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Article

Effect of ginger extract on the quality of pangasius fish steaks during chilled storage

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Abstract: The effect of ginger extract on the quality of pangasius (*P. hypophthalmus*) fish steaks during chilled temperature was studied. Pangasius fish steaks were treated with different ginger extract dilutions (2.5%, 5%, 10% and 20%), then packed in polyethylene bags and stored at a chilled temperature. Overall, the cumulative observations of biochemical, microbiological and sensory parameters, and the shelf life of pangasius fish were evaluated. Organoleptic, biochemical (pH 6.12 to 6.70, PV 1.02 to 10.24 m.eq./kg and TVB-N 3.33 to 24.58 mg/100 g) and microbial analysis (TPC 3.56 to 5.63 log cfu/g) showed that chilled stored air packed pangasius steaks treated with 20% ginger extract dilution had longer shelf life of 22 days, while untreated air packed pangasius steaks had a shelf life of 12 days. The findings of the present experiment, clearly suggest that a combination of ginger extract and chilled temperature could be used to prolong the shelf life of pangasius fish steaks.

Keywords: fish steak; antimicrobial; antioxidant; chilled storage; ginger extract

1. Introduction

Fish has always been an important food for the human diet globally and still constitutes an important part of human nutrition. The main advantages of fish are its high nutritional content and easy digestibility. Fish have high-quality proteins, vitamins and omega-3 fatty acids, especially the pelagic ones. As a result, the demand for fish products in the domestic and international markets has increased [1]. Pangasius fish became the foremost favoured aquaculture species because they tolerate intensive farming conditions [2]. There is an effort the consume by developing completely different value-added products from pangasius fish due to its light flavour, white flesh colour, and firm cooked texture [3]. However, the marketing of value-added products requires infrastructure in the form of a cold chain from the point of the producer to the point where the product is consumed. Generally, these value-added products are kept in chilled or frozen storage till they are consumed. The lack of these facilities in the domestic sector makes it extremely difficult to market these products [4].

The latest trend worldwide is the demand for fresh food without any chemical preservatives. Therefore, people are paying more and more attention to alternative additives of natural origin, which gradually trigger the elimination of synthetic preservatives in food [5]. These antioxidants are polyphenol compounds present in all plants and all parts of plants such as bark, stems, leaves, fruits, roots, flowers, pods and seeds [6]. The utilisation of spices as antioxidants in processed foods is a

promising another option to the use of synthetic antioxidants, because of consumers are increasingly interested in natural food additives [7]. Generally, spices are added to fish products due to the enhancement of taste and aromas; currently, people are increasingly aware that spices can also improve the oxidative stability of processed products. Therefore, spices and herbal extracts are marketed as antioxidants used in the food industry [8].

Compared with natural preservatives such as spices and different plant extracts, synthetic preservatives used in seafood hurt human health and have not effect on the taste and aroma of the product. The biologically active compounds and phytochemicals in ginger exhibit strong antibacterial, antioxidant and antifungal properties against several microorganisms in fish preservation [9]. There have been references to the antioxidant and antimicrobial effects of ginger and other spices on the shelf life of meat products [10,11]. However, only a few studies have reported the use of ginger and other plant extracts to improve the shelf life of fish and fishery products [12,13]. This study aimed to study the effect of ginger extract treatment on the microbial and sensory quality of pangasius fish steaks in chilled storage.

2. Materials and methods

2.1. Sample preparation

Freshly caught pangasius fish (*P. hypophthalmus*) were procured from local a fish farm. The total length of pangasius fish selected for the present research work ranged from 39 cm to 46 cm and the total weight ranged from 0.85 kg to 1.1 kg. After washing, fish were packed along with crushed ice (1:1 ratio) in insulated boxes for transportation to the processing hall of the Department of Fish Processing Technology and Microbiology. College of Fisheries, Ratnagiri. Pangasius fish and steak were washed by using 2 ppm chlorinated water. The fins and the head were removed. After being washed with 2 ppm chlorine water, fish steaks of a thickness (1.5 cm–2.0 cm) were prepared as per the protocol suggested by Shalima [14].

