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Quality Characteristics of Traditionally Sundried Fishes for Poultry Feed in Tuticorin, South East Coast of India

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Abstract: Bycatches were dried unhygenically and transported to other states for poultry feed from Tuticorin coast. There are more than 25 species of bycatches are used for sun drying for poultry feed. Feed farmers purchase low cost trash fishes discarded in the fish landing regions for poultry feed preparation and transfer it through unhygienically in trucks to the local drying area. Fishes were dried on sandy floor without washing, degutting, salting and implementing any hygienic measures to avoid the intact of natural contaminants like insects or dust. The semi-dried fishes were packed in gunny packs and taken to dry fish wholesale market by the dry fish farmers or other middlemen involved in dry fish marketing. The chemical composition and qualities such as moisture, protein, lipid, ash, peroxide value, total volatile base nitrogen content and microbiological properties were analyzed. Moisture content was above the acceptable limit in 18 species of fishes. Protein and lipid content of dried fish samples was lower with the range of 4.85 to 11. 20% and 0.02 - 1.88%, respectively. Ash content was found to be highest in all the fish samples (10.91 - 25.02%). Peroxide and Total Volatile Basic Nitrogen (TVB-N)value of the fish samples were found above the acceptable limit of 10 - 20meq/kg of fat and up to 30 mg/100g, respectively. Bacterial count was found higher, however *Salmonella* and Coliform was found in most of the dried fish samples. Organoleptic quality of the dried fish samples was found very bad with objectionable flavor, odor and insect infestations. Extension work are needed to develop hygienically dried fishes with good nutritive value improve economic value in commercialized markets.

Key words: Traditional Dried Fishes · Organoleptic Quality · Proximate Composition · Peroxide Value · Bacterial Count

INTRODUCTION

Fish is an extremely perishable food item and require preservation. Several methods are followed over the world for preserving fish to extend its shelf life including drying, salting and smoking [1]. These fish products are having great economic importance and the demands for such products are increasing. Fish quality is a complex concept involving a whole range of factors which for the consumer include safety, nutritional quality, availability, convenience, integrity, freshness, organoleptic quality and the obvious physical attributes of the species, size and product type [2]. Drying is regarded as a traditional and primitive method of fish preservation and the method varies from species to species, region to region. However, around 20% of the artisanal catch is being dried by traditional sun drying methods and used in the poultry market [3]. Varieties of fishes were unhygenically dried and these dry fishes were not only used for human consumption but also used in other commercial small scale industries like aqua feed and poultry feed preparations [4]. Sun drying of fishes for human consumption is carried out by drying the fishes on the rack or hanging method using energy of the sun to evaporate the water and air currents to carry away the vapor. But drying of fishes for poultry feed by open air on the sandy floor was done without limited condition. Higher level of concentration was given on the hygienicity of the drying process of fishes for human consumption than the fishes dried for poultry feed. It has been reported that contaminated feeds affects the chicken immune system and also act as a carrier for transferring disease to consumers. A major problem associated with unhygienic sun drying of fish is the infestation of the

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products by the fly and insect larvae during and storage which deteriorate the products [5]. The ungutted fish usually takes 5 to 7 days to dry during which it gets heavily contaminated. Consequently as much as 25% of the flesh is lost and the products sell at about half the price of the unspoiled fish. To protect the products from the infestation of insects, the processors, whole sellers and retailers often use various harmful insecticides and fungicides indiscriminately such as DDT, Nagos, Rubraletc [6]. Sun dried fish treated with insecticides creates wide spectrum of health complications [7]. High levels of heavy metals as arsenic, cadmium, lead, copper and iron have been to cause rapid physiological changes in fish [8]. There are frequent complaints from the traders about the quality of the products. Sun drying of fishes in the Tuticorin region was carried out based on two commercial purposes such as, for business and human consumption. Sun drying of fishes for human consumption is generally carried out on rack made of bamboo splits and poles, or on ground over the fishing nets, whereas sun drying for business purposes is performed in sandy ground. In a view to improve the quality of dried fish products various types of drying methods has been developed. Therefore, proper drying of fishes are highly essential to save the valuable sources of protein by reducing the spoilage which can be used as human and poultry food. In the current study, quality were analyzed for the traditionally sun dried fishes used for poultry farming to determine the quality of marine dried products for animal feed.

