Journal of Aquatic Biology & Fisheries | 2026 | 14(1) | pp. 31-37
ISSN 2321–340X
OPEN ACCESS
http://www.jabf.in/
University of Kerala, INDIA

# Refrigerated storage stability of millet incorporated cutlets from Silver pompano, *Trachinotus blochii* (Lacepède, 1801)

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**ABSTRACT**

The storage stability of cutlets prepared from Silver pompano (*Trachinotus blochii*) was evaluated under refrigerated conditions. The cutlets standardised from pompano were labelled the control sample (CC). Barnyard millet (BM) and little millet (LM) were incorporated into CC samples at 25% and 15%, respectively. The biochemical (pH, TVB-N, PV, FFA, and TBA), microbiological (Total Plate Count (TPC) and Psychrophilic count (PC)), and organoleptic attributes of the cutlets were assessed during storage. The biochemical and microbiological changes showed an increasing trend over storage time in all samples. However, among the samples, lower values were noticed in the BM samples. The overall acceptability scores also showed a higher value for the BM cutlets with an extended shelf life of 15 days. The study concludes that BM cutlets had better quality indices and had a shelf life of 15 days during storage.

**ARTICLE HISTORY**

Received on: 05-01-2026
Revised on: 13-03-2026
Accepted on: 28-04-2026

**KEYWORDS**

Silver pompano, Millets, Fish cutlets, Refrigerated storage, Shelf life

## 1. Introduction

Value-added products have gained more popularity among potential consumers due to their easy availability, minimal cooking, safety, high quality, and extended shelf life (Sen et al., 2022). The seafood industry is exploring increased market expansion by developing a range of value-added products (Morrissey & DeWitt, 2013). Enrobed products favoured by a larger population are considered the best form of value addition as they increase the bulk of the product and improve its appearance, texture, flavour, and nutritive value (Rathod et al., 2012). Cutlets are enrobed products with a distinctive flavour and well-balanced protein and fat levels, served almost everywhere, from breakfast in restaurants to snacks in fast-food outlets (Singh et al., 2015). Driven by their nutritional quality, fish cutlets are also gaining popularity, making them a strong competitor for cutlets from chicken and other meat sources (Elavarasan, 2018). The cutlets prepared from Pangasius, Rohu, and Catla have been reported to have better consumer acceptability, thereby yielding higher profits from their culture (Talab et al., 2022; Arumugam, 2017; Rathod & Pakarkar, 2013).

Fish is widely known for its high digestibility and sufficient quantity of essential nutrients (Elavarasan, 2018). With urbanisation and growing awareness of nutritional quality, consumption has increased (Hitha, 2018). The Silver pompano (*Trachinotus blochii*), an emerging fish for mariculture, is gaining importance in the global market due to its unique taste and premium meat quality (Jayakumar et al., 2013; Kalidas et al., 2012). Silver pompano has exceptional potential to improve feed conversion ratio, survival rate, and economic returns in a short period, thereby improving the livelihoods of farmers (Hannibal et al., 2011). It can be an excellent choice for developing value-added products due to its high meat quality and high levels of omega-3 fatty acids, including eicosapentaenoic acid and docosahexaenoic acid (Jayakumar et al., 2013).

