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Experimental study on the effect of drying temperature on the final quality of dried fish

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Abstract

The production of dried fish is a key community efforts to increase the economic value of fish in the Aceh region, with most product sold in traditional markets. To improve the community's economy, the quality of dried fish must be enhanced to meet the standards of modern markets. This research aims to improve the production system and quality of dried fish. The study examines the effect of drying temperature on the quality of dried fish by comparing two methods: constant drying temperature and gradual reduction. The constant drying temperature was set at 80°C, while the gradual reduction started at 80°C and decreased by 10°C every 2 hours until reaching 60°C. The results showed that the drying temperature significantly impacts the final quality of dried fish. Drying at a constant temperature of 80°C resulted in a harder texture and darker color of the dried fish compared to the gradual reduction method. This is due to the rapid heat and mass transfer processes causing case hardening in the fish, making its texture harder. This research provides valuable insights to improve the drying process and ensure the production of high-quality dried fish.

Keywords:
Preservation, drying, dried fish, temperature.

1 Introduction

Aceh is one of the regions in Indonesia with a high potential for marine and fisheries resources [1]. Fish is one of the types of food that is consumed almost daily by humans [2]. Fish is favored because it has various health benefits for humans [3]. Fish contains various beneficial protein contents for humans [4]. Fish is one of the perishable food products that quickly deteriorates in quality [5]. One effort made to address this characteristic of fish is preservation. Fish is preserved to inhibit the process of quality deterioration [6]. One of the fish preservation techniques commonly used by most communities is drying. [7]. In addition to extending the shelf life of fish, drying also serves to increase the economic value of the fish [8, 9].

Dried fish resulting from the drying process is usually sold in traditional markets. The process of making dried fish in the Aceh region still utilizes traditional methods, namely direct sun drying, resulting in poor-quality dried fish [10]. Direct sun drying still has many drawbacks, including variable weather conditions [11], intermittent availability of solar energy [12], unexpected rain [13], uneven drying temperatures [14], the use of larger drying areas [15], dust contamination [16], no sources were directly referenced for this translation as it is a straightforward sentence [17]. The use of traditional drying involves drying intervals, causing moisture to re-enter the dried fish [18]. To address the issues with the drying process, a drying machine is one suitable solution to be used in the drying process [19]. The use of drying equipment also enhances thermal performance and increases the energy and exergy efficiency of the drying process [4].

Literature on the development of drying equipment has been extensively conducted. However, there is still limited literature discussing the issues related to the use of drying temperatures in the fish drying process. Harris [20] reported that the use of a drying temperature of 65°C is the best way to obtain dried fish with the highest quality, Ohijeagbon [21] reported that the best fish drying is achieved using a temperature of 100°C. Hasan [22] reported that drying at a temperature of 80°C with gradual temperature reduction to 45°C is the best treatment to obtain dried fish of the highest quality. Based on the previous background, it motivates researchers to examine the effect of drying temperature treatment on the final quality of dried fish. This research is conducted to obtain an appropriate fish drying system, to increase both production and the quality of dried fish.

2 Research methods

Fig. 1 illustrates an overview of the drying equipment system used. The drying apparatus is built into components consisting of the combustion chamber, drying chamber, and exhaust chimney. The drying chamber dimensions are 150 cm in length and 82 cm in width (Fig. 2). The main frame of the drying equipment is made of iron. The walls of the drying equipment are made of aluminum. Plywood insulation is used on the outer walls of the drying equipment to enhance thermal insulation.

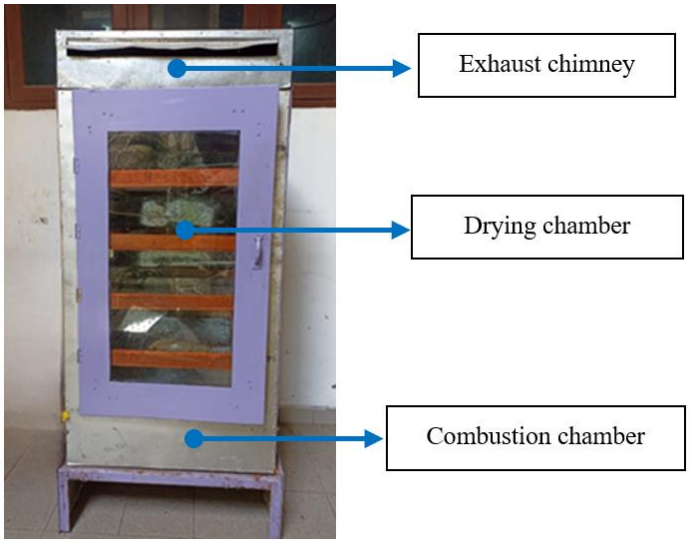

Fig. 1. Drying equipment.

