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The Effect of Inlet Air Velocity on the Reduction of Moisture Content in Drying Catfish With a Capacity of 2 Kg

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ABSTRACT

One way to preserve or extend the shelf life of fishery products is by drying. However, the obstacle that exists in the community is that the preservation method is not maximized. Drying techniques using mechanical devices or artificial drying to overcome the shortcomings of conventional drying methods. In this study, drying catfish was carried out using coconut shell material as a smoking tool. The purpose of this study was to determine the effect of temperature on the drying rate in a dryer with a capacity of 2 kg of starch fish as an ingredient for smoking. The inlet air variations used in this study are 0.7 m/s, 0.8 m/s, 0.9 m/s, 1.0 m/s and 1.1 m/s. The results of this study indicate that the variation of inlet air 1.1 m/s is the variation that most reduces the water content in catfish as much as 15.08%. The reduction of moisture content of the material will increase if the inlet air flow velocity is increased. The drying process is influenced by temperature and airflow velocity. The results obtained by using a dryer that uses coconut shell charcoal are very efficient and economical because coconut shell charcoal is very easy to obtain and can be obtained at an affordable price.

Keywords: _air velocity, drying, moisture content, catfish, water content_

1. INTRODUCTION

Fish is one of the sources of animal protein that is widely consumed by the public. However, these fish require a fast and precise handling process due to the process of spoilage. The preservation process is very necessary in the processing of fish products quality and quality of fish can be maintained to consumers (Imbir et al., 2015). Fresh fish meat contains up to 80% water by mass and is a category of perishable food and has a short shelf life if not processed (Bala and Mondol, 2001).

Pickling techniques generally rely on the process of lowering the water activity of the preserved food which will inhibit or prevent the unwanted activity of microorganisms and enzymes that require an aqueous environment, as well as the growth of molds and fungi (Duan et al., 2004). The preservation process aims to extend the durability and good quality results that require good treatment during the preservation process by maintaining the cleanliness of the materials and tools used, using fresh fish and clean salt. Fish preservation has a variety of ways, namely salting, drying, and cooling (Margono et al., 2000; Imbir et al., 2015).

Increasing the shelf life of fish can be done with some form of processing. Fish drying is important as it preserves fish by inactivating enzymes and removing moisture necessary for bacterial and fungal growth (Ikrang and Umani, 2019).

Fish preservation by inhibiting bacterial activity in fish spoilage can be done by reducing water

content with drying process. In Indonesia, many people still use traditional methods by utilizing direct solar heat or drying in the fish drying process. However, there are obstacles when viewed from the conditions of the Indonesian region which has a rainy weather climate that will interfere with the drying process (Lukmansyah et al., 2019).

Drying fish in open sunlight poses problems such as high moisture content, uncontrolled drying and contamination (Mohod et al., 2014). Conventional drying methods also take long times to depending on the intensity of the sun's heat. Based on these problems, mechanized drying systems can overcome these problems (Raynaldo et al., 2021). The sun drying method has the main disadvantages of requiring a large open area exposed to direct sunlight, the moisture content of the dried fish is unstable, and fish dried in direct sunlight will be exposed to dust or dirt and mold and bacterial contamination making it unhygienic (Rehn et al., 2013; Guarner and Brandt, 2011; Fudholi et al., 2010; Yaldiz et al., 2001; Suzuki et al., 1988). Preservation techniques such as salting, smoking, frying, fermentation, and processing into sauces have been developed (Fudholi et al. 2010).

Based on these considerations, in this study, a fish drying equipment with a capacity of 2 kg with coconut shell charcoal fuel was made and will be tested with variable incoming air flow speed.

2. METHODOLOGY

2.1. Materials and Tools

The materials and equipment used are catfish as the main raw material in Figure 1, coconut shell charcoal as fuel, corrugated zinc as the top cover of the dryer, and zinc-coated steel plate (Lokfom BJLS) as the casing and cover of the dryer. The equipment used are thermocouples, anemometers, fans and digital scales and other manufacturing equipment.

Figure 1. Catfish

2.2. Methods

The working principle of the catfish dryer is to use a hot air circulation system that comes from fuel combustion and spreads by natural convection through the smoking chamber to the chimney, where the fish dried by smoking is hung in a row using a neatly arranged grill clasp and hot air will flow through the rows of fish from bottom to top due to the pull of the chimney where there is a significant temperature difference between the bottom and top of the dryer. The hot air will continue to move turbulently until the temperature of the hot air reaches the drying temperature and absorbs the water content in the fish out through the wall gap and vertically upwards.

