p-ISSN: 1907-8056
e-ISSN: 2527-5410
AGROINTEK
Jurnal Teknologi Industri Pertanian
journal homepage: journal.trunojoyo.ac.id/agrointek

Quality of *Clarias* sp with the addition of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) in cold storage

Akbar Fitriyanto[1], Nanik Suhartatik[1*], Vivi Nur'aini[1], Harto Widodo[2]

[1]*Agricultural Product Technology, Universitas Slamet Riyadi, Surakarta, Indonesia*
[2]*Research centre for pharmaceutical ingredients and traditional medicine, BRIN, Karanganyar, Indonesia*

Article history
Received:
29 December 2023
Revised:
16 April 2024
Accepted:
28 August 2024

Keyword
catfish;
cold storage;
fillet;
ginger;
turmeric

ABSTRACT

Apart from being sold in whole form, fish is also sold in ready-to-use fillets. Fillets were easier for buyers because they were practical, easy to use, and clean. The disadvantage of serving in the form of fillets was that they were very susceptible to damage due to the ease of damage. Fish fillets have a high moisture and protein content. Without any protection, this material will quickly deteriorate. This study aimed to determine the effect of ginger and turmeric extracts on catfish fillets stored at cold temperatures The study used a factorial complete randomized design with the ratio of ginger and turmeric extracts as the first factor and storage days as the second factor. The results show that the use of ginger and turmeric as additional ingredients in the storage of catfish fillets was less effective in inhibiting fillet deterioration. The moisture content of the catfish fillets decreased from 82.66% to 70.51% after 6 days of cold storage. The pH value of the catfish fillet increased, while water-soluble protein and TVB-N were varied for some treatments. The pH value of fresh fish fillets without the addition of ginger and turmeric was 5.50 and reached 6.30 after 6 days of cold storage. Fillets with turmeric and ginger have a lower pH (6.15), and the ratio of the rhizome extracts did not significantly affect the pH value. According to the TVBN value, ginger and turmeric extracts could maintain the quality of fish fillets for up to 4 days at cold temperatures. Further research needs to be done to study the effect of packaging on the fresh fillet quality.

This work is licensed under a Creative Commons Attribution 4.0 International License.

[*] Corresponding author
Email : n_suhartatik@yahoo.com
DOI 10.21107/agrointek.v19i3.24022

INTRODUCTION

Fish is a source of protein, with levels reaching 27.997% (Fatma et al. 2020). The arrangement of amino acids in fish meat is almost the same as the arrangement of amino acids in the human body. Fish meat contains unsaturated fatty acids with very low cholesterol levels. In addition, fish meat also contains several minerals such as potassium, chloride, phosphorus, sulfur, magnesium, calcium, iron, manganese, flour (F), and others (Ullah et al. 2022).

Catfish (*Clarias sp*.) includes consumption fish that are also widely cultivated in Indonesia. Besides being sold in fresh form, fish is also sold in fillet or frozen form (Lastriyanto et al. 2019). This form of fillet is more practical, easy to use, and looks clean. Fish sold in the form of fillets in supermarkets in Indonesia usually come from tuna, swordfish, snapper, or other fish with high economic value. Fish meat is very perishable due to its high moisture content, pH is close to neutral, and protein levels are in it (Sanjee and Karim 2016). In addition, fish are also easily polluted by environmental conditions, such as dirty water and equipment, from the fish themselves or from people who touch them. Various methods are carried out to increase the shelf life of these fish fillets, starting from freezing (Lastriyanto et al. 2019; Sanjee and Karim 2016), combination of cooling and frying (Utami et al. 2022), application of edible coating (Mezhoudi et al. 2022; Ranjbar et al. 2023), salting process (Lubis et al. 2015) or with the addition of bioactive compounds of plant/plant part extracts (Mezhoudi et al. 2022; Ulina et al. 2016). The most reliable use of antibacterial compounds is salt, which is a combination of drying processes that are widely applied to the processing of salted fish (Fitri et al. 2022). The form of fillets was chosen because the level of freshness of fish can be maintained, and the proteins are not damaged, as is the case with salted fish processing (Fitri et al. 2022).

Indonesians usually process fish using herbs or spices derived from rhizomes. Fish is consumed by frying with seasonings that are mashed with a bit of salt as a flavor. The rhizomes often used as spices are ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*). Another natural ingredient that has also been studied is garlic (*Allium sativum Linn*.), which inhibits the decline in fish quality during Storage (Al-Afifah et al. 2022). Sidiki et al. (2015) said that the addition of ginger is more effective in inhibiting the growth of gram-positive than gram-negative microbes.

