ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 14, Issue, 05, pp.21533-21538, May, 2022
DOI: https://doi.org/10.24941/ijcr.43567.05.2022

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

QUALITY MANAGEMENT OF DRY FISH WITH REFERENCE TO VISAKHAPATNAM FISHING HARBOR: ANDHRA PRADESH, INDIA

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ARTICLE INFO

Article History:
Received 05th February, 2022
Received in revised form
19th March, 2022
Accepted 15th April, 2022
Published online 30th May, 2022

Key words:

Dry fish, VFH,
Drying Yards,
Solar Dryers.

ABSTRACT

The conventional method employed in salt drying of fishes that are intended for humanconsumption are facing serious health hazards due to improper and unscientific methods. In this backdrop, an investigation has been carried out on the hygiene of fish drying being practiced at Visakhapatnam Fishing Harbor between March 2019 and February 2020. Presence of insect larval forms on the drying fish and intervention of stray animals into the fish drying areas has been observed which is a challenge to maintain quality of the product produced and an alarming situation that warrants the need of incorporating hygienic and scientific ways of salt drying. Implementation of enough solar dryers or providing fish drying yards of conditioned atmosphere at the study area is recommended. Further research will find the quality improvement practices of drying seafood to overcome health hazards apart from providing employment generation and enhancing foreign exchange.

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Citation: ***Sudharani P. Kishan K.P.C. Ramamohanrao M., Manjulatha C.*** **2022.** "Quality Management of Dry fish with reference to Visakhapatnam Fishing Harbor: Andhra Pradesh, India". *International Journal of Current Research*, 14, (05), 21533-21538.

INTRODUCTION

Seafood acts as a main component in the diet of most countries around the world and contributes as a main supply of animal protein. Improved fishing techniques and infrastructure resulted in increased fish catch in many countries. The advent of multiday trawling at the Visakhapatnam Fishing Harbour (VFH) further boosted the availability of fish. Most fish tend to spoil within few hours after capture, as it is a highly perishable food. Major part of the fresh fish landed at the harbour will be sent to the Seafood Trading Centres located at the harbour for export marketing. The non-export quality will be sold at the local market, VFH on whole sale as well as retail basis. Fish which have not been immediately consumed or sold in the fresh market are adapted to salting and sun drying, as a practical method of preserving it for future use. In view of the safety and quality of salted and sun-dried seafood, to analyse species composition meant for drying and in order to determine the accuracy of hygiene practices in drying yards, and February 2020 by collecting random samples of dry fish species fortnightly throughout the study period from harbour landings of VFH. Dry fish landings and trade(Das, 2013) at the present study area and dry fish production at Thootukudi (Madani, 2018)were investigated previously. The halo talent fungi in salted and dry fish of the present study area (Chakrabarti R., 1999) and among Andhra Pradesh coast (Chakrabarti R., 2003) were also reported by the researchers. Microbiological assessment of dried fish in Oman (Aaisha K.,2021)microbial and chemical quality of selected dried fish varieties in Sri Lankan market (Ranasinghe I., 2014),nutritional and microbial quality of major sun-dried fishes from West Bengal Fish market (Kundu R., 2016),quality and safety aspects of three sun-driedmarine fish species (Pravakar P., 2013), microbial Screening on Salt Dried Marine Fishes (Logesh, 2012), biochemical quality assessment of ten selected dried fish species of North East India (Ullah N., 2016),bacterial species associated with anatomical parts of fresh and smoked bonga fish (Akinjogunla, O.J 2011)were reported. The seasonal abundance of blowflies infesting drying

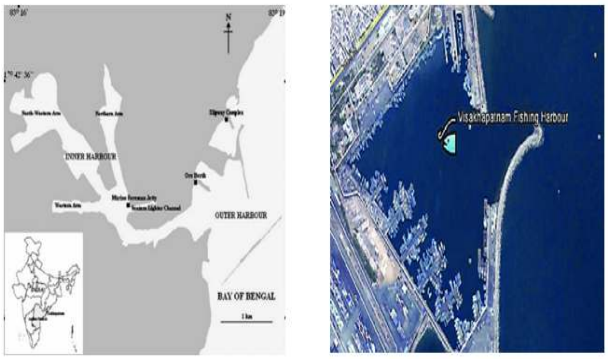
As an alternative measure for open sundrying, experimental investigation of solar greenhouse dryer (Sahu, T. K., 2016), solar tunnel dryer (Bala B., 2001), comparative studies of fish smoking and solar drying (Kallon A., 2017) in the Sierra Leone artisanal fishing industry were also done. The shelf life of sun-dried fishes was estimated by collecting from Tuiticorin villages in different seasons (Immaculate K.,2013).