Fig. 1: Auctioned trash fishes

Fig. 2: Transfer of trash fishes in trucks

Fig. 3: Drying of trash fishes on the floor

Fig. 4: Dried trash fishes in gunny bags

MATERIALS AND METHODS

Collection of Raw Fishes: In the fish landing, firstly, the commercially important fishes were unloaded and sold. Secondly, the low value fishes were auctioned by local marketers and sold (Fig.1). Fishes of no preference for sale were finally added to trash and these trash fishes were purchased by the poultry feed manufacturers with least cost and transported to the drying yard by trucks (Fig.2) without ice and covered by tarpaulin cover. In the drying yards, the dirty and ungutted fishes were simply spread on the sandy floor (Fig.3) and it was dried for 3 - 5 days and it was packed in gunny bags (Fig. 4) and transported. The five days old dried fishes were collected for the study from the drying yards, transported to the laboratory in polythene bags, powdered and their proximate composition, quality and organoleptic characters were analyzed.

Physiochemical Evaluation: Physiochemical composition of the fish samples were analyzed by standard methods. Protein was analyzed according to Lowry's method [9]. Ash was analyzed by incineration at 550°C in a muffle furnace [10]. The moisture content was calculated using 25g of sample, dried in a thermo ventilated oven at 105°C until it attained a constant weight [11]. The chloroform - methanol extraction procedure was used for lipid determination [12]. TVB-N was determined according to the procedure of Siang and Kim [13] by using Conway micro diffusion unit. All of those chemical determinations were carried out in triplicate. The peroxide value (PV) was determined by titrating the iodine liberated from potassium iodide with standardized 0.01 N sodium thiosulphate solution using the method of Low and Ng [14] and it was expressed as milli equivalents of free iodine kg^{-1} of lipid.

Microbiological Analysis: Total bacterial count was performed by spread plate method using plate count agar (PCA) medium. 1 ml of desired dilution of sample was pipette 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°C in inverted position. After 48 hours of incubation, the plates having 30 to 300 colonies were counted in order to get the cfu/g [15]. Lauryl sulphatetryptose (LST) broth was used for isolation of Coliform. After incubation at 35 ± 1°C for 48 ± 2 hours the broth tubes that showed gas production was selected and a loop full of the broth culture was transferred to EC broth and that was further incubated at 45.5 ± 0.2°C for 48 ± 2 hours. Gassing tube was selected for Coliform 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 [16].

Organoleptic Analysis: Organoleptic characteristics such as color, odor, texture, infestation, broken pieces and overall quality were 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 [17 - 19] to judge the quality of the dried fish.

RESULTS

Species used for sun drying by traditional method for poultry farming were represented in Table 1. Variety of fishes is being used in sun drying in the selected study areas and their common names were also mentioned. Total of twenty five species of fishes were identified in traditional drying area used for drying. Among them, ten species were recorded as commercial fishes; fifteen species are non commercial. Availability condition was also present in Table1, as common, few and rare. Drying of reef fishes such as (*Amphiprion sebae, Acanthurus leucosteron*) was also observed.

Proximate composition of traditional dried fishes was represented in Table 2. Moisture content of twenty five marine fish sample collected from study area was found in the range of 11.91 - 24.11%. The protein content was found from 4.85 to 11.06%. The range of lipid and ash content were 0.02 - 1.88% and 10.91 - 25.02%, respectively.

The TVB-N content and peroxide values of the traditionally dried fishes were represented in Table 3. TVB-N content of fishes was found in a range of 28.9 - 46.32 mg/100g in fishes collected from Mottaigopuram area. The highest TVB-N was observed in (*Bleekeria viridianguilla*) where as lowest value was noted in (*Sardinella gibbosa*). Among the total 25 experimental fishes except *Sardinella gibbosa* all the other fishes the spoilage indicator values exceeded the acceptable limit.

