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Quality Characteristics of Salted Dried Fish from Selected Retail Markets in Kerala during Different Seasons

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Abstract

A study was conducted to evaluate the biochemical and microbial quality of salted dried fishes available in the retail markets in Kerala during different seasons. Moisture content of salted dried fishes was in the range of 5.27-43.7, 18.14 - 49.37 and 6.63-48.75 % for summer, monsoon and post monsoon, respectively. The study found that the moisture content of the fishes was above the acceptable limits in all the seasons. A statistically significant difference ($p<0.05$) was observed in moisture content among the seasons in all the fishes. The salt content of the salted dried fishes was found below the acceptable levels in all the seasons. Microbiological quality varied between the seasons and quality was found better in summer followed by post monsoon and monsoon. Coagulase positive staphylococci was found in all the seasons and was above the acceptable limits of 2 log cfu/g. Yeast and mold count was higher during monsoon season and most of the dried fish's average count was above the recommended limit (2.69 log cfu/g) of FSSR, 2011 whereas during summer and post monsoon, the count was within the limit. The study highlights the importance of imposing stringent measures on hygienic and sanitary practices in post-harvest handling, storage and marketing in order to safeguard the health of consumers.

Keywords: Salted dried fish, moisture content, seasonal variation, coagulase positive staphylococci

Introduction

Salting and drying is the simple and cheapest method of fish preservation. In India, dried seafood contributes 2.62 % of all form of fish exports and earned 1148.38 Crores during 2020-21 (MPEDA, 2022). Salting of fish followed by drying is a traditional method to extend the shelf life of fish. Salting is generally aimed to reduce water activity (a_w), which inhibits the growth of spoilage micro-organisms as well as inactivates autolytic enzymes (Ashie et al., 1996; Horner, 1997). Moreover, salt contains chloride ions and these chloride ions are toxic for some microorganisms (Leroi et al., 2000).

Salted and dried fishes are popular in the local markets in India and some commercially important species are exported to other countries. But, due to their poor quality, there was decline in exports in recent years. Bombay duck, pink perch, croakers, mackerel, soles, silver bellies, ribbon fish, sharks, prawns and anchovies are some of the major species usually employed for curing in our country. The major quality issues associated with salted dried fishes are low quality of the final product, high salt content, insect infestation and microbial contamination which accelerates rapid deterioration during transport, distribution and storage (Maruf et al., 1990). Hence, determination of quality of such processed fishes available in the market is very important for guarding consumer's health and hygiene (Lilabati et al., 1999).

Fish is a reservoir of large number of microorganisms. Unhygienic handling and storage of fish in contaminated places is the major factor causing poor quality of fish in retail trade. This may lead to off smell, physical damage, contamination with dirt and objectionable microorganisms (Sugumar et al., 2004). Both spoilage and pathogenic microorganisms are found in dried fishes. The major concern of food processors, consumers and public health authorities related to the consumption of dried fish is its microbial safety. *Staphylococcus aureus* is the most common pathogen encountered in salted and dried fish because of its inherent survival in high

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osmotic environment. In food ecosystem, *Staphylococcus aureus* can grow in a water activity of 0.83 and produce toxin at a_w of 0.85. In view of these characteristics, this organism is rightly considered as a target pathogen in dried fishery products (FAO, 2003). The presence of *S. aureus* in fish is often related to improper and unsanitary handling by personnel, who are carriers of this microorganism. These microorganisms are frequently found in seafood and some of them are capable of producing toxins. It is reported that about one-third of strains of *S. aureus* can produce enterotoxins, which involved in food poisoning and other types of infections in humans (Halpin-Dohnalek & Marth, 1989). Other major problem found in salted dried fish is the occurrence of fungi, which adversely affects the quality and safety of dried fishes. Several authors have reported varies types of fungi in salted dried fishes from both west and east coast of India. Their dominance also varies from place to place and season to season. (Prakash et al., 2011; Chakrabarti & Varma, 1997). The occurrence of fungi in salted dried fishes were through the use of contaminated salt and fish, dust in and around drying yards, store rooms, contaminated coastal water and unhygienic handling of fish. The fungal contamination in fishes can lead to spoilage, discolouration, rotting, off-flavour, softening of flesh and in certain cases produces potentially dangerous mycotoxin (FAO, 1982), which decreases the consumption of salted dried fish.

