

COMPARATIVE STUDY ON BACTERIOLOGICAL QUALITY AND ORGANOLEPTIC ATTRIBUTES OF RAW FISH AND PROCESSED FISH BALLS FROM THREE ECONOMICALLY IMPORTANT FRESHWATER FISHES

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ABSTRACT

Several factors contribute to fish spoilage from catching to consumption, including improper handling after harvest, exposure to high temperatures, and delayed icing, which together accelerate microbial growth. Freezing extends fish shelf life by slowing microbial and enzymatic activities, allowing storage for longer period without substantial quality loss. Value-added fish products have gained considerable attention in recent years; however, they remain susceptible to microbial spoilage even under frozen storage conditions. Microbial spoilage analysis and organoleptic analysis help to determine the freshness and consumer suitability for the fish products. Organoleptic analysis provides a comprehensive evaluation, assessing appearance, flavour, texture, juiciness, and overall acceptability. This study aimed to evaluate raw fish and fish ball spoilage using microbiological tests including- Total Plate Count (TPC), Coliform Count (CC), Psychrophilic Count (PC), and organoleptic analysis on days- 0, 7, 14, and 21 at storage temperature -12 ± 2 °C. Results indicated that microbial count rose more rapidly in the raw sample than in fish-balls of three species- *Labeo rohita*, *Tor putitora*, and *Sperata seenghala*. Sensory evaluation showed that the raw sample spoiled within 7 days, while the fish ball remained acceptable for over 14 days due to the presence of various ingredients during freezing storage.

KEYWORDS: Microbial spoilage, fish balls, bacterial count and sensory evaluation.

INTRODUCTION

Fish quality is moderately affected during freezing storage due to several physicochemical changes. During storage, these changes accelerate autolytic degradation, lipid oxidation, and microbial spoilage, which ultimately reduce the freshness, and overall quality of the fish (Liu et al., 2009; Obemeata et al., 2011). But during the marketing process, poor handling and mechanical damage also cause contamination of the fish products, which also accelerates spoilage (Bwanamudogo et al., 2022). Lack of cold chain maintenance- such as delayed icing, insufficient refrigeration, or exposure to high ambient temperatures creates favourable conditions for bacterial growth. Microorganisms like bacteria and viruses are mainly responsible for this type of spoilage in fish, which reduces the nutritive value and also causes serious illness in humans (Rathod et al., 2021), but maximum damage is caused by the bacterial pathogen. These microorganisms affect the fish's body both externally and internally (Beyari et al., 2021). Metabolic processes of bacteria found in the fish body lead to various changes, like alteration in the coloration, proteolysis, slime layer, and even swelling of products (Comi, 2017; Zhuang et al., 2021). The reason behind the spoilage of fish products is that the biological composition (fatty acids and free amino acids) makes it a more perishable product than other non-vegetarian food products (Masniyom, 2011), and also the environmental factor influences this process. The most commonly found bacteria in the frozen fish are - *Salmonella* spp., *Aeromonas* spp., *Vibrio* spp., *Flexibacter* spp., *Micrococcus* spp., *Proteus* spp., *Providencia* spp., *Psychrobacter* spp., *Moraxella* spp., *Pseudomonas* spp. (Novoslavskij et al., 2016), *Staphylococcus aureus*, *Escherichia coli* (Adebayo et al., 2012), and *Clostridium botulinum*. These are mainly found in the skin, gills, muscles, and viscera of fish. Consuming spoiled fish can lead to serious health issues such as food poisoning, scombroid poisoning, and even botulism. Spoiled fish often contains harmful bacteria *Clostridium botulinum*, as well as high levels of histamine, which can cause symptoms like nausea, vomiting, diarrhoea, headaches, skin rashes, and difficulty breathing. Fishes get these bacterial pathogens from the aquatic environment, which is polluted by human activities (Alikunhi, 2017). To analyse the fish spoilage most commonly performed microbiological tests (Figure 1) are- Total Plate Count (TPC), Coliform Count (CC), and Psychrophilic Count (PC). TPC provides a general estimate of the total viable bacterial population by plating diluted fish homogenate on nutrient agar and incubating at 35–37°C for 24–48 hours, with results expressed in CFU/g (Colony Forming Unit). Coliform count is used to estimate the presence of coliform bacteria, which are indicators of faecal contamination and poor hygiene in food, including fish. A high coliform count suggests unsanitary handling and contaminated water used during processing. Psychrophilic count is used to assess the number of cold-loving bacteria (bacteria that can tolerate extreme cold conditions) that grow at low temperatures and are major contributors to fish spoilage during refrigeration. These bacteria can thrive between 0–20°C, with an optimum around 15°C. A rising

psychrophilic count during storage is a clear indicator of microbial spoilage and helps determine the shelf life of chilled fish products. Hence, these tests provide a comprehensive understanding of microbial status, guiding processors and consumers in maintaining fish freshness, ensuring food safety, and determining product acceptability over time. In recent few years, increasing consumer awareness regarding nutrition, health, and convenience has led to a growing demand for value-added and ready-to-eat fish products (Geethalakshmi et al., 2013). However, even after processing and proper storage, value-added fish products can still undergo quality deterioration due to the growth of microorganisms, oxidation of lipids, and other biochemical changes during storage (Khan et al., 2025). Organoleptic analysis method (Figure 1) is a scientific method that is used to check the freshness of food products that measures, and interprets responses to products, as perceived through the five senses of sight, smell, touch, taste, and sound present in humans (Stone and Sidel, 1995). For sensory evaluation of food products, trained sensory panellists evaluate the samples and provide their judgments regarding the products very helpful in the research sector and food industries (Isra et al., 2024). For centuries this sensory method has been used to evaluate food products by laymen and become a crucial tool for assessing the quality of food (Claudia and Herrero, 2021).