The peroxide value of unhygenically sand dried fishes were in the range of 16.88 - 31.24 meq/kg of fat. Out of 25 dried fishes except two fishes the peroxide value exceeded the acceptable limit. The lowest and highest values were recorded in *Abalistes stellatus* and *Poecilopsetta colorata* respectively.

The results of bacteriological study of traditional sundried fishes used for poultry farming are presented in Table 4. Fresh fish and fishery products often have an bacterial count of 10^4-10^5cfu/g, although there are examples of sea foods with an bacterial count of 10^6 - 10^8cfu/g without objectionable quality changes and above 10^8cfu/g leads very poor quality [20]. Aerobic plate count in traditionally dried fish samples was found in the range of 1.85 x 10^6 to 4.66 x 10^9cfu/g, highest was found in *Upeneus sulphurous* and lowest was found in *Arothron hispidis* dried fish. Among the total 25 experimental dried fishes 17 dried fishes had Coliform and 15 species had *Salmonella* contamination.

Table 1: List of fish species used for sun drying for poultry feed

Fish speciess used for sun drying					
Species name	Local name	Commercial	Non commercial	Availability	Collection sites
Leiognathus equlus	Kaaral	Commercial		Common	Mottaikopuram
Sardinella gibbosa	Shooda	Commercial		Common	Mottaikopuram
Dipterygonotus balteatus	Indiran		Non commercial	Common	Mottaikopuram
Pellona ditchela	Vengana		Non commercial	Common	Mottaikopuram
Saurdia tumbil	Thannipanna	Commercial		Common	Mottaikopuram
Abalistes stellatus	Gilathi		Non commercial	Few	Mottaikopuram
Trichiurus lepturus	Savalai	Commercial		Common	Mottaikopuram
Fistularia commersonii	Kokku		Non commercial	Few	Mottaikopuram
Lutjanus argentimaculatus	Velameen	Commercial		Rare	Mottaikopuram
Carangoides praeustus	Parai	Commercial		Few	Mottaikopuram
Himantura bleekeri	Senthitukkai	Commercial		Common	Mottaikopuram
Cookeolus japonicus	Mundakanni		Non commercial	Few	Mottaikopuram
Liza parsia	Manalai	Commercial		Common	Mottaikopuram
Plotosus lineatus	Sungankeluru		Non commercial	Few	Mottaikopuram
Poecilopsetta colorata	Naakumeen		Non commercial	Common	Mottaikopuram
Arothron hispidis	Pethai		Non commercial	Common	Mottaikopuram
Stolephorus	Nethili	Commercial		Few	Mottaikopuram
Upeneus sulphurous	Navarai	Commercial		Common	Mottaikopuram
Dactyloptena orientalis	Samimeen		Non commercial	Common	Mottaikopuram
Amphiprion sebae	Kalarmeen		Non commercial	Very rare	Mottaikopuram
Brakyptorosis serrulata	Kalluvetti		Non commercial	Rare	Mottaikopuram
Echeneis naucrates	sucker		Non commercial	Common	Mottaikopuram
Apoleichthus taprobanensis	Vannathi		Non commercial	Few	Mottaikopuram
Acanthurus leucosteron	Orandah		Non commercial	Common	Mottaikopuram
Bleekeria viridianguilla	Saemia		Non commercial	Common	Mottaikopuram

Table 2: Proximate composition of sun dried fishes

Species	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)
Leiognathus equlus	14.38	8.75	1.88	18.71
Sardinella gibbosa	11.91	4.85	1.22	18.64
Dipterygonotus balteatus	21.39	8.65	1.14	20.32
Pellona ditchela	19.2	8.22	0.88	21.41
Saurdia tumbil	19.03	5.66	1.44	16.95
Abalistes stellatus	19.61	6.44	0.49	19.4
Trichiurus lepturus	15.21	5.58	1.16	19.78
Fistularia commersonii	23.23	5.49	1.51	18.29
Lutjanus argentimaculatus	24.11	5.32	0.02	19.45
Carangoides praeustus	15.63	11.06	0.33	10.91
Himantura bleekeri	22.48	8.05	0.37	25.02
Cookeolus japonicus	20.55	7.18	0.33	21.29
Liza parsia	13.43	11.2	0.62	26.6
Plotosus lineatus	16.77	8.78	0.69	23.03
Poecilopsetta colorata	21.55	7.37	0.07	13.8
Arothron hispidis	13.45	6.95	0.83	13.71
Stolephorus indicus	22.53	9.4	0.45	13.14
Upeneus sulphurous	15.15	9.45	1.16	16.08
Dactyloptena orientalis	20.43	7.8	1.88	11.88
Amphiprion sebae	17.76	9.02	1.17	16.46
Brakyptorosis serrulata	20.55	9.08	1.41	18.33
Echeneis naucrates	14.55	9.97	1.8	14.29
Apoleichthus taprobanensis	20.13	9.33	0.33	13.43
Acanthurus leucostermon	20.48	6.32	0.6	15.25
Bleekeria viridianguilla	13.43	7.75	0.95	13.61