Several studies have been reported on quality of dried fishes available in different region of India (Vijayan and Surendran, 2012; Saritha et al., 2012; Joseph and Gopakumar 1997; Prasad et al., 1994). However, reports on quality of dried fishes related to seasonal variation was limited. Rupali et al. (2018) studied the quality of three important dried fishes from Tripura market during different seasons. Immaculate et al. (2013) reported quality and shelf-life status of dried fishes from south east coast in different seasons. Chakrabarti & Varma (1999) studied seasonal variations of fungi and other selected parameters in salted and dried fishes at lower Visakhapatnam Coast. The present study was conducted to investigate the biochemical and microbial quality of salted dried fishes available in the local markets in Kerala during different seasons.

Materials and Methods

Ten different species of major salted dried fish sold at different markets in Central Kerala including Alappuzha, Kottayam and Cochin were collected throughout the year. The dried fishes were brought to the laboratory in air tight polythene bags and analyzed immediately for moisture content (AOAC, 2016), water activity (Aqualab, Washington) and salt content (AOAC, 2016). All samples' analyses were carried in triplicate.

Microbial quality of salted dried fish samples was analyzed by estimating the load of aerobic plate count, S. *aureus* count and yeast & mould count. Twenty-five gram of sample was drawn aseptically and homogenized with 225 ml of phosphate buffer in a filter stomacher bag using a Stomacher® 400 Circulator (Seward Limited, UK) for 2 min. The homogenized sample was serially diluted using 9 ml sterile phosphate buffer for bacteriological analysis. Duplicates of three consecutive dilutions were plated on Plate Count Agar (Difco) and incubated at 35 ± 2°C for 48 ± 2 h for obtaining aerobic plate count (FDA, BAM 2001). For estimating S. *aureus* count, 1 ml of homogenate in phosphate buffer was spread equitably to 3 plates (0.4 ml, 0.3 ml and 0.3 ml) on Baird–Parker agar (Difco, USA) plates supplemented with potassium tellurite and egg yolk emulsion. The plates were incubated at 35 °C for 48 h. Convex, black, shiny colonies with narrow white margin surrounded by clear zone were regarded as presumptive *S. aureus* and enumerated. These colonies were confirmed by conducting gram staining, coagulase test, catalase test and anaerobic utilization of glucose and mannitol (FDA, 2001). Yeast & mold count were estimated as per AOAC 2016. Samples were homogenized and serially diluted in 0.1 % peptone water and 1 ml of each dilution was plated on 3 M Petrifilm™ yeast and mold count plates and incubated for 5 days at 25 °C. Colonies with small, blue-green colonies with defined edges and no foci was counted as yeast and large, variably-colored colonies with diffuse edges and center foci were counted as molds.

All statistical analyses were carried out in triplicate (n=3). Results are expressed as mean ±standard deviation. Analysis of variance (ANOVA) was performed using the statistical software SPSS.16 (SPSS Inc. Chicago). The statistical significance was identified at 95 % confidence level ($p<0.05$).

Results and Discussion

Moisture content is a very important factor in dried fishes, which indicates the quality of the product. Moisture content of salted dried fishes (Table 1) was

Table1. Biochemical quality of salted dried fishes in different seasons

Sample Name	Moisture (%)			Water activity (a_w)			Salt (%)		
	Summer	Monsoon	post monsoon	Summer	Monsoon	post monsoon	Summer	Monsoon	post monsoon
Prawns	7.02±0.42	20.32±0.71	16.88±0.35	0.61±0.33	0.84±0.06	0.73±0.04	2.96±0.17	1.55±0.65	2.67±0.09
Anchovy	5.27±0.3	18.14±0.66	6.63±0.29	0.56±0.03	0.72±0.1	0.64±0.01	15.29±1.05	10.25±0.29	11.62±0.8
Sole	39.59±0.51	44.53±0.54	43.07±0.21	0.75±0.00	0.76±0.005	0.75±0.00	18.87±1.83	17.09±1.4	18.67±0.8
Catfish	40.26±0.63	47.84±0.47	46.34±0.55	0.75±0.00	0.75±0.005	0.75±0.003	20.03±0.39	16.14±0.02	19.92±0.09
Silver belly	36.97±2.2	46.89±0.76	43.98±0.97	0.74±0.00	0.76±0.002	0.74±0.004	19.93±0.77	18.9±0.74	19.41±1.06
Mackerel	39.61±0.85	48.01±0.9	42.6±2.5	0.72±0.01	0.76±0.002	0.74±0.011	19.68±1.04	18.63±0.36	19±0.25
Crocker	35.97±0.43	45.64±0.01	43.73±0.97	0.74±0.00	0.77±0.02	0.75±0.00	22.54±0.069	19.22±1.63	21.63±0.46
White fish	36.52±0.55	46.56±0.29	38.88±1.37	0.74±0.00	0.76±0.002	0.75±0.004	22.84±0.045	19.86±0.88	21.31±2.5
Sharks	43.70±0.63	49.37±1.00	48.75±1.01	0.734±0.00	0.75±0.003	0.74±0.003	24.15±1.9	20.91±1.3	22.71±0.81
Lizard fish	34.44±0.38	43.01±1.15	42.29±0.68	0.73±0.2	0.76±0.009	0.74±0.00	20.95±0.52	18.92±0.86	20.9±0.7