According to Singh et al. (2015), incorporating a dietary fibre source into value-added products increases its nutritive value and antioxidant potential. Millets are a rich source of dietary fibre, minerals, vitamins, essential fatty acids, phytochemicals, and antioxidants, which help reduce cholesterolemia, improve glycaemic response, and increase nutrient availability (Elangovan et al., 2022). Millets are considered an alternative to wheat products and are being increasingly used for gluten-free food production (Siroha & Bangar, 2024). Encouraging millet cultivation and its incorporation into food products can play a vital role in achieving the objectives of United Nations Sustainable Development Goal 2 (SDG2), which focuses on improving nutrition, ensuring food security, and eliminating hunger (Bhatt et al., 2023). Among the millets, barnyard millet (*Echinochloa esculenta*) contains the highest amount of crude fibre (8.1-16.3%), protein (11.2-12.7%) and iron content (15.6-18.6 mg 100 $g^{-1}$) (Renganathan et al., 2020). Little millet (*Panicum sumatrense*) is rich in crude fibre (7.7 g 100 $g^{-1}$), fat (4.7 g 100 $g^{-1}$), iron (9.3 mg 100 $g^{-1}$) and phosphorus (220 mg 100 $g^{-1}$) (Gopalan et al., 2010). Several authors have incorporated barnyard millet and little millet into food products (Elavarasan et al., 2024; Salunke et al., 2019) and analysed their shelf life under refrigerated conditions (Salman et al., 2022; Talab et al., 2022). However, studies on the incorporation of millet into fish products and on the diversification of pompano products are limited. Hence, the current study aims to develop and evaluate the shelf life of cutlets prepared from Silver Pompano and millets by assessing the biochemical, microbial, and sensory parameters during refrigerated storage conditions (4 ± 1 $^0$C).

## 2. Materials and Methods

### 2.1 Raw material preparation

Silver pompano (*Trachinotus blochii*), with an average weight of 675.5 ± 5 g and length of 39.7 ± 3 cm, procured from the RGCA farm, Pozhiyoor, Thiruvananthapuram, Kerala, India, was brought to the laboratory in insulated boxes at chilled conditions. The fish were cleaned with potable water. Barnyard millet and little millet were procured from the local supermarkets.

### 2.2 Preparation of cutlets

Fish cutlets were prepared from silver pompano according to the recipe by Joseph (2021). It was labelled as the control cutlet (CC). The cooked and mashed barnyard millet and little millet were incorporated into the fish cutlets at 25% and 15% of the substrate weight, respectively, and denoted as BM and LM samples, respectively. The millet incorporation level was adopted based on preliminary standardisation experiments conducted as part of the development phase of this research, which showed that these proportions yielded the most acceptable sensory and textural characteristics. The cutlets were breaded, flash-fried at $180^0$ °C for 30 seconds, labelled, and packed in low-density polythene (LDPE) pouches (12 µ polyester laminated with 75 µ LDPE). These samples were stored at refrigerated temperature ($4 \pm 1^{0}$ °C), and the biochemical, microbiological, and sensory analyses were conducted at 3-day intervals until the samples underwent spoilage. Each formulation was prepared in triplicate independent batches, and all analyses were performed on these batches.

### 2.3 Biochemical analysis

The pH of the products was measured using a digital pH meter (Eutech Cyber Scan EI, Singapore). Total Volatile Base-Nitrogen (TVB-N) values were evaluated by the micro diffusion method (Conway, 1962). Free Fatty Acid (FFA) values of the products were analysed according to AOCS (2000). The peroxide value (PV) was measured iodometrically following AOCS (2005). The Thiobarbituric acid value (TBA) was determined using the AOAC (2005) method.

### 2.4 Microbiological analysis

Total Plate Count (TPC), *Escherichia coli, Vibrio spp., Salmonella spp., Faecal streptococci, and Staphylococcus aureus* were determined by the FDA-BAM method (2021). The Total Psychrophilic Count (PC) was estimated using the method of APHA (1985).

### 2.5 Sensory analysis

Sensory analysis was conducted with 30 untrained assessors, aged 18-35 years. The products were analysed for appearance, texture, flavour, juiciness, odour, and overall acceptability using a 9-point hedonic scale (Reddy, 1992). The samples were coded and presented in randomised order to eliminate any order bias and carryover effect.

### 2.6 Statistical analysis

The mean values of the data obtained during the experiments were analysed using ANOVA and the Tukey test in IBM SPSS Statistics 25. The test significance was estimated at 5% level ($p < 0.05$).