Table 3: Quality status of dried fishes

Quality status of dried fishes		
Species	TVB-N (mg/100g)	PV (meq/kg of fat)
Leiognathus equlus	30	20.73
Sardinella gibbosa	28.9	21.34
Dipterygonotus balteatus	35.64	22.5
Pellona ditchela	39.15	29.22
Saurdia tumbil	33.11	29.51
Abalistes stellatus	41.05	16.88
Trichiurus lepturus	39.25	18.42
Fistularia commersonii	35.34	25.21
Lutjanus argentimaculatus	38.42	28
Carangoides praeustus	36.88	20.24
Himantura bleekeri	32.5	29.15
Cookeolus japonicus	35.5	23.11
Liza parsia	35.41	21.05
Plotosus lineatus	33.26	30.24
Poecilopsetta colorata	43.96	31.24
Arothron hispidis	31.33	27.3
Stolephorus	35.94	22.5
Upeneus sulphurous	35.64	30
Dactyloptena orientalis	32.07	25.6
Amphiprion sebae	33.96	27.9
Brakyptorosis serrulata	34.64	28.73
Echeneis naucrates	31.07	22.5
Apoleichthus taprobanensis	39.25	29.22
Acanthurus leucostermon	43.43	29.58
Bleekeria viridianguilla	46.32	26.99

Table 4: Microbial quality of the sun dried fishes

Microbial analysis of dried fishes			
Species	TPC (cfu/g)	Coliform	*Salmonella*
Leiognathus equlus	3.36×10^6	Present	Present
Sardinella gibbosa	1.90×10^8	Present	Present
Dipterygonotus balteatus	3.0×10^7	Nil	Present
Pellona ditchela	5.30×10^6	Present	Present
Saurdia tumbil	5.56×10^8	Nil	Present
Abalistes stellatus	5.88×10^6	Nil	Nil
Trichiurus lepturus	6.37×10^6	Present	Nil
Fistularia commersonii	9.88×10^6	Nil	Present
Lutjanus argentimaculatus	7.36×10^6	Nil	Present
Carangoides praeustus	3.36×10^8	Nil	Present
Himantura bleekeri	4.85×10^8	Present	Present
Cookeolus japonicus	3.37×10^7	Present	Present
Liza parsia	4.88×10^8	Present	Present
Plotosus lineatus	6.66×10^7	Present	Nil
Poecilopsetta colorata	2.54×10^6	Nil	Nil
Arothron hispidis	1.85×10^6	Nil	Nil
Stolephorus	4.20×10^7	Present	Nil
Upeneus sulphurous	4.66×10^9	Present	Present
Dactyloptena orientalis	5.57×10^6	Present	Nil
Amphiprion sebae	5.85×10^7	Present	Nil
Brakyptorosis serrulata	6.37×10^7	Present	Nil
Echeneis naucrates	5.66×10^8	Present	Nil
Apoleichthus taprobanensis	2.99×10^9	Present	Present
Acanthurus leucostermon	4.23×10^9	Present	Present
Bleekeria viridianguilla	5.1×10^8	Present	Present

The fish species such as *Bleekeria viridianguilla, Acanthurus leucostermon, Apoleichthus taprobanensis, Upeneus sulphurous, Liza parsia, Cookeolus japonicas, Himantura bleekeri, Pellonaditchela, Sardinella gibbosa, Leiognathus equlus* had both *coliform* and *Salmonella* contamination. Both the pathogen were absent in *Abalistes stellatus, Poecilopsetta colorata, Arothronhispidis* dried fishes and remaining fishes any one of the pathogen is present.

