



Microbial Assessment of Traditionally and Scientifically Dried Fish Products of East Midnapore, West Bengal, India

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ABSTRACT

Background: The purpose of the present investigation was to compare the microbial load of three traditionally and scientifically dried fish. In traditional drying, sometimes good hygienic practices are compromised. But in case of solar drying or scientifically drying like-drying in a food dryer/can control the drying environment and suitable hygienic condition is also ensured.

Methods: Present investigation was carried out for a period of 6 months, from October, 2023 to March, 2024. The study focused on three commonly consumed fish species: Bombay duck, Scaly hairfin and Ribbon fish and the microbial populations were assessed using three types of media: Nutrient broth, Thiosulfate citrate bile salts sucrose agar and MacConkey agar. The results from the serial dilution and spread plate methods were used to determine the colony-forming units (CFU) per milliliter (ml) at different dilution levels.

Result: The findings of the study revealed that fish dried using traditional methods had higher ($p < 0.001$) microbial loads as compared to those dried using a food dryer machine. The overall decrease of microbial loads with the food dryer machine suggests that it offers improved safety and better colour, texture for dried fish products which was attributed to the controlled and consistent drying conditions provided to the fish product dried in food dryer machine.

Key words: Colony-forming units, Microbial load, Traditional dried fish, Tray dryer/fish rack.

INTRODUCTION

Fisheries and aquaculture play a crucial role in food, nutritional and livelihood security to millions of people over the world. Fish serves as an affordable and nutritious source of animal protein, making it a cost-effective option for combating hunger and malnutrition in the country. Over the time, India's Fisheries sector has grown significantly, becoming a key contributor to the nation's socio-economic development. Presently, India is the 3rd largest fish producing country and accounts for the 16% of the total inland and 5% of the total marine fish production, respectively. In 2022-23, India's total fish production stood at 175.45 lakh tonnes, which includes 131.13 lakh tonnes and 44.32 lakh tonnes from inland and marine sector, respectively. Fisheries sector contributes in the national economy (about 1.1%) through supporting the agricultural economy by 6.72%. Our country exported 1.73 million metric ton of sea food (valued US\$ 8.09 billion), which is all time high by export value and India's contribution to the global fish production reached 8.92% (Department of Fisheries, Govt. of India 2023).

Fish is an excellent source of high quality protein, containing different essential vitamins and minerals. However, it is an extremely perishable commodity, after being caught (Dewi *et al.*, 2011). Fish curing is an ancient method of preservation in our country primarily involves two steps viz., salting and drying (Anonymous, 2001). Salted fish products have been shown to be safe for consumption. It reduces water activity by transporting salt into the food structures, a process governed by various physical and chemical mechanisms, including diffusion, osmosis and a series of complex chemical and

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biochemical reactions (Turan *et al.*, 2007). Fish curing is the simple and cheap method of preservation, requires minimum technical expertise and it has a great significance in the socio-economic sustainability of small scale fisher folk communities (Patterson and Ranjhita 2009; Saritha *et al.*, 2012; Jakhar *et al.*, 2018).

Fish drying in traditional methods is often rudimentary and good hygienic is rarely practiced. Due to high humidity during monsoon period, drying cannot be achieved in desired level by traditional method. Due to high moisture content, it serves as a habitat for microbial population such as bacteria, fungi and viruses and insect attack may also be observed (Azam, 2002; Devi *et al.*, 2025). Currently, 5.15 million metric ton fish is being cured out of the total fish production (Department of Fisheries, Govt. of India 2023). The important cured fish producers are China, Japan,

USSR, Indonesia, Philippines, Ghana, Canada and India (Relekar *et al.*, 2014). In 2023-24, India holds 11th position worth US\$ 37.60 million (0.51% share) and 8th position by quantity 22381 MT (1.26% share) in dried edible items (MPEDA 2024). Marine fish drying is very common in the entire coastal zones of India. In West Bengal this practice is primarily restricted to South 24 Parganas and East Midnapore. These dried fishes have a good demand both in domestic and international market and plays an important role in employment generation of coastal poor people (Goswami *et al.* 2002). The dry fishes have a key role in the upliftment of socio-economic state of the rural area of the West Bengal (Payra *et al.*, 2016; Sit *et al.*, 2021).