## 3. Results and Discussion

### 3.1 Changes in pH

The pH values observed during the initial day of storage for CC, BM, and LM samples were 6.41, 6.37, and 6.39 , respectively (Figure 1). No significant differences in pH were observed among samples up to the 6$^{th}$ day of refrigerated storage ($p > 0.05$). However, from the 9$^{th}$ day, a significant difference was observed ($p < 0.05$) for CC (6.41), BM (6.37), and LM (6.39), respectively. On the 15$^{th}$ day of storage, the pH values rose to 6.98, 6.7, and 6.84 for the CC, BM, and LM samples, respectively. The pH elevation in the fish cutlets can be attributed to the formation of volatile alkaline compounds, such as ammonia and trimethylamine, resulting from the autolytic activity of endogenous enzymes or bacterial growth (Moon et al., 2017; Pawar et al., 2020). The findings showed that pH increased more in the CC samples than in the millet-incorporated cutlets. A similar increase in pH values was observed during the refrigerated storage of cutlets made from Catla (Pawar et al., 2012) and Common carp (Talab, 2014).

### 3.2 Changes in TVB-N values

The TVB-N values of CC, BM and LM samples observed during the storage period are depicted in Figure 2. The initial TVB-N values recorded were 2.72 mg 100 $g^{-1}$, 2.5 mg 100 $g^{-1,}$ and 2.56 mg 100 $g^{-1}$ for the CC, BM, and LM samples, respectively. The mean values of BM and LM samples did not differ significantly ($p > 0.05$) from one another till the 6$^{th}$ day of storage. However, significant differences were observed from the 9$^{th}$ day till the end of the storage period ($p < 0.05$). The TVB-N values of the BM and LM samples increased to 4.08 mg 100 $g^{-1}$ and 4.28 mg 100 $g^{-1}$, respectively, at the 15$^{th}$ day of the storage period. The sudden increase in TVB-N content can be attributed to the activity of endogenous enzymes leading to bacterial spoilage (Chomnawang et al., 2007). Similar increases in TVB-N values were observed by Praneetha et al. (2015) in refrigerated storage of cutlets and by Akkus et al. (2004) in refrigerated storage of fish balls.

### 3.3 Changes in FFA values

FFA values recorded on the initial day were 0.024 %, 0.022 % and 0.026 %, respectively, for CC, BM and LM cutlets (Figure 3). From the 6$^{th}$ day of refrigerated storage, the observed values for CC, BM, and LM samples were significantly different ($p < 0.05$). The BM cutlets had lower FFA and 0.051 % oleic acid on the 15$^{th}$ day of storage, compared to LM and CC samples with 0.063 % and 0.077 % oleic acid, respectively. Furthermore, FFA values of the CC sample were significantly ($p < 0.05$) higher on the 15$^{th}$ day of the storage period. The observed FFA values increased as a result of lipolytic enzyme deactivation during flash frying of the cutlets (Ninan et al., 2011). This finding is consistent with prior investigations by Bharathipriya et al. (2019) and Manjhi et al. (2018), who also observed similar values for Ready-To-Eat cutlets and meatballs.

### 3.4 Changes in peroxide value

During the initial days of the study, no significant differences were observed in peroxide values for CC, BM, and LM