The result of the organoleptic observation is presented in Table 5. Organoleptic characteristics of the traditional dried fishes were investigated in determining colour, odour, texture, insects' infestation, presence of broken pieces and overall quality. The colour of the traditionally dried fishes from silvery colour to become yellowish, brownish, reddish color, no one had the natural colour. All the dried fish texture was very soft and easy flexible rather than firm. Except the dried fishes such as *Leiognathus equlus, Dipterygonotus balteatus, Trichiurus lepturus, Liza parsia, Stolephorus, Upeneus sulphurous* all other fishes has infestation either by insects or flies. Infestation by flies, insects and their eggs and larvae were very common in most of them. Broken pieces were noticed in *Upeneus sulphurous, Stolephorus, Liza parsia, Saurdia tumbil,*

Table 5: Organoleptic quality of the sundried fishes

Organoleptic quality						
Species	Colour	Odour	Texture	Infestation	Broken pieces	Overall Quality
Leiognathus equlus	Yellowish	sour	Soft	Nil	Nil	Not so good
Sardinella gibbosa	Brownish	sour	Soft	by insects	Nil	Bad
Dipterygonotus balteatus	off white	sour	Soft	Nil	Slightly broken	Bad
Pellona ditchela	reddish	sour	Soft	by flies	Slightly broken	Bad
Saurdia tumbil	Brownish	sour	Soft	by flies	Nil	Bad
Abalistes stellatus	Brownish	sour	Soft	by insects	Slightly broken	Bad
Trichiurus lepturus	whitish	sour	Soft	Nil	Slightly broken	Bad
Fistularia commersonii	whitish	sour	Soft	by insects	Slightly broken	Bad
Lutjanus argentimaculatus	Brownish	sour	Soft	by flies	Broken	Bad
Carangoides praeustus	Yellowish	sour	Soft	by flies	Broken	Bad
Himantura bleekeri	Brownish	sour	Soft	by flies	Broken	Very bad
Cookeolus japonicus	Brownish	sour	Soft	by flies	Broken	Bad
Liza parsia	Brownish	sour	Soft	Nil	Nil	Bad
Plotosus lineatus	off white	sour	Soft	by flies	Broken	Bad
Poecilopsetta colorata	Brownish	sour	Soft	by flies	Broken	Very bad
Arothron hispidis	Brownish	sour	Soft	by flies	Broken	Bad
Stolephorus	Brownish	sour	Soft	Nil	Nil	Not so good
Upeneus sulphurous	Brownish	sour	Soft	by flies	Nil	Not so good
Dactyloptena orientalis	Brownish	sour	Soft	by flies	Broken	Very bad
Amphiprion sebae	reddish	sour	Soft	by flies	Broken	Bad
Brakyptorosis serrulata	reddish	sour	Soft	by flies	Broken	Very bad
Echeneis naucrates	reddish	sour	Soft	by flies	Broken	Very bad
Apoleichthus taprobanensis	reddish	sour	Soft	by flies	Broken	Very bad
Acanthurus leucostermon	reddish	sour	Soft	by insects	Broken	Very bad
Bleekeria viridianguilla	reddish	sour	Soft	by insects	Broken	Bad

Sardinella gibbosa and Leiognathus equlus. Slightly sour to sour odour was developed in all the products. The overall quality of all the products from producer source was not good through the sum of the score was not so attractive with deteriorative quality. They were unhygenically processed lead to deterioration in colour and texture compared to those of the original products.