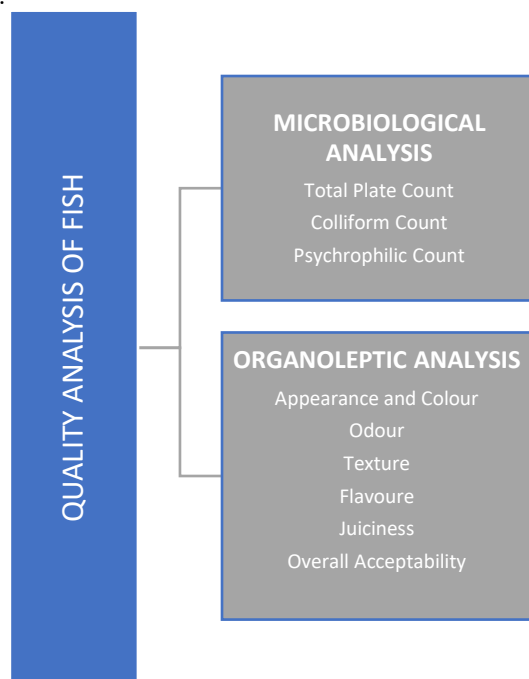


Figure 1: Quality analysis of fish – raw fillet and fish ball analysed through microbiological tests and organoleptic analysis parameters.

MATERIALS AND METHODS

Collection of Sample: Fresh samples (one sample from each species) of *L. rohita*, *T. putitora*, and *S. seenghala* were purchased from the local market in village Khatiar (Tehsil-Fatehpur, District-Kangra, Himachal Pradesh) near Pong reservoir. These were brought to the lab in polyethylene bags along with crushed ice. The head, viscera, and skin of the fish were removed, after which the raw muscle was thoroughly washed, filleted, and processed under laboratory conditions. Total plate count, Psychrophilic Count, and Coliform bacterial count in the sample were determined by the method described by APHA (1984) and readymade media (Hi Media) were used for the analysis. Organoleptic analysis was done by using Keeton (1983) method.

Total Plate Count: It includes- sample preparation and dilution, Plating the sample, incubating the plate, and counting the colonies. With the proper hygienic conditions take 10 g of sample mixed with 90 ml of 0.1 % sterile peptone with a pre-sterilized blend. Ten-time dilution (serial dilution) was done in sterilized tubes containing 9 ml volume of 0.1 percent peptone water. The sample preparation was completed in the laminar flow. 23.5 grams of plate count agar (Code No. M091) was suspended in 1 litre of distilled water. To dissolve the suspension, boil it with an adjusting final pH 7.0 ± 0.2 . Then sterilization takes place for 15 minutes with autoclaving at 15 lb pressure (121°C). Then pour plate technique was tracked for plating. One ml of inoculums was taken in duplicate and media was poured up to 2/3rd level of the petri plate. The plates were incubated at $35 \pm 2^{\circ}\text{C}$ for 24 hrs. Following incubation, plates showing 30-300 colonies were preferably counted and expressed as \log_{10} cfu/g of sample.

Psychrophilic Count: The sampling procedure for total plate counts was followed for media preparation and plating but the incubation time is different. The plates were incubated at $4 \pm 1^{\circ}\text{C}$ for 10-14 days and the colonies were counted.

Coliform Count: 41.5 g of Violet Red Bile Agar obtained from Hi-Media Laboratories Pvt. Ltd., Mumbai (code No.M091) was suspended in 1000 ml of distilled water, boiled with stirring to dissolve the medium completely, and cooled to 45°C . The final pH was adjusted to 7.4 ± 0.2 at 25°C . Pour plate with overlay techniques was followed for inoculation of suitable sample dilution and the plates were incubated at $35 \pm 2^{\circ}\text{C}$ for 24 hrs. The colonies were counted and results were expressed as \log_{10} cfu/g of sample.

Sensory evaluation: For the present study semi-trained experienced sensory panel formed of Teachers and students of the Department of Life Sciences (Zoology) of Sant Baba Bhag Singh University evaluated the sensory attributes for raw fillets

as well as fish ball viz. appearance and colour, odour, texture, and overall acceptability while two more attributes were analysed i.e. flavour and juiciness (especially for the value-added product-fish ball) on 8 points descriptive scale (Keeton, 1983) in which point 8- denoted extremely desirable while point 1- denoted extremely poor. Panellists were seated in a noise and odour-free room. Coded samples of raw and value-added products were preheated in the oven and then served warm to panellists.

Statistical Analysis: Means and standard errors were calculated for different parameters. The data analyses were performed using SPSS software. Differences between samples were analysed using independent-measures one-way ANOVA. Post-hoc comparisons were conducted using Duncan’s test. The values were expressed as mean \pm SE. p values.

RESULTS

Total Plate Count (TPC) in raw fillet and fish ball of *L. rohita* stored under frozen conditions at -12 ± 2 °C: Initially the TPC value in raw fish fillet of three species- *L. rohita*, *T. putitora* and *S. seenghala* were 3.51 ± 0.03 log cfu/g, 3.62 ± 0.06 log cfu/g, 2.95 ± 0.03 log cfu/g respectively. On the 7th day of the storage, TPC was observed as 6.52 ± 0.05 log cfu/g in *L. rohita*, 6.32 ± 0.02 log cfu/g in *T. putitora* and 5.23 ± 0.02 log cfu/g in *S. seenghala*. By the end of 14th day, TPC was recorded as 7.58 ± 0.01 log cfu/g, 8.24 ± 0.01 log cfu/g, 6.92 ± 0.02 log cfu/g in the respective fish species samples. At the 21st day, the TPC was calculated as 10.09 ± 0.08 log cfu/g, 10.55 ± 0.01 log cfu/g, and 9.14 ± 0.03 log cfu/g in the samples (Figure 2).