MATERIAL AND METHODS

During the study period, random samples of dry fish were collected fortnightly from the drying yards (Plate 1, Plate 2) of VFH (Map 1) located on the east coast of India (17˚ 41′44.89′N and 83˚ 18′ 9.01″E) extending 5 km from the north western arm to the outer harbor and is connecting to open Sea through the entrance channel.

Collected samples were packed in polythene bags, brought to the laboratory, washed with tap water, wiped gently and were identified up to their species level using FAO identification sheets (FAO, 1984; FAO, 2010) and online species identification websites (www.fishbase.org). Samples were not available during the month of May 2019 as it is the fishing ban period every year from 16th April 2019 to 15th June 2019 and the harbor remains closed.

Data of dry fish (partly dry/raw) landed at VFH from single day as well as multiday trawlers involved in fishing was noted every day on family wise occurrence. The resultant data gives the total dry fish landed on the given day from all the trawlers. Weekly pooled up data was used to derive monthly estimates besides calculating annual landings (Table 2). Further, after being landed, the fate of dry fish is thoroughly observed during the entire study period with reference to its utilization.



Map 1: Photo 1: Visakhapatnam Fishing Harbour (study area)

Plate 1. Fish drying yard - sample collection point

Plate 2. Fish left for drying – sample collection point

SPSS 16.0 version is used for statistical analysis. Bar graphs were plotted considering monthly and annual landings on family wise occurrence of dry fish at VFH during the study period.

RESULTS

A large diversity of fish is used for drying, among which the most common being mackerels, croakers and ribbonfish, with traders and retailers showing no preference for any. In the present research, 22 species of fin and shellfishes were identified from single day and multiday trawler landings at VFH and presented in Table 1. The major components of dry fish were three species each of Leiognathidae, carangidae, Engraulidae, two species each of Scombridae, Sphyraenidae, one species each of Trichiuridae, Clupeidae, Nemipteridae, Mullidae, Cynoglossidae, Synodontidae, Belonidae, Sergestidae and Solenoceridae.

Name of the Family	Name of the species
Trichiuridae	*Trichiuruslepturus* (Linnaeus, 1758)
Clupeidae	*Sardinella longiceps* (Valenciennes, 1847)
Scombridae	*Rastrelligerkanagurta* (Cuvier, 1816)
	Scomberomorus guttatus (Bloch & Schneider,1801)
Nemipteridae	*Nemipterus*sps. (Swainson, 1839)
Mullidae	*Upeneus*sps. (G.Cuvier, 1829)
Leiognathidae	*Leiognathus*sps. (Lacepede, 1802)
	*Secutors*sps. (Bloch, 1787)
	Gazza sps. (Ruppell, 1835)
Carangidae	*Decapterus*sps. (Bleeker, 1851)
	*Scomberoides*sps. (Lacepede, 1801)
	*Parastromateus*sps. (Bloch, 1795)
Engraulidae	*Anchovies* (Linnaeus, 1758)
	*Thryssa*sps. (Cuvier, 1829)
	*Encrasicholina*sps. (Fowler, 1938)
Cynoglossidae	*Cynoglossus*sps. (Hamilton, 1822)
Sphyraenidae	*Barracuda* sps. (Rafinesque, 1815)
	Sphyraenajello (G.Cuvier, 1829)
Synodontidae	*Saurida*sps. (Valenciennes, 1850)
Belonidae	*Belonida*sps. (Bonaparte, 1832)
Sergestidae	*Acetus*sps. (H. Milne Edwards, 1830)
Solenoceridae	*Solenocera*sps. (Lucas, 1849)

The annual landing of dry fish (partly dry/raw) at VFH was 1203.828 tons (Table 2) during the study period with the highest composition of the family Trichiuridae (315.503 t& 26.29%), followed by Clupeidae (304.364 t) Scombridae (220.996 t), Nemipteridae (183.722 t) and Mullidae (174.597 t) representing 25.28%, 18.36%, 15.26% and 14.5% respectively. Species of Belonidae are at the lowest composition representing 0.273 t and 0.02% annually during the study

Table 2. Monthly and annual data on family wise occurrence of dry fish (partly dry/raw) landings (kgs) at VFH during March 2019 - April 2020