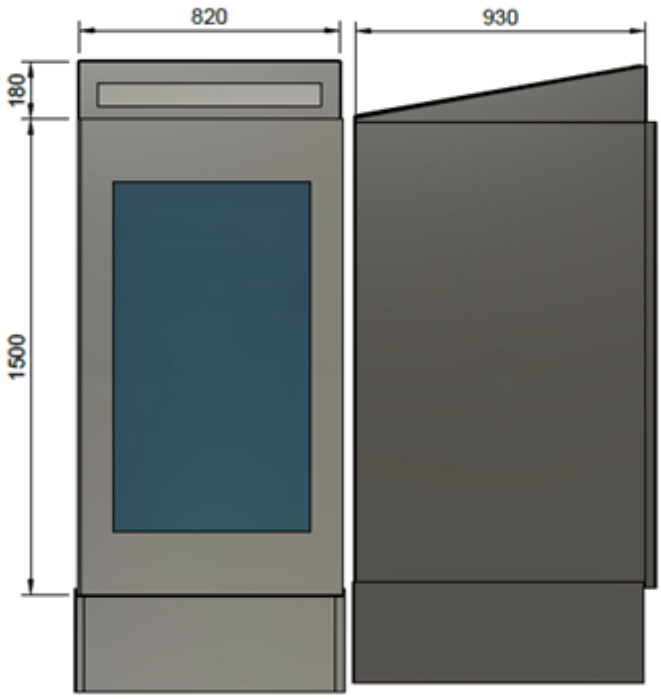

Fig. 2. Dimensions of the drying equipment.

In this study, there are 2 variables to be tested: the drying temperature treatment at a fixed temperature and gradual reduction. The fixed temperature referred to here is the drying process carried out at a temperature of 80°C from the beginning of drying until it is completed. Gradual reduction involves a drying process using a temperature that changes as the fish's moisture content decreases. The gradual drying temperature starts at 80°C and will be gradually reduced over 2 hours by 10°C until it reaches 60°C. Subsequently, drying will continue at 60°C until the desired moisture content is achieved.

The cleaned fish are then immersed in a salt solution with a concentration of 30% for 6 hours. Afterward, the fish are dried in the drying chamber until reaching a moisture content of 15-20%. Weight loss data of the fish will be collected every hour to determine the amount of moisture that has been reduced.

In determining the characteristics and quality of the fish, a sensory evaluation is conducted. Sensory evaluation involves analyzing the characteristics of an object using human sensory organs. The sensory evaluation is conducted using a scoring test, with the smallest value at 1 and the highest at 9. The rejection limit for the test product is five; if the score is less than 5, the product will be considered of poor quality. This evaluation will be carried out by 10 panelists. The factors and quality descriptions observed include color, taste, and texture. Fig. 3 is the scheme for the placement of measurement points.