2.2. Preparation of ginger extract

Fresh and good quality ginger (*Zingiber officinale Rosc*.) was purchased from the local vegetable market situated in Ratnagiri. Preparation of **s**tandard ginger extract from fresh ginger was carried out [15] and depicted in **Figure 1**. After the preparation of ginger extract, different ginger extract dilutions were prepared by adding distilled water and were used for application to fish steaks during the present study. The steaks were divided into 5 groups. One group was kept untreated as control and the remaining four groups were dipped in a solution of ginger extract 2.5%, 5%, 10% and 20% dilutions respectively for 2 min.

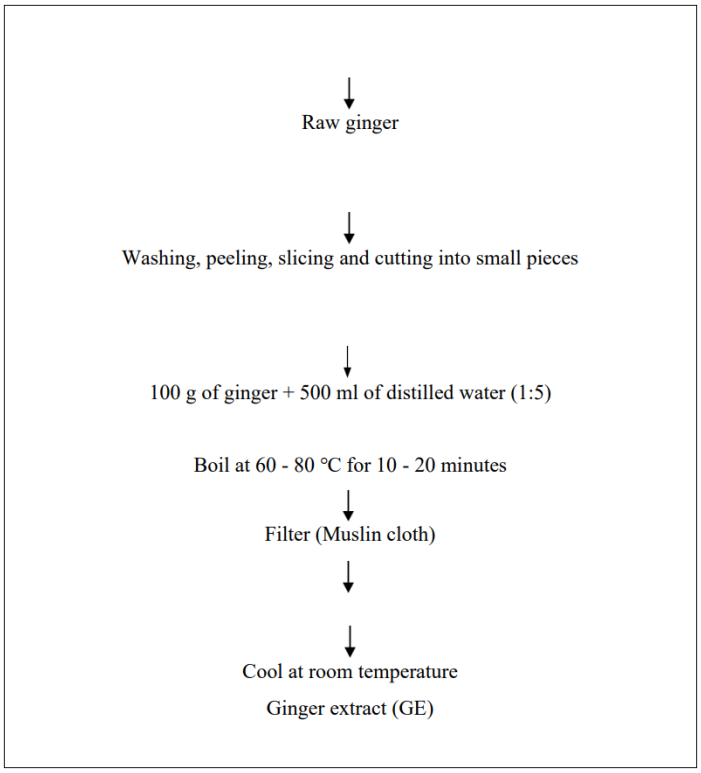

Figure 1. Preparation of standard ginger extract.

The packed samples of untreated and treated were coded as Untreated air-packed steaks (A), Air-packed steaks treated with 2.5% ginger extract dilution (B), Air-packed steaks treated with 5% ginger extract dilution (C), Air-packed steaks treated with 10% ginger extract dilution (D) and Air-packed steaks treated with 20% ginger extract dilution (E). Packing of untreated (control) and treated (four treatments) steaks was carried out in LDPE bags. The four replicates of each group were prepared. The untreated and treated samples were chilled at 2–4 ± 1 ℃ for 22 days in a chilling machine and subjected to further analysis of the sensory, biochemical and microbiological analysis characteristics during chilled storage for 22 days.

2.3. Sampling

Samples were taken every alternate day (0, 2, 4, 6 etc.) and subjected to for further analysis of the sensory, biochemical and microbiological analysis characteristics during chilled storage.

2.4. Biochemical analysis

Analytical grade chemicals (M/s HiMedia Lab) were used for biochemical and microbiological analysis. The proximate composition such as moisture, crude protein, crude fat and ash content in pangasius fish steaks was determined [16]. pH of treated and untreated fish steaks was measured by the standard method [16]. The TVB-N content was assessed according to previous studies [17,18]. The amount of peroxide or hydro-peroxide groups was also measured using titrimetric determination for analysis of oxidative stability of chilled stored pangasius fish steaks. The peroxide value was expressed as m.eq./kg fat [16].

2.5. Microbiological analysis

Microbiological analyses such as total plate count, total psychrophilic count and *E. Coli* were enumerated [19].