DISCUSSION

Fish is one of the protein foods that need careful handling since it spoils easily after harvest due to high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish. Due to poor handling, about 30 - 50% of harvested fish are wasted in Tuticorin. These losses could be minimized by the application of proper handling, processing and preservation techniques. The major quality control issues encountered in dried fish are variable but often low quality final product, its less nutrition, insect infestation and microbial contamination which induce a rapid rate of deterioration during transport, distribution and storage [21]. Dry fish yards are located in very remote rural locations, characterized by lack of infrastructure facilities and poor sanitary conditions responsible for deterioration of dried fish. The *Codex Alimentarius* commission recommends that, only fresh fish intended for human consumption with good quality should be used for preparing dried fish [22]. However, very often, the harvested fish intended for drying for poultry feed reach the processing area in a highly spoiled state after several hours of harvest. The trucks used for carried the raw fishes generally lack of cold storage facilities and the fish will be stored at ambient temperature until reaching the processing area. The products are processed in traditional way without following standard Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP). Obviously, the above mentioned factors significantly affect the quality of the final dried product. Owing to these reasons, the quality and safety of the final products are highly unpredictable and a range of quality variations are observed for the same product group [23]. Scientific knowledge of the quality and safety of dried fishery products produced in most developing countries is poorly developed. Several studies have attempted to determine the effect of different processing methods and processing conditions [24 - 26] and storage temperature [27] on the quality of dried fish products.

Moisture content determines the quality of dried fish products. The 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 [28]. In the present study moisture content of the traditionally dried fishes were found within the range of 11.91- 24.11%. High moisture content (Above 10%) makes it susceptible to rapid microbial growth and fast deterioration. Moisture content of the solar tunnel dried fishes was within the range of 15% [8]. Moisture content of traditionally dried fishes from current study was higher than the earlier reports [29, 30]. More dehydrated fishes had less than 8% moisture had long period of storage [31].

The protein content of traditionally sundried samples was found from 4.85 to 11.06%. These values are comparable with those of Maltida *et al.* [32] who obtained an average protein content of 18.5% for 540 fish species. This research concluded that the very broad fish taxonomic diversity did not significantly influence the content and composition of muscular protein. In effect other studies revealed that muscular proteins content does not vary significantly with age, processing method and storage condition [33]. Heat treatment, sun drying and smoke drying increased protein contents due to product dehydration which concentrated proteins, thus increasing the nutritional value of the fishes [34, 35]. In the present study lower protein content were observed for the unhygenically time delayed dried fishes. The quality loss prior to drying leads to protein loss [36].

Lipid content of the traditionally dried samples was in the range of 0.02 - 1.88%. According to their lipid content fish can be grouped into four categories: like lean fish (<2%), low fat(2-4%), medium fat or semi-fat (4-8%) and high fat (>8%) or fatty fishes. The lipid content of the fish fluctuates with age, season, physiological and nutritional status [37, 38]. At the same time lipid is the most variable component in dried fishes, fat content was generally low, ranging between 0.13% - 3.9% [39]. Gall *et al.* [40] reported lipid content of *Tranchinotus carojininus* fish was 5.17%. The lipid content of yellow spotted travally *Carangoides fulvoguttatus* is 0.24% [41]. Lipid content is 1% in *Elagatis bipinnulatus* [42], wheras the lipid content of *Scomberoides* was 2.00% [43]. The lipid content of fin fish *S.tol* was 1.205% [44].The dried fish had higher fat content than the fresh fish [45]. After drying there was an increase in fat content and this variation could be the result of evaporation of moisture contents which in agreement of the previous work [46]. But the lipid levels and fatty acid content in the same species depending on the age, size, maturity, season and food availability, freshness of the fishes, geographical variation, salinity and water temperature [47]. In the present study loss of freshness was one of the major reason affect the lipid content of dry fishes.

Ash content of dried fish is higher than that of fresh fish. The inorganic content remains as ash after the organic matter is removed by incineration [45]. Ash content of traditionally dried fishes was found in the ranges from 10.91 - 25.02%. Soundarapandian *et al.* [48] stated that body ash content of the crustaceans especially crab is high (>3) [48]. The ash content of fresh yellow spot travelly *Carangoides fulvoguttatus* was 1.50% [41] butin the present study ash content of *Carangoides praeustus* was 1.07%. Ash content of *Tranchinotus carojinus* was 1.16% [40] where as the % ash content of Scad fish is higher and it was 12%. Hughes *et al.* [50] reported ash content of *Caranx georgianus* was 1.34% [50] 1.3% ash content for *Seriolala landi* [51]. Limitation of ash content in dried fish is in the range of 10 - 12% [45]. High amount of ash content indicates presence of silica [52], Celite [53-55] and sand [56]. Presence of this material in fishmeal it was difficult to digest by mammals [52], poultry [57] and penaeid shrimp [58]. High level of ash was observed in freshness lost fish raw material [59] and it was agreed with this study.