TPC on 0 day, in fish ball of *L. rohita* was 1.25 ± 0.11 log cfu/g, *T. putitora* was 1.38 ± 0.03 log cfu/g, and for fish ball of *S. seenghala* was 1.12 ± 0.06 log cfu/g. As the storage proceeded, on 7th day the value analysed in fish ball of *L. rohita* was 1.67 ± 0.16 log cfu/g, in *T. putitora* was 1.74 ± 0.02 log cfu/g, and in *S. seenghala* was 1.42 ± 0.04 log cfu/g. While on 14th day the value was observed 2.62 ± 0.2 log cfu/g, 2.74 ± 0.03 log cfu/g, and 2.27 ± 0.03 log cfu/g in the fish ball. At the 21st day, the TPC was determined as 3.18 ± 0.10 , 3.24 ± 0.04 log cfu/g, and 2.73 ± 0.01 log cfu/g in the respective fish ball (Figure 3).

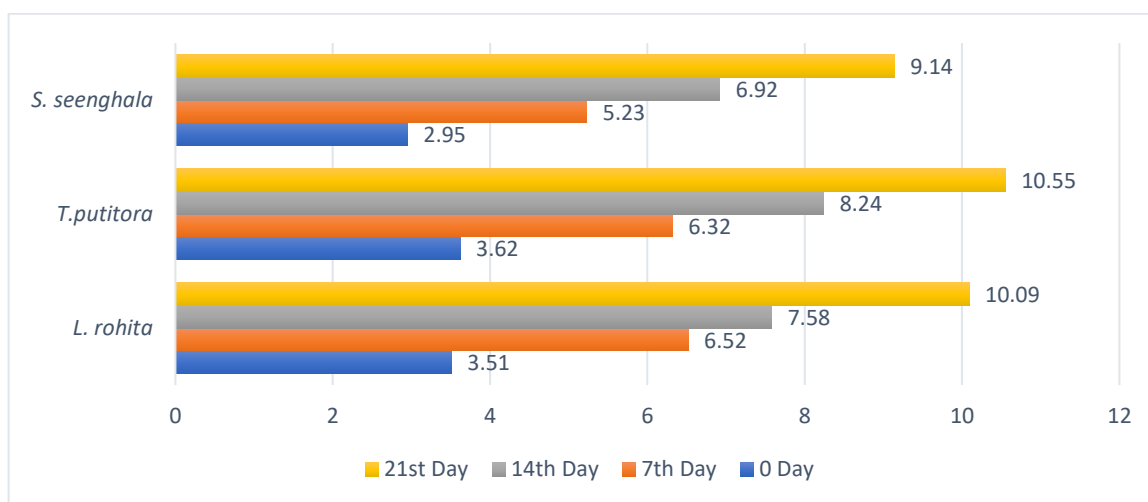


Figure 2: Total Plate Count (TPC) in raw fillets of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at -12 ± 2 °C.

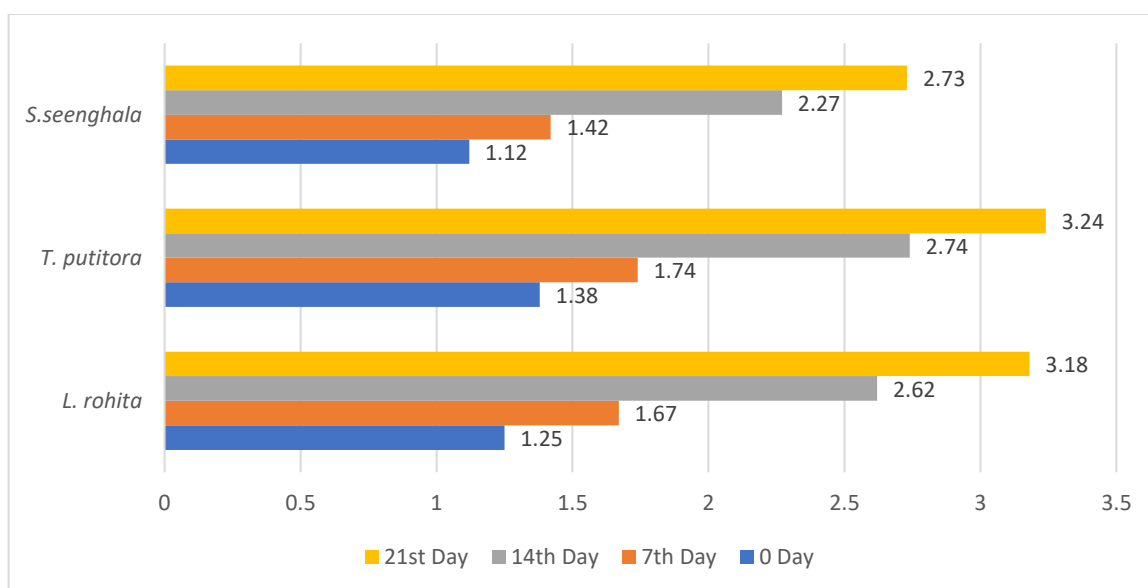


Figure 3: Total Plate Count (TPC) in the fish balls of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at -12 ± 2 °C.

Coliform count (CC)

CC in raw fillet and fish ball of *L. rohita* stored under frozen conditions at $-12\pm 2^\circ\text{C}$:

Initially in *L. rohita*, the value of CC value in raw fish fillet was 1.82 ± 0.02 log cfu/g, in *T. putitora* was 1.93 ± 0.04 log cfu/g, and in *S. seenghala* was 1.40 ± 0.02 log cfu/g. As the storage duration increases, on the 7th day CC value was recorded in the raw muscle as 2.44 ± 0.09 log cfu/g, 2.69 ± 0.03 log cfu/g and 2.25 ± 0.04 log cfu/g in the respective samples. By the end of 14th day, the CC values observed in *L. rohita*, *T. putitora*, and *S. seenghala* was 3.09 ± 0.04 log cfu/g, 3.18 ± 0.05 log cfu/g, and 2.79 ± 0.03 log cfu/g respectively. At the 21st day of storage, the values were analysed as 4.61 ± 0.03 log cfu/g, 5.20 ± 0.03 log cfu/g, 4.94 ± 0.02 log cfu/g (Figure 4).