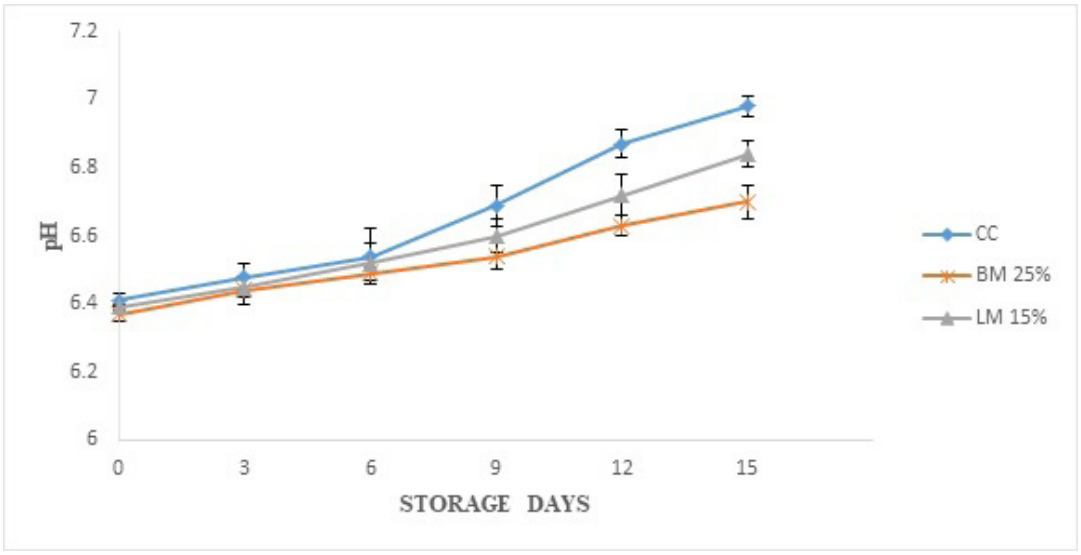



**Fig. 1.** Changes in pH values of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

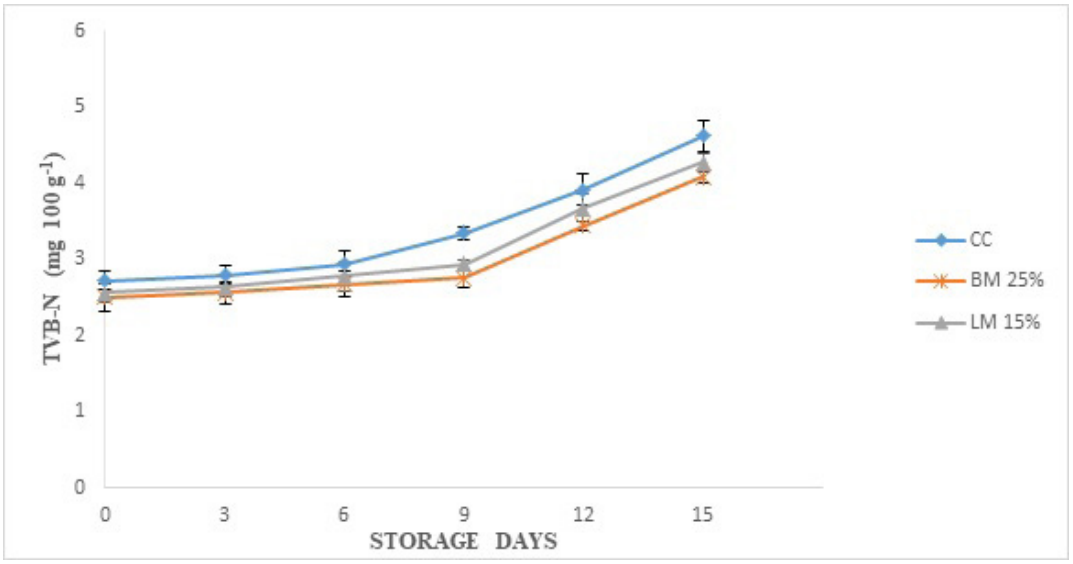



**Fig. 2.** Changes in TVB-N values of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

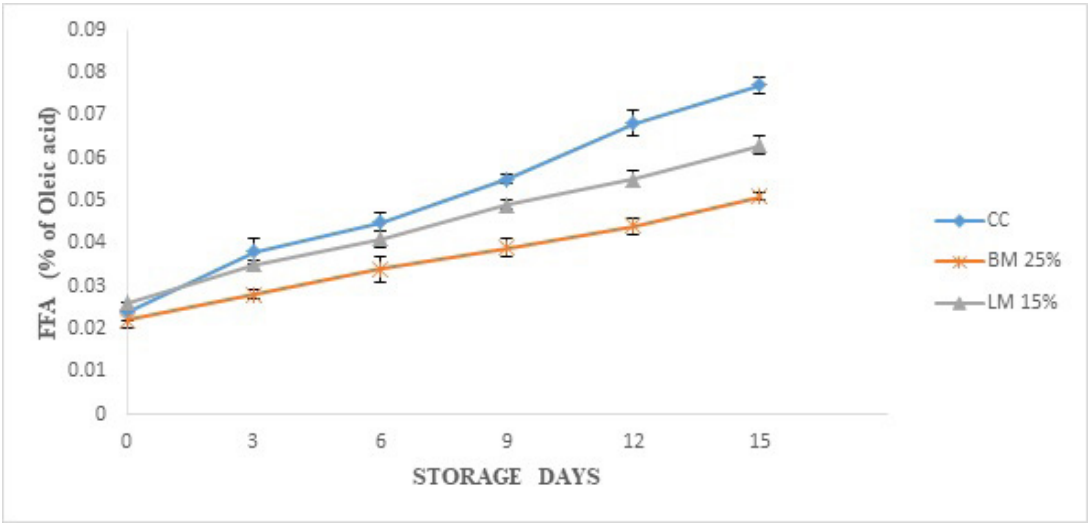



**Fig. 3.** Changes in FFA values of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

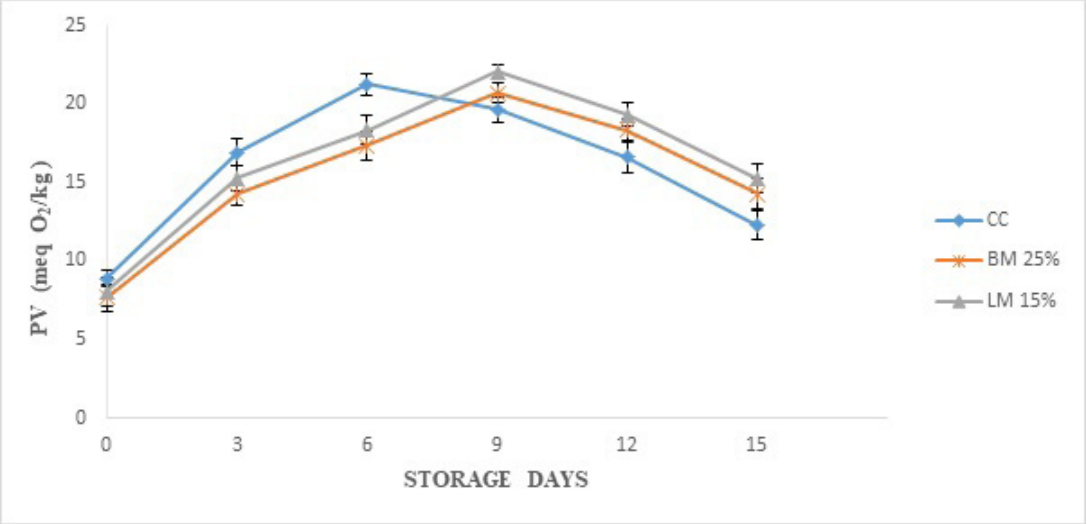



**Fig. 4.** Changes in PV values of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

samples ($p > 0.05$). On the 6th day of storage, the PV of CC samples increased to 21.25 meq $O_2$ $kg^{-1;}$ thereafter, they declined to 12.25 meq $O_2$ $kg^{-1}$ on the 15th day of storage, as shown in Figure 4. On the other hand, BM and LM cutlets showed a steady increase in the peroxide value to 20.68 meq $O_2$ $kg^{-1}$ and 22.06 meq $O_2$ $kg^{-1}$, respectively, till the 9th day of refrigerated storage; thereafter, they experienced a steady fall to 14.28 meq $O_2$ $kg^{-1}$ and 15.26 meq $O_2$ $kg^{-1,}$ respectively, on the 15th day of refrigerated storage. The observed values of PV for both BM and LM samples maintained a similar trend throughout the storage study. However, both samples were significantly different ($p < 0.05$) from the CC sample. Similar findings were reported by Praneetha et al. (2017), who observed a decrease in peroxide value after a steady increase. The decrease in the peroxide value is due to the decomposition of unstable peroxides, which react with protein, thereby decreasing the value (Yerlikaya et al., 2005).