Ginger belongs to the Zingiberaceae family, and its main bioactive components are gingerol and shogaol (Ghasemzadeh et al. 2018). Shogaol is an oxidation product of gingerol and has better biological ability than gingerol (Ghasemzadeh et al. 2016). Furthermore (Ghasemzadeh et al. 2018) reported that the minimum inhibitory concentration (MIC) of ginger extract against *Staphylococcus aureus* was 12.5 µg/ml, against *Escherichia coli* was 25 µg/ml, and against *Pseudomonas aeruginosa* was 6.25 µg/ml. Ginger extract is also able to inhibit the growth of *Geotrichum candidum, Trichophyton rubrum, Fusarium oxysporum*, and *Scopulariopsis brevicaulis*. The ginger extract showed no inhibition of *Bacillus cereus, Candida albicans*, and *Aspergillus flavus.* Meanwhile, turmeric, also included in the Zingiberaceae family, has two classes of active compounds, curcuminoid (as well as the main color component) and its essential oils (Ibáñez and Blázquez 2021). Besides being a natural coloring, turmeric is also used to give a unique aroma to some foods from certain countries, one famous of which is curry. Turmeric is also often used as a typical Indonesian fish seasoning. Turmeric essential oil can inhibit the growth of aflatoxin-producing fungi, *Aspergillus flavus* (Ferreira et al. 2013), and turmeric extract has also been shown to inhibit the growth of *Staphylococcus aureus* (Gupta et al., 2015).

Utami et al. (2022) used a storage temperature of 5^{o}C where this temperature was usually used in refrigerators. Research about the ability of seagrass (*Thalassia hemprichii*) bioactive compounds in catfish fillets has also been conducted by Ulina et al. (2016). The results showed that the seabed flora extract, which is rich in flavonoids, alkaloids, tannins, and phenols, could maintain the quality of catfish fillets for up to 8 days in cold storage (refrigerator).

This study used refrigeration temperature, a temperature that is often used to display fish fillets in supermarkets. In addition, this study also used additional ingredients in the form of ginger and turmeric extracts as natural antimicrobial compounds. The use of salt was deliberately eliminated to avoid potential suppression of the number of microbes due to the presence of salt, and only the effects of these two spices will be studied. The results of this study are expected to provide information on the use of natural

antimicrobial ingredients to extend the shelf life of catfish fillets. They can be developed into superior local products.

The shelf life of catfish fillets was previously carried out by Utami et al. (2022). It showed that the value of TVB, TPC, moisture content, and protein content of catfish fillets still met the standard criteria for consumption. However, organoleptic was no longer acceptable to consumers. The study aimed to determine the physicochemical and organoleptic characteristics of catfish fillets with the addition of turmeric and ginger during storage at low temperatures.

METHODS

Materials

The materials used in the study were catfish obtained from catfish farming at Wedi, Klaten, Indonesia. The catfish weighed ± 250 grams with an age of 3 months. Turmeric and ginger were obtained from local traditional markets. Analytical supporting chemicals such as Plate Count Agar media, HCl, aqua dest, Conway indicators, saturated K_2CO_3, boric acid, BSA (Bovine Serum Albumin), Na_2CO_3, TCA 7.5%, NaOH, potassium tartaric, $CuSO_4$, and Folin ciocalteau used were the standards for analysis.

The tools used in the study were as follows: oven (Memmert UN110), cutting board, knife, desiccator (Duran DN 200), burette (Pyrex), Conway dish, weighing bottle (Pyrex), pH meter (ATC pH-009), spectrophotometer (Genesys 10S Uv-vis), a digital scale with accuracy 0.0001 g (Denver M-310), Autoclave (Autoclave Steam Sterilizer MA635), Incubator (Memmert In 55), Anaerobic Jar (Micromaster AAN004-1PC), petri dish (Charuzu 15 mm x 90 mm), colony control J-2, blender (Philips HR 2115) and sterilizable jar, bent glass rod, pipette (Scilogex 20–200 ml).

Experimental design

The experimental design conducted in this study was a factorial, completely randomized Design with two factors, namely the ratio of turmeric and ginger as the first factor and storage duration as the second factor. The ratio of turmeric and ginger used in this study was 0:0, 2:1, 1:1, and 1:2. Storage was carried out in the refrigerator with a duration of 0, 2, 4, and 6 days. The data obtained were analyzed with fingerprints at a significant rate of 5%. If there was a significant difference, continue with the Duncan test to determine the difference between treatments at a significant level of 5% using SPSS. Software.

Preparation of ginger and turmeric (rhizomes)

Ginger and turmeric were washed thoroughly, and no dirt sticks were found. Both types of rhizomes were directly crushed using a Miyako brand chopper separately and accommodated without a stripping process. Before being put in the shredder, the rhizome was first cut into smaller sizes approximately 0.5 cm thick.

Preparation of fillet catfish (Al-Afifah et al., 2022).

Catfish were killed quickly by piercing the fish's brain with a sharp kitchen knife. The fish were then weeded to separate the feces and stomach and washed under running water. Catfish fillets were made by taking meat on the left and right sides of the fish body. Catfish fillets are then washed with chlorinated water (contains 0.5 mg chlorine/L). The fillets were weighed to determine the proportions of turmeric and ginger to be added. Meat fillets along with rhizomes (ginger and turmeric) are mashed, put in ziplock plastic (C-TIK), and put in the refrigerator. Sample observations were carried out on that day (0), after 2, 4, and 6 days of cold storage.

