Simulation model on the potato as the samples on the dryer operation module with thickness variation

B Haryanto1,3*, T R F Sinuhaji1, E Tarigan1 and R Br. Bukit2

1Faculty of Engineering, Universitas Sumatera Utara, 20155, Medan, Indonesia
2Faculty of Economic and Business, Universitas Sumatera Utara, 20155, Medan, Indonesia
3Center of Excellence for Sustainable Energy and Materials, Universitas Sumatera Utara, Medan, Indonesia.

*Email: bode.haryanto@usu.ac.id

Abstract. During the COVID-19 virus impact on most areas in Indonesia, most of the teaching and research activities done at home. The idea to force the activity at home by giving the idea to research drying operation. It is the sample of how students can apply the drying operation at their home. The idea to dry the potato as the material sample was applied and have given the result the size or shape of the sample, the operation time and temperature impact the drying kinetics. As a result of drying at the open area and naturally were give the information has impacted the rate of drying. The type of shape was the most impacted in comparing the temperature and operation time.

1. Introduction
The 2019 novel coronavirus (2019-nCoV) is officially named as Coronavirus Disease-2019 or COVID-19 by WHO on February 11, 2020. The virus transmission is occurred by person-to-person that may occur through droplet or contact transmission. Currently, there is no definite treatment for COVID-19 although some drugs are under investigation. [1]. Indonesia is one of the most affected countries in Southeast Asia. Reported that thousands of cases that are increasing every day make this country must be strictly restricted to every public activity [2].

During the COVID-19 virus has an impact on the work environment including research operations. Working from home is to reduce the spread of disease by controlling consumption, work time, and personal interaction [3]. Staying at home is to decrease the effect of COVID-19 mobility [4]. Research from home is an alternative related to scientific activities including research conducted this time. Relating to studies on the impact of environmental conditions such as available environmental performance, company profitability, and asset utilization have been reported [5] and adjusting the current COVID-19 conditions.
Drying is an ancient process that dates back centuries. So that students can do research at their own home. The relevant research is drying with the help of sunlight or this is known as natural drying. Drying is greatly influenced by the material transfer mechanism to the ambient air, such as vapour pressure, drying air, temperature, air velocity, thickness, and exposed surfaces [6].

Potatoes are known as daily food which is a type of vegetable and a source of carbohydrates, which is very easy to get in this tropical country. Figure 1 shows the shape of the potato. Drying various natural materials like this has been reported by several researchers, for cabbage [7], cherry tomato [8], rice [9,10], seaweed [11, 12], corn [13] and others food like fish [14], meet pieces [15], and previous research has been carried out drying using a tray dryer with ginger [16] and turmeric [6] as samples.

The purpose of this study is to take the opportunity to do research from home during lockdown on-campus activities impact of the COVID 19 pandemic. Potatoes that are dried until their weight does not change provide information on the kinetics of drying and changing their shape from when fresh to dry.

2. Methods
The material chosen in this study was potatoes bought at the traditional market in Selayang, Medan. The tools used in this study are cutters and rulers. Samples were prepared in three sizes. The material was then weighed as shown in Figure 2a with a digital balance device. Also, the volume was measured with a measuring cup like Figure 2b. Drying was done openly with an online environment temperature analysis like the example in Figure 2c.

Moisture removing rate on percentage of dry basis can be calculated using Eq. (1) [17]:

\[ M_{\text{initial}} = \frac{W_w - W_d}{W_d} \times 100\% \]  

(1)

Figure 1. Potato

Figure 2 a. The balance instrument; b. The volume measurement, c. The sample online data of natural temperature around operation area
Where $M_{\text{initial}}$ is the initial moisture removing rate (%, dry basis), $W_w$ is the weight of wet potato (mg), and $W_d$ is the weight of dry potato (mg).

$$\text{Weight}_{(t)} = \text{Weight}_{(0)} - \text{Weight loss}_{(t)}$$

(2)

Where, $\text{Weight}_{(0)}$ is the weight of wet potato before drying and $\text{Weight}_{(t)}$ is the weight of dry potato at specified time intervals. $\text{Weight loss}_{(t)}$ is the weight of the dry potato at specified time intervals.