Initially the CC value in fish ball in the three samples were 1.02 ± 0.06 log cfu/g, 1.06 ± 0.02 log cfu/g, and 1.00 ± 0.09 log cfu/g. As the storage increases, on the 7th day CC value was recorded as 1.32 ± 0.02 log cfu/g in *L. rohita*, 1.28 ± 0.05 log cfu/g in *T. putitora*, and 1.25 ± 0.03 log cfu/g in *S. seenghala*. By the end of 14th day, the CC values observed as 2.00 ± 0.02 log cfu/g, 1.92 ± 0.02 log cfu/g and 1.85 ± 0.04 log cfu/g. At the 21st day of storage, the values were analysed as 2.22 ± 0.05 log cfu/g, 2.27 ± 0.06 log cfu/g, and 2.15 ± 0.05 log cfu/g in the fish ball of the respective fish sample (Figure 5).

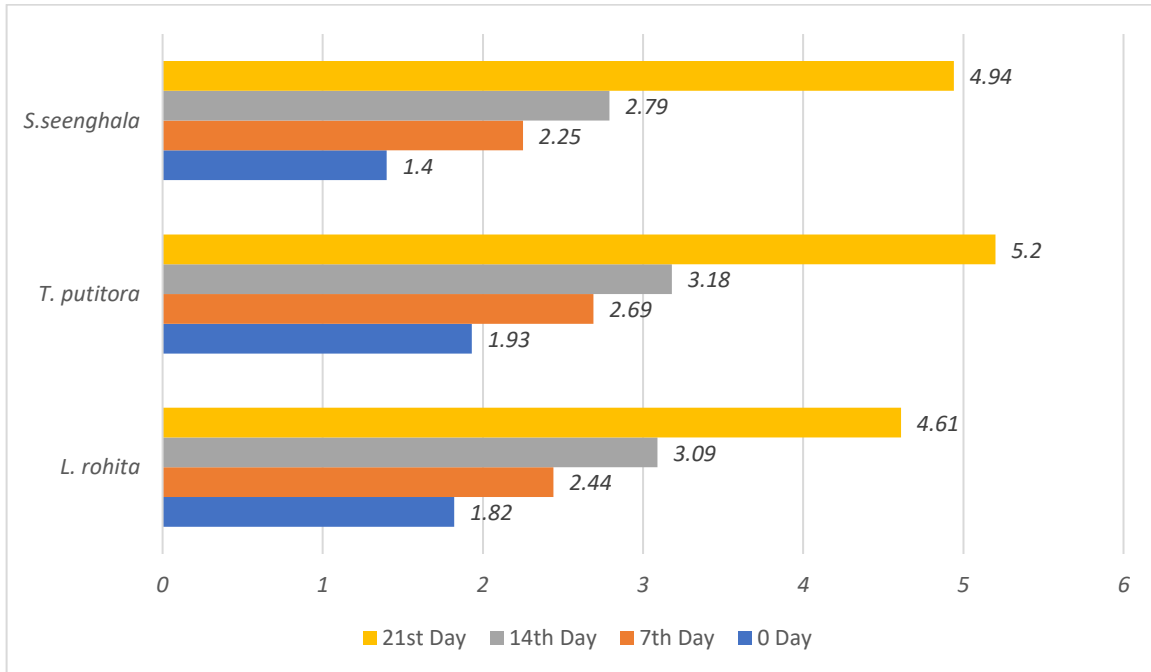


Figure 4: Coliform count (CC) in raw fillets of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at $-12\pm 2^\circ\text{C}$.

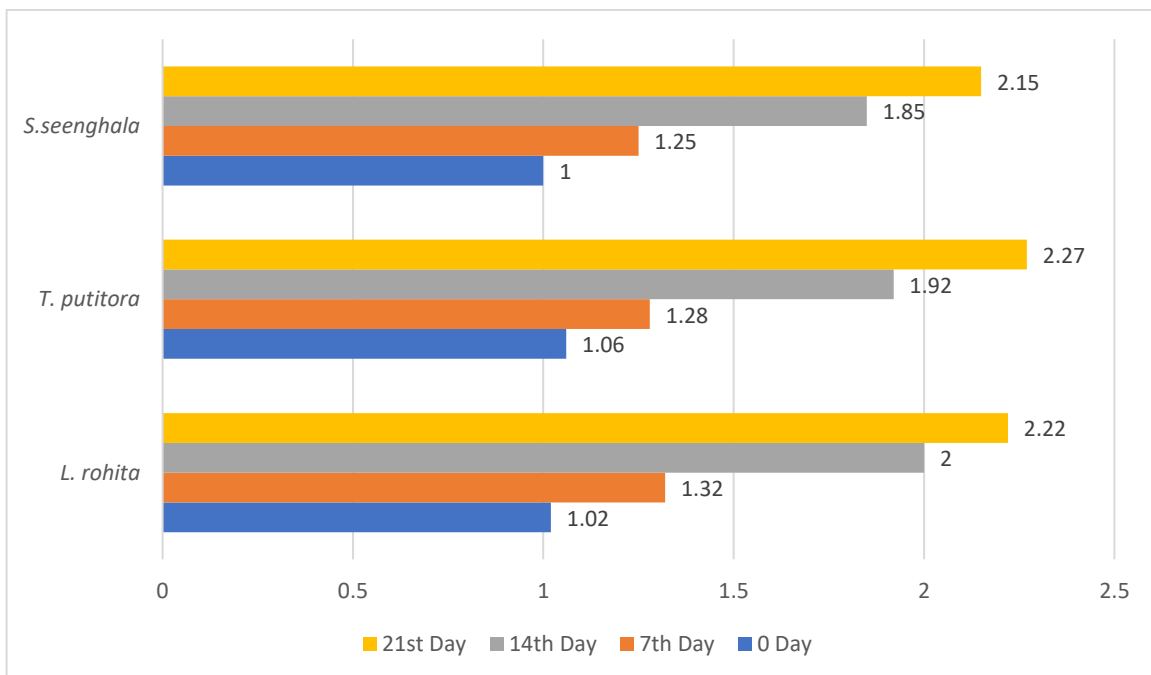


Figure 5: Coliform count (CC) in the fish balls of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at $-12\pm 2^\circ\text{C}$.

