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Effect of UV Light Treatment on The Quality of Soft-Boned Milkfish (*Chanos Chanos*) During Room Temperature Storage

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A B S T R A C T

Milkfish (Chanos chanos) is known to have fish flesh that tastes delicious but has lots of small spines that are quite annoying when milkfish are consumed. Cooking milkfish with high temperature and high pressure can soften the small spines in milkfish so that it is more convenient to consume. Soft-boned milkfish is a product that easily deteriorate due to its high moisture content. UV irradiation is widely used to extend the shelf life of foods. In this study, 60 minutes UV light exposure time were used as treatment to extend the shelf life of soft-boned milkfish. This research was conducted with two experimental treatments, namely without UV light exposure and with 60 minutes UV light exposure. The length of storage time in room temperature observed was 0, 2 and 3 days. Each experimental treatment was tested with three replicates. The purpose of this study was to determine the effect of UV light on the quality of soft-bone milkfish during storage in room temperature as seen from the TPC (Total Plate Count), moisture content, and sensory analysis. The results showed that soft-boned milkfish was measured to have water content around 67%. Soft-boned milkfish that were treated with 60 minutes UV light exposure showed lower TPC value during 2nd and 3rd days of storage in room temperature compared to soft-boned milkfish that were not treated with UV light.

Keywords: Soft-boned milkfish, UV light treatment, fish quality

1. Introduction

Milkfish (*Chanos-chanos*) is known to have fish flesh that tastes delicious but has lots of small spines. The small spines on milkfish are undesirable when milkfish are consumed. Several processed milkfish products that can be found in the market in Indonesia are known to use several methods to solve the problem of small spines on milkfish. Boneless milkfish products are fresh milkfish products that have had their small spines removed so that it can be cooked into the final product without undesirable small spines. There are also soft-boned milkfish products, which are cooked milkfish products with softened bones so that it can be consumed without undesirable small spines.

Soft-boned milkfish is a processed milkfish that is cooked using high pressure and temperature over a long period of time. High temperature and high pressure make fish spines soft. Soft-boned milkfish is a product that easily deteriorate due to its high moisture content. High moisture content in soft-boned milkfish causes bacterial growth to accelerate and develop well during storage time. Deterioration of soft-boned milkfish is usually characterized by the appearance of mucus, dull color, foul odor, sour taste and mushy texture.

UV light has been proposed as an alternative treatment for the reduction of micro-organisms in foods. Preservation technology with UV irradiation is widely used to extend the shelf life of foods such as raw chicken (Houghton et al. 2012), milk (Cilliers et al. 2014), apple juice (Usaha et al. 2015) and mulberry juice (Chintya and Nisa, 2015). Inactivation of Listeria monocytogenes bacteria with UV light on solid media and seafood has also been done (Cheigh et al. 2013). Lim and Harison (2016) also stated that UV light can reduce the number of bacteria on tomatoes and food surfaces. The safe limit of UV light irradiation on food is regulated by CFR (Code of Federal Regulation) 179.39 (2016) that the radiation source conditions used are low-pressure mercury lamps with 90 percent emission at a wavelength of 253.7 nm.

One of the properties of UV light is that it has a low penetrating power, so it is more effective for controlling bacteria that are close to the surface of the medium that is directly exposed (Pelczar and Chan, 2012). The use of UV irradiation on food does not affect nutritional value. Cillers et al. (2014), UV treatment presents several benefits over traditional thermal technologies, including a relatively low initial investment cost, low production and maintenance costs. UV light treatment is suspected to reduce bacteria in soft-boned milkfish, it can maintain quality. The purpose of this study was to determine the effects of UV light treatment on the quality of soft-bone milkfish during storage time as seen from the TPC (Total Plate Count), moisture content, and sensory analysis.

2. Materials and Methods

2.1 Materials

Fresh milkfish with average weight 250 gram were used as raw material. Fresh milkfish were obtained from brackish water fish farm at District of Tugu, Semarang City, Central Java Province, Indonesia. The ingredients used in processing soft-boned milkfish were turmeric, garlic, shallots, coriander, bay leaves, kaffir lime leaves, galangal, lemongrass, ginger and salt. These ingredients were obtained from traditional market at District of Banyumanik, Semarang City, Central Java Province, Indonesia. Material composition of soft-boned milkfish listed in table 1.