### 3.5 Changes in TBA values

TBA values observed for CC, BM, and LM on the first day of storage were 0.154 mg MA $kg^{-1}$, 0.122 mg MA $kg^{-1,}$ and 0.132 mg MA $kg^{-1,}$ respectively (Figure 5). The values of LM and BM samples were not significantly different ($p > 0.05$) until the 6th day of storage, whereas the TBA values of the CC sample were significantly different from those of both LM and BM samples ($p < 0.05$). The TBA values of the CC, BM, and LM samples increased significantly to 1.05 mg MA $kg^{-1}$, 0.824 mg MA $kg^{-1,}$ and 0.91 mg MA $kg^{-1,}$ respectively, on the 15th day of the storage period. The degree of lipid oxidation is often indicated by the TBA value (Aubourg, 1999). The increasing trend in TBA values was also reported in Rohu cutlets (Praneetha et al., 2017) and Rohu fingers (Praneetha et al., 2015).

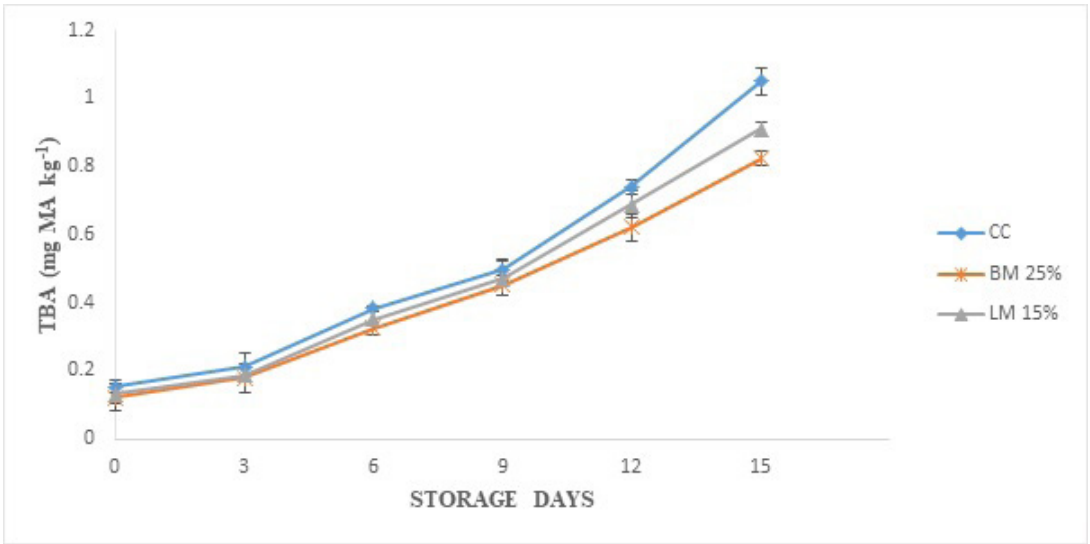



**Fig. 5.** Changes in TBA values of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

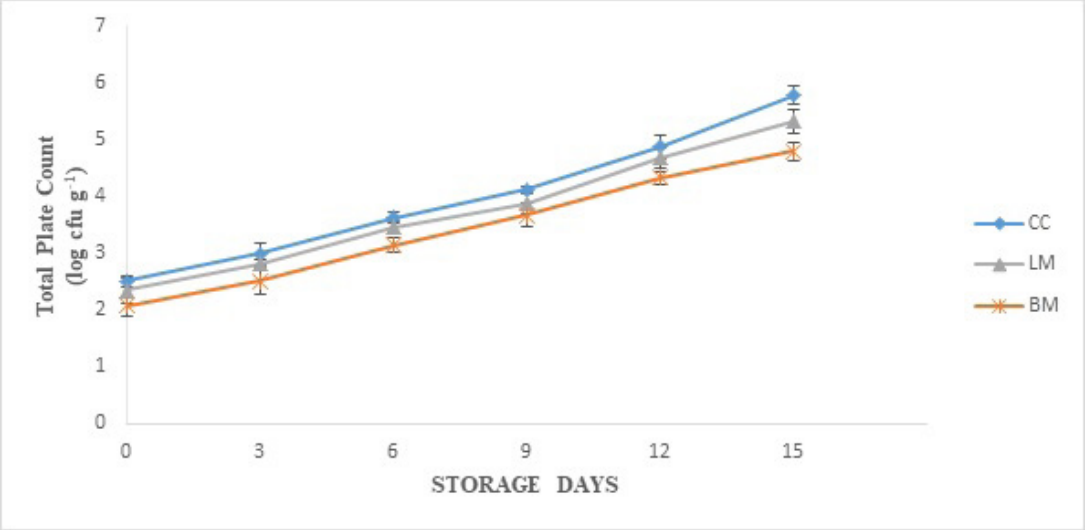



**Fig. 6.** Changes in Total Plate Count of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

### 3.6 Changes in Microbial Count

The changes in TPC and PC values of the cutlet samples are illustrated in Figures 6 and 7, respectively. The TPC values of CC, BM and LM samples increased to 5.77 log cfu $g^{-1}$, 4.79 log cfu $g^{-1}$ and 5.322 log cfu $g^{-1,}$ respectively, during the 15$^{th}$ day of refrigerated storage. Similarly, the psychrophilic count increased to 3.44 log cfu $g^{-1}$, 3.18 log cfu $g^{-1}$ and 3.31 log cfu $g^{-1,}$ respectively, for CC, BM and LM samples during the 15$^{th}$ day of the storage