Parameters

The parameters observed in this study included chemical analysis, namely the moisture content of the thermogravimetric method, pH, water-soluble protein content using the Lowry method (Gultom et al. 2015), microbiological analysis using PCA medium referring to Sanjee and Karim (2016), organoleptic and sensory test analysis with scoring test methods (Pimentel, Gomes da Cruz and Deliza, 2016). The sensory test involves 10 semi-trained panelists. In front of the panelists, the product is given, and a score of 1 to 5 is asked to describe the likeliness of the color and aroma (ginger, curcuma, and off-odor).

A TVB-N test using the Conway dish was conducted by Kim et al. (2023). Accordingly, five grams of fish fillets and 20 ml of distilled water were put in a 50 ml conical tube and homogenized at 200 rpm for 2 min using a homogenizer. The mixture was filtered through Whatman No.1 filter paper for 10 min. One milliliter of the sample and 1 ml sample of saturated K_2CO_3 solution were put in the outer space of the Conway dish. Then, 1 ml of 0.01 N H_2SO_4 solution was put in the inner

space of the Conway dish. The sealed Conway dish was stored in a BOD incubator at 25◦C for an hour. After incubation, 1 ml of Brunswick regent (0.2 g methyl red and 0.1 g methylene blue were dissolved in 100 ml ethanol) was added to the inner space and titrated with 0.01 N NaOH. TheEequation (1) calculates fish fillets' TVB-N content.

$$TVB-N\left(\frac{mg}{100}g\right) = 0.14\ x\ \frac{(b-a)\ x\ f}{W} x\ 100\ x\ d \qquad (1)$$

where b is the blank titration volume (distilled water was used instead of 0.01 N NaOH), a is the titration volume using 0.01 N NaOH, f is the 0.01 N NaOH standard factor, d is the dilution factor, and W is the fish fillet sample weight (g). Each sample was measured three times.

RESULTS AND DISCUSSION

Moisture content of fish fillet

The level of fish freshness will decrease, followed by physicochemical, microbiological, and sensory changes. The moisture content of catfish fillets with the addition of turmeric and ginger at cold temperature storage can be seen in Table 1. The moisture content of fish fillets decreased in storage, while the ratio of turmeric and ginger did not provide a noticeable difference in the moisture content of catfish fillets.

The moisture content of fish fillets is linked to the degradation of their proteins. When the meat is fresh, it possesses a strong capacity to retain moisture. However, as decomposition sets in after death, the fish's flesh starts to diminish in its moisture retention capabilities. It is due to physiological changes that lead to the denaturation of proteins, which in turn affects their water-binding properties. Consequently, water is slowly released from its bound state within the proteins and eventually exudes from the flesh systematically. Physically, there will be puddles around the fish fillets. The moisture content of fresh catfish fillets (0 days) ranged from 81.12 - 82.67%, while after being stored at cold temperatures for 6 days, it decreased from 75.43 – 76.01%. The same results were also shown by Utami et al. (2022), who stated that the moisture content of catfish fillets stored at cold temperatures ranged from 75.07 – 77.06%.

Acidity (pH)

The degree of pH could also be used as an indicator of fish freshness. In general, fish, after being caught, will experience a decrease in pH caused by anaerobic respiration of sugar in the blood into lactic acid. The accumulation of lactic acid will cause a decrease in pH, and this anaerobic respiration will stop once the sugar residue in the blood runs too low (Komolka et al., 2020).

Table 1 Moisture content of catfish fillets at cold temperature storage

Turmeric and Ginger Ratio	Days of Storage			
	0 day	2 day	4 day	6 day
(0:0)	82.47 ± 0.70^{d}	76.87 ± 0.79^{c}	73.99 ± 0.29^{b}	71.48 ± 0.39^{a}
(2:1)	82.66 ± 2.19^{d}	76.52 ± 0.36^{c}	74.42 ± 0.07^{b}	70.81 ± 0.07^{a}
(1:1)	82.36 ± 0.32^{d}	78.36 ± 1.20^{c}	73.65 ± 0.33^{b}	70.94 ± 0.12^{a}
(1:2)	81.12 ± 1.27^{d}	77.20 ± 1.40^{c}	74.36 ± 0.27^{b}	70.51 ± 0.02^{a}

Note: Numbers followed by different letters in the same column showed different after Duncan's follow-up test of 5% level