Fresh fish rapidly deteriorates unless it is well preserved. Drying is a method of food preservation that removes water from the food, inhibiting microbial growth. Fish can be preserved by drying, smoking, or salting. Drying food is the oldest preservation method known, as dried fish can be preserved for several years. It is cost-effective in suitable climates, can be done by fishermen and families and the prepared product is easily transportable to markets. But due to lack of controlled environmental as well as suitable hygienic condition, quality drying is not possible with traditional drying. In case of solar drier, we can control

the drying environment and suitable hygienic condition is also monitored. Thus, here we tried to compare the microbial load in both traditionally and scientifically dried fish to make a clear statement about the quality of the dried fish through different methods.

MATERIALS AND METHODS

Study area

The present study was conducted in the *Khaties* located in coastal areas (Fig 1) of East Midnapore, West Bengal, is a region of significant ecological interest. Situated along the Bay of Bengal at approximately 21.9333°N latitude and 87.8333°E longitude, East Midnapore is known for its extensive and pristine beaches. This area provides a unique environment for studying coastal ecosystems and their microbial populations. East Midnapore lies approximately 180 kilometers from Kolkata, making it relatively accessible from the state capital. The coastal strip stretches over a significant distance, characterized by long sandy beaches, gentle waves and scenic landscapes. The area lies within the tropical climatic zone, experiencing hot summers, mild winters and a monsoon season that brings substantial rainfall. Dry fish production is a significant livelihood for coastal communities in East Midnapore district.

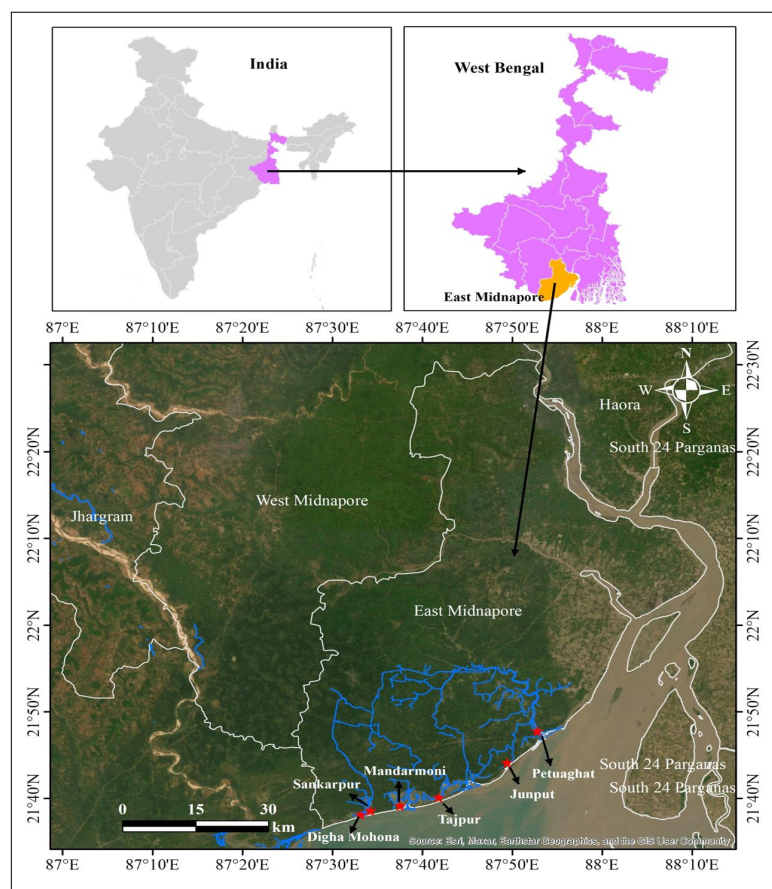


Fig 1: Location map of the study site.