Table 1. Materials composition of Soft-Boned Milkfish

Name of material	Amount	Percentage
Milkfish	1000 g	72.46 %
Turmeric	40 g	2.90 %
Garlic	100 g	7.25 %
Shallots	100 g	7.25 %
Coriander	20 g	1.45 %
Bay leaves	4 leaves	-
Kaffir lime leaves	2 leaves	-
Galangal	100 g	7.25 %
Lemongrass	1 pc	-
Ginger	10 g	0.72 %
Salt	10 g	0.72 %

2.2 Methods

The steps in making soft-boned milkfish were preparing the raw materials by first washing the whole milkfish, removing the scales and removing the viscera from milkfish. Then a second washing was carried out, namely cleaning the remaining blood that were still attached to the milkfish flesh. All ingredients except lemongrass and bay leaves were ground and mixed as spices for milkfish. Next, the milkfish were coated with spices on the inside and outside of the milkfish. After milkfish coated with spices, milkfish were placed in the autoclave. Before milkfish were placed, lemongrass and bay leaves were prepared in autoclave as a base. The temperature used for cooking was 121°C with a pressure of 15 psi (1 atm) and cooking time of 90 minutes. After the cooking process in the autoclave was completed and the autoclave pressure drops to normal, soft-boned milkfish were taken from the autoclave and cooled at room temperature. After reaching room temperature, the soft-boned milkfish were ready to be exposed to UV light and stored for up to 3 days to assess changes in sensory quality and TPC.

The UV light source comes from 2 fluorescent lamps with a diameter of 5/8 inch type of Black Light Blue (BLB) 8 Watt. The dimensions of the irradiation container were 60x60x60 cm^3 made of glass. Black Light Blue lamps that have UV A content are placed at the top and bottom of the display case, so that the sample in the middle of the two lamps was maximally exposed to light. The distance from the lamp to the sample was 30 cm. The UV lamp has been turned on for at least 30 minutes before the experiment so that the intensity of UV radiation is stable. The irradiation container needs to be covered with a black cloth to keep the UV light inside the container. To determine the UV light exposure time, a preliminary experiment was conducted in different exposure times (0, 30 and 60 minutes). The results of the experiment are listed in table 2 below.

In this study, soft-boned milkfish stored at room temperature until 3 days. Before storage at room temperature, soft-boned milkfish were analysed for moisture content, TPC and sensory value. During storage at room temperature, on the 2^{nd} days and 3^{rd} days of storage, soft-boned milkfish were analysed for TPC and sensory value. All laboratory analyzes were carried out referring to Indonesian national standards (Standard Nasional Indonesia/SNI) for moisture content analysis, TPC analysis and sensory assessment.

3. Results and Discussions

3.1 Effect of different UV exposure time on TPC

The length of exposure time in UV treatment influenced the TPC of soft boned milkfish products. Table 2 showed that in the sample of soft boned milkfish without UV treatment, the TPC was $5.3x10^5$ CFU/g, a high level of microbial contamination, which can potentially affect the quality and safety of soft-boned milkfish. After 30 minutes of UV exposure, it showed a total increase in the TPC of soft boned milkfish to $6.5x10^5$ CFU/g. This increase showed that a short exposure time was not enough to have the desired effect in reducing the growth of microorganisms. However, after 60 minutes of UV exposure, the total TPC of soft-boned milkfish showed a lower TPC to $2.1x10^5$ CFU/g. This significant decrease suggests that longer UV exposure could effectively reduce the number of microorganisms. This shows that UV light has the potential to penetrate the walls of microbial cells and damage genetic material, thus stopping the growth and reproduction of microorganisms.

Overall, the results of this study confirm that the use of UV light exposure could control total TPC in soft-boned milkfish while still considering the adequacy of UV exposure time. Although there was a total increase in TPC at 30 minutes of UV exposure, a significant decrease occurred at 60 minutes of UV exposure. UV light works by damaging the DNA of microorganisms, thus preventing their proliferation. This method is safe and effective, especially fishery products that are susceptible to cross-contamination. Besides, UV light leaves no chemical residue, making it an attractive option for producers who want to maintain food safety without using preservatives.

Table 2. TPC of Soft-Boned Milkfish Preliminary Research with different UV light exposure time

Exposure Time (minutes)	TPC (cfu/g)	log TPC
0	$5.3x10^5$	5.7 ± 0.3
30	$6.5x10^5$	5.8 ± 0.2
60	$2.1x10^5$	4.8 ± 0.9

3.2 Moisture content

The results in table 3 showed that moisture content of soft-boned milkfish was high (67.32% - 67.72%). Moisture content of soft-boned milkfish in this study is higher than the moisture content of soft-boned milkfish processed at 121°C with pressure 1 atm in 120 minutes reported by Nopiyanti et al. (2023) resulting in a product with moisture content 57.73%. The faster cooking time (90 minutes) in this study resulted in products with higher moisture content. During storage at room temperature, as showed in table 3, at 2nd days of storage, moisture content tended to decrease. Soft-boned milkfish with UV light exposure treatment showed a higher decrease of moisture content compared to soft-boned milkfish without UV light treatment. Even though the moisture content of soft-boned milkfish tends to decrease, the moisture content of soft-boned milkfish was still relatively high, so that soft-boned milkfish were easily deteriorated during storage in room temperature.