Physiological saline solution (0.85% NaCl) was used as a diluent for the preparation of homogenate. A 10 g sample was aseptically weighed and diluted with 90 mL physiological saline solution. Appropriate dilutions were prepared from the homogenate using physiological saline and plated on TGBE agar by pour plate method. The petri dishes containing samples were incubated at 37 ℃ for 24 h–48 h.

The colonies developed on agar plates were counted and calculated. Petri dishes having colonies ranging between 30–300 were selected.

2.6. Sensory evaluation

Sensory evaluation of samples was carried out based on the assessment of various sensory parameters such as appearance, colour, odour, texture and overall acceptability. A panel of 10 judges performed a sensory analysis of chilled stored samples during the experimental period, on a 9-point hedonic scale with 9 (Like extremely) 1 (dislike extremely) and 5 (borderline of acceptability). The samples were considered unfit for consumption when the average overall acceptability was below 5 [20]. The scores given by the panellists for each of the attributes were pooled and the average scores were presented (Appendix).

2.7. Statistical analysis

The recorded data were analyzed by using the analysis of variance (ANOVA) tool provided in SPSS version 16.00 to test for significant differences. Significant differences were tested at a significance level of 5%, and the significant difference was called $p < 0.05$ [21].

3. Results and discussion

3.1. Proximate composition of fresh fish steak

The moisture, crude protein, fat, and ash in the fresh fish steak were 74.52%, 16.79%, 7.64% and 1.02%, respectively and are presented in **Table 1**. Similar observations of the proximate composition of pangasius fish regarding moisture, crude protein, fat and ash (74.32%, 17.02%, 7.50% and 1.04% respectively) were reported by Patil [22]. Moreover, previous researchers also observed similar results for moisture, protein, fat and ash content in fresh pangasius fish meat (76.62%, 14.37%, 6.76% and 2.25% [23] and 78.2%, 17.24%, 2.84% and 1.3% respectively) [4]. However, slight variation in proximate compositions of the fish muscle where observed may be due to various factors such as size, sex, stage of maturity and seasons [24].

Table 1. Proximate composition of fresh pangasius fish.

Composition (%)	Pangasius fish muscle
Moisture	74.52 %
Crude protein	16.79 %
Fat	7.64 %
Ash	1.02 %

3.2. Quality of fresh pangasius fish

The sensory, biochemical and microbial quality characteristics of fresh raw pangasius are shown in **Table 2**. Sensory quality assessments indicate that Caterpillar's overall acceptance is high (9.0). Biochemical results showed lower initial pH (6.11), TVB-N (4.09 mg/100 g) and PV (1.10 m.eq./kg). The total plate count and total psychrophilic count of fresh pangasius fish were 4.4×10^3 cfu/g and 1.36×10^3 cfu/g respectively.

Table 2. Quality of fresh pangasius fish.

Quality parameter	Pangasius fish
Sensory score for overall acceptability (1–9 point hedonic scale)	9.00
pH	6.11 ± 0.01
TVB-N (mg/100g)	4.09 ± 0.01
PV (m.eq./ kg)	1.10 ± 0.02
Total plate count (cfu/g)	4.4×10^3
Total psychrophilic count (cfu/g)	1.36×10^3

3.3. Yield percentage

The yield percentage of pangasius fish steaks was 59.23% from whole fish. This yield was higher than that reported by Patil [22], who found a total yield of 55.17%. There are several factors that affect the yield percentage of fish steaks such as fish size, feed ratio, diet composition, sexual maturity [25] and methods of dressing [26].

3.4. Organoleptic quality of chilled stored pangasius fish steaks

After a comparative analysis of the organoleptic score, samples 'A', 'B', 'C', 'D' and 'E' indicated a decreased trend up to 12 (4.6), 16 (4.4), 16 (4.5) and 18 (4.3) day of the storage. The overall acceptability of sample 'E' remained in the range up to 22 (4.0) days (**Figure 2**). Overall acceptability scores (1–5 hedonic scale) of control rohu fish steak were 4.86 to 3.14 at the end of the 5th day. Similar observations were recorded that treated fish steaks with single-strength ginger extract for one and two min had a score of 4.86 to 3.57 and 4.86 to 3.29 at the end of the 7th and 9th day respectively [27].