### 3. Results and Discussion

In table 1. explains the sample size used in this study. There are three samples of potatoes of different thickness.

| Sample | Thickness (cm) | Length (cm) | Wide (cm) | Weight (mg) | Rho (mg/ml) |
|--------|----------------|-------------|-----------|-------------|-------------|
| 1      | 0.5            | 3.0         | 2.0       | 6.60        | 1.1930      |
| 2      | 1.0            |             |           | 12.90       |             |
| 3      | 1.5            |             |           | 17.72       | 1.1930      |

![Drying Kinetics](image)

(a)

![Moisture Removing Rate vs Time](image)

(b)

Figure 3. (a). The Drying Kinetics on first day and (b). Moisture removing rate in sample in first day
Figure 3A shows the drying kinetics model on the first day. During the six hours, the sample weight decreased. For sample 1 the initial weight was 6.60 mg until at six hours the weight became 1.32 mg. For sample 2 the initial weight was 12.9 mg until at six hours the weight became 5.52 mg. For sample 3 the initial weight was 17.72 mg until at six hours the weight became 8.72 mg. This indicates that a certain amount of weight has disappeared into the air, the water content of the potato sample.

By using eq. (1) [17] the moisture removing rate of the sample is obtained, expressed in Figure 3B. In Figure 3B, the graph given fluctuates with the largest value given at the fifth hour. In sample 1 the value given was 73.49%. In sample 2 the value was given at 32.13% and in sample 3 the value given was 25.95%. From the graph also indicates the thickness affects the moisture removing rates with the conclusion that can be given is the thicker a material, the percentage reduction in water content will be slower, so it requires a longer time to dry the material. This is consistent with the study of Meas, et al. 2011 [8] that the depth or thickness states give a longer time to dry the material.

Figure 4A is a profile showing a decrease in overall sample weight to a constant sample weight shown on the seventh day. In Figure 5, the constant weight in sample 1 on the seventh day was 0.78 mg, in sample 2 was 1.52 mg and in sample 3 was 2.36 mg.
As stated in the references expressed by Sansaniwan and Kumar, 2015 [17] The rate of moisture loss depends on the total moisture present in the mass of the product. It has been observed that the rate of moisture loss of the sample increases with increasing sample mass and decreases significantly as the drying days progress. However, moisture loss also depends on the ease of heat transfer in the sample. The more the convective heat transfer coefficient, the greater the loss rate of water vapor and vice versa.

Figure 4B shows the effect of time on the moisture reduction rate. The graph shows the largest reduction in the initial time and then decreases the rate each time. This is following the statement of Ronoh, et al, on 2009 [18] which states that the moisture content decreased exponentially with an increase in drying time. The results show that under drying conditions the rate of drying was highest within the first hours of drying. Thereafter, the drying rate reduced significantly.

Figure 5 shows the change in weights when done under various conditions. In part A, the sample was carried out under rain conditions in a room where humidity reaches 100%. In part B under the same conditions that are in a room without rain conditions. In section C in outdoor conditions. Each part of the measured temperature is the approach temperature ie when in part A the temperature was around 25 °C, part B was 27 °C, and part C was 31 °C.

From the graph, it is explained that the highest total weight loss occurs in condition C, which is done in outdoor conditions. According to Ronoh et al., on 2009 [18] increases the drying rate of the material because higher temperatures are developed.

Figure 6 shows the change in potato samples during the drying period. The sample changes colour from initially bright and clear to dull blackened. There was a change due to drying in the test sample. The dehydration temperature and rate have a great influence on the texture of the sample and, in general, faster processes and higher temperatures cause greater changes. The water that migrates to the surface carries solutes from the sample, originating tensions in the structure, variables according to the type of sample, its composition and the processing parameters. The drying may cause some changes in mechanical properties, structure, volume, porosity and density of the samples. The high temperature causes profound physical and chemical alterations on the surface of the samples, thus leading to the formation of a hard impenetrable surface layer, which keeps the samples dried on the surface but moist inside. Structural changes during the sample drying process affect the final product texture of a material,
according to the rate of water elimination in the sample. If shrinkage occurs, like in the air-dried samples, a very dense structure is formed and the dried product is harder [19].

![Figure 6. The progress of changing on surface and shapes: 1 = The three samples on the first day; 2 = Appearance of the sample on the second day of drying. 3 = Appearance of the sample on the fourth day of drying; 4 = Appearance of the sample on the last day of drying.](image)

The enzymatic browning process is one of the browning reactions that occur in fruits and vegetables during thermal processing including the drying process. The enzyme PPO (polyphenol oxidase) is widely distributed among plant materials and may cause undesirable color and flavor changes during post-harvest processing, due to enzymatic browning, when in the presence of oxygen. Therefore, it is necessary to deactivate the enzyme which is usually an important treatment before the process of preserving the material, such as drying, which will determine the quality of the product. Dehydration alters the surface characteristics of the sample, and thus the color and reflectance. Chemical changes that occur in pigments such as carotene and chlorophyll are produced by heat and oxidation during drying. In general, the longer the process and the higher the temperature, the greater are the losses in these pigments [19].