Table 3. Moisture Content of Soft-Boned Milkfish during storage

Storage Time (Days)	Moisture content (%)	
	without UV Exposure	60 minutes UV Exposure Time
0	67.32 ± 0.31	67.72 ± 2.86
2	58.89 ± 1.99	53.33 ± 3.25
3	55.23 ± 2.97	64.42 ± 1.65

3.3 TPC

The TPC value in soft-boned milkfish is presented in table 4. Based on table 4, it shows that the log TPC value of soft-boned milkfish increases with the length of storage time. Soft-boned milkfish without UV exposure showed a significantly higher increase of TPC value compared to soft-boned milkfish that was exposed to UV light for 60 minutes. Before storage, log TPC value for soft-boned milkfish without UV exposure treatment was recorded at 4.7 ± 0.1 log CFU/g, while for those soft-boned milkfish were treated with UV exposure, the results were lower at 4.3 ± 0.3 log CFU/g. This decrease indicates that UV treatment could affect the number of microorganisms at the beginning of storage.

On the third day of storage, the log TPC of soft-boned milkfish without UV exposure reached 7.4 ± 0.3 CFU/g logs which showed a drastic increase and showed that microorganisms continued to multiply without control. Meanwhile, soft boned milkfish treated with UV exposure showed a log TPC of 6.8 ± 0.2 CFU/g which was lower than untreated one. This lower TPC value not only reflected the effectiveness of UV treatment in killing organisms, but also showed that soft-boned milkfish that has been treated with UV exposure has a longer shelf life compared soft-boned milkfish that were not treated with UV exposure.

From the data, it can be concluded that UV light exposure for 60 minutes gave a positive effect on controlling the number of micro-organisms in soft-boned milkfish. Although TPC continued to increase over storage time, microbial growth rates in products treated with UV light exposure remained lower compared to samples that were not treated with UV light. This results showed that UV treatment can be an effective alternative to improve the safety and quality of soft boned milkfish during storage. This is in line with the research of Fan et al. (2021), that UVC-LED radiation of up to 4000 mJ/cm2 can significantly reduce the population of *S. Typhi murium, L. monocytogenes, and E. coli* incubated on raw tuna fillet. In addition, the use of UVC-LED radiation has no significant effect on the quality of raw tuna fillets so the use of UVC-LED can be a solution to improve microbiological safety and extend the shelf life of seafood.

Table 4. Log TPC (log cfu/g) of Soft-Boned Milkfish

Storage Time (Days)	Log TPC (log cfu/g)	
	without UV Exposure	60 minutes UV Exposure Time
0	4.7 ± 0.1	4.3 ± 0.3
2	6.3 ± 0.6	5.8 ± 0.2
3	7.4 ± 0.3	6.8 ± 0.2

3.4 Sensory value

The results of sensory analysis of untreated soft-boned milkfish were showed in table 5 and for treated one in table 6. The sensory values before storage (day 0) and after 2nd days storage in room temperature showed that all sensory attributes were still accepted by panellists (the scores still above 7). Sensory value of soft-boned milkfish on all sensory attributes decreased along with the length of storage time. According to Bassam *et al*. (2022), the protein contained can cause the emergence of volatile compounds due to protein degradation which causes the aroma of meat to decrease.

After 3rd days of storage for each sensory attribute had a value below seven indicating that all samples of soft-bone milkfish at all long-time storage treatments were shown to be unfit for consumption. This was due to a chemical reaction that occurs between the sample, the surrounding environmental conditions and it was in line with the TPC results. The changes of appearance that occurs were that the color changes to dull and the shape was not intact. According to Chikpah et al. (2022), color characteristics are an important quality because they are related to the freshness, nutritional value and safety of food products. Because the appearance, odor and texture of the milkfish was poor, the panelists gave a low score for soft-boned milkfish after 3rd days storage in room temperature.

Table 5. Sensory Value of Soft-Boned Milkfish without UV exposure

Storage Time (Days)	Appearance	Odor	Flavor	Texture	Slime
0	8,8±0,4	8,7±0,5	8,7±0,5	8,8±0,4	9,0±0,0
2	7,2±0,8	7,3±0,5	7,2±0,8	7,5±0,5	7,5±0,8
3	4,0±1,7	2,5±2,4	3,5±2,2	3,8±2,2	3,2±1,7

Table 6. Sensory Value of Soft-Boned Milkfish with 60 minutes UV exposure time

Storage Time (Days)	Appearance	Odor	Flavor	Texture	Slime
0	8,3±0,5	8,3±0,5	8,2±0,8	8,2±0,4	9,0±0,0
2	7,2±0,9	7,2±0,7	7,0±0,9	7,3±0,8	7,7±0,8
3	4,3±1,6	3,0±0,0	4,0±1,1	5,7±1,2	5,7±1,5

4. Conclusion

Soft-boned milkfish had high moisture content around 67%. High moisture content in soft-boned milkfish meant that the shelf life of this product was only 2 days. 30 minutes exposure time on UV was not enough to have the desired effect in reducing the growth of microorganisms in soft-boned milkfish. UV exposure for 60 minutes could reduce the TPC value of soft-boned milkfish. After 2nd and 3rd days storage at room temperature, soft-boned milkfish that were treated with 60 minutes UV light exposure before being stored showed lower TPC value than soft-boned milkfish that were not treated with UV light before storage.

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