Table 2 pH of catfish fillet at cold temperature storage

Turmeric and Ginger Ratio	Hari penyimpanan			
	0 day	2 day	4 day	6 day
(0:0)	5.50±0.00^{bc}	5.70±0.14^{cde}	5.75±0.21^{cde}	6.30±0.14^{h}
(2:1)	5.35±0.07^{ab}	5.80±0.00^{def}	5.90±0.00^{efg}	6.15±0.07^{gh}
(1:1)	5.20±0.00^{a}	5.65±0.07^{cde}	5.90±0.14^{efg}	6.15±0.07^{gh}
(1:2)	5.15±0.07^{a}	5.55±0.07^{bcd}	6.05±0.07^{fgh}	6.05±0.21^{fgh}
Purata	5.30±0.15^{v}	5.67±0.11^{w}	5.90±0.15^{x}	6.16±0.14^{y}

Note: Numbers followed by different letters in the same column showed different after Duncan's follow-up test of 5% level

Table 3 Water-soluble protein content of catfish fillets during cold temperature storage

Turmeric and Ginger Ratio	Days of Storage			
	0 day	2 day	4 day	6 day
(0:0)	5.02 ± 0.00^{b}	11.43 ± 0.12^{c}	13.95 ± 0.00^{d}	17.74 ± 0.13^{g}
(2:1)	4.84 ± 0.00^{b}	11.61 ± 0.12^{c}	14.22 ± 0.00^{d}	18.19 ± 0.26^{h}
(1:1)	4.39 ± 0.12^{a}	11.70 ± 0.25^{c}	14.95 ± 0.00^{e}	18.28 ± 0.13^{h}
(1:2)	4.75 ± 0.38^{b}	11.61 ± 0.12^{c}	15.85 ± 0.00^{f}	18.47 ± 0.12^{h}

Note: Numbers followed by different letters in the same column showed different after Duncan's follow-up test of 5% level

Table 4TVB-N Figureures of catfish fillets at cold temperature storage

Turmeric and Ginger Ratio	Days of Storage			
	0 day	2 day	4 day	6 day
(0:0)	5.60 ± 0.00^{a}	9.80 ± 0.00^{cde}	10.64 ± 0.39^{de}	16.66 ± 1.78^{g}
(2:1)	5.60 ± 0.00^{a}	7.56 ± 0.00^{abc}	9.80 ± 1.97^{cde}	14.42 ± 0.19^{f}
(1:1)	7.00 ± 1.97^{ab}	8.40 ± 0.39^{bcd}	9.38 ± 0.19^{bcd}	11.90 ± 0.59^{e}
(1:2)	7.00 ± 1.97^{ab}	7.42 ± 0.19^{abc}	8.96 ± 0.39^{bcd}	15.54 ± 0.19^{fg}

Note: Numbers followed by different letters in the same column showed different after Duncan's follow-up test of 5% level

This process will happen in a matter of hours. A decrease in pH will cause protein denaturation. Correspondingly, the growth of microbes that are naturally present in fish meat will also trigger the breakdown of proteins and the use of sugar residues as a source of nutrients. The pH of catfish fillets increases with the longer the storage time. This result was based on research conducted by Kim et al. (2023), which found that the pH of fish fillets increases with the longer storage time.

The final pH of catfish fillets reached 6.3 after 6 days of cold storage without the addition of turmeric or ginger rhizomes (Table 2). The addition of turmeric rhizomes was able to affect the pH of catfish fillets. Catfish fillets treated with turmeric and ginger reached 6.05 for turmeric and ginger ratio 1:2. Slightly lower than without treatment but statistically showed no significant difference for turmeric and ginger addition treatment or ratio.

The pH value of the fish fillet before storage with the addition of turmeric and ginger decreased. The untreated fillets had a pH of 5.5, while the treated fillets with turmeric and ginger added decreased pH to 5.2 (Table 2). It shows that the more turmeric and ginger concentrations are added, the lower the pH. Tissue damage that occurs when preparing fillets will activate destructive enzymes, especially protease enzymes. Protein degradation will produce nitrogen-based compounds, which will create alkaline conditions so that fillets that add ginger and turmeric will have a lower pH than the control. The difference in pH is not too big, even though it is statistically significant. The same results were also reported in research conducted by Mugahi et al. (2022). Decreases in pH value were detected on the carp fillets added with turmeric, cinnamon, and lemon before cold storage (days 0) but not at the carp fillet treated with the mixture of turmeric and cinnamon and the control one.

On day-2 of storage, the pH of catfish fillets was lowest at the ratio of ginger turmeric (1:2) with a pH value of 5.5 and the same value as the pH of catfish fillets before storage (fresh). A rise in pH is used as an indicator of fish that are no longer fresh. The increase in pH is caused by the emergence of alkaline compounds, such as ammonia, trimethylamine, and other volatile compounds (Kim et al. 2023; Volpe et al. 2019).Volatile components, such as H_2, methane (CH_4), ammonia, hydrogen sulfide (H_2S), and phosphene (PH_3) (Volpe et al. 2019). The pH of fish entering the post-rigor phase will approach neutral to 7.5-8.0 or higher if the spoilage has been very severe. The pH of fish fillets is still below the neutral number, so it can be said that catfish fillets still meet the criteria for consumption.