The oxidization and microbial activities are responsible for the deterioration of the organoleptic qualities of fish. However, the addition of preservatives improved the odour, texture, taste and appearance and also increased the shelf life of fish [28].

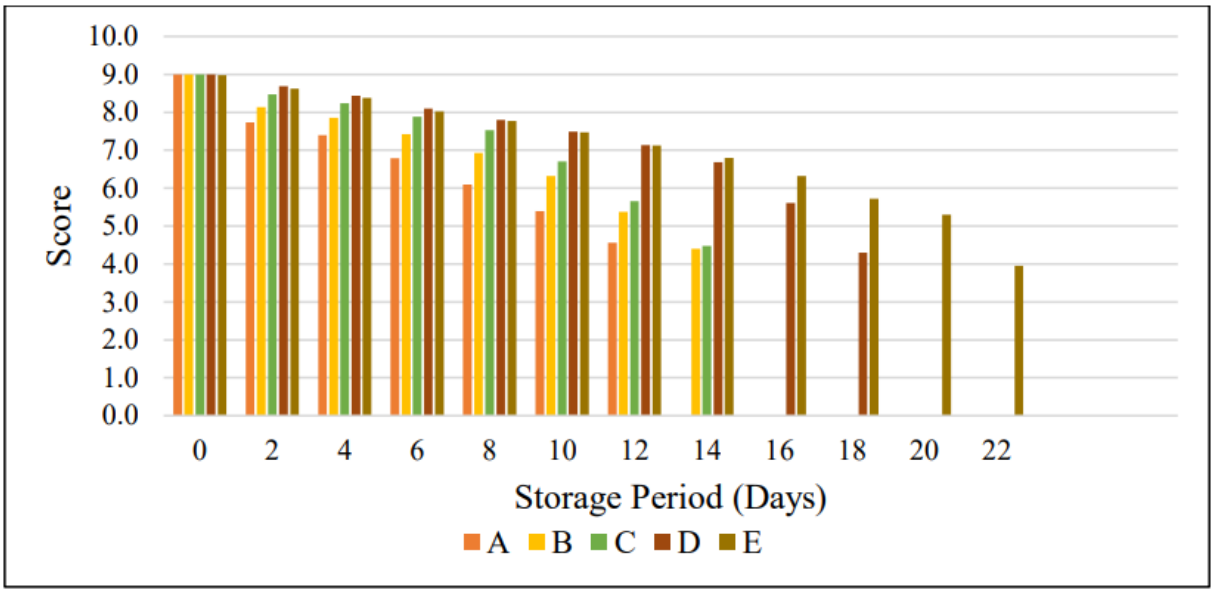

Figure 2. Organoleptic score for overall acceptability of chilled stored pangasius fish steaks.

3.5. Changes in pH during chilled storage

The pH values of samples 'A', 'B', 'C', 'D' and 'E' indicated an increase from 6.15 to 6.45 (12th day), 6.13 to 6.51 (14th day), 6.13 to 6.49 (14th day), 6.12 to 6.60 (18th day) and 6.12 to 6.70 (22nd day) respectively during chilled storage (**Figure 3**). Similar observations were noted for the pH values of all air-packed pangasius steaks increased during chilled storage. pH values of untreated fish steaks increased from 5.89 to 6.63 on the 20th day of chilled storage [22]. However, the pH of catla fish steaks increased from 5.56 to 6.51 during chilled storage on the 24th day of chilled storage [29]. The pH value of *P. monodon* was 6.5, which increased to 7.2 on the 27th day of chilled storage [30].

