The Performance of a Modified Dehumidifier Drying Machine for Peanut Seeds (Arachis Hypogaea L.) Drying

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Abstract. The amount of peanut consumption in Indonesia has increased while panut production is still insufficient, so it must be imported. Domestic peanut production is caused by several factors such as seed quality, soil conditions, fullfillment of nutrient need and other. One of strategy to increase peanut production is by using a good quality of seeds. The quality of the seed is affected by the moisture content of the seed. how to reduce water content in peanut seeds through the drying process. Drying with low relative humidity can reduce the drying temperature so that the quality of the seeds is maintained. A performance test was conducted by a dehumidifier drying machine with the temperature of 30°C, 40°C, 50°C. Drying was carried out until the moisture content reach 10-11% with every 30 minutes observations. The result showed that the dehumidifier drying machine gave constant air temperature and relative humidity at the drying chamber during the drying period. Duration of drying at the temperature of 30°C, 40°C, 50°C was 15 hours; 14 hours; 4.5 hours. This drying requires a faster time than natural drying in the sun which takes 3-5 days.

Keywords: Peanut Seed, Dehumidifier Drying, Temperature, Humidity.

1 Introduction

Peanut is one type of food crop that has a high value both in terms of economic value and nutritional content (especially protein and fat) [1]. But domestic peanut production has not been able to sufficient the needs. Peanut productivity in Indonesia is around 638,896 tons/year, while the demand for peanuts reaches ±816 thousand tons/year [2]. Domestic peanut production is caused by several factors such as seed quality, soil conditions, fulfillment of nutrient needs and others.

One of the main factors of peanut productivity is seed. To increase the yield of peanut production, the seeds used must be superior and have high quality. Seed quality consists of four components, namely physical quality, physiological quality, genetic quality and seed health quality [3]. The physical quality of the high seed can be seen from the physical appearance of the seed which is clean, bright, pithy and has a uniform size. Then the physiological quality of a good seed can be seen from its viability values such as high germination (>80%) and good vigor values including growth speed,

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growth uniformity and shelf life [4]. The quality and shelf life of seeds are influenced by the moisture content of the seeds. The moisture content of peanuts at the beginning of harvest ranges from 35%-50% and in this condition Aspergillus fungi will grow and form aflatoxins. Meanwhile, peanuts used for seeds have a moisture content of about 9%-12% [5]. The lower the moisture content of the seeds, the longer the shelf life of the seeds. To reduce the moisture content of the material, drying is generally carried out using the direct sunlight method. This method is easier and cheaper but takes between 4-5 days to get peanut seeds with a moisture content of 10% [6]. The drying process can also be done mechanically with hot air flow in an enclosed space which takes a shorter time. Mechanical drying with the addition of a dehumidifier can produce good product quality because the temperature and humidity can be controlled.

The basics of dehumidifier drying are the combination of air conditioning and heating [7]. The working principle of the dehumidifier is to pass air into the evaporator so that the temperature becomes cooler than room temperature and a condensation process occurs [8]. Water vapor will condense when the dehumidifier temperature reaches the dew point temperature. Water vapor will drip down and dry air will flow to the heat recovery unit for further use in the heating chamber. In previous studies, the use of a dehumidifier drying machine was used on ginger, corn, and curly red chili commodities [7]. Therefore, this study aimed to test the performance of the drying machine with a dehumidification process for drying soybean seeds.

2 Material and Method

2.1 Tools and Materials

The tools used in this study include oven (Memmert UF30), analytical balance (Ohaus SPX622 Scout), and dehumidifier drying machine. The additional components included a condenser (Samsung, AR09KRFLAWKX type), heater, fan (YWF4E-300S type), suction blower (Nankai), DHT22 sensor, 16x2 liquid crystal display (LCD), 12C LCD, 1 channel on/off the relay, micro module SD card, DS3221 timer module, and Arduino Mega 2560. The body was made from stainless steel 304. The material used in this research is peanut (Arachis hypogaea L).

2.2 Sample Preparation

Peanuts (cultivated in Batu, Indonesia, cultivar: unknown) were purchased from a local market which it was not more than two days after harvested. The average moisture content of each sample was 50 g. The initial moisture content of peanut was 45% determined to be on a wet basis according to the oven method, drying at 105 °C for 12 h [9].