Water-soluble Protein Levels

The breakdown of proteins into simpler compounds will cause an increase in the pH of muscle cells and an increase in water-soluble proteins. Water-soluble protein is a component of oligopeptide group proteins composed of ten

amino acid chains and is easily soluble in water (Rani et al. 2020). Based on the data shown in Table 3, the water-soluble protein content of catfish fillets increased during the storage process. It was not significantly different for the ratio of adding turmeric and ginger rhizomes at a significance level of 5%. The water-soluble protein content in catfish fillets before storage ranged from 4.39 to 5.02 g/100 g, while after 6 days of storage at cold temperatures, it increased to 17.74 to 18.47 g/100 g (Table 3). The water-soluble protein content of fish fillets has a value approximately the same as the average water-soluble protein content of freshwater fish delivered by Gultom et al. (2015), which ranges from 5.17 to 6.70 mg / g of fish in South Sulawesi which ranges from 4.66 to 6.96% as conveyed by Fatma et al. (2020).

Water-soluble proteins in fish meat consist of myofibrillar proteins, which are proteins used in muscle contraction, such as myosin, actin, tropomyosin, troponin, and other proteins in minimal amounts (Abdollahi and Undeland 2018). Degradation of muscle tissue can be caused by microbial growth or lower pH. Since the protein is damaged, the ability of the protein to attain water will decrease. Many factors influence the breakdown of myofibrillar proteins and occur either due to enzymatic reactions or due to the growth of microbes that are naturally present in fish meat (Li et al. 2023). Factors affecting the myofibrillar protein in this research include microbial growth, pH, and bioactive compounds in curcuma or ginger.

TVB-N

Total Volatile Base Nitrogen is one of the chemical test parameters used to determine the deterioration of fish quality. TVBN is an evaporating base compound to determine biochemical quality changes in fish body tissues due to a messy enzymatic system after fish death (Kim et al. 2023). The test results have been processed using SPSS in Table 4, showing a significant difference with P value <0.05.

The resulting TVBN value increases during the long storage process. The highest TVBN value was found in control after 6 days of cold storage, which is 16.66 mg N/100 g. The standard TVBN value for fresh fish for consumption according to SNI 2354: 8: 2009 is 20-30 mg N / 100 g. After 6 days of storage, the TVBN value reached 16,66 mg/100 g and met the standard for consumption. (Kim et al. 2023) reported that this is due to degradation by enzymes in the fish, which produce simple compounds that are volatile. The increase in TVBN value levels during storage occurs due to the overhaul of proteins or amino acids resulting in volatile bases, including dimethylamine (DMA), ammonia (NH_3), monomethyl amine (MMA), hydrogen sulfide (H_2S), and trimethylamine (TMA) due to the trimethylamine oxide (TMAO) (Volpe et al. 2019). TVB-N value for fish fillets added with ginger and turmeric showed varied results. Catfish fillets with the addition of ginger and turmeric gave higher data than the control. (Ibáñez and Blázquez, 2021) reported that turmeric, which is dominated by volatile compounds, does not contain nitrogen-based compounds, as does the water extract from ginger (Zhang et al. 2022). Another explanation that can be assumed for this fact is the death technique chosen. Catfish are fish that make a lot of movement during the catching process. Even though the death technique chosen is by stabbing, it is still possible for catfish to move actively, resulting in varying TVB-N values. However, further studies need to be carried out on the TVB-N catfish fillet so that a better explanation can be obtained.

TPC (Total Plate Count) of Catfish Fillet during cold storage

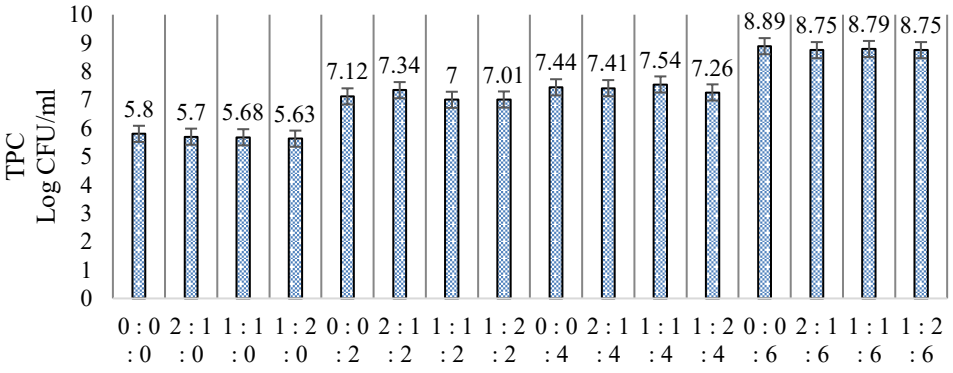
Total Plate Counts were carried out to determine the amount of microbial distribution in a food product. Based on the TPC value (Figure. 1), the ratio of turmeric and ginger extracts did not have a noticeable effect on the number of aerobic microbes. However, the length of storage had a significant effect (α >5%). The longer the storage time, the higher the number of aerobic microbes. Bioactive compounds in turmeric can inhibit bacterial growth, one of which is by changing the shape of cells, damaging cytoplasmic membranes, and triggering cell damage (Gupta et al. 2015).