period. A significant increase in the microbiological values of CC, BM, and LM samples was observed ($p < 0.05$) throughout the storage period. However, the microbiological values did not surpass the limit of acceptability of $10^6$ cfu/g (FDA, 2021**)** during storage. The pathogenic bacteria, including *Escherichia coli, Vibrio spp, Salmonella spp, Faecal streptococci, and Staphylococcus aureus,* were not detected during the entire storage study. A notable increase was observed in the values of CC, BM and LM samples ($p<0.05$) over the course of the storage period; however, they never crossed the limit of 7 log cfu $g^{-1}$ (ICMSF,1978). Pathogenic bacteria such as Escherichia coli, Vibrio spp., Salmonella spp., Faecal streptococci, and Staphylococcus aureus were not detected during the entire storage study, which can be attributed to the flash frying of the products preceding refrigerated storage. This observation aligns with investigations by several authors using a similar method of study (Salman et al., 2022; Pawar et al., 2020; Praneetha et al., 2017; Vanitha et al., 2015).

### 3.7 Changes in sensory quality

The overall acceptability scores of the CC, BM and LM samples are given in Figure 8. Compared with LM cutlets and the CC sample, which exhibited storage stability of 15 and 12 days, respectively, the study found that BM cutlets had an extended shelf life of 15 days and superior sensory attributes. The initial mean overall acceptability scores for the CC, BM, and LM samples were 8.89, 8.99, and 8.94, respectively. The values recorded for the millet-incorporated samples were found to be significantly different from the

