Stay home practical: Effect of thickness and environmental conditions on drying kinetics of radish as the samples

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Abstract. The world Health Organization (WHO) declared a pandemic caused by SARS-CoV-2 or Covid-19 in 2020. Indonesia in one of the countries affected by the Corona Virus Disease (Covid-19) for a long time. Education is one aspect of life that is affected. Research on drying is one solution for students to carry out scientific activities at home by utilizing solar energy and natural materials such as radishes as samples. This study found that the thickness of the sample and environmental conditions such as temperature of the surrounding operating conditions affect the drying rate and drying time.

1. Introduction

At the beginning of 2020, the World Health Organization (WHO) declared a pandemic status due to an outbreak of a disease caused by SARS-CoV-2 or called Covid-19. Corona Virus Disease (Covid-19) is an RNA Virus with a crown-like appearance. There are four genera of Covid-19, namely α - coronavirus (alphacoV), β - coronavirus (betacoV), δ - coronavirus (deltacoV), and γ - coronavirus (gammacoV) [1]. Indonesia is ranked as the fourth most populous country in the world. This causes Indonesia to be one of the countries experiencing a pandemic for a long time when compared to countries with small populations [2].

The impact of environmental conditions in various related aspects affects various activity [3]. The Covid-19 pandemic has affected many aspects of human’s live. One aspect of life that has been affected by the Covid-19 pandemic is education. The Secretary of the Ministry of Education and Culture urges distance learning to prevent the spread of the Covid-19 virus for all levels, from elementary school to college [4,5]. For universities, the Covid-19 pandemic has had an impact on research activities. One alternative is to do research from home as a scientific activity by utilizing tools and materials that are around [6,7].

One of the research activities that can be done at home is natural drying. Drying is a process that has been carried out for a long time in order to extend the shelf life of agricultural products [6,7]. Natural drying is done by cutting the material into a certain shape as thin layer. In an open container, the samples in drying process is directly exposed to the sun and wind [8]. Previously research on drying naturally have been done with samples such as: carrot [8], potato [6], and ginger [7]. A research in comparing drying kinetic of radish and cucumber also have been reported [9].

Radish (Raphanus sativus L.) is a root that can be consumed and cultivated in the world. Radishes are vegetables that can be stored for a long time during the winter [10]. Radishes contain
phytochemicals, glucosinolates, saponins, flavonoids, polyphenols, essential oils, vitamin A and vitamin C which have the potential as antibacterial, indigestion medicine, and stimulant. Due to the high water content of radishes, in Asia, radishes are processed into dried products, pickles and fermented products [11-13]. The purpose of this study was to obtain the kinetic characteristics of drying radish with different thicknesses based on the reduction of the sample weight along with the drying time.

![Figure 1. Radish](image)

2. **Experiment and Method**

   The material in this experiment was white radish purchased at a local traditional market in Selayang, Medan. The sample was washed with water and then cut with a cutter into the same shape with three thickness variations (1 cm, 1.5 cm and 2 cm) as shown as a sample in Figure 2A. Then, the three samples with different thicknesses were weighed with a digital scale (Figure 2B) and natural drying research is done openly with an online environmental temperature analysis as shown in Figure 2C.

![Figure 2. A. Radish as a sample, B. The digital balance instrument C. The sample of temperature data around the operating area](image)
To calculate the drying kinetics used the equation:

\[
\text{Drying rate} = \frac{\text{Weight loss}(t)}{\text{dt}}
\]  

(1)

Where, weight loss \( t \) is the reduction in sample weight at a certain time interval. Weight loss\( t \) was calculated by equation 2:

\[
\text{Weight } (t) = \text{Weight } (0) - \text{Weight loss } (t)
\]

(2)

Measurement in samples weight changes were carried out every hour for up to 7 hours and this measurement method was carried out until the 8th day.

3. Results and Discussion

Table 1 shows the physical properties of radish as the samples with thickness variations. It can be seen in the table that the sample thickness affects the sample weight. The thickness variation and the weight of the radish is the source of data measured in this study.

| Sample | Thickness (cm) | Diameter (cm) | Shape     | Weight (mg) |
|--------|----------------|--------------|-----------|-------------|
| 1      | 1.0            | 2.8          | Rounded   | 14.40       |
| 2      | 1.5            |              |           | 20.54       |
| 3      | 2.0            |              |           | 27.54       |

Table 1. Identification the radish physical properties

Radish drying rate with three thickness variations on the first day is represented in Figure 3. The natural drying process causes the mass transfer phenomenon, that is evaporation process of the sample water content into the air due to heat energy from the sun [8]. The drying process reduces the weight of the samples for 7 hours. The sample 1 has decreased from 14.4 mg to 5.12 mg, sample 2 has decreased from 20.54 mg to 9.58 mg, and sample 2 has decreased from 27.54 mg to 14.22 mg. The longer drying time causes the material shrinkage to be higher so that there is a reduction in the material weight and volume [8,13].
Figure 4 shows the drying kinetic by adding the day up to the eight days. On the 8th day, sample 1 was 1.28 mg, sample 2 was 1.64 mg, and sample 3 was 2.32 mg. It can be seen that sample 1 has reached a constant level on the 5th day. The evaporation rate will be slower as the water content in the sample decreases and slice thickness affects drying time [14]. As the thickness of the sample slices increases, the drying time will be longer due to the greater distance traveled by water vapor to the surface. When compared with Figure 3, the three samples experienced a significant weight reduction until the 8th day. This indicates that the drying rate decreases with increasing drying time [14].

Figure 5 shows how environmental conditions affect the sample weight reduction during the drying process. Significant weight reduction with shorter drying time can be obtained with higher drying temperature [15,16]. The graph shows that in sunny conditions in the open room (C) samples 1, 2, and
3 experienced a weight decrease with the largest value compared to other environmental conditions (A and B). This proves that the research is in accordance to the theory, where the temperature results in a significant sample weight reduction and the drying process will take a shorter time as the temperature increases [15,16].

The drying process carried out on radish causes a structure changes as shown in Figure 6. It is very clear in Figure 6 show the volume shrinkage occurred in the sample on the 8th day. Volume shrinkage caused by a significant reduction of material water content that makes the product surface harder [14,15]. Drying not only affects the sample shape but affects the color of the sample as well. In the drying process there is a reaction that forms a dark pigment in the material. The high processing temperature and long processing time tend to produce more dark pigment in the material [15,17].

4. Conclusion
The drying rate is influenced by the sample thickness and the environmental conditions during the drying process. The drying process carried out in an open room with sunny weather conditions resulted in greater weight reduction, thus shortening the drying process time. The thickness of the sample in also an important aspect in this study. A high sample thickness results in a higher drying time. The reduced material water content causes sample changes such as discoloration and shrinkage.

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