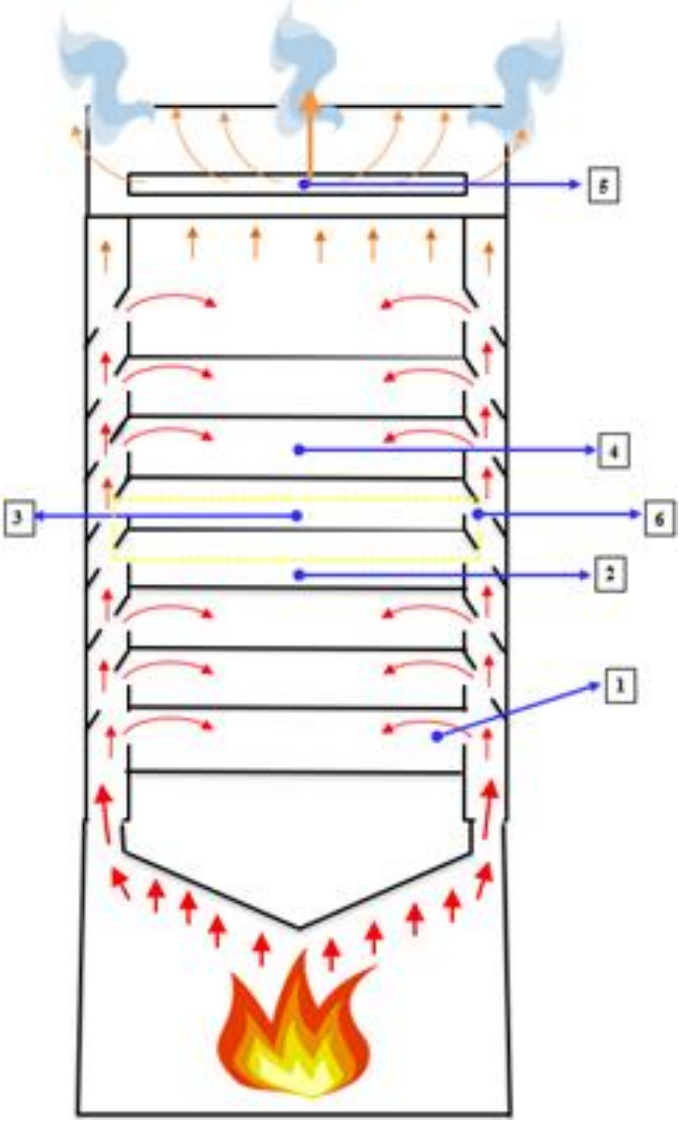

Fig. 3. Placement of measurement devices.

Point 1: Inlet hot air
Point 2: First temperature measurement point
Point 3: Second temperature measurement point
Point 4: Third temperature measurement point
Point 5: Outlet air temperature
Point 6: Rack used for research

3 Results and discussion

3.1 Decrease in moisture content

Based on the data obtained from the research results, the graph of the decrease in sample mass can be plotted as shown in Fig. 4.It can be observed from the moisture content reduction graph that the decrease in moisture content using both the fixed temperature and gradual decrease methods occurs simultaneously during the first 5 hours of drying. Subsequently, the reduction in moisture content occurs differently. The fixed temperature method requires a shorter drying time, namely 11 hours, compared to 14 hours for the gradual decrease method.

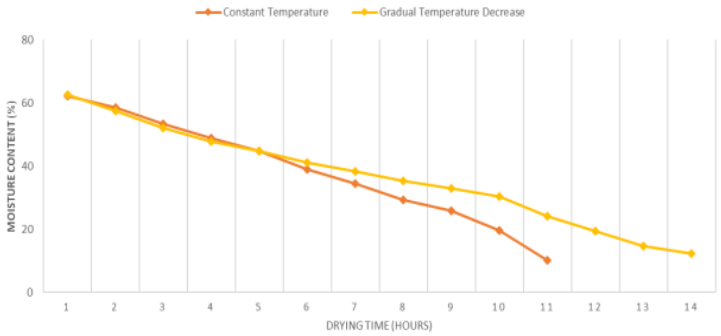

Fig. 4. Decrease in moisture content using fixed temperature drying and gradual decrease.

3.2 Mass reduction

From the data obtained from the research results, a graph depicting the reduction in sample mass can be plotted as shown in Fig. 5.The reduction in mass occurs rapidly during the initial 5 hours of drying. Subsequently, the mass reduction slows down as the moisture content in the fish decreases. The reduction in moisture content takes less time with the fixed temperature method, requiring 11 hours compared to 14 hours with the gradual reduction method.

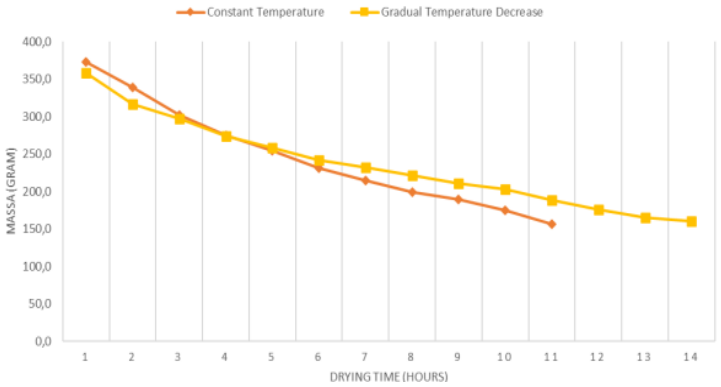

Fig. 5. Reduction in fish drying material mass with fixed temperature drying method and gradual reduction.

3.3 Characteristics of the end product

3.3.1 Color

Based on the results of the sensory evaluation conducted by 10 panelists regarding the assessment of the color of dried fish in terms of the drying process using constant temperature and gradual decrease, as shown in Fig. 6.

In Fig. 6, it is evident that there is a significant difference in the visual appearance of the final product of dried fish. The gradual temperature reduction method shows the highest preference score of 7, resulting in a bright cream color (see Fig. 7), while the fixed temperature drying treatment has the lowest preference score of 5.8, yielding a dull brown color (see Fig. 8). Rapid drying processes often involve high temperatures, accelerating the oxidation of fats in the fish. This fat oxidation leads to a color change, turning the fish brown [23].

