

The Effect of Different Steaming Duration on Water Content of Golden Goatfish (*Upeneus sulphureus*) Nugget

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Abstract

This study aimed to determine the effect of different steaming durations (20, 30, 40, and 50 minutes) on the water content of golden goatfish (*Upeneus sulphureus*) nugget. The research employed a completely randomized design (CRD) with four treatments and six replications. Water content was analyzed using one-way ANOVA followed by the Least Significant Difference (LSD) test. The results showed that steaming duration significantly affected the water content ($F = 23.64$; $p < 0.01$). The lowest water content (57%) was achieved at 50 minutes of steaming, while the highest (65%) was at 20 minutes. Longer steaming times reduced water content and extended shelf life up to 3 days. These findings indicate that steaming duration is a critical factor in producing nuggets with lower water content and better durability, supporting quality control in fish-based processed products.

Keywords: steaming duration, fish nugget, water content, Upeneus sulphureus, food preservation

1. Introduction

Fish nuggets are processed fish products made from minced fish meat mixed with spices, molded, steamed, and coated with breadcrumbs (Wibowo & Sulistiyati, 2020). The steaming process is essential as it affects the physicochemical properties, particularly water content (Huda et al., 2019). Water content is a critical parameter influencing the appearance, texture, taste, and shelf life of food products (Nurhayati et al., 2021; Rahmawati et al., 2020).

Golden goatfish (*Upeneus sulphureus*) is a demersal fish species widely available in Indonesian coastal waters, yet it remains underutilized (Puspitasari et al., 2022). Processing it into nuggets can increase its economic value and provide a high-protein food source (Sari & Maharani, 2023). However, the high initial water content of fresh fish (approximately 80%) makes nuggets prone to spoilage (Kurniawan et al., 2019).

Steaming reduces water content through evaporation, which can inhibit microbial growth and enzymatic reactions (Fitriani et al., 2022). Recent studies have shown that longer steaming times significantly reduce water content and extend shelf life (Hasanah et al., 2021; Lestari & Fitriani, 2024; Pratama & Nugroho, 2023). Nevertheless, optimal steaming duration for golden goatfish nuggets has not been extensively studied. Therefore, this study aimed to evaluate the effect of different steaming durations (20, 30, 40, and 50 minutes) on the water content of golden goatfish nuggets and to determine the

most effective treatment for producing nuggets with low water content and improved durability.

2. Research Methods

2.1. Research Design

This study used a completely randomized design (CRD) with one factor: steaming duration (20, 30, 40, and 50 minutes), each with six replications (Gomez & Gomez, 2019; Widodo & Utami, 2022). This design was chosen to minimize bias from uncontrolled variables (Sulistyo & Handayani, 2020).

2.2. Place and Time

The research was conducted at the Food Processing Laboratory, SMK Pelayaran Muhammadiyah Tuban, from May 14–16, 2023.

2.3. Materials and Equipment

Materials: Golden goatfish (*Upeneus sulphureus*), tapioca flour, shallots, salt, breadcrumbs.

Equipment: Meat grinder, mixing bowl, baking pan, electric balance, mortar, porcelain crucible, analytical balance (Ohaus), oven (Memmert), desiccator.

2.4. Nugget Preparation and Steaming Treatment

Fresh fish were filleted, ground, mixed with tapioca flour (10% w/w), salt (2% w/w), and ground shallots (5% w/w). The mixture was molded into nugget shapes and steamed at 100°C for 20, 30, 40, and 50 minutes according to treatment groups. After steaming, nuggets were cooled and coated with breadcrumbs.

2.5. Water Content Analysis

Water content was determined using the oven-drying method (AOAC, 2019; Sudarmadji et al., 2021). Procedure:

1. Porcelain crucible was dried and weighed (A).
2. Approximately 2 g of sample was placed in the crucible and weighed (B).
3. Sample was dried at 105°C for 5 hours until constant weight.
4. Crucible + dried sample was weighed (C).
5. Water content (%) = $[(B - C) / (B - A)] \times 100\%$

2.6. Data Analysis

Data were analyzed using one-way ANOVA at $\alpha = 0.05$ and 0.01. If significant differences were found, the Least Significant Difference (LSD) test was performed

(Hanafiah, 2020; Pratama & Nugroho, 2023). Statistical analysis was conducted using SPSS version 26.

3. Results and Discussion

3.1. Water Content of Fresh Fish

The average water content of fresh golden goatfish was 80.83%, as shown in Table 1 and Fig. 1. This value is consistent with the range reported for demersal fish (Prabha & Manjulatha, 2019; Fitriani et al., 2022).