Values are indicated as mean ± standard error with n=3

in the range of 5.27-43.7, 18.14 - 49.37 and 6.63-48.75 % for summer, monsoon and post monsoon season. Highest moisture content was recorded in sharks and lowest in anchovies in all the seasons. There was a significant statistical difference ($p<0.05$) observed between the seasons in all the fishes. The moisture content was found above the recommended level of 30 % (BIS, 2001) in all fishes in all the seasons expect prawns and anchovies. Similar results were reported by Prasad et al. (1994) for salt dried fishes of Cochin area. Saritha et al. (2012) also reported high moisture content in the salted dried fishes collected from the Cuddalore dry fish market of India. The study also showed a high positive correlation with APC for fishes like prawns, sole, catfish and lizard fish. In the present study, highest moisture content was recorded in monsoon followed by post monsoon and summer season. The seasonal variation in moisture content in salted dried fishes may be due to variability in drying time and period, environmental changes and level of salt used for drying.

Water activity is another major factor, which determines the microbial, chemical and enzymatic stability of foods. The water activity of salted dried fishes during summer was observed from 0.56 to 0.75 and the highest value is recorded in sole and catfish and lowest value was recorded in anchovies. During monsoon, highest value was recorded in prawn (0.84) and lowest in anchovies (0.72), respectively. In post monsoon, highest value (0.75) was found in sole, catfish, crocker and white fish and lowest value (0.64) was recorded in anchovy (Table 1). The results showed that water activity of salted dried fishes available in the retail markets in all the seasons were within the limit (0.78) recommended by FSSR (2011) except in prawns during monsoon. There was a statistically significant difference ($p<0.05$) observed for prawns, anchovies, silverbelly, Crocker, whitefish and sharks between the seasons.

Salt content of dried fishes is shown in Table. 1. Salt content in dried fishes was ranged from 2.96-24.15, 1.55-20.91 and 2.67-22.71 % during summer, monsoon and post monsoon season. The study found most of the fish samples, salt content was below the recommended level of 25-30 % (BIS, 2001) and moisture content was higher, which agrees with the earlier reports (Prasad et. al., 1994). There was no statistical difference ($p<0.05$) observed for fishes between the seasons except anchovy and catfish. Compared to other seasons, salt content of dried fishes in monsoon was comparatively lower, which may be attributed to the uptake of moisture due to the hygroscopic nature of salt (Sharma et al., 2013).

Microbial safety and stability have been considered as a prime factor for determining the quality of salted dried fishes. Average aerobic plate count (APC) of salted dried fishes (Table 2) ranged from 2.83 to 4.86, 4.05 to 7.47 and 3.87 to 5.67 cfu/g during summer, monsoon and post monsoon, respectively. In dried fishes such as shrimp, anchovy, catfish and lizard fish, APC was above the acceptable limit as per FSSR, 2011 (5 log cfu/g) during monsoon and post monsoon season. A statistically significant