Sample collection and species identification

Present investigation was carried out for a period of 6 months, from October, 2023 to March, 2024. In this study, the collection of microbial samples from dry fish was a critical step to ensure the integrity and accuracy of the research. The samples were collected in air-tight containers to maintain their original state and to prevent contamination. Three different species were collected in a sterile container, with two specimens of each species being carefully obtained from coastal fishermen belongs to Sankarpur, Digha mohana, Tajpur, Mandarmoni, Junput and Petuaghat. Initially, the species were identified and selected based on their distinct characteristics. The fishes were subjected to a traditional drying method to reduce their moisture content, which is essential for preserving the fish by inhibiting microbial growth. Using sterilized tools, the microorganisms were transferred into air-tight containers to avoid any physical damage or contamination. The samples were then kept at room temperature to preserve their natural conditions. After the collection and initial identification, the samples were transported to the college laboratory for further analysis. The air-tight containers ensured that the environmental conditions at the time of collection were preserved, minimizing any external influences on the microbial samples' characteristics.

In the second part of the study, the same three specimens were collected from the local fish market. Using sterilized tools, two specimens of each species were carefully transferred into air-tight containers to prevent contamination. These samples were also transported to our college laboratory for further analysis. These fresh samples were then placed in a food dryer machine (Model-Amulakh Food Dehydrator) for drying, ensuring a controlled and consistent drying process at 50°- 55°C. The air-tight containers used during this process minimized contamination and preserved the original conditions of the fresh fish samples.

Sample preparation for microbial analysis

Sample preparation for microbial analysis involves a series of critical steps to ensure that the sample is properly homogenized and free from contaminants. In this process, a sterile homogenizer is employed to achieve a uniform mixture, which is essential for accurate results. Initially, 1 g of each species is carefully measured in electronic balance (model-Wenser) and combined with 3 ml of distilled water. This mixture is then subjected to thorough mixing until all mussels are evenly distributed, ensuring a representative sample for analysis.

The entire procedure is conducted within a laminar flow to maintain a sterile environment and prevent any external contamination, which could compromise the integrity of the results. Prior to the preparation, all glassware and instruments, such as pipettes, petri dishes, conical flasks etc. were autoclaved to eliminate any potential extraneous microbial presence. Distilled water is utilized throughout the process to avoid introducing any impurities that could affect the microbial count.

Preparation of media

Preparation of media for microbial analysis is a vital step to ensure the accurate cultivation and identification of microorganisms. In this process, three types of media are employed: TCBS (Thiosulfate-Citrate-Bile-Sucrose) agar, nutrient broth and macConkey agar. Each type of media serves a specific purpose and supports the growth of different types of microorganisms. For every sample, two sets of each type of media are prepared to ensure reproducibility and reliability of the results.

Before starting the preparation, all media components are weighed using an electrical weighing machine to ensure precise measurements. Additionally, all petri dishes are covered with paper and autoclaved to sterilize them, eliminating any potential contaminants.

Serial dilution process

To perform the serial dilution process, following steps were performed:

- **Preparation of test tubes**

Take 8 test tubes and arrange them in a test tube stand. Label each test tube sequentially using a marker pen.

- **Adding sterile water**

Add 9 ml of sterile water to each test tube. The sterile water ensures that any potential contaminants are eliminated.

- **Adding sample**

Using a homogenizer, prepare the sample by thoroughly mixing it. Take 1 ml of this homogenized sample and add it to the first test tube (Tube 1).