Psychrophilic count (PC)

PC in raw fillet and fish ball of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at -12 ± 2 °C: The initial value of PC in raw fish fillet of *L. rohita*, *T. putitora* and *S. seenghala*, were 2.35 ± 0.02 log cfu/g, 2.54 ± 0.04 log cfu/g, and 2.08 ± 0.01 log cfu/g respectively. As the storage proceeded, PC recorded as 4.14 ± 0.03 log cfu/g, 4.46 ± 0.01 log cfu/g, and 4.23 ± 0.03 log cfu/g on the 7th day of the storage. These values further increased to 5.40 ± 0.01 log cfu/g, 5.35 ± 0.03 log cfu/g and 5.25 ± 0.02 log cfu/g in raw muscle by the end of 14th day. At the 21st day, the values were recorded as 6.52 ± 0.05 log cfu/g, 6.41 ± 0.03 log cfu/g and 6.37 ± 0.03 log cfu/g in the three samples (Figure 6).

whereas no PC found in the fish ball of *L. rohita*, in fish ball of *T. putitora* the value was 0.85 ± 0.18 log cfu/g while no value observed in the fish ball of *S. seenghala*. As the storage proceeded, PC recorded as 1.00 ± 0.07 , 1.31 ± 0.10 log cfu/g and 0.96 ± 0.10 log cfu/g in the three species on the 7th day of the storage. These values further altered as 1.66 ± 0.03 log cfu/g, 2.01 ± 0.22 log cfu/g, and 1.36 ± 0.2 log cfu/g in fish ball by the end of 14th day. At the 21st day, the values were recorded as 1.86 ± 0.04 log cfu/g, 2.19 ± 0.28 log cfu/g and 1.82 ± 0.15 log cfu/g (Figure 7).

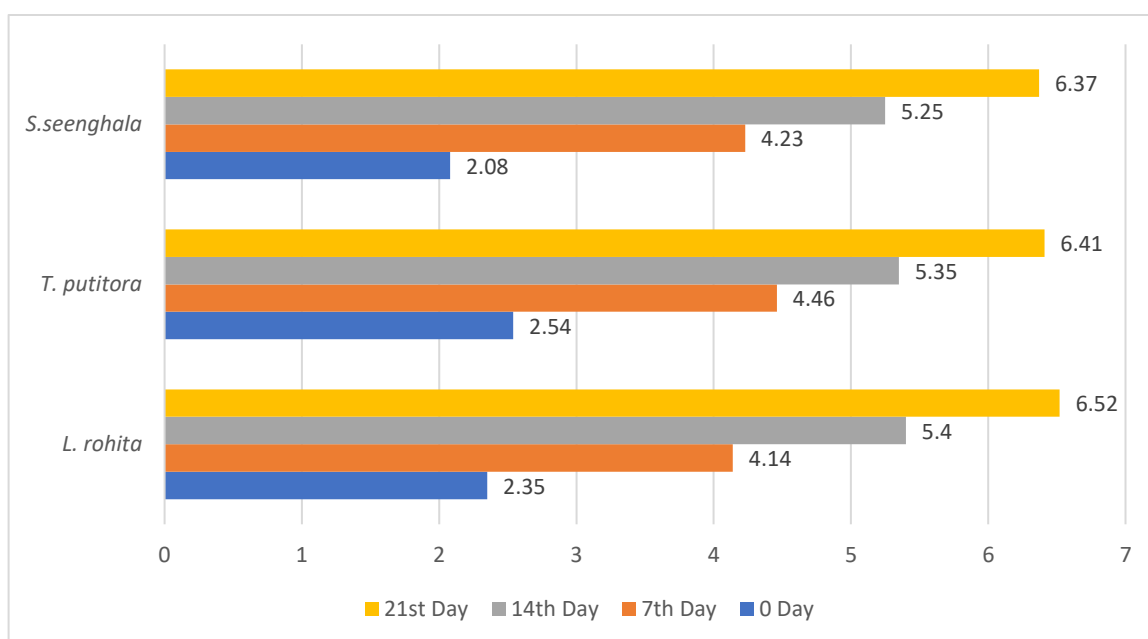


Figure 6: Psychrophilic count (PC) in raw fillets of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at -12 ± 2 °C.