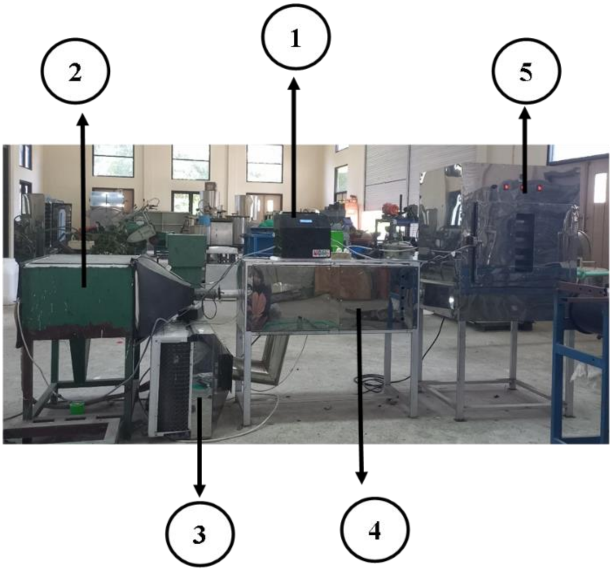
2.3 Drying Experiment

The dehumidifier dryer machine equipment were self–made by the laboratory. Each component of dehumidifier dryer that generated power can be seen in Table 1.

Table 1. Power generated by dehumidifier dryer.

Component	Power (Kw)
Dehumidifier/AC	0.746
Fan	0.090
Heater	1
Blower	0.15
Electronic Instrumentation	0.00181
Total	1.98781

The research was conducted in the Laboratory of Mechatronics, Departement of Agricultural Engineering, Faculty of Agricultural Technology, University of Brawijaya. The drying temperatures of peanut seeds used were 30 °C, 40 °C, and 50 °C [8]. Seed drying is carried out at an appropriate temperature of 38-43 °C [10]. Drying is carried out until the peanut seeds reaches a moisture content of 9-11% with recorded every 30 minutes. There are three trays in the drying chamber and a single layer of peanut seeds with mass 50 g was spread on each tray. Temperature and relative humidity were measured using a DHT22 sensor placed at six points). The components of the dryer can be seen in Fig. 1. The performance of the dehumidifier drying machine can be evaluated by the distribution drying temperatures and relative humidity, moisture content and energy consumption.



1. Contol Box; 2. Dehumidifier Unit; 3. Condensor; 4. Heat Recovery Unit; 5. Drying Chamber

Fig. 1. The dehumidifier drying machine

2.4 The Distribution Drying Temperatures and Relative Humidity

The distribution RH and temperature values uses a DHT-22 sensor which is placed at six points: the environment, the dehumidifier chamber, air outlet after dehumidifier unit, Air outlet after heat recovery unit, the drying chamber, and the air duct after the drying room. Observations were made every 30 minutes until the peanut moisture content reached 10-11%. RH and temperature readings are performed automatically with an Arduino-based data acquisition control system. Drying was carried out at temperatures of 30 °C, 40 °C, and 50 °C.

2.5 Consumption Energy

The amount of energy required for one treatment can be calculated from the energy consumption. For electrical energy consumption, it is calculated in kWh units obtained from the result of multiplying the conversion of electrical energy (kWatt) with the drying time [11]. Energy efficiency calculation is obtained through a comparison between energy output (output) and energy input (input). The input energy or incoming energy is the total energy produced by the drying machine components in the form of a dehumidifier, fan, heater, blower, and electronic circuit. Energy calculations are obtained from the power results of each component times the drying time. The input energy or incoming energy is the total energy produced by the drying machine components in the form of a dehumidifier, fan, heater, blower, and electronic circuit. Energy calculations are obtained from the power results of each component times the drying time.