Fresh catfish fillets (before storage) contain total aerobic bacteria ranging from 5.63 to 5.80 log10 CFU/g, while on day 6 it increased to 8.75 to 8.89 log10 CFU/g. Change in the microbial count caused by the dominancy of psychrotrophic bacteria during cold storage. Meanwhile, there was a slower growth rate during cold storage. The maximum standard for aerobic bacteria in fresh fish fillets, according to the International Commission on Microbiological Specification for Foods (ICMSF), is 5.60 -7.00 log10 CFU/g, while the SNI 01-2729-2006 mark is 5 x 10^5 or 5 log10

CFU/g for fresh fish. Based on the standards issued by ICMSF, the catfish fillets in this study have not met the standards. Meanwhile, Admasu et al. (2023) said that the total aerobic bacteria in the fillets of some fresh fish in Ethiopia ranged from 6.68 – 9.00 log10 CFU/g. According to Zhu et al. (2022), microbial contamination that is naturally present in fresh fish were *Pseudomonas* spp., *Salmonella* spp., *Photobacterium* spp., *Karnococcus, Shewanella* spp, *Brochothrix thermophacta, Acinetobacter, Photosynthetic bacteria cibatius, Psb maritimus*, and *Psb. proteolyticus*. The size of the initial contaminants in fish fillets is influenced by environmental factors, such as handling equipment during the fishing process, workers, hygiene and sanitation of the processing process, and others (Admasu et al. 2023).

In addition to environmental factors, another factor that also affects the total contamination in fish fillets is the presence of antimicrobial compounds. The natural antimicrobial compounds used in this study are *Curcuma longa,* commonly called turmeric, and ginger (*Zingiber officinale*). Ulina et al. (2016) reported that seagrass extract (*Thalassia hemprochii*) was able to prevent a total increase in microbes for up to 8 days of storage at cold temperatures. However, catfish fillets underwent texture changes that decreased consumer acceptance. Another case with the use of antimicrobial compounds Moringa leaf extract (*Moringa oleifera*) in edible coating fish fillets in research conducted by Mezhoudi et al. (2022).

Research conducted by Hermalena et al. (2022) showed that the use of ginger in the edible coating of tilapia fillets effectively inhibits total aerobic microbes in fish fillets until the first day of cold-temperature Storage. The third day of storage gave a total of aerobic bacteria reaching 2.8 x 10^5-3.2 x 10^6 CFU/g.



turmeric: ginger: days of storage

Figure 1 Total aerobic count of catfish fillet

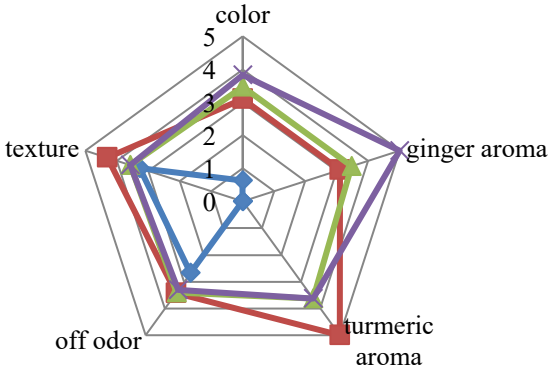


Figure 2 Radar graph of catfish fillet appearance after 2 days of cold storage

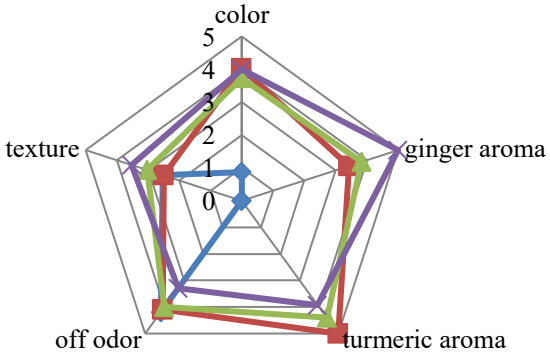


Figure 3 Radar graph of catfish fillet appearance after 4 days of cold storage

Fillet Organoleptic Test

Organoleptic tests use a scoring test method to assess whether the product is still acceptable or not. The results of the organoleptic test can be seen in Figure 2 (2 days of storage) and Figure 3 (4th day of cold storage). The higher the value, the higher the score given by the panelist for the tested parameter. For example, if the panelist gave a score of 5 to the ginger aroma, it means that the ginger aroma of the fillets was the strongest. Based on the results of the test, the score for color was increased along with storage time. The addition of ginger and turmeric to the catfish fillets also affects the aroma of catfish fillets. With the difference in addition, the aroma produced will be more assertive in each sample and remain stable after 6 days.