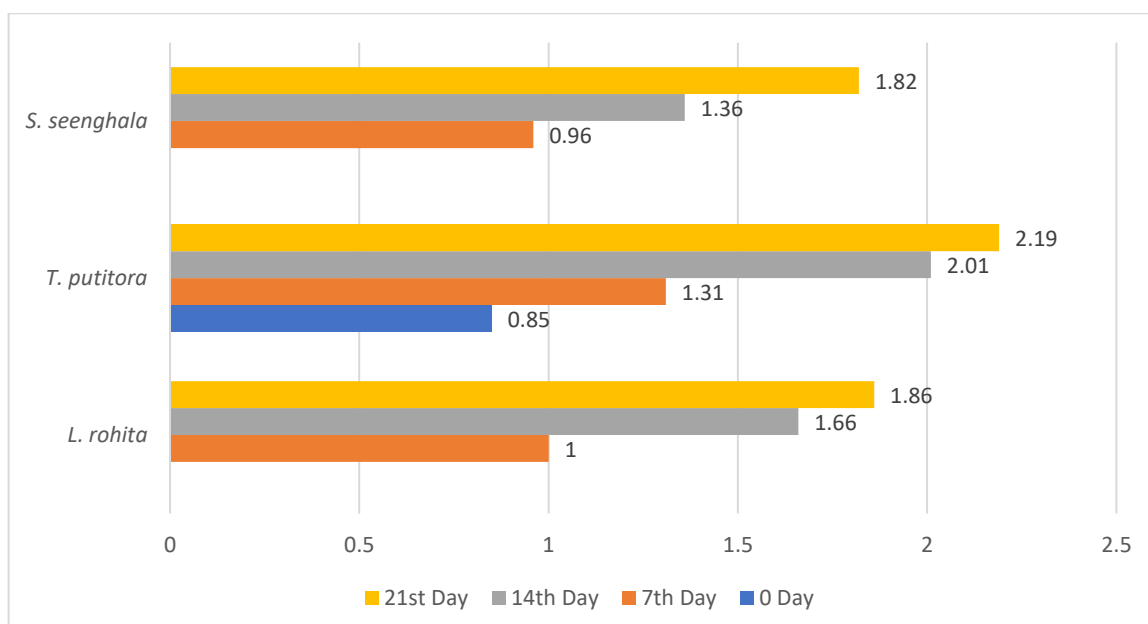


Figure 7: Psychrophilic count (PC) in the fish balls of *L. rohita*, *T. putitora* and *S. seenghala* stored under frozen conditions at -12 ± 2 °C.

Sensory Evaluation

Raw Fillets: On day 0, the appearance and colour of raw fillets of *L. rohita* (L), *T. putitora* (T) and *S. seenghala* (S) were very good with a score of 6.9, 6.8, and 6.7. By the 7th day of storage, this score declined to 3.7 (slightly poor) in *L. rohita*, 3.2 (poor) in *T. putitora*, and 3.1 (poor) in *S. seenghala*. The odour scores in raw fish fillets were reduced from 7.1 in *L. rohita*, 7.0 in *T. putitora*, and 6.9 in *S. seenghala* (from initial day) to the 3.4 in *L. rohita*, 3.1 in *T. putitora*, and 3.0 in *S.*

seenghala on the 7th day of storage, depicting a drop from slightly sharp seaweed and shellfish odour to sour rancid odour at the 7th day of storage. Initially the sensory score for texture of raw fillets was 6.8 in *L. rohita*, 6.7 in *T. putitora*, and 6.6 in *S. seenghala* which was very desirable at 0 day but during storage texture of fillets became slightly undesirable with score 3.6, 3.5, 3.4 at the 7th day of storage in the respective fish species. The overall acceptability score for raw fillets of *L. rohita*, *T. putitora* and *S. seenghala* was 6.93, 6.83 and 6.73 respectively on the 0 day which reflects their very good acceptability. On the 7th day of storage, these fillets have scored- 3.56, 3.26 and 3.16 that demonstrating slightly unacceptability. The overall sensory quality declined significantly ($p < 0.05$) was observed during storage.

Fish Ball: The initial sensory scores for fish ball of *L. rohita*, *T. putitora* and *S. seenghala* was 7.7 ± 0.2 , 7.9 ± 0.09 , and 7.5 ± 0.05 indicating an excellent appearance. However, by the end of the 21st day storage period, these scores dropped to 5.9 ± 0.22 , 6.0 ± 0.04 and 5.7 ± 0.03 respectively, reflecting a shift toward slightly poor sensory quality (Figure 8, Figure 9, and Figure 10). At the start of storage, *L. rohita*, *T. putitora* and *S. seenghala* samples showed appealing desirable flavour characteristics, receiving scores of 7.8 ± 0.09 , 7.9 ± 0.10 and 7.7 ± 0.09 . As storage progressed, the flavour quality declined noticeably, reaching 6.1 ± 0.06 , 5.8 ± 0.2 , and 5.9 ± 0.02 by the end of 21 day indicating desirable and moderately desirable flavour. On day 0, the juiciness scores for *L. rohita*, *T. putitora* and *S. seenghala* were 7.4 ± 0.05 , 7.5 ± 0.06 and 7.7 ± 0.03 , reflecting their highly juicy texture. By the end of the storage period, these scores declined to 5.8 ± 0.1 , 6.0 ± 0.07 , and 5.8 ± 0.06 . This reduction suggests that a moderate level of juiciness in *L. rohita* and *S. seenghala*, while showed only slight juiciness in *T. putitora* in the final stage of storage. At the beginning of storage, *L. rohita*, *T. putitora* and *S. seenghala* exhibited highly desirable texture, receiving scores of 7.5 ± 0.2 , 7.4 ± 0.08 , and 7.4 ± 0.1 . By the 21st day, however, their texture quality had declined, with scores dropping to 6.0 ± 0.3 , 5.9 ± 0.01 , and 5.7 ± 0.08 , indicating only slightly desirable texture in all the samples. Initially, all the three samples received high overall acceptability scores of 7.6 ± 0.06 , 7.67 ± 0.3 and 7.57 ± 0.07 , reflecting their excellent quality. By the 21st day of storage, these ratings had declined, with value 5.95 ± 0.10 , 5.92 ± 0.2 5.77 ± 0.05 indicating moderate acceptability in two samples and only slight acceptability in *S. seenghala* at the end of the storage period.