3 Result and Discussion

3.1 Temperature and Relative Humidity

Table 2. indicate the distribution of temperature and relative humidity data were taken from the data acquisition system during drying. There are six observation points: 1. Ambient; 2. Dehumidifier unit; 3. air outlet after dehumidifier chamber; 4. Air outlet after heat recovery unit; 5. Drying chamber; 6. Air outlet after drying chamber. Fig. 2, Fig. 3, Fig. 4 shows temperature and relative humidity during drying at 30 °C, 40 °C, and 50 °C. Observations were conducted until the peanut reaches 10-11% of water content. All of the drying temperatures show that drying with a dehumidifier machine resulted in constant air temperature and relative humidity at the drying chamber during the drying period. The average drying temperature at 30 °C is 31.81±3.41 °C; 40 °C is 31.81±3.41 °C, and 50 °C is 53.61±1.85 °C. Then the relative humidity in the drying chamber at temperatures of 30 °C, 40 °C, 50 °C, respectively, 34.45±3.02; 38.97±3.46 and 28.63±3.15, this humidity is lower than the ambient humidity.

Table 2. The distribution temperature and relative humidity .

Position	Temperature (°C)	Relative Humidity (%)	Temperature (°C)	Relative Humidity (%)	Temperature (°C)	Relative Humidity (%)
Ambient	27.6±1.20	69±2.44	29.34±1.76	69.33±5.94	30.13±1.91	64.15±6.41
Dehumidifier Unit	13.96±0.71	88.54±3.81	16.29±0.58	88.32±1.88	15.82±2.10	86.56±6.46
Air outlet after dehumidifier unit	12.18±1.53	89.11±2.43	16.92±0.62	90.57±5.67	14.97±2.93	89±3.68
Air outlet after heat recovery unit	22±1.34	55.40±6.35	23.15±1.21	63.67±6.13	23.07±3.15	60.28±3.91
Drying chamber	31.81±3.41	34.45±3.02	44.08±3.12	38.97±3.46	53.61±1.85	28.63±3.15
Air outlet after drying chamber	50.17±4.74	28.20±3.10	51.62±4.19	26.14±3.11	60.25±2.75	18.66±1.08