Family/ Month	Mar-'19	Apr-'19	May-'19	June-'19	July-'19	Aug-'19	Sep-'19	Oct-'19	Nov-'19	Dec-'19	Jan-'20	Feb-'20	Annual Total	Total %
Trichiuridae	54700	22876	0	19870	20070	19560	19756	18785	22675	25670	32870	58671	315503	26.29
Clupeidae	35647	19576	0	19570	27789	26768	21234	21048	20985	29980	34987	46780	304364	25.28
Scombridae	25670	18698	0	17890	19684	18989	16578	14589	18679	19960	23689	26570	220996	18.36
Nemipteridae	17849	13748	0	13009	17599	17985	14690	13108	15578	17998	20990	21168	183722	15.26
Mullidae	19890	14009	0	13980	15080	16100	14890	13150	14589	15209	17590	20110	174597	14.50
Leiognathidae	139	21	0	19	22	20	22	14	32	59	63	195	606	0.05
Carangidae	124	28	0	27	20	19	22	10	16	17	59	138	480	0.04
Engraulidae	120	60	0	69	74	63	24	28	29	70	85	99	721	0.06
Cynoglossidae	109	81	0	69	68	51	35	43	30	34	77	90	687	0.06
Sphyraenidae	80	50	0	45	78	80	68	61	62	79	72	90	765	0.06
Synodontidae	44	22	0	20	30	29	27	19	24	28	31	39	313	0.03
Belonidae	39	24	0	25	28	19	18	17	21	20	28	34	273	0.02
Sergestidae	40	28	0	23	38	32	27	21	28	29	37	38	341	0.03
Solenoceridae	58	39	0	37	49	48	31	29	37	40	44	48	460	0.04
Monthly Total	154509	89260	0	84653	100629	99763	87422	80922	92785	109193	130622	174070	1203828	100
Total %	12.83	7.41	0	7.03	8.34	8.29	7.26	6.72	7.71	9.07	10.85	14.46	100	---------

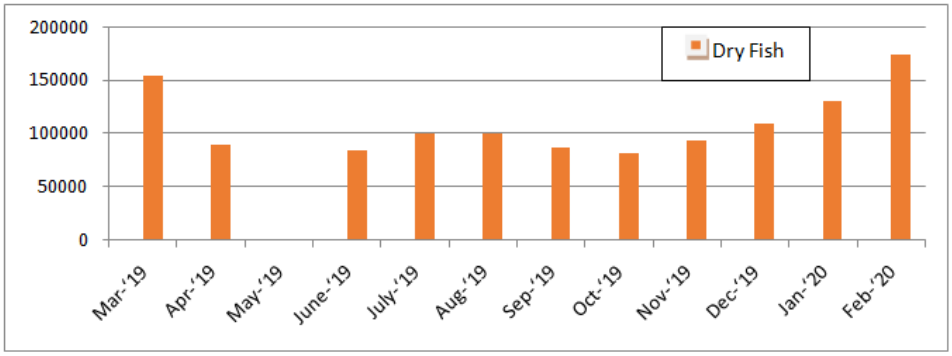


Fig. 1. Monthly landings of dry fish (partly dry/raw) in kgs at VFH during March 2019 - February 2020

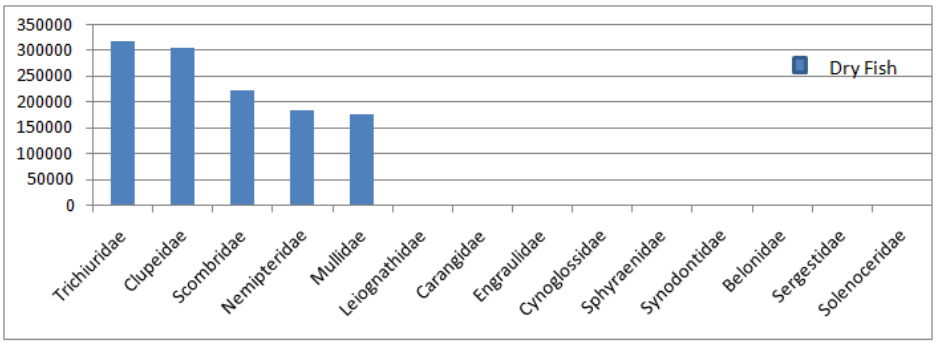


Fig. 2. Annual landing on family wise occurrence of dry fish (partly dry/raw) in kgs at VFH during March 2019 - February 2020