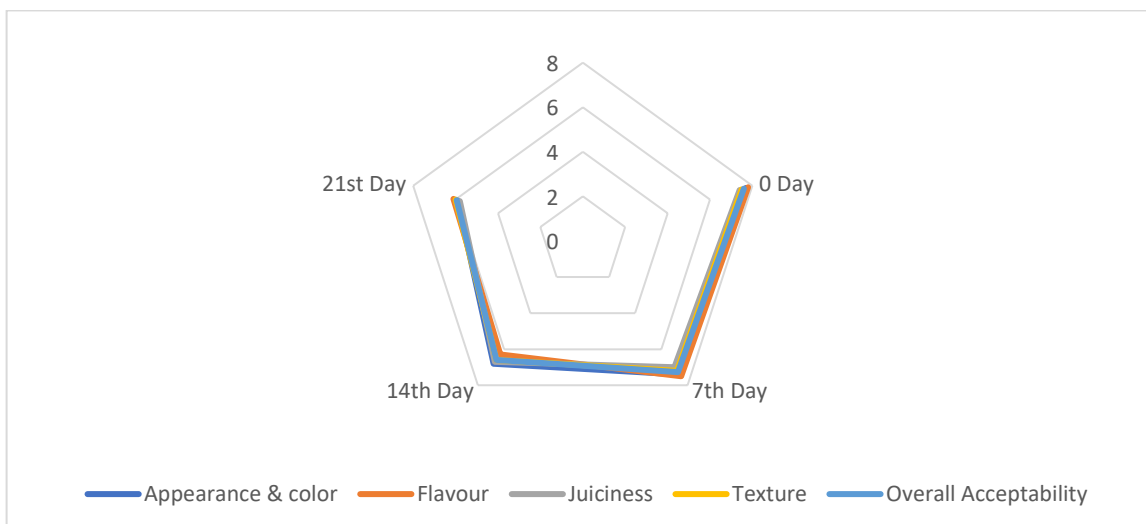


Figure 8: Organoleptic analysis of fish ball prepared from *L. rohita*.

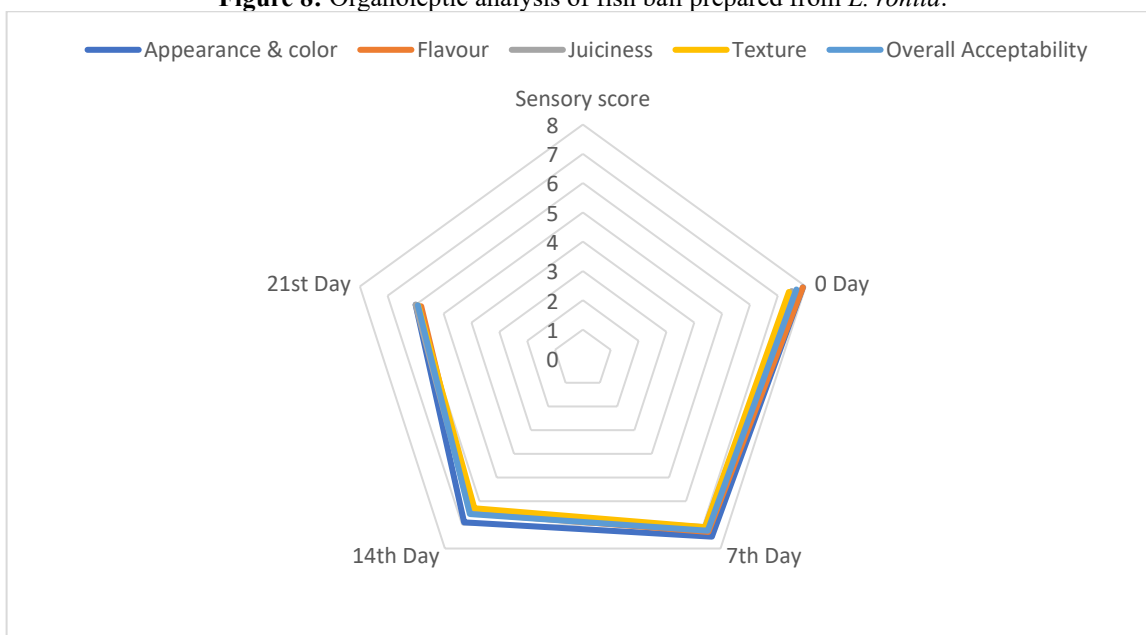


Figure 9: Organoleptic analysis of fish ball prepared from *T. putitora*.

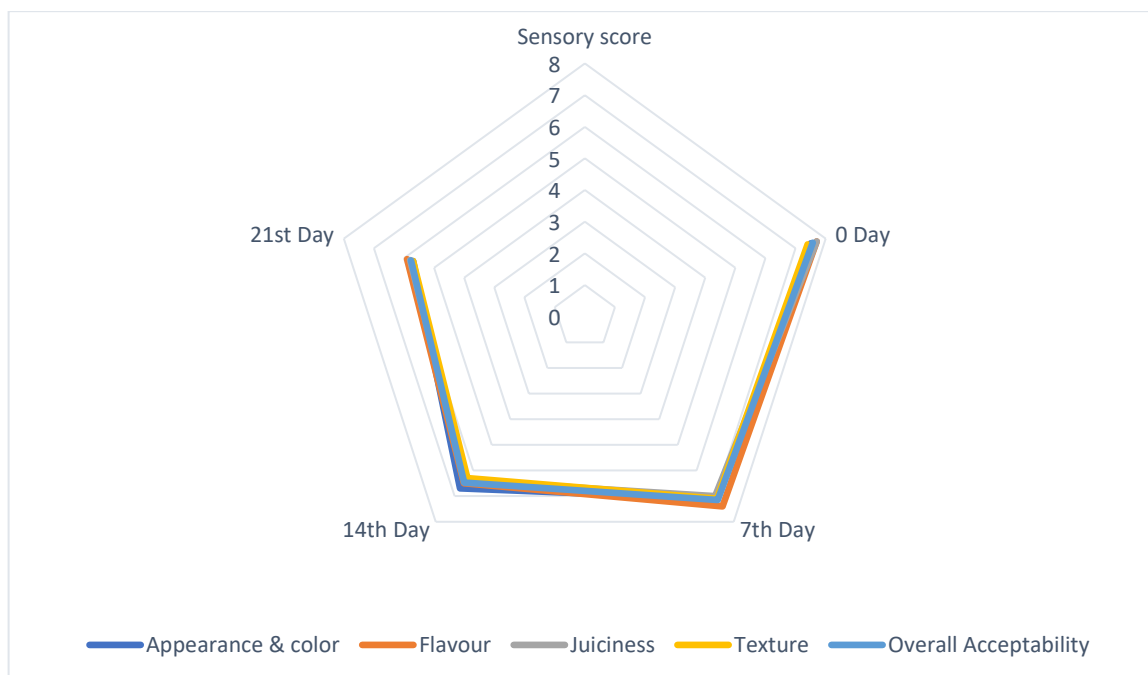


Figure 10: Organoleptic analysis of fish ball prepared from *S. seenghala*.