Peroxide value was used to determine the quality of fat and it is widely used as an indicator for the assessment of degree of primary lipid oxidation [60] and values expressed as millimoles or milliequivalents of active oxygen per kg of fat. Peroxide value of traditionally sundried fish samples was in the range of 16.88 - 31.24 meq/kg of oil. This value exceeds the acceptable limit of 10 - 20 meq per kg of fat [61]. The peroxide value gives a measure of the first stages of oxidative rancidity which does not correlate well with of rancidity [61, 62 &63]. However the value above 20 meq / kg fat, the fish will probably give rancid smell and taste [60]. The increased fat oxidation in terms of peroxide value with increasing length of drying at high temperature [64]. Traditionally sundried Silver pomfret had 39.22 meq/kg peroxide value [8]. Peroxide value usually gives a measure of the first stage of oxidative rancidity and which usually does not related with the sensory assessment of rancidity. A peroxide value of more than 20meq/kg oil for fish usually gives bad smell and rancid taste [65]. In the present study also most of the dried fishes had above 20meq/kg of fat gave rancid smell while collecting sample.

The freshness of fishmeal is measured by Total volatile base nitrogen (TVB-N) content, which rises as fish spoils[66]. The values of TVB-N for traditional sundried fishes was ranging from 28.9 - 46.32 mg/100g, except *Sardinella gibbosa* all the other dried fishes TVB-N values are above the acceptable limit of dried fish product [67]. TVB - N is mainly composed of ammonia, primary, secondary and tertiary amines but other substances may be present such as dimethylamine, methylamine and formaldehyde [68]. Its increase is related to the activity of spoilage bacteria and endogenous enzymes in the unfrozen state[69]. The greatest factor affecting the quality of dried fishes is freshness of raw fish, processing method, 80% is dependent on the condition of the fish when they are received at the drying yards [70]. The concentration of TVB in freshly caught fish is typically reported to vary between 5 and 20 mg N/100g, whereas levels of 30 mg N/100g is generally regarded as the limit of acceptability for premium quality fishes [71,72]. In some Countries fisherman are paid for their catch on a scale relating to TVN content [73]. TVB-N showed a strong inversely relationship with total amino acid. Fishmeal with high TVB-N value and low of both available amino acid and fatty acids was observed with Peruvian fish meals [74].

Bacterial counts of traditional dried fishes were in the range of 2.54×10^6 to 4.66×10^9cfu/g. The higher bacterial count for traditional sun dried fish samples probably due to the fact that the higher moisture content and long period of exposure to environment and poor hygienic processing condition. The bacterial growth is inhibited in fish samples with lower 25% moisture content [67] whereas with less than 15% moisture content inhibited mold growth [67]. Fishes damage through bacterial spoilage ammonia generated from amino acid decomposition-thus reducing the quality of the available protein [75] and the present study agreed with this. Traditional drying is often rudimentary and good hygiene is rarely practiced. During the rainy season, when humidity levels are high, sufficient drying cannot be achieved using traditional methods. In such conditions, stored dried fish will re-absorb moisture and become susceptible to bacteria, fungal or insect attack [76]. The high bacteria counts on the dried fishes could be attributed to the frequent contamination of water with sewage, transported and processing method where the flesh can often be contacted by hand. Although contamination may occur at this stage, the significant public health problems associated with fish arise from their ability to concentrate viruses and bacteria from the surrounding water [77]. Although drying reduces water activity and destroys bacteria through the agency of heat, post-processing contamination can occur especially during handling and transportation of processed foods to the point of sale [78]. The presence of small numbers of *bacteria* in food is common but not a health threat because they are eliminated by cooking or pasteurization [79]. Additionally, large numbers, typically > 10^8 cfu/g-1 are required for production of enough toxins to cause illness. Thus higher level of contamination is sufficient for an outbreak of diseases [80].