4. Conclusion
The thickness of the sample affects the drying rate so that it will prolong the drying time. This is seen when comparing moisture removing rate to test samples by size. As the results of drying, at the open area, and naturally gave the information on the rate of drying. The initial weight of sample 1, W0 = 6.60 mg, after drying 7 days the weight reduction became 0.78 mg, in sample 2, W0 = 12.90 mg the weight reduction to 1.52 mg and on sample 3, W0 = 17.72 mg become 2.36 mg. The biggest reduction in water content in sample 1, where the data obtained at the fifth hour amounted to 73.49%. The biggest weight reduction was on the sample is done in condition C with temperature 31°C, which is done in outdoor conditions. Color changes are caused by enzymatic processes produced by organic samples. The enzymatic browning process is one of the browning reactions that occur in fruits and vegetables during thermal processing including the drying process.
References

[1] Wu, Yi-Chi, Chen C, and Chan Y 2020 The outbreak of COVID-19: An overview J. Chin Med Assoc. 83 pp 217-220

[2] Guzman R D and Monica Malik 2020 Dual Challenge of Cancer and COVID-19: Impact on Health Care and Socioeconomic Systems in Asia Pacific JCO Global Oncology: 6 pp 906-912

[3] Jones C J, Philippon T, VenkateswaranV 2020 Optimal Mitigation Policies in a Pandemic: Social Distancing and Working from Home NBER Working Paper Series 26984

[4] Engle R J, Strompen J and Zhou A 2020 Staying at Home: Mobility Effects of COVID-19. SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3565703

[5] Bukit B, Haryanto B, Ginting P 2018 Environmental performance, profitability, asset utilization, debt monitoring and firm value IOP Conference Series: Earth and Environmental Science 122 (1) 012137

[6] Haryanto B, Hasibuan R, Lubis A H, Wangi Y, Khosman H, and Sinaga A W 2020 Drying rate of turmeric herbal (Curcuma longa L.) using tray dryer. Journal of Physics: Conference Series 1542 pp 1-6

[7] Sakhale B K, and Pawar V N 2007. Studies on the effect of drying modes on quality of dehydrated cabbage. Jurnal. Teknol. dan Industri Pangan 8 pp 55-58

[8] Ismail, Osman, and Akyol E 2016 Open-air sun drying: the effect of pretreatment on drying kinetic of cherry tomato Sigma J Eng & Nat Sci 34 pp 141-151

[9] Imoudu, Peter B., and Olufayo A A 2000 The effect of sun-drying on milling yield and quality of rice. Bioresource Technology 74 pp 267-269

[10] Meas, Pyseth, H J P Anthony, Cleland D J, Bronlund J E, Mawson A J, Hardacre A, and Rickman J F 2011 Effect of different solar drying methods on drying time and rice grain quality. International Journal of Food Engineering 7 pp 1-11

[11] Surata I W, Nindhia T G T, and Atmika I K A 2013 Table type sun drying for seaweed presevation Applied Mechanics and Materials 376 34-37

[12] Suherman, Djaeni M, Kumoro A C, Prabowo R A, Rahayu S, and Khasanah S 2018 Comparison drying behavior of seaweed in solar, sun and oven tray dryers MATEC Web of Conferences 156 pp 1-4

[13] Nino J, Nelwan L O, and Purwanto Y A 2017 Application of natural air drying on shelled corn in Timor IOP. Conf. Series: Earth and Environmental Science 147 pp 1-10

[14] Ojutiku R O, R J Kolo, and M L Mohammed 2009 Comparative study of sun drying and solar tent drying of Hyperopisus bebe occidentalis Pakistan Journal of Nutrition 8 pp 955-957

[15] Ayanwale B A, Ocheme O B, and Oloyede O O 2007 The effect of sun-drying and oven-drying on the nutritive value of meat pieces in hot humid environment Pakistan Journal of Nutrition 6 pp 370-374

[16] Haryanto B, Hasibuan R, Ashari A, and Ridha M 2018 Herbal dryer: dring of ginger (Zingiber officinale) using tray dryer International Conference on Agriculture, Environment, and Food Security 122 pp 1-5

[17] Sansaniwal S K, and Kumar M 2015 Analysis of ginger drying inside a natural convection indirect solar dryer: An experimental study Journal of Mechanical Engineering and Science (JMES) 9 pp 1671-1685

[18] Ronoh. E K, C L Kanali, J T Mailutha, and Shitanda D 2009 Modelling thin layer drying of amaranth seeds under open sun and natural convection solar tent dryer Agricultural Engineering International : the CIGR eJournal 10

[19] Guine, Raquel P F 2018 The drying of foods and its effect on the physical-chemical, sensorial and nutritional properties International Journal of Fodd Engineering 4 pp 93-100