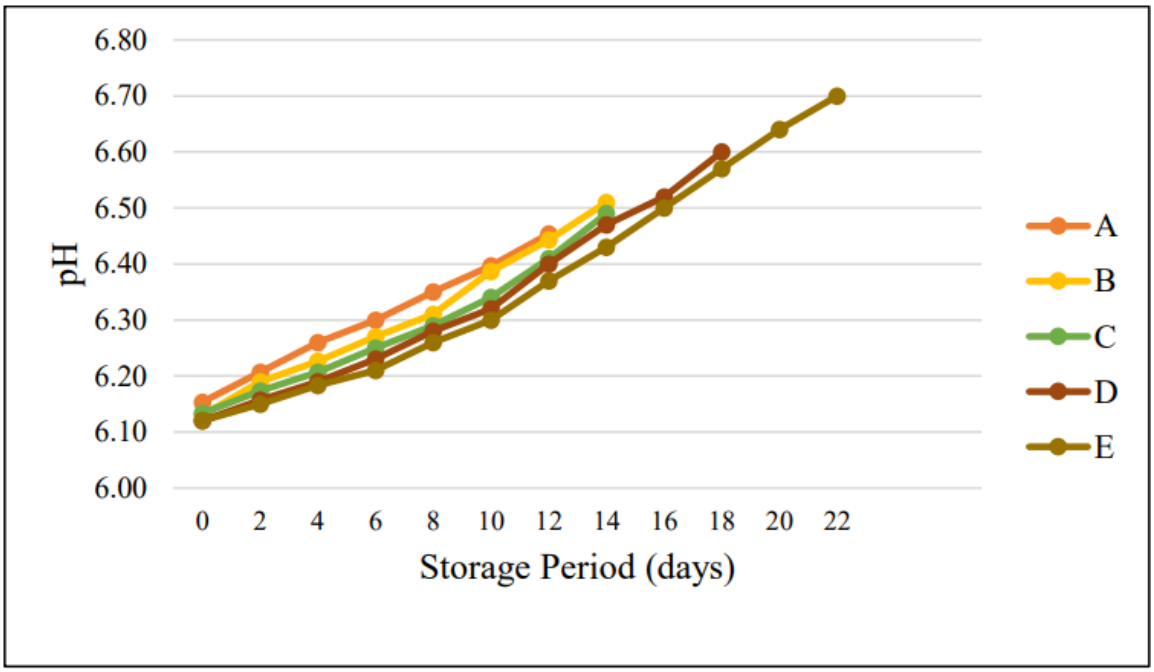

Figure 3. Changes in pH of chilled stored pangasius fish steaks.

3.6. Changes in peroxide values during chilled storage

Samples 'A', 'B', 'C', 'D' and 'E' were found to be increased from 1.22 to 10.44 m.eq./kg (12th day), 1.18 to 10.69 m.eq./kg (14th day), 1.09 to 10.51 m.eq./kg (14th day), 1.07 to 10.89 m.eq./kg (18th day) and 1.02 to 10.24 m.eq./kg (22nd day) respectively during stored in chilled temperature (**Figure 4**). Similar observations concerning the peroxide value of untreated rohu fish steaks were found; an increase from 2.87 to 8.85 m.eq./kg at the end of the 5th day was observed and fish steaks treated with ginger extract for one and two min showed increased PV from 2.89 to 5.47 m.eq./kg and 2.85 to 5.49 m.eq./kg at the end of the 7th and 9th days of storage [27]. Similar results were reported in another study, where control fish steak peroxide values increased from 2.94 to 15.40 m.eq./kg during chilled storage on the 20th day [22].