Among the 25 experimental dried fishes of the present study 17 species of the fishes were contaminated by coliform. The high total coliform counts of traditionally dried fishes from the drying yards for poultry food could be attributed to poor handling practices by the fishermen. Besides, the seas around coasts are influenced by inputs of terrestrial and fresh water microorganisms and by human activities. For instance, the sea in the study area of Tuticorin has become convenient dump for sewage and other waste products [81]. These waters contaminated with sewage pose the risk that enteric organisms from infected individuals may be present and concentrated by the filter feeding activities of fish. However, a large infective dose of Enteropathogenic *E. coli* (EEC) is required for either the enterotoxigenic or invasive illness to occur. Thus fishes must be highly contaminated or inadequately preserved to allow for prolific growth [77]. Several factors may contribute to the presence of coliforms in dried fishes, including poor handling practices by food handlers or cross contamination from food contact surfaces or high storage temperatures as in the tropics [82]. Coliforms are still considered indicators for assessing general hygienic status of food contact surfaces [83] the contamination of dried fishes in the present study could be attributed to poor handling practices and improper storage temperatures.

In the present study pathogenic bacteria also were detected in most of the dried fish samples (15 fishes). Thus, this study shows that improper drying of the fishes in unhygienic way can lead to growth of most pathogenic bacteria and can render the product unsafe for human and animal consumption. Presence of *Salmonella* in sea foods due to poor handling practices by food handlers or cross contamination from food contact surfaces or high storage temperatures as in the tropics [84, 85]. Egg production in chicken can be affected by factors such as feed consumption, quality of feed, parasite infestation in feed, disease and environmental factors [86]. Inadequate nutrition (Protein) can cause hens to drop in egg production and stop laying egg. Pathogenic bacteria contamination in chicken feed cause fowl pox, avian encephalomyelitis, avian influenza, fowl cholera, infectious coryza, infectious bronchitis, coccidiosis diseases to chicken.

The organoleptic quality of traditionally sundried fish samples was found very poor. Objectionable colour, odour, texture bad in all the quality were observed in most of the dried fishes. Attractive quality of the dried fish products was reduced in traditional sun drying [15]. Discolouration and insect infestation was most common in traditionally sundried products compared to solar tunnel dryer product [87]. The observation of organoleptic quality in this current study was found similar with other studies with bad quality products from traditionally dried fishes [29, 88, 89]. Organoleptically good quality dried fishes only obtain in solar tunnel dryer compared to unhygenically traditionally dried fish samples [8]. Better quality dried fishes gave good appearance, firm and dry and white in colour [8], in contrast in this study it was shows in wet in appearance as a result of high moisture content. The variation in colour and appearance could be attributed to the method of drying, moisture content of fish [36]. Nutrient densities were increased by dehydration and marked improvement in the organoleptic qualities of fishes [31] and in the present study dehydration were not proper, nutrient quality also decreased so due to this organoleptic quality also decreased. The problem of exposure of open air dried fishes to rain fall, dust, flies, microorganisms and other contamination; this makes the locally dried traditional fishes not suitable for animal consumption also. Storage in unhygienic condition was also found which usually took place in the tent having no platform. Sometimes it was also observed that, raw and final dried fishes were kept in the same tent which badly affects the quality of dried final product.

CONCLUSION

In most of the fish drying areas, sun drying is carried out in an unhygienic condition. Due to different reasons, it was observed that poor quality final product was obtained. Different problems observed during study period were selection of poor quality raw fishes for drying, damaged fishes in most cases; washing of raw fishes with dirty water. No dressing of used fishes in many cases; drying directly on the floor which affect the quality of the dried product strongly. Moisture, dust and other harmful substances from the environment can easily mixed to the fish and make the fish susceptible to the microorganism or insect attack, most of the dry fish farmers (83.93%) did not take any protective measure for protecting the raw fish from insect infestation. The requirement of a satisfactory dried fish product is highly desirable and to achieve this, scientific drying method should be practiced in all the drying process. Extension work needs to be done so that there is awareness to dry fish farmers on handling procedures and quality regulations to ensure reduction in losses and quality of the product.

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