Table 2. Microbial quality of salted dried fishes in different seasons

Sample Name	APC (log cfu/g)			Coagulase positive *Staphylococci* count (log cfu/g)			Yeast & mold (log cfu/g)		
	Summer	Monsoon	post monsoon	Summer	Monsoon	post monsoon	Summer	Monsoon	post monsoon
Shrimp	4.86±0.17	5.85±0.35	5.67±0.29	ND	ND	ND	1.23±0.23	2.493±0.16	1.65±0.82
Anchovy	3.82±0.00	7.47±0.16	5.05±0.06	ND	ND	ND	0.00±0.00	2.95±0.37	2.47±70.65
Sole	4.04±0.02	4.68±0.17	4.3±0.07	ND	ND	ND	1.04±0.61	2.10±0.55	1.73±0.42
Catfish	3.2±0.11	5.25±0.56	5.05±0.03	2.47±0.3	ND	ND	2.1±0.11	2.72±0.11	2.56±0.28
Silver belly	3.55±0.77	4.67±0.08	4.05±0.11	ND	ND	ND	1.61±0.82	2.48±0.32	2.01±0.73
Mackerel	3.59±0.24	4.05±0.03	3.87±0.08	ND	ND	1.65±0.04	1.2±0.69	3.04±0.02	1.53±0.78
Crocker	3.87±0.32	4.19±0.47	4.07±0.02	ND	ND	ND	0.00±0.00	2.05±0.38	0.97±0.48
Whitefish	4.30±0.14	4.88±0.1	4.81±0.17	ND	ND	ND	1.6±0.4	3.0±0.17	1.73±0.53
Shark	3.84±0.43	4.67±0.73	4.39±0.69	ND	2.2±0.09	2.15±0.1	1.42±0.66	2.86±0.92	1.88±1.64
Lizard fish	2.83±0.38	5.19±0.73	5.04±0.74	ND	ND	ND	1.42±0.71	2.52±0.03	2.27±0.1

*ND=Not detected; Values are indicated as mean ± standard error with n=3

difference ($p<0.05$) was also observed between the seasons for those fishes. High APC during monsoon was due to improper drying and low temperature of the environment. High bacteria count of about 7 log cfu/g in dried fishes of Cochin markets. Many authors reported high bacterial count in dried fishes in different markets including Cuddalore dry fish market and Tuticorin fish market (Saritha et al., 2012; Sinduja et al., 2011). Microbial contamination in the salted dried fishes may be due to post harvest delay, improper transportation, unhygienic handling and processing during the salting and sun drying process, contaminated working floor, salt and water.

The presence of coagulase positive Staphylococci (CPS) in salted dried fishes are shown in the Table 2. CPS was found in all the three seasons and their count was above the acceptable limit (2 logcfu/g) recommended by BIS 2001. Highest CPS count was found in catfish (2.47 log cfu/g) and lowest count was found in mackerel (1.65 log cfu/g). Inadequate use of salt and high moisture content in sharks may be due to the presence of CPS in both monsoon and post monsoon. Several researchers have reported varying rates of CPS from dried salted fish products. Prasad et al. (1994) found coagulase positive *S. aureus* in dried fishes collected from Kakinada. Sindhu & Surendran (2006) reported 4 coagulase positive *S. aureus* from 16 dried fish samples collected from retail markets of Cochin. Vijayan & Surendran (2012) also reported coagulase positive *S. aureus* in dried fishes of north eastern states of India. Presence of coagulase positive Staphylococci in salted dried fishes can be due to several factors such as cross contamination during storage, unhygienic handling during drying operations and contamination by workers, who are asymptomatic carriers of coagulase positive Staphylococci.

The quality of dried fishes is often adversely affected by the growth of fungus (Chakrabarti & Varma, 1999). Average Yeast and Mold count of summer, monsoon and post monsoon was ND to 2.1, 2.1 to 3.04 and 0.97 to 2.76 log cfu/g, respectively. Present study showed high yeast and mold count during monsoon season and most of the dried fish's average count was above the acceptable limit (2.69 log cfu/g) recommended by Food Safety and Standards Regulations of FSSR, 2011, whereas during summer and post monsoon, the count was within the acceptable limit. Variations in fungal growth during different seasons were reported in previous works (Immaculate et al., 2013; Sinduja et al., 2011; Chakrabarti & varma, 1999). Higher yeast and mold count during monsoon may be due to high moisture content of the samples and high relative humidity in the atmosphere. In addition to that, open display of fishes in the markets, use of contaminated salt, spoiled fish, dust in and around drying yards, unhygienic handling and improper drying could also be contributed. Therefore, more emphasis has to be given for hygienic handling and sanitation during production, distribution, storage and marketing of salted dried fish in order to avoid potential health risk to the consumers.

The present study found that dried salted fishes sold in the retail markets in Kerala have high moisture content and low salt content in all the seasons, which affect the quality and safety of the dried fishes. Microbial analysis revealed that salted dried fishes available in summer were found better than monsoon and post monsoon seasons. Special emphasis should be given for dried fishes in monsoon for improving the quality and safety especially during marketing and storage. The study also suggests that there is a need of revision of prerequisite programs and an improvement in hygiene and sanitation practices during handling and processing operations of fish from fishing to retail outlet to ensure the safety of dried salted fishes in market.

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