Figure 2. Manufacture of Fish Drying Equipment

A fish dryer with a capacity of 2 kg was made as shown in Figure 2. After the manufacture of the tool is complete, the drying process is carried out by weighing the catfish and put into the dryer as shown in Figure 3. Prepare coconut shell charcoal fuel in Figure 4. In the drying process, the drying process is carried out for 12 minutes and the air flow speed into the combustion chamber is adjusted for five variables 0.7 m/s, 0.8 m/s, 0.9 m/s, 1.0 m/s and 1.1 m/s. Record temperature data in the smoking chamber and combustion chamber. Then data processing was carried out with the calculation of water weight reduction and reduction at each time increment every one minute and the rate of water content reduction using the equation below (Holman, 1986).

$$Ww = Wb - Wk \qquad (1)$$
$$Vw = \frac{W_w}{t} \qquad (2)$$

Description:
Ww   : Evaporated water content (kg)
Wb   : Initial weight of material (kg)
Wk   : Final weight of material (kg)
Vw   : Moisture content reduction rate (kg/s)
t   : Heating time (s)

Figure 3. Arranging catfish on a fish dryer

Figure 4. Coconut shell charcoal

7	0.1	0.1	0.1	0.1	0.1
8	0.12	0.12	0.12	0.12	0.12
9	0.13	0.13	0.13	0.14	0.13
10	0.15	0.15	0.15	0.15	0.15
11	0.15	0.15	0.15	0.15	0.15
12	0.15	0.15	0.15	0.15	0.15

Table 2. Reduction of Water Content in Catfish

Time (min)	Water Content Reduction (%)				
	Air Velocity 0.7 m/s	Air Velocity 0.8 m/s	Air Velocity 0.9 m/s	Air Velocity 1.0 m/s	Air Velocity 1.1 m/s
1	51.61	45	38.35	28.57	15.09
2	50.5	44.5	36.98	26.98	13.20
3	49.4	43.37	35.6	26.44	12.07
4	48.38	42.16	33.97	23.8	9.4
5	47.3	40.96	32.88	22.21	7.5
6	46.23	39.75	31.5	20.62	5.6
7	45.16	38.55	30.13	19.04	3.7
8	44.08	37.34	28.81	17.45	1.8
9	43	36.14	27.39	16.35	1.5
10	41.9	34.93	26.02	14.28	0.01
11	41.9	34.93	26.02	14.28	0.01
12	41.9	34.93	26.02	14.28	0.01

3. RESULTS AND DISCUSSION

3.1. Research Results

In this study, after data collection and data processing with calculations, data on the reduction of water weight in catfish per unit time for all variations of air velocity entering combustion chamber, data on the reduction of water content in catfish per unit time for all variations of air velocity entering the combustion chamber and data on the rate of reduction of water content in catfish for all variations of air velocity entering the combustion chamber as in Table 1, Table 2 and Table 3.

Table 1. Water Weight Reduction in Catfish

Time (min)	Water Weight Reduction (Kg)				
	Air Velocity 0.7 m/s	Air Velocity 0.8 m/s	Air Velocity 0.9 m/s	Air Velocity 1.0 m/s	Air Velocity 1.1 m/s
1	0	0	0	0	0
2	0.02	0.02	0.02	0.02	0.02
3	0.03	0.03	0.03	0.03	0.03
4	0.05	0.05	0.05	0.05	0.05
5	0.07	0.07	0.07	0.07	0.07
6	0.08	0.08	0.08	0.08	0.08

3.2. Discussion

The results of the observation data that has been obtained in the form of water weight reduction data against time for each variation of air velocity into the combustion chamber, and water content reduction data against time for each variation of air velocity into the combustion chamber. then the data is processed into bar and line graphs as in Figure 5 and Figure 6.
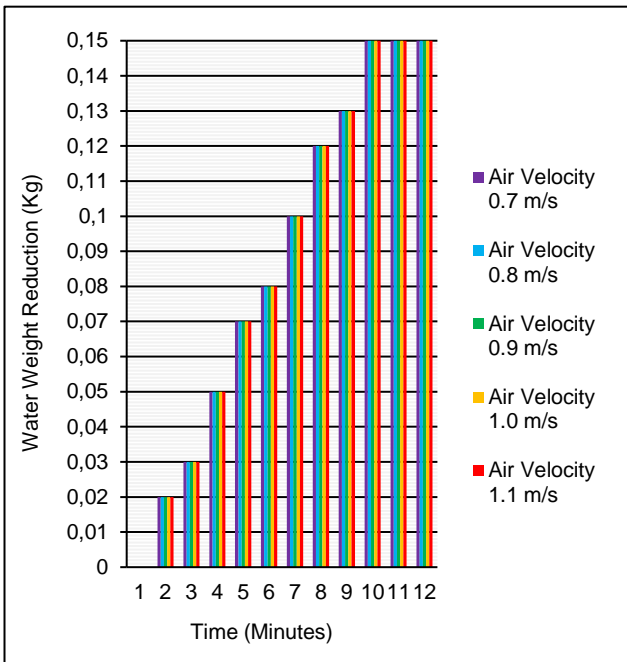
Figure 5. Water Weight Reduction with Time at All Air Velocity Variations.
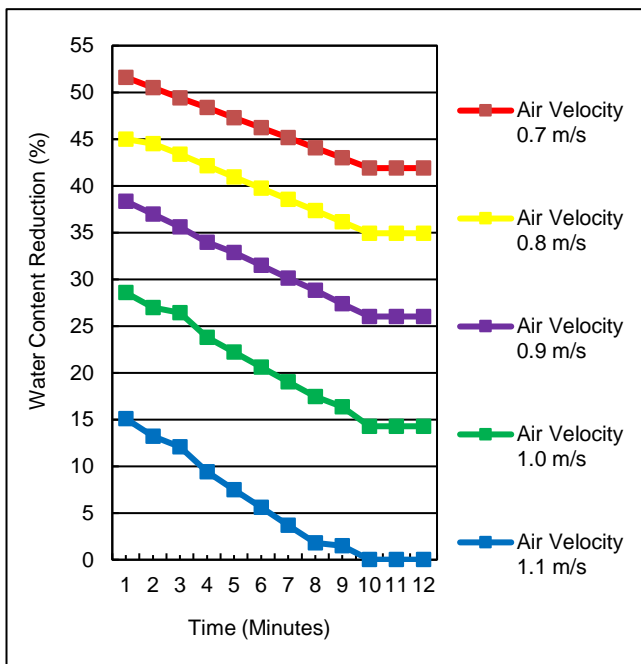