DISCUSSION

Fish balls prepared from all the three species showed an overall increase in bacterial load during storage, as reflected in the total plate count, psychrophilic count, and coliform count. Both the raw fillets and the fish balls exhibited an increase in bacterial spoilage during storage; however, the raw fish showed a noticeably higher rate of spoilage compared to the fish balls. Despite some interspecific variation in microbial counts, all three species exhibited relatively slight variation in microbial spoilage. Praneetha et al. (2017) observed that the TPC of bacteria showed a steady and significant increase ($p < 0.01$), rising from an initial load of 4.30×10^4 cfu/g to 7.56×10^4 cfu/g in the fish cutlet samples prepared from *Labeo rohita*. Similarly, the psychrophilic bacterial count increased from 2.12×10^2 cfu/g to 4.48×10^4 cfu/g during refrigeration storage. The effect of spices was studied by Chauhan et al. (2017) in which the microbiological spoilage was explained as TPC increased from 2.04 ± 0.68 to 5.06 ± 0.73 log CFU/g in the spiced fish balls, whereas in the samples without spices it rose from 2.11 ± 0.69 to $6.33^a \pm 0.53$ log CFU/g. The samples prepared without spices reached complete spoilage by the 12th day.

El-Lahamy et al. (2018a) reported that the initial total bacterial load in mullet varied with the preparation method: raw samples recorded 3.3 log cfu/g, while fried and grilled samples showed slightly lower values of 2.95 and 3.04 log cfu/g, respectively. In all cases, the microbial counts exhibited a gradual rise as storage progressed. The freezing process slows or halts many spoilage-causing microbial and enzymatic activities, but it cannot reverse any deterioration that has already occurred (Amin et al., 2023; Alakavuk and Mol, 2021) analysed that the coliform load in ready-to-eat seafood such as fish balls was lower in winter (2.40 ± 1.33 log cfu/g) compared to summer (3.11 ± 0.80 log cfu/g), indicating greater microbial risk in warmer months, which accelerate bacterial growth and increase the likelihood of contamination during handling and distribution.

Ganie et al. (2016) observed in their study that during the 21 days storage period, all measured microbial groups- total plate counts, psychrotrophs, coliforms, yeasts, and moulds- showed a significant ($p < 0.05$) upward shift from their initial levels in fish balls prepared with different flour binders (showed similar microbial behaviour), suggesting that storage duration had a much greater impact on microbial growth than the specific binder used. This indicates that the progression of microbial growth was driven more by how long the product was stored than by the type of binder incorporated. Siregar et al. (2021) observed that fish balls prepared from *Sphyraena barracuda*, the total bacterial load in all treatments remained below the acceptable threshold on the first day of storage. However, from the second to the fifth day, the control sample showed a sharp and rapid increase in microbial contamination, rising markedly from 2.50 ± 0.007 to 7.50 ± 0.00 . This sharp increase in the control sample is primarily due to the absence of any antimicrobial treatment or preservation method. Without additives such as salt, spices, organic acids, or vacuum packaging, the natural microflora in the fish muscle multiply rapidly (Budaraga et al., 2021). Pato et al. (2023) observed that the initial total plate count (TPC) of *Pangasianodon hypophthalmus* was recorded as 1.09×10^4 cfu/g. However, by the 30th day of storage, microbial load had increased markedly, reaching 3.32×10^7 cfu/g, clearly demonstrating how microbial load increases with extended storage duration, indicating a direct link between storage time and microbial growth (Duman and Ozpolat, 2012). Mugale et al. (2015) analysed that the total plate count (TPC) of fish balls made from minced Tilapia meat stored at $0-2^\circ\text{C}$ showed a significant increase, from initial day- 1.1×10^3 cfu/g to 3.1×10^3 cfu/g by 12 days of storage. Freezing is an effective and practical method for extending the shelf life of foods (Daita, 2025). Pato et al. (2023) observed in Catfish (*Pangasianodon hypophthalmus*) exhibited declined sensory ratings, with appearance at 7.0, odour at 7.4, taste at 6.7, and texture at 6.3 after 30 days of frozen storage due to biochemical and physical changes occurring during frozen storage.

Organoleptic parameters are influenced by a combination of elements, including the nature and number of chemical compounds of spices, the temperature conditions, and the complex interactions between various ingredients and other flavour-active components (Sujianti et al., 2020; Syafira, 2022).

CONCLUSION

Microbial spoilage is the foremost cause of spoilage in fish, despite various methods available, but it continues and causes serious health issues. The present study showed that not only in the microbiological aspect but also in the organoleptic analysis, these fish balls showed better results than the raw fillets. In the species-specific results of *L. rohita*, *T. putitora*, and *S. seenghala*- *T. putitora* has the maximum spoilage in term of total plate count and coliform count while *L. rohita* has maximum spoilage in term of Psychrophilic count while in the organoleptic analysis all the three species showed appreciated results with slight variation. However, overall, as the demand of the consumer for their nutritional requirements, these species give the best results in value addition. In the freezing temperature storage, these can be consumed up to 21 days. Presently, ready-to-eat products have become the lifeline in the present scenario in this fast-moving world. As the in-pong reservoir raw fish and tawa fish are specialities of the market, but this value added product-fish ball, introduced in the local market could become a new opportunity for the rural communities who mainly rely on this market.

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