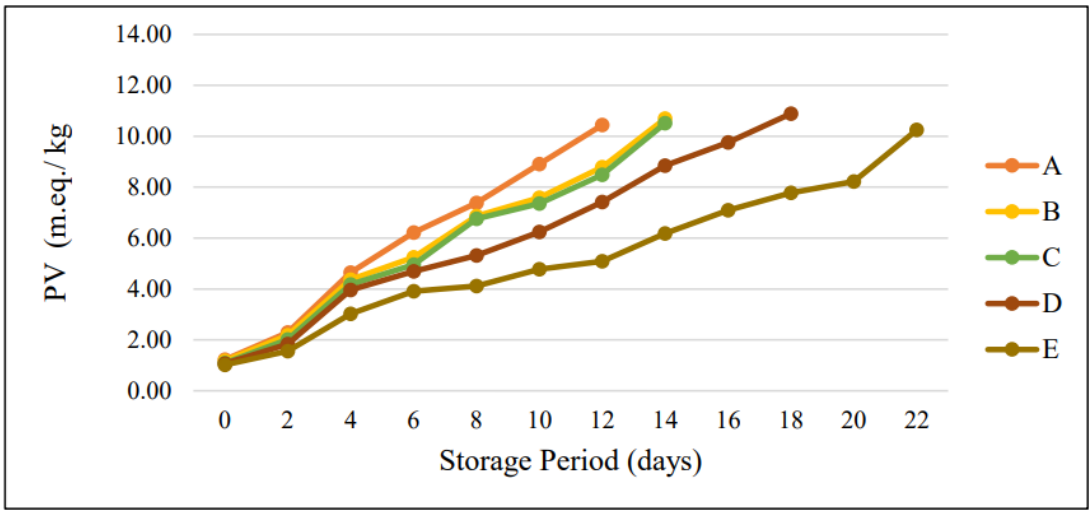

Figure 4. Changes in PV of chilled stored pangasius fish steaks.

3.7. Changes in total volatile base nitrogen (TVB-N) during chilled storage

The TVB-N content of samples 'A', 'B', 'C', 'D' and 'E' were found to be gradually increase from 4.12 to 24.72 mg/100 g, 3.78 to 24.93 mg/100 g, 3.68 to 24.69 mg/100 g, 3.52 to 25.42 mg/100 g and 3.33 to 24.58 mg/100 g at the end of the 12, 14, 14, 18 and 22 days respectively (**Figure 5**). Rohu steaks treated with ginger extract for one and two min had TVB-N values of 12.02 to 21.67 mg/100 g and 11.68 to 19.81 mg/100 g at the end of the 7th and 9th day respectively [27]. Whereas, similar results of the TVB-N values in the control sample were 24.85 mg/100 g at the end of the 5 days, 26.23 mg/100 g and 25.78 mg/100 g in 0.5% and 1% ginger extract concentration at the end of the 11 and 17 days respectively in *S. sarda* fish finger [31].

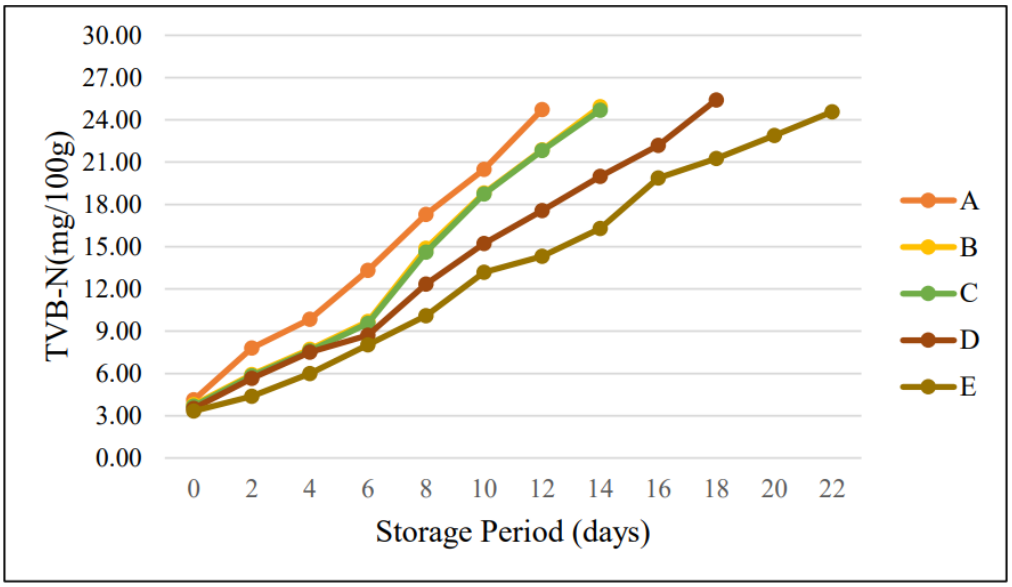

Figure 5. Changes in TVB-N of chilled stored pangasius fish steaks.