Off odor (Figure 3) was detected after 2 days of cold storage. The addition of ginger or turmeric has little effect on the off odor. This result has met the TVBN value, which arises after 2 days of cold storage. The addition of turmeric and ginger has little effect in removing the off odor in catfish fillets. The texture of the fish fillet was still good until 4 days of cold storage. Fish tends to be tender and fresh, while along with the length of storage, the texture becomes mushy and easily destroyed so that it gets a value of 1-2.

CONCLUSION

The administration of turmeric and ginger had a significant effect on the total dissolved protein and TVB-N, while TPC value, moisture content, and pH value remained constant. Cold Storage had a significant effect on all parameters. There was an interaction between the two treatments, especially the pH value, TVB-N, and total dissolved protein. Further research needs to be done to study the effect of turmeric and ginger during cold storage on the whole appearance of fried fish fillets or to study the effect of packaging materials on the quality of the fresh fish fillets.

REFERENCES

Abdollahi, M., and I. Undeland, 2018. Structural, functional, and sensory properties of protein isolate produced from salmon, cod, and herring by-products. *Food and Bioprocess Technology* 11(9): 1733–1749. https://doi.org/10.1007/s11947-018-2138-x.

Admasu, F., A. Mikru, K. Balkew, and M. Adane, 2023. Microbial profile of fresh and semicooked Nile tilapia (*Oreochromis niloticus*) and hygienic practice of fish handlers in Hawassa, *Ethiopia. International Journal of Microbiology* 2023: 1–11. https://doi.org/10.1155/2023/5866719.

Al-Afifah, L., M. Widiastuti, and R.Salsabila, 2022. Analisis penambahan ekstrak bawang putih terhadap masa simpan filet ikan nila merah pada suhu rendah. *Jurnal Ilmiah Perikanan dan Kelautan.* Retrieved from: researchgate.net

Fatma, N., Metusalach, N. A. Taslim, and M. Nurilmala, 2020. The protein and albumin contents in some species of marine and brackishwater fish of South Sulawesi, Indonesia. *AACL Bioflux*, 13(4): 1976–1985. Retrieved from: http://www.bioflux.com.ro/docs/2020.1976-1985.pdf

Fitri, N., S. X. Y. Chan, N. H. Che-Lah, F. A. Jam, N. M. Misnan, N. Kamal, M. N. Sarian, M. A. Mohd Lazaldin, C. F. Low, H. S. Hamezah, E. R. Rohani, A. Mediani, and F.

Abas, 2022. A comprehensive review of the processing of dried fish and the associated chemical and nutritional changes. *Foods*, 11(19). https://doi.org/10.3390/foods11192938

Ghasemzadeh, A., H. Z. E. Jaafar, A. Baghdadi, and A. Tayebi-Meigooni, 2018. Formation of 6-, 8- and 10-shogaol in ginger through the application of different drying methods: Altered antioxidant and antimicrobial activity. *Molecules*, 23(7). https://doi.org/10.3390/molecules230716466.

Ghasemzadeh, A., H. Z. E. Jaafar, and A. Rahmat, 2016. Variation of the phytochemical constituents and antioxidant activities of *Zingiber officinale* var. rubrum Theilade associated with different drying methods and polyphenol oxidase activity. *Molecules*, 21(6), 1–12. https://doi.org/10.3390/molecules21060780

Gultom, O. W., S. Lestari, and R. Nopianti, 2015. Analisis proksimat, protein larut air, dan protein larut garam pada beberapa jenis ikan air tawar Sumatera Selatan. *Jurnal Teknologi Hasil Perikanan*, 4(2): 120–127. http://ejournal.unsri.ac.id/index.php/fishtech.

Gupta, A., S. Mahajan, and R. Sharma, 2015. Evaluation of antimicrobial activity of *Curcuma longa* rhizome extract against *Staphylococcus aureus*. *Biotechnology Reports*, 6, 51–55. https://doi.org/10.1016/j.btre.2015.02.001.

Hermalena, L., R. A. Salihat, and J. Daulay, 2022. Uji mikrobiologis fillet ikan nila dilapisi edible film pati jahe gajah. *Jurnal Katalisator*, 7(1): 140–147. https://doi.org/http://doi.org/10.22216/jk.v5i2.5717.

Ibáñez, M.D., and M.A. Blázquez, 2021. *Curcuma longa* l. rhizome essential oil from extraction to its agri-food applications. a review. *Plants*, 10(1): 1–31. https://doi.org/10.3390/plants10010044

Kim, D.Y., S.W Park, H.S. Shin, 2023. Fish freshness indicator for sensing fish quality during storage. *Foods*, 12(9). https://doi.org/10.3390/foods12091801

Komolka, K., R. Bochert, G. P. Franz, Y.Kaya, R. Pfuhl, and B. Grunow, 2020. Determination and comparison of physical meat quality parameters of Percidae and Salmonidae in aquaculture. *Foods*, 9(4). https://doi.org/10.3390/foods9040388

Lastriyanto, A., B. D. Argo, and R. A. Pratiwi, 2019. Karakteristik fisik dan protein fillet daging ikan lele beku (*Clarias batrachus*) hasil penggorengan vakum. *Jurnal Keteknikan Pertanian Tropis dan Biosistem*, 7(1): 87–96. Retrieved from: https://jkptb.ub.ac.id/index.php/jkptb/article/view/461.