There are fluctuations in the monthly landings (Table 2, Fig. 1) with the highest landing (174.070 t and 14.46%) in Feb- 2020 and the lowest landing (80.922 t and 6.72%) in Oct- 2019. But, Engraulidae (120), Cynoglossidae (109), Synodontidae (44), Belonidae (39), Sergestidae (40) and Solenoceridae (58) showed the highest landings in Mar- 2019 and the lowest landing (24) of Engraulidae in Sep- 2019 and that of Cynoglossidae (30) in Nov- 2019. Out of the species of 14 families reported in the present research, Trichiuridae, Clupeidae, Scombridae, Nemipteridae and Mullidae are dominating during every month of the study period. Members of Leiognathidae and Carangidae occupied second dominating place during Mar- 2019 and Feb- 2020 respectively. Number of Engraulidae and Cynoglossidaeare fluctuating whereas that of Sphyraenidae, Synodontidae, Belonidae, Sergestidae and Solenoceridaeare more or less stable, but even though they are scanty, the representatives of all the families reported are existing in the samples throughout the study period (Table 2, Fig. 2). As the harbour will be closed during fishing ban, the landing of dry fish(partly dry/raw) is comparatively low in the corresponding two months (April & June) of the study period. No fishing during May'19. The fish (partly dry/raw) which is meant for drying were landed from the trawlers and heaped (Plate 3) in pulling carts. It was observed that, these heaps were subjected for Sundry at the harbour, species wise with or without salt (Plate 4). After the space in drying yards was filled, every possible place at the study area was being used for drying irrespective of following consumer safety, as there was no other option. Flies and insect larvae on the drying fish, intervention of stray animals into the fish drying yards was

The product may not only lacks quality but also being wasted while dried by the side of walk way. The dried fish was being heaped temporarily at the drying place itself at every evening by covering with water proof polythene sheets (Plate 6). The next day morning women of the fishermen families will spread the fish again for dry under sunlight. The drying process will be continued for 6 to 7 days till the fish becomes completely dry. Later, all the dry fish will be loaded in baskets and gunny bags and sent to the dry fish market at the harbour (Plate 5) for auction, where it will be sold to vendors. The dry fish industry in VFH includes 50 local and non-local traders.

Plate 3: Landing of partly dry/rawat the studyarea to be sent for drying

Plate 4. Drying of landed fish (partly dry/raw) at the study area

Plate 6. Drying fish covered temporarily with polythene sheets

DISCUSSION

Fish drying is a major activity at the study area, carried out mainly by small-scale fisher folk. However, most of the fish drying is being processed under poor hygienic conditions. Dried fish are in great demand within and outside the country and form an important source of protein rich food in various forms. Over the years, fish drying has grown from a subsistence kind of occupation to a full-fledged flourishing business. At the present study area, production of dry fish is a reliable supplementary income source to minimize the uncertainty of fishing income, especially during the fishing ban period of 60 days every year. About 17% of the total catch is being used for salting and drying in India (Anon, 2001). Dried fish is catering to different sectors such as quality fish/prawns for human consumption. (Madhumita das, 2013). Dry fish processing and marketing was one of the major backyard industries of VFH long back. Using the available grounds at the harbour as drying platforms, there will be every possibility of contamination. The fishes are being dried slowly and unhygienically in direct sunlight and in the absence of moving air. Women are the major stakeholders of this sector at VFH becausefish drying was the only livelihood skill, they are good in, as most of them were illiterate.

They will buy fish from the harbor landings, use the available harbor premises for drying,as there is no enough space in drying yards.50% of the total dry fish produced, in terms of quantity during the study period was contributed by ribbon fish, sardines, mackerels, breams and mullets (Table 1), where as in Thoothukudi, it was contributed by Sardines and anchovies only (Madani *et al*., 2018).Lack of enough stocking sheds at the study area, made it difficult to handle the bulk quantities of fish that led to the wastage of the resource. This is evident with the previous research at the present study area,on the management of trawl by catch (Sudharani, *et al*, 2021b), where a part of the fish was unused and being discarded into the sea. Due to the increasing popularity of dried fishes, scientific assessment of the quality aspects of the product is taking place worldwide. The fish usually taking 5 to 7 days to dry chanced the infestation of the products by flies and insect larvae as observed at the study area. It results in deterioration of the product during drying and storage before consumption (Azam *et al*., 2003). The present observation is also intonation with the reports of previous studies about the contamination of dry fish with filth, soil particles, different groups of faecal coliforms and *Vibrio*sps.