Figure 6. Reduction of moisture content against time at all air velocity variations.

In this study, the drying of catfish is done with a dryer that has been designed to have a maximum drying chamber capacity of 2 kg for one drying process. The combustion chamber is under the drying chamber and there are holes for air entry. This dryer is made with zinc material and zinc-coated steel plate in the form of a box. The fuel used is coconut shell charcoal which has been burned first before being used for the drying process.

The observation in this study is the reduction in water weight of catfish during an interval of 12 minutes at variations in air velocity into the combustion chamber, namely 0.7 m/s, 0.8 m/s, 0.9 m/s, 1.0 m/s and 1.1 m/s. The data from the observation of water weight reduction in dried catfish was processed into a bar graph as shown in Figure 5. The results showed that the water weight reduction of catfish in all air velocity variations of 0.7 m/s, 0.8 m/s, 0.9 m/s, 1.0 m/s and 1.1 m/s had the same value for each interval of drying time increase. At interval of 1 minute, the water weight reduction is 0 Kg. At interval of 2 minutes, the water weight reduction was 0.02 Kg. At interval of 3 minutes, the water weight reduction was 0.03 Kg. At interval of 4 minutes, the water weight reduction is 0.05 Kg. At interval of 5 minutes, the reduction in water weight was 0.07 Kg. At interval of 6 minutes, the reduction in water weight was 0.08 Kg. At interval of 7 minutes, the reduction in water weight was 0.1 Kg. At time interval of 8 minutes, the water weight reduction was 0.12 Kg. At interval of 9 minutes, the water weight reduction is 0.13 Kg. And at interval of 10-12 minutes, the reduction in water weight is 0.015 Kg.

The observation data on the reduction of moisture content in dried catfish was processed into a line graph as shown in Figure 6. The results showed that the moisture content of catfish in all variations of air velocity into the combustion chamber 0.7 m/s, 0.8 m/s, 0.9 m/s, 1.0 m/s and 1.1 m/s decreased during the drying time. At an air velocity of 0.7 m/s, the moisture content at the initial time interval was 51.61% and at the final time interval was 41.9%. At an air velocity of 0.8 m/s, the moisture content at the initial time interval was 45% and at the final time interval was 34.93%. At an air velocity of 0.9 m/s, the moisture content at the initial time interval was 38.35% and at the final time interval was 26.02%. At an air velocity of 1.0 m/s, the moisture content at the initial time interval was 28.57% and at the final time interval was 14.28%. And at an air velocity of 1.1 m/s, the water content at the initial time interval was 15.09% and at the final time interval was 0.01%. The results showed that the reduction of water content in the 10-12 minutes time interval had a constant value, namely at an air speed of 0.7 m/s was 41.9%, at an air speed of 0.8 m/s was 34.93%, at an air speed of 0.9 m/s was 26.02%, at an air speed of 1.0 m/s was 14.28%, and at an air speed of 1.1 m/s was 0.01%.

4. CONCLUSION

Based on the research that has been done, it is found that the reduction of water weight and water

content is influenced by the speed of the incoming air flow in the combustion chamber, the higher the speed of the incoming air flow, the greater the reduction of water weight and water content. This also affects the rate of water content reduction, the higher the speed of the incoming air flow, the higher the rate of water content reduction. Drying catfish with a dryer that has been made has good economic value because of the highwater content reduction results and the drying equipment also has cheap materials.

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