3.8. Changes microbiological quality during chilled storage

3.9. Total plate count

During the storage period, the total plate count (cfu/g) increased along with the storage period in all the treatments. The total plate count of samples 'A', 'B', 'C', 'D' and 'E' were found to be increased from 9.6×10^3 to 3.2×10^5 cfu/g (3.98 to 5.51 log cfu/g), 4.0×10^3 to 2.4×10^5 cfu/g (3.60 to 5.38 log cfu/g), 4.3×10^3 to 2.45×10^5 cfu/g (3.63 to 5.39 log cfu/g), 3.9×10^3 to 2.1×10^5 cfu/g (3.59 to 5.32 log cfu/g) and 3.6×10^3 to 4.3×10^5 cfu/g (3.56 to 5.63 log cfu/g) at the end of the 12. 14, 14, 18 and 22 days of storage period respectively (**Figure 6**).

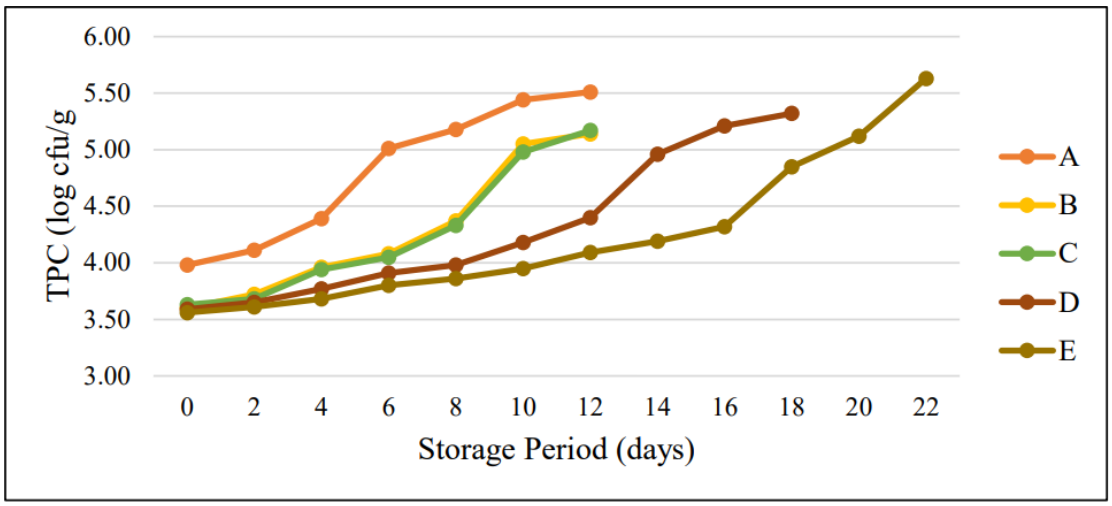

Figure 6. Changes in total plate count of chilled pangasius fish steaks.

This result is in agreement with that of Maurya [27], who reported that rohu steaks treated with ginger extract for one and two min had a TPC found to be increased from 4.16 to 3.86 log cfu/g and 5.62 to 5.33 log cfu/g at the end of the 7th and 9th day.

The total plate count was 1.62 × 10^3 in fresh meat and gradually increased to 1.08 × 10^5 on the 18th day [30].

3.10. Total psychrophilic count

Psychrophilic bacteria are microorganisms responsible for the spoilage of fresh fish at low temperatures. In the present study, the total psychrophilic count increased along the storage period in all the treatments. The total psychrophilic count of samples 'A', 'B', 'C', 'D' and 'E' was found to be increased from 1.48 × 10^3 to 1.5 × 10^5 cfu/g (3.17 to 5.18 log cfu/g), 7.7 × 10^2 to 1.25 × 10^5 cfu/g (2.89 to 5.10 log cfu/g), 5.2 × 10^2 to 1.21 × 10^5 cfu/g (2.72 to 5.08 log cfu/g), 3.9 × 10^3 to 1.4 × 10^5 cfu/g (2.59 to 5.15 log cfu/g) and 3.3 × 10^2 to 2.23 × 10^5 cfu/g (2.52 to 5.35 log cfu/g) at the end of 12. 14, 14, 18 and 22 days of storage period respectively. In treated fish steaks, the growth of the total psychrophilic count was slower than in untreated steaks (**Figure 7**).