(Logesh, *et al*., 2012)as well as considerable spoilage, blowfly infestation, development of insect larvae during open sundrying and storage (Wall R., 2001). Losses from insects, animals and weather may be up to 30 to 40% (Hollick 1999; Wall *et al*., 2001). At the present study area also, between 10% and 60% post-harvest wet weight of the resource losses would be expected during the entire study period. Also, the physical and organoleptic qualities of most of the traditional sun-dried products available in the market are not satisfactory for human consumption (Kamruzzaman 1992; Saha 1999), which is in agreement with the observation in the present study. Products shall be sold finally at about half the price of the unspoiled fish(Balachandran K.K., 2001). Further, to protect the products from the infestation of insects; the processors, whole sellers and retailers often use various harmful insecticides and fungicides such as DDT, etc. indiscriminately (Reza, *et al*2005). Moreover, few halotolerant fungi such as *Aspergillus flavus*, *A.niger*, *Penicillium* sp. and *Mucor*sps. (Chakrabarti and Varma, 1999) and *Aspergillusniger*, *A.flavus*, *A. fumigatus*, *Penicillium* sps., *Mucor*sps., and *Wallemiasebi* (Chakrabarti and Varma, 2003) have appeared rapidly in rainy season and at longer time in winter season. Retention of moisture content in the dried fish in sun drying may be the reason for fungal growth. Moisture content might have been developed in monsoon season during storage after traditional sun drying. This opinion is in support by the research on food quality of sundried fish in West Bengal, India (Kundu, *et al*. 2016). Moisture content of the final product should be reduced to less than 15-16% where most of the microbiological and enzymatic activities will slow downor stop(Scott, W.J., 1957).Therefore, for reducing the spoilage, proper drying of fish is essential to save these valuable resources of protein that can be used ashuman food. The organoleptic, biochemical, bacteriological as well as heavy metal content of stored dried fish up to 60 days are at acceptable level for human consumption (Pravakar, *et al*., 2013). But, the shelf-life period of dried fish has reduced to 30 days (Immaculate, et al., 2013) due to fungal growth in monsoon season during storage. All these studies are in tune with the present investigation focussing on proper maintenance of fish at drying. Additionally, excess salt is being used before leaving the fish in open sundry to avoid spoilage, but it may also be injurious to consumers health. The salt content of the fully dried fish at the present study area needs to be investigated, whereas the imported and the dry fish in local market of Sri Lanka recorded more than 12% of salt content (Ginigaddarage *et al*., 2018). This investigation is shedding light on the present opinion of implementing solar dryers where the usage of salt content may be minimized.

Solar drying is an alternative to the traditional sundrying for producing products of required quality and minimizes the post-harvest losses. In view of the landing size of dry fish at the study area, the solar dryer provided for drying 200kg of fish isn't sufficient. The changing pattern of the lifestyle and increasing number of households in the rural area have an impact on market demand since consumers prefer to the products that should be acceptable in terms of both quality and safety. Utilization of greenhouse drying instead of open sun drying increased the product quality and prevented spoilage (Sahu, *et al*., 2016) where the drying rate will be very fast and reduces the crop losses.Among post-harvest technology of agricultural products, the hot air drying is also the most widely used methodto get more uniform, hygienic dried products rapidly (Wankhadea *et al*., 2013). In order to solve the problem at the present study area, some new drying methods and techniques such as vacuum freeze drying, microwave drying and solar tunnel drying (Bala and Mondol, 2001; Chua, *et al*. 2002) may also be used according to the feasibility, where the seafood will be completely protected from rain, insects, dust and a high-quality dry fish will be produced to the level of export market.

Conclusion

Fish are a fundamental source of food for poor rural people. Fisheries sector is one of the renowned potential ways of empowerment to the fisher folk. Marketing situations and demand is changing rapidly that would lead them to carry out dry fish production as a business by individuals and groups of women. All of them are from economically vulnerable background and earns for the family. The current status shows that there are some groups of women active in the dry fish processing and marketing sector. Even though solar dryer was provided at the study area previously, it won't be sufficient for drying the entire landed fish at VFH. To ensure proper utilization of the resources, enough dryers and cemented drying yards maintained under controlled atmospheric parameters may be established at VFH toavoid contamination and to get reasonable economic returns within less time in a hygienic manner. As indicated in the present study, a few commercially important species are exclusively processed,as dry fish. With the present investigation, it is evident that the dry fish has export market value in parallel with that of fresh fish.

The present study recommends that the stakeholders may be facilitated and encouraged to do more value additions and support to access new technology and find direct market linkages relating to the dry fish market at VFH, that may help them to grow up to the level of entrepreneurs. Further research on quality testing of the dried fish will provide a clear picture for the necessity of drying yards with conditioned atmosphere and more solar dryers to meet the requirement for the production of high-quality dry fish at the study area. It will help the small-scale entrepreneurs to improve their livelihood and intern adds to the economy of the country.

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