- **Serial dilution**

Mix the contents of tube 1 thoroughly. Then, take 1 ml from tube 1 and transfer it to tube 2. Mix tube 2 thoroughly and repeat this process for the remaining test tubes (Tube 3 through Tube 7). This creates a series of dilutions, each tenfold less concentrated than the previous one.

Culture method of microorganisms

The culture method of microorganisms is a fundamental technique used to isolate and identify microorganisms from a sample. This process involves several steps, including sample preparation, serial dilution and plating on various media to support microbial growth.

Spread plate method

After completing the serial dilution process, the spread plate method is used to cultivate microorganisms on agar plates. Follow these steps:

- **Selecting dilutions**

Use the dilutions for plating.

- **Inoculating plates**

Take 0.1 ml of the diluted sample from tube and spread it evenly over the surface of a TCBS agar plate. Repeat

this process for the nutrient broth and MacConkey agar plates. Perform the same steps using the diluted sample from tube.

The serial dilution and spread plate methods ensure that the microorganisms are isolated in a manner that allows for accurate counting and identification. By using different types of media, a variety of microorganisms can be selectively cultivated and analysed, providing valuable insights into the microbial composition of the sample.

Incubation

The plates were incubated at 37°C for a period of 24 hours. This temperature is optimal for microorganisms, especially human pathogens. Ensuring precise temperature control is essential to provide the best conditions for growth. During incubation, it is important to handle all media with immense care. Plates should be placed carefully in the incubator to avoid disturbing the samples. Maintaining proper humidity levels in the incubator prevents the media from drying out, ensuring the agar remains hydrated and suitable for microbial growth.

Regular checks during the incubation period are important to monitor growth patterns and identify any contamination issues early. After 24 hours, the plates are carefully removed and examined for microbial growth.

RESULTS AND DISCUSSION

Present study compared the microbial populations in three fish species-Bombay duck, Scaly hairfin and Ribbon fish in dried condition using traditional method and a food dryer machine (Table 1). The microbial analysis was conducted using three types of media: nutrient broth, TCBS and macConkey agar. The presence of the pathogenic loads in dried fishes is acquiring importance in view of the safety

and quality of the seafood (Patterson and Ranjitha 2009). Many of the bacteria capable of causing disease are considered to be saprophytic in nature but only become pathogenic when fishes are physiologically unbalanced, nutritionally deficient, or as a result of other stressors such as poor water quality, overstocking, which allow opportunistic bacterial infections to human beings (Akinjogunla *et al.* 2011). The microbial counts were assessed using nutrient broth, TCBS agar and MacConkey agar media, with serial dilutions to determine colony-forming units per gram of sample solution (Fig 2). Measurements were taken at dilution factors of 10^5 and 10^7 CFU/gm (Table 2). Further, the species wise impact of different drying methods is described below.

Bombay duck

In the case of Bombay duck, the results indicate a significant ($p < 0.001$) reduction in microbial loads when using the food dryer as compared to traditional drying method. For instance, in nutrient broth, traditional drying showed 650 CFU/gm at 10^5 dilution, while the food dryer showed 70 CFU/gm at 10^1 dilution. Similar trends were observed with TCBS and MacConkey agar, where the food dryer consistently resulted in lower microbial counts than traditional drying. The reported bacterial loads in certain studies are higher than 3×10^4 CFU/g, as noted by Pravakar *et al.* (2013), but lower than the 2.43×10^8 CFU/g documented by Rana *et al.* (2020). In another study, Majumdar (2017) observed bacterial counts ranging from 2.44×10^5 to 2.52×10^6 CFU/g in sun-dried products. Al Banna *et al.* (2022) reported that the plate counts of dried Bombay duck were $9.8 \pm 0.1 \times 10^7$ while the *Vibrio* count was $3.7 \pm 0.2 \times 10^5$. The differences in bacterial contamination are determined by factors like the drying methods, the initial contamination

Table 1: Microbial population (CFU/ 0.1 gm) of the three fish samples in traditional and food drying method.