Li, N., J. Xie, and Y. M. Chu, 2023. Degradation and evaluation of myofibril proteins induced by endogenous protease in aquatic products during storage: a review. *Food Sci Biotechnol*, 32: 1005–1018. https://doi.org/https://doi.org/10.1007/s10068-023-01291-4.

Lubis, N., S. Mus, and N. Sari, 2015. Quality analysis of catfish fillet (*Pangasius hypophthalmus*) salted with different salt levels during the storage room temperature. *JOMFAPERIKA*, 2(2): 1–8. https://jom.unri.ac.id/index.php/JOMFAPERIKA/article/view/6808.

Mezhoudi, M., A. Salem, O. Abdelhedi, N. Fakhfakh, M. Mabrouk, T. Khorchani, F. Debeaufort, M. Jridi, and N. Zouari, 2022. Development of active edible coatings based on fish gelatin enriched with Moringa oleifera extract: Application in fish (*Mustelus mustelus*) fillet preservation. *Food Science and Nutrition*, 10(11): 3979–3992. https://doi.org/10.1002/fsn3.2993

Rani, P., B.E. Setiani, and Y. B.Pramono, 2020. Pengaruh metode *thawing* terhadap kadar protein, kadar lemak, dan protein terlarut daging ayam petelur afkir beku. *J. Teknologi Pangan*, 5(2): 64–70. Retrieved from: https://ejournal3.undip.ac.id/index.php/tekpangan/article/view/26599/0

Ranjbar, M., M.H. Azizi Tabrizzad,G. Asadi, and H. Ahari, 2023. Investigating the microbial properties of sodium alginate/chitosan edible film containing red beetroot anthocyanin extract for smart packaging in chicken fillet as a pH indicator. *Heliyon*, 9(8), e18879. https://doi.org/10.1016/j.heliyon.2023.e18879

Sanjee, S. Al, and M.E. Karim, 2016. Microbiological quality assessment of frozen fish and fish processing materials from Bangladesh. *International Journal of*

Food Science, 2016. https://doi.org/10.1155/2016/8605689

Sidiki, V. T., A.S. Naiu, and F.A. Dali, 2015. Mutu organoleptik dan mikrobiologis ikan tongkol yang diawetkan dengan bawang putih selama penyimpanan suhu ruang. *Jurnal Ilmiah Perikanan dan Kelautan*, 3(3): 1–6. Retrieved from: https://ejurnal.ung.ac.id/index.php/nike/article/viewFile/1316/1062

Ulina, G. V., and R. Sumardianto, 2016. Potensi antibakteri ekstrak lamun *Thalassia hemprichii* pada fillet ikan lele (*Clarias batracus*) selama penyimpanan dingin. *J.Peng.andBiotek.Hasil Pi*, 5(1), 64–70. http://www.ejournal-s1.undip.ac.id/index.php.jpbhp

Ullah, M. R., M.A. Rahman, M.N. Haque, M.R. Sharker, M.M. Islam, and M.A. Alam, 2022. Nutritional profiling of some selected commercially important freshwater and marine water fishes of Bangladesh. *Heliyon*, 8(10), e10825. https://doi.org/10.1016/j.heliyon.2022.e10825

Utami, T. A., A. Munandar, and D. Surilayani, 2022. Analisis mutu fillet ikan lele (*Clarias* sp.) pada penyimpanan suhu chilling dan digoreng. *Media Teknologi Hasil Perikanan*, 10(1): 43. https://doi.org/10.35800/mthp.10.1.2022.39783

Volpe, M.G., E. Coccia, F. Siano, M. Di Stasio, and M. Paolucci, 2019. Rapid evaluation methods for quality of trout (*Oncorhynchus mykiss*) fresh fillet preserved in an active edible coating. *Foods*, 8(4). https://doi.org/10.3390/foods8040113

Zhang, S., X. Kou, H. Zhao, K.K. Mak, M. K. Balijepalli, and M.R. Pichika, 2022. Zingiber officinale var. rubrum: Red Ginger's Medicinal Uses. *Molecules*, *27*(3). https://doi.org/10.3390/molecules27030775

Zhu, Y., W. Wang, M. Li, J. Zhang, L. Ji, Z. Zhao, R. Zhang, D. Cai, and L.Chen, 2022. Microbial diversity of meat products under spoilage and its controlling approaches. *Frontiers in Nutrition*, 9(4). https://doi.org/10.3389/fnut.2022.1078201