Table 1. Water content of fresh golden goatfish (*Upeneus sulphureus*)

Fish replication	1	2	3	4	5	6	Mean (%)
Water content (%)	80	85	80	80	80	80	80.83

Source: Research result, 2023

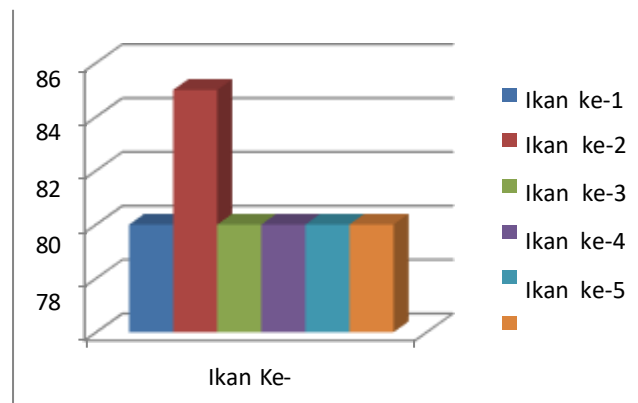


Fig. 1. Water content of fresh golden goatfish (six replications)

3.2. Water Content of Nugget Before Steaming

Before steaming, the average water content of nuggets was 70.83% (Table 2, Fig. 2). This initial value is similar to findings by Suryanti et al. (2020) for fish-based nuggets and serves as a baseline for evaluating the effect of steaming (Kurniawan et al., 2019).

Table 2. Water content of nugget before steaming

Fish replication	1	2	3	4	5	6	Mean (%)
Water content (%)	70	70	70	75	70	70	70.83

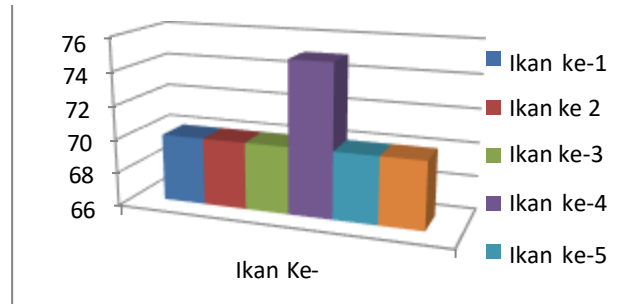


Fig. 2. Water content of fresh golden goatfish (six replications)

3.3. Effect of Steaming Duration on Water Content

Table 3 shows the water content of nuggets after different steaming durations, and Figure 3 presents the graphical comparison.

Table 3. Water content (%) of golden goatfish nuggets after different steaming durations

Fish replication	1	2	3	4	5	6	Mean (%)
20 minute	65	65	65	65	65	65	65.00
30 minute	65	60	65	60	60	60	61.67
40 minute	60	60	60	60	60	60	60.00
50 minute	60	55	55	55	55	60	56.67

Different superscript letters indicate significant differences ($p < 0.01$)

Source: Research result, 2015

ANOVA results (Table 4) showed a highly significant effect of steaming duration on water content ($F = 23.64$; $p < 0.01$; F -table 1% = 5.42). The LSD test ($LSD_{0.01} = 2.97$) indicated that all treatments differed significantly from each other.

The water content decreased as steaming duration increased, from 65% (20 min) to 56.67% (50 min). This is because prolonged heating increases water evaporation from the protein matrix (Huda et al., 2019; Lestari & Fitriani, 2024). These results align with Hasanah et al. (2021), who reported a linear reduction in water content with extended steaming in fish-based products, and with Pratama & Nugroho (2023), who confirmed that CRD effectively detects such differences.

Table 4. Water content (%) of golden goatfish nuggets after different steaming durations

Source of variation	df	Sum of squares	Mean square	F-value	F-table 5%	F-table 1%
Treatment	3	216.67	72.22	23.64**	3.29	5.42
Replication	5	20.83	4.17	1.40 ns		
Error	15	45.83	3.06			
Total	23	283.33				

*ns = not significant; ** = significant at $p < 0.01$ *

Source: Research result, 2015

3.4. Implications for Nugget Quality and Shelf Life

Nuggets steamed for 50 minutes had the lowest water content (57%), which was within the acceptable range for fish nuggets (26.73–65.66%) (BSN, 2020). Lower water content inhibits microbial growth and enzymatic spoilage, thereby extending shelf life (Rahmawati et al., 2020; Kurniawan et al., 2019; Nurhayati et al., 2021).

In this study, nuggets steamed for 20 and 30 minutes showed signs of rancidity and spoilage within 1–2 days, while those steamed for 50 minutes remained stable for up to 3 days. This is consistent with Sari & Maharani (2023), who found that reducing water content below 60% significantly improves the shelf life of fish nuggets, and with Fitriani et al. (2022), who emphasized the role of water activity in microbial stability.

4. Conclusion

Based on the results, the following conclusions can be drawn:

1. Steaming duration significantly affects the water content of golden goatfish nuggets ($F = 23.64$; $p < 0.01$).
2. The lowest water content (57%) was achieved at 50 minutes of steaming.
3. Nuggets with lower water content (50 min steaming) had better shelf life (3 days) compared to those with higher water content (20–30 min steaming), which spoiled faster.
4. Therefore, a steaming duration of 50 minutes is recommended to produce golden goatfish nuggets with optimal water content and extended durability.

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