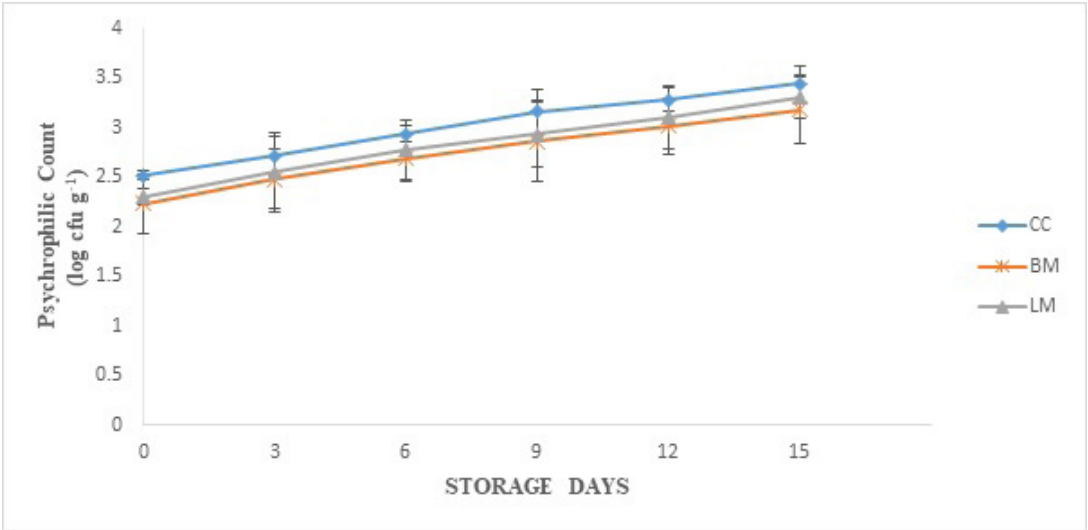



**Fig. 7.** Changes in Psychrophilic Count of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

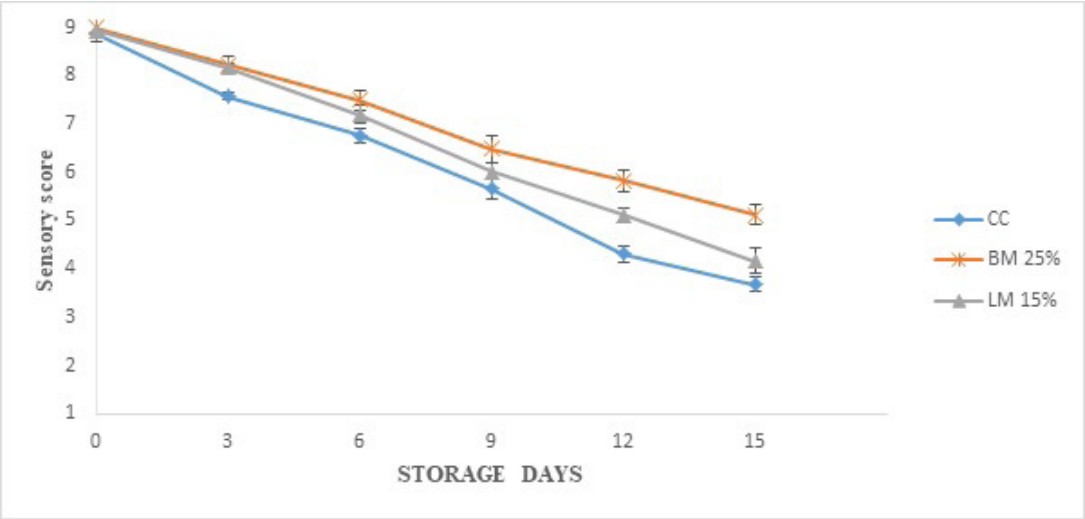



**Fig. 8.** Changes in sensory scores of cutlets during refrigerated storage expressed as mean ± standard deviation (n=3)

CC sample ($p < 0.05$). The sensory evaluation of cutlets revealed that BM cutlets remained stable for up to 15 days of refrigerated storage, with a score of 4.5. The CC and LM cutlets had shorter shelf lives, with sensory scores of 3.68 and 4.16, respectively. Several authors have observed that the ideal shelf life of refrigerated fish products is from 9-12 days (Boran and Kose, 2007; Taskaya et al., 2003).

## 4. Conclusion

The study evaluated the effects of refrigeration on the quality parameters, viz., biochemical, microbial, and sensory properties, of cutlets prepared from Silver Pompano and millets. The BM cutlets had a shelf life of 15 days, while the CC sample was rejected at the 12$^{th}$ day. The study also outlines the scope for developing various value-added products from silver pompano meat, which can be stored at refrigerated conditions for up to 15 days with acceptable physicochemical, microbial, and sensory quality. However, further studies incorporating pilot-scale production trials and broader consumer testing to assess market feasibility are necessary before establishing commercial applicability. Millet integration improved the quality, sensorial acceptability, and shelf stability of silver pompano cutlets, although large-scale validation is required.

## Acknowledgement

The authors would like to sincerely thank the Director of the School of Industrial Fisheries, Cochin University of Science and Technology, for providing the facility and support. We also appreciate the cooperation and support of Ms Sara Johny and Mr Reshin Shaji, students of the School of Industrial Fisheries, extended throughout the study.

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