Name of the fish sample	Method of drying	Media used	Dilution factor	Total CFU/gm
Bombay duck	Traditional	Nutrient borth	10^5	650
		TCBS agar	10^5	150
		MacConkey agar	10^5	497
	Food drying	Nutrient borth	10^1	70
		TCBS agar	10^1	21
		MacConkey agar	10^1	57
Scaly hairfin	Traditional	Nutrient borth	10^6	108
		TCBS agar	10^1	51
		MacConkey agar	10^5	660
	Food drying	Nutrient borth	10^{-2}	76
		TCBS agar	10^1	94
		MacConkey agar	10^1	21
Ribbon fish	Traditional	Nutrient borth	10^6	105
		TCBS agar	10^5	100
		MacConkey agar	10^5	108
	Food drying	Nutrient borth	10^1	99
		TCBS agar	10^1	30
		MacConkey agar	10^1	53

levels and the handling, processing and storage conditions of the dried fish.

Scaly hairfin

In case of Scaly hairfin, similar pattern of results were obtained with traditional drying. A higher microbial load was found in the traditionally dried fish when compared to the food dryer. In nutrient broth, traditional drying yielded 108 CFU/gm at 10^6 dilution, whereas the food dryer resulted in 76 CFU/gm at 10^2 dilution. The TCBS and MacConkey agar results also supported the effectiveness of the food dryer in reducing microbial contamination. Mansur *et al.* (2013) reported that the total bacterial count of some sun-dried fish products ranged between 1.84×10^4 and 5.3×10^6 CFU/g. In a comparable study, Reza *et al.* (2009) reported that the aerobic plate count for marine dried fish products varied between 3.27 and 4.49 log CFU/g. Islam *et al.* (2020) found that sun-dried hairfin anchovy had a total bacterial count of 6.19 log CFU/g. Majumdar *et al.* (2023) found that the highest values for TPC and TVIC were 7.88 log CFU/g and 5.35 log CFU/g, respectively.

Ribbon fish

For Ribbon fish, the results were consistent with the other species, showing higher microbial load with traditional

drying. In nutrient broth, traditional drying resulted in 105 CFU/gm at 10^6 dilution, while the food dryer showed 99 CFU/gm at 10^1 dilution. TCBS and MacConkey agar results further confirmed the superior performance of the food dryer in minimizing microbial presence. Basu *et al.* (1989) reported a TPC value of 4.2×10^4 CFU/g in dried ribbon fish from markets in Andhra Pradesh. Jahan *et al.* (2019) found bacterial loads in T1, T2 and T3 dried ribbon fish to be 9.81×10^4 , 9.30×10^4 and 8.80×10^4 CFU/g, respectively. A comparative study by Nagwekar *et al.* (2017) indicated that scientifically dried fish showed superior microbial and biochemical quality compared to traditionally sun-dried fish.

Overall, the discussion highlights the significant advantages of using an experimental dried fish (food dryer machine) or solar dryer over traditional drying methods in terms of reducing microbial contamination, maintaining hygienic condition and safe in case of consumption. The food dryer provides a controlled drying environment that effectively minimizes the microbial load, ensuring a safer and higher quality product. These findings suggest that the food dryer is a more efficient and reliable method for drying fish, with clear implications for improving food safety and extending the shelf life of dried fish products.