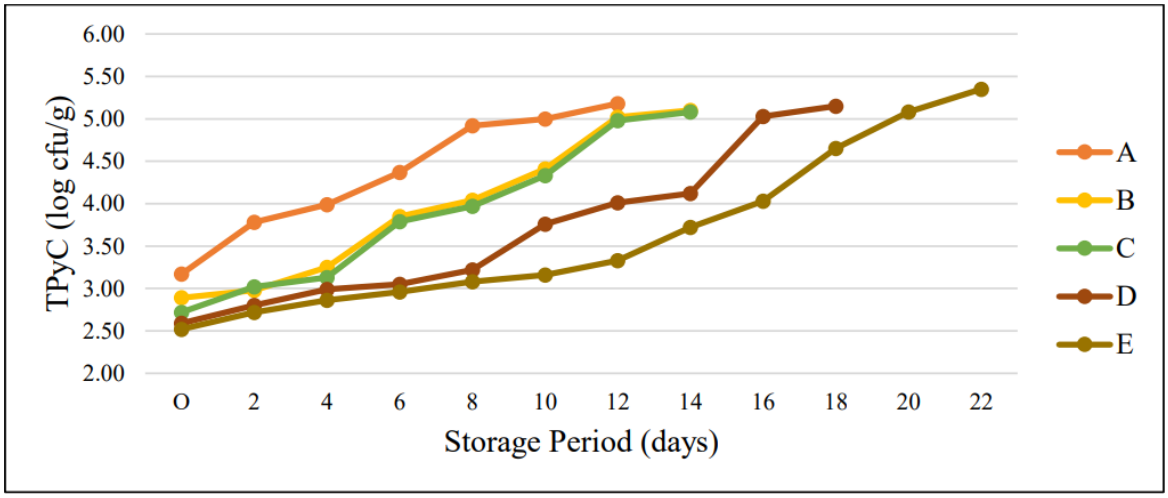

Figure 7. Changes in total psychrophilic count of chilled pangasius fish steaks.

A similar observation of increase in total psychrophilic counts from 3.46 to 5.25, 3.38 cfu/g to 4.66 and 3.19 to 4.77 log cfu/g in control, ginger extract treated for one and two min rohu steaks respectively, at the end of the storage period of 5, 7 and 9th days [27]. Also, the same psychrotrophic bacteria count in raw anchovy fish was 2.8 × 10^3 cfu/g [32]. The psychrotrophic count increases from 1.10 × 10^3 cfu/g in fresh fish to 2.42 × 10^5, 7.50 × 10^4 cfu/g in control air-packed black kingfish flesh and samples treated with 1.5% sodium acetate respectively [33]. The psychrophilic count was increased from 1.30 × 10^3 cfu/g in fresh shrimp to 4 × 10^3 cfu/g on the 15th day and reached 3.56 × 10^5 cfu/g [30].

3.11. *Escherichia coli*

E. coli was not detected in all the chilled stored air-packed pangasius fish steaks during the storage period. The *E. coli* was not detected in anchovy (*E. encrasicholus*) patties during the storage period [32]. The *E. coli* was not detected in catla fish steaks, during the entire period of chilled storage [29]. *E. coli* is a pathogenic microorganism that gets access to the fish during handling and processing [34]. This bacterium is mostly of human origin. The occurrence of *E. coli* is indicative of faecal contamination in fish and fishery products [35].

4. Conclusion

The dipping of fish in Ginger extract was very effective providing good sensory acceptance and has the potential to be used as a natural preservative to extend the shelf life of fish and fishery products. The results of this study indicate that ginger extract could be used in the place of synthetic antioxidants to prevent antioxidation and microbial deterioration in fish.

Author contributions: Conceptualization, RDP and NDC; methodology, DIP; software, BMY; validation, RDP, NDC and ASM; formal analysis, RDP; investigation, NDC; resources, RDP; data curation, RDP; writing—original draft preparation, RDP; writing—review and editing, NDC; visualization, NDC; supervision, NDC; project administration, NDC; funding acquisition, RDP. All authors have read and agreed to the published version of the manuscript.

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Appendix

Table A1. Score sheet for organoleptic quality evaluation.

Sr. No.	Characteristic	Sample				
		A	B	C	D	E
1.	Appearance					
2.	Colour					
4.	Texture					
5.	Odour					
6.	Overall acceptability					

Name:

Date: **Signature**