck (3.88×10^4 cfu/g) compared with Silver pomfret (4.66×10^4 cfu/g). Salmonella and Coliform were

found totally absent both in traditional sun dried and solar tunnel dried fish samples.

Table 5. *Aerobic Plate Count (APC), Coliform and Salmonella test of Raw, Traditional sun dried and Solar tunnel dried fish sample.*

Fish sample	Collection source	APC (cfu/g)	Coliform	Salmonella
		Raw Fish Sample		
Bombay duck	Kutubdia	3.36×10^4	Nil	Nil
Silver pomfret	Shaparirdip	4.30×10^3	Nil	Nil
		Dried by traditional sun drying method		
Bombay duck	Chakti	6.57×10^4	Nil	Nil
	Boro Bazar	2.88×10^4	Nil	Nil
	Cox'bazar	1.60×10^5	Nil	Nil
Silver pomfret	Chakti	2.85×10^5	Nil	Nil
	Kazidewry	3.37×10^5	Nil	Nil
		Dried by solar tunnel drier		
Bombay duck	Cox'bazar	3.88×10^4	Nil	Nil
Silver pomfret	Cox'bazar	4.66×10^4	Nil	Nil

4. Discussion

4.1. Organoleptic Quality

The organoleptic quality of traditional sun dried fish sample was found very poor comparing with solar tunnel dried products. Objectionable color, odor and texture were observed in traditional sun dried products, whereas the dried fish products from solar tunnel drier were good in all of the quality. Rahman *et al.* also observed attractive quality products from BFRI Fish Dryer compared to traditional sun dried products [24]. However, no discoloration was found both in traditional sun dried and solar tunnel dried products, only with insect infestation in traditional sun dried products in a study [25]. The observations of organoleptic quality in this current study was found similar with other studies with good quality products from solar tunnel dryer [26,27,28].

4.2. Proximate Composition

The moisture content of the traditional sun dried product of the two studied sample collected from different area were found within the range of 19.08% to 25.86%. The protein content of traditional sun dried Silver pomfret and Bombay duck was found from 41.16% to 54.58%. The range of lipid and ash content were 5.16% to 7.18% and 16.95% to 21.41%, respectively. On moisture free basis protein, lipid and ash content was found 55.51% to 68.71%, 6.75% to 9.02%, and 21.29% to 28.87%, respectively. Highest moisture content (25.86%) was found in Silver pomfret collected from Cox's bazar, whereas the lowest moisture content (19.08%) was found in Bombay duck collected from Shaparirdip. The moisture content of the solar tunnel dried Bombay duck and Silver pomfret samples were 13.43% and 15.25%, respectively. On the other hand, other nutrients like protein, fat and ash content were to be similar in the both tested samples.

Moisture content of solar tunnel dried products was lower than traditional sun dried products. Moisture content is a determinant of the quality of dried food products. Clucas (1982) reported that dried fish with 25% or more moisture is not sufficient to inhibit microbial growth whereas dried fish with 15% or less moisture is well enough to inhibit microbial growth [29]. Similar cutoff point was also reported by Fraizer (1978). Moisture content of solar dried Bombay duck and Silver pomfret was found below this cutoff points, whereas traditional sun dried products was not within this range [30]. Moisture content of solar tunnel dried fish samples from current studies was found lower than as studied by Reza *et al*. (2006) [28]. Lipid content of both traditional sun dried and solar tunnel dried products were found similar; however protein content was found higher in solar tunnel dried fish sample. Ahmed *et al.* (1979) also reported an increased protein and fat content in solar tunnel dried fish products compared with traditional sun dried fish products [7]. According to the study of Azimuddin *et al*. (2006), ash content of dried fish varied from 8.90 to 25.03% [31]. Our current study showed that ash content of solar dried fish products ranged from 8.29 to 9.45%, however, this range was from 16.95 to 21.41% for traditional sun dried products.

4.3. Water Reconstitution Properties

The water holding capacity at different time interval was measured for both studied fish samples. It can be observed from the Table 3 that as the temperature of the soaking water increased the rate of rehydration also increased. This is might be due to the fact that increased temperature of soaking water opens the structure of fish products which favour the rapid rehydration. This is similar to the finding of Brennan *et al*. (1990) and Tunde-Akintunde (2008) that

rehydration of food products depend principally on the internal structure of the dried pieces, extent to which water-holding components (e.g. protein and starch) have been damaged during drying [32,33]. Ituen *et al*. (1985) observed similar trend of slower rehydration rate in the later stage [34]. Roiz (1997) reported that soaking sun dried products with water for more than one hour give more tender products [35]. Our current study showed that solar tunnel dried fish samples hold more water and rehydrated more rapidly than the same fish samples dried traditionally.

4.4. Peroxide Value and Total Volatile Base Nitrogen Content (TVB-N)

Peroxide value of traditional sun dried fish sample were in the range of 16.88 to 39.22 meq/kg oil, whereas this values were in the range of 18.62 to 21.78 meq/kg oil for solar tunnel dried fish (Table 4). Peroxide value of Silver pomfret were in the range of 10-20 meq/kg oil as suggested by Connell, however this value for Bombay duck was slightly exceed than the suggested range [36]. Peroxide value usually gives a measure of the first stage oxidative rancidity and which usually does not related with the sensory assessment of rancidity. A peroxide value of more than 20 meq/kg oil for fish usually gives bad smell and rancid taste [37]. TVB-N is usually used as a determinate of the degree of freshness of fish products during storage [38,39]. The values of TVB-N for traditional sun dried products were in the range of 23.11 to 31.05 mg/100gm. The TVB-N value for solar tunnel dried fish sample was ranging from 22.40 mg/100gm in Silver pomfret and 27.30 mg/100gm in Bombay duck which were within the range of acceptable limit for dried fish products [39].

4.5. Bacteriological Quality

Aerobic Plate Count (APC) of raw Silver pomfret and Bombay duck were in the range of $4.3x10^3$ and $3.36x10^4$ cfu/g. Most of the traditional sun dried fish samples were shown to have much higher APC than the raw and solar tunnel dried fish samples and the within the range of $2.88x10^4$ to $3.37x10^5$ cfu/g. Aerobic Plate Count of solar tunnel dried fish samples were found similar to the finding of raw fish samples. The higher APC for traditional sun dried fish samples probably due to the fact that the higher moisture content and longer storage periods and poor hygienic condition compared with solar tunnel dried fish samples. According to Sen *et al.* (1961), bacterial growth is inhibited in fish samples with moisture content lower 25%, whereas with less than 15% moisture content mold growth inhibited as well [39].

5. Conclusion

The quality aspects of two species of commercially available dried fish products were evaluated by examining the organoleptic properties, chemical composition, water reconstitution properties, peroxide value, TVB-N and bacteriological study of the samples. The organoleptic characteristics as color, odor and texture of Bombay duck and Silver pomfret dried fishes by solar tunnel drier were excellent compared with traditional sun dried fish samples. The nutritional qualities were also good as well. Moisture content of the solar dried samples was also good enough to halt microbial growth and was free from environmental dust and infestation, which is more common for traditional sun dried fish samples.

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