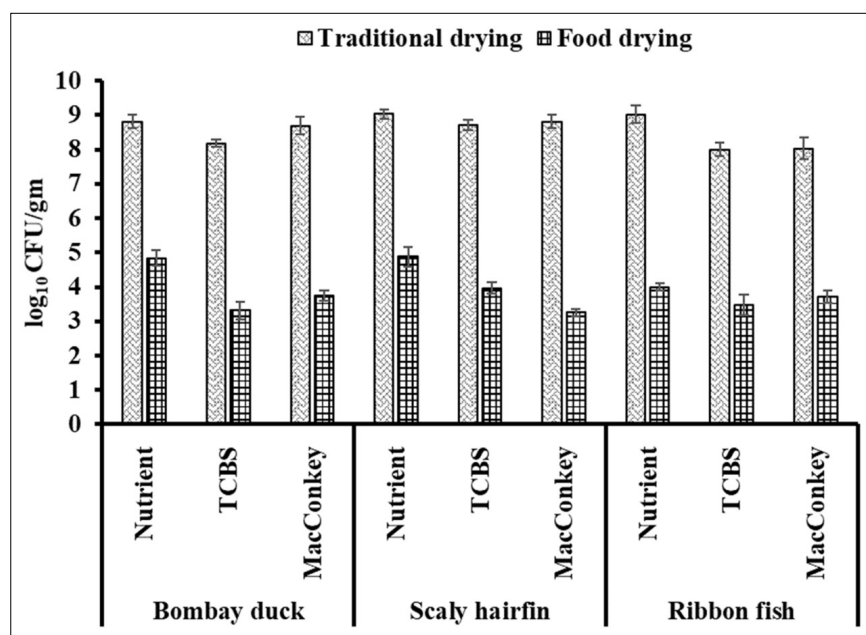


Fig 2: Comparison of microbial population (log₁₀ CFU/gm) of three dried fish samples.

Table 2: Microbial population (log CFU/gm) of the three fish samples in traditional and food drying method with their SD value.

Methods of drying	Name of the fish sample								
	Bombay duck			Scaly hairfin			Ribbon fish		
	Nutrient broth	TCBS	MacConkey	Nutrient broth	TCBS	MacConkey	Nutrient broth	TCBS	MacConkey
Traditional	8.81	8.17	8.69	9.03	8.7	8.81	9.021	8	8.03
Food drier	4.84	3.32	3.75	4.88	3.97	3.25	3.99	3.47	3.72
SD value	0.185	0.107	0.261	0.135	0.156	0.192	0.245	0.205	0.316
SD value	0.231	0.253	0.146	0.284	0.162	0.112	0.106	0.299	0.182

CONCLUSION

The present study was conducted to compare the microbial populations in fish species dried using traditional methods versus scientific methods (a food dryer machine). The analysis focused on three commonly consumed fish species: Bombay duck, Scaly hairfin, and Ribbon fish. The microbial populations were assessed using three types of media: Nutrient Broth, TCBS, and MacConkey agar. The results showed that traditionally dried fish had significantly higher microbial loads compared to those dried using a food dryer machine. Total bacterial counts in traditionally dried samples ranged from 8.81 to 9.03 log₁₀ CFU/gm, while food dryer samples had significantly lower counts, ranging from 3.99 to 4.88 log₁₀ CFU/gm. Similarly, *Vibrio* loads in traditionally dried fish were 8.17, 8.7, and 8.0 log₁₀ CFU/g, while food-dried samples had lower levels at 3.32, 3.25, and 3.47 log₁₀ CFU/g. In addition, *E. coli* counts dropped from 8.69, 8.81, and 8.03 log₁₀ CFU/g in traditional samples to 3.75, 3.25, and 3.72 log₁₀ CFU/g with food drying. The overall reduction of microbial loads with the food dryer machine suggests that it offers enhanced safety and quality for dried fish products. However, traditional drying methods, commonly used, showed higher microbial loads, posing potential risks to food safety. These findings have significant implications for the fish drying industry. Adopting a food dryer machine or solar drier can provide better control over the drying process, leading to safer and higher-quality dried fish products. This study highlights the potential benefits of using food dryer machines to ensure better control over the drying process and to produce safer dried fish products with lower microbial contamination. The food dryer machine proved to be more effective in reducing microbial contamination across all tested fish samples.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

The experimental fishes does not include in any threatened or endangered category as per Red data book. So, ethical consent does not required here.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data

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