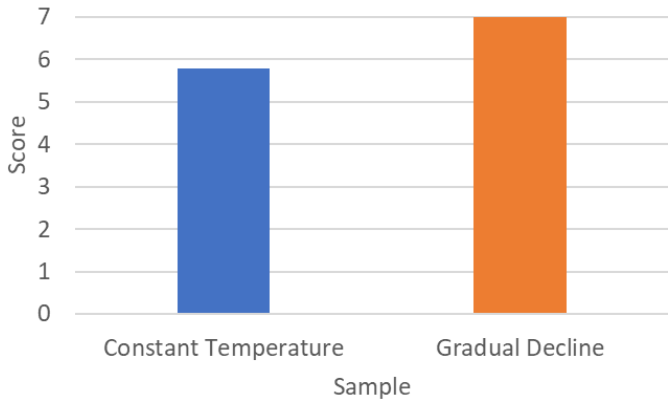

Fig. 6. Graph of color characteristics assessment.


Fig. 7. Dried fish results using a constant temperature drying method.


Fig. 8. Dried fish results using a gradual temperature decrease drying method.

3.3.2 Flavor

In the organoleptic test for the final taste characteristics of dried fish with varying drying temperature treatments, the results are shown in Fig. 9.

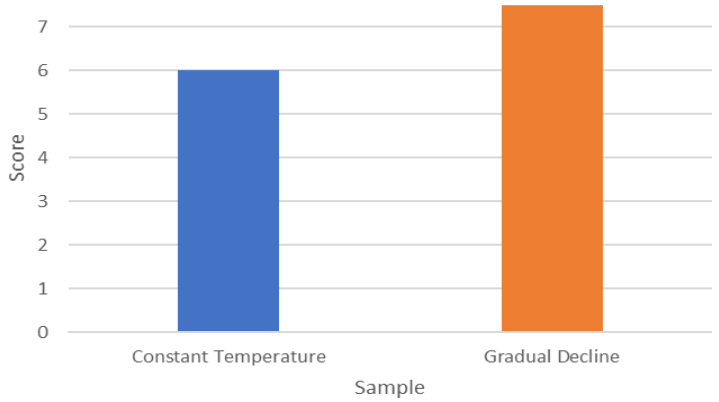

Fig. 9. Taste characteristic evaluation.

The Fig. 9 illustrates the panelists' evaluation of the taste of the dried fish, where the highest preference score of 7.5 was found in the gradual temperature decrease drying method. Conversely, the lowest preference score of 6 was recorded for the constant temperature drying method.

3.3.3 Texture

The organoleptic test for the final texture characteristics of dried fish with different drying temperature treatments is shown in Fig. 10.

In Fig. 10, the results of the panelists' evaluation are shown. The gradual temperature decrease treatment received the highest preference score of 7.4, producing a softer texture compared to the constant drying method. This is because heat and mass transfer occur gradually, preventing thermal stress and case hardening [20]. The lowest preference score of 4.9 was recorded for the constant temperature treatment.

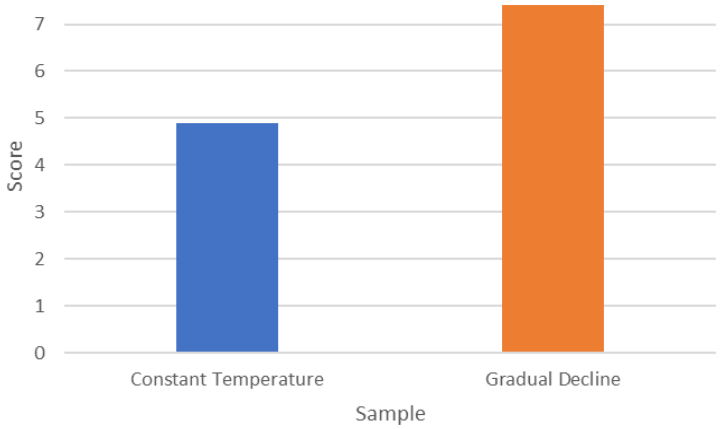

Fig. 10. Texture characteristic evaluation graph.

4 Conclusion

Based on the results of the research conducted, it can be concluded that drying at a constant temperature of 80°C results in a texture that tends to be harder compared to the gradual temperature decrease drying method, and it produces a darker color. The best quality dried fish is obtained using the gradual temperature decrease drying method.

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