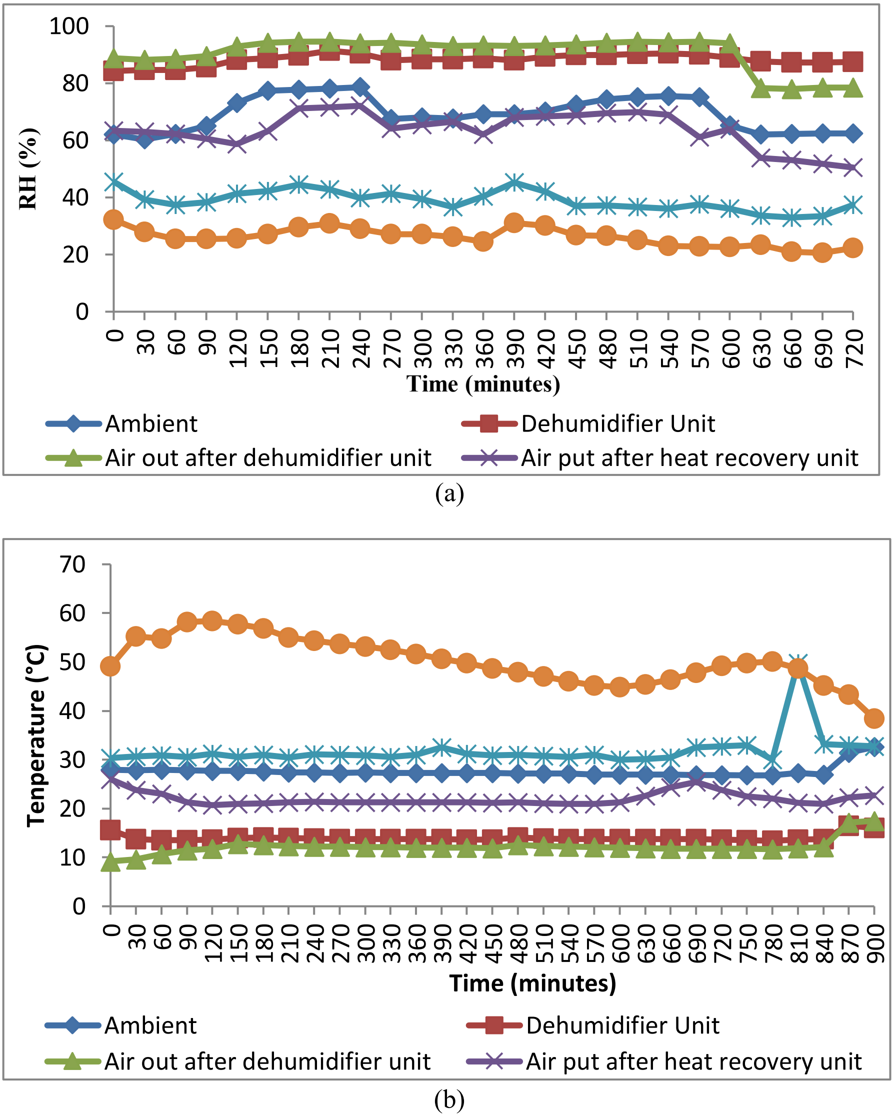
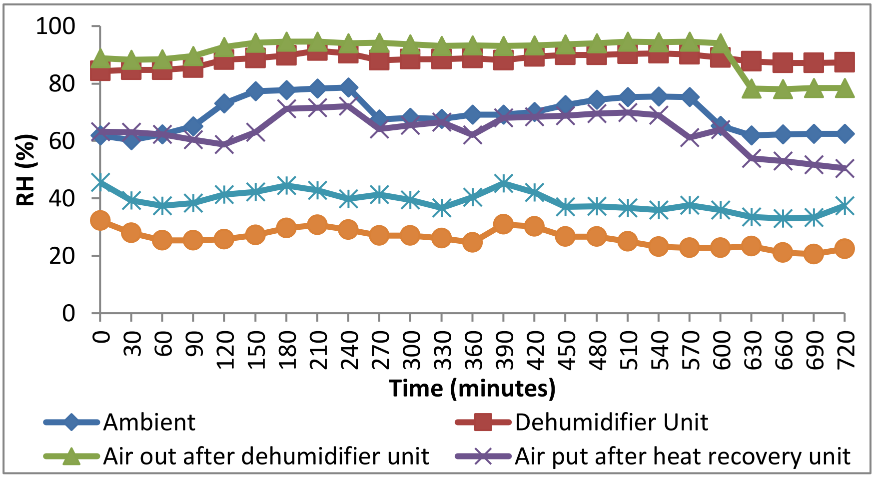
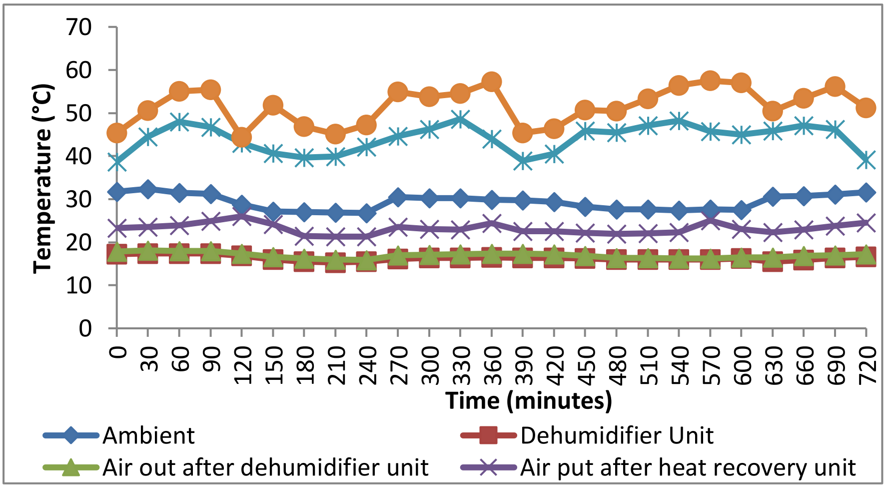


Fig. 2. The temperature (b) and relative humidity (a) at 30 °C



(a)



(b)

Fig. 3. The temperature (b) and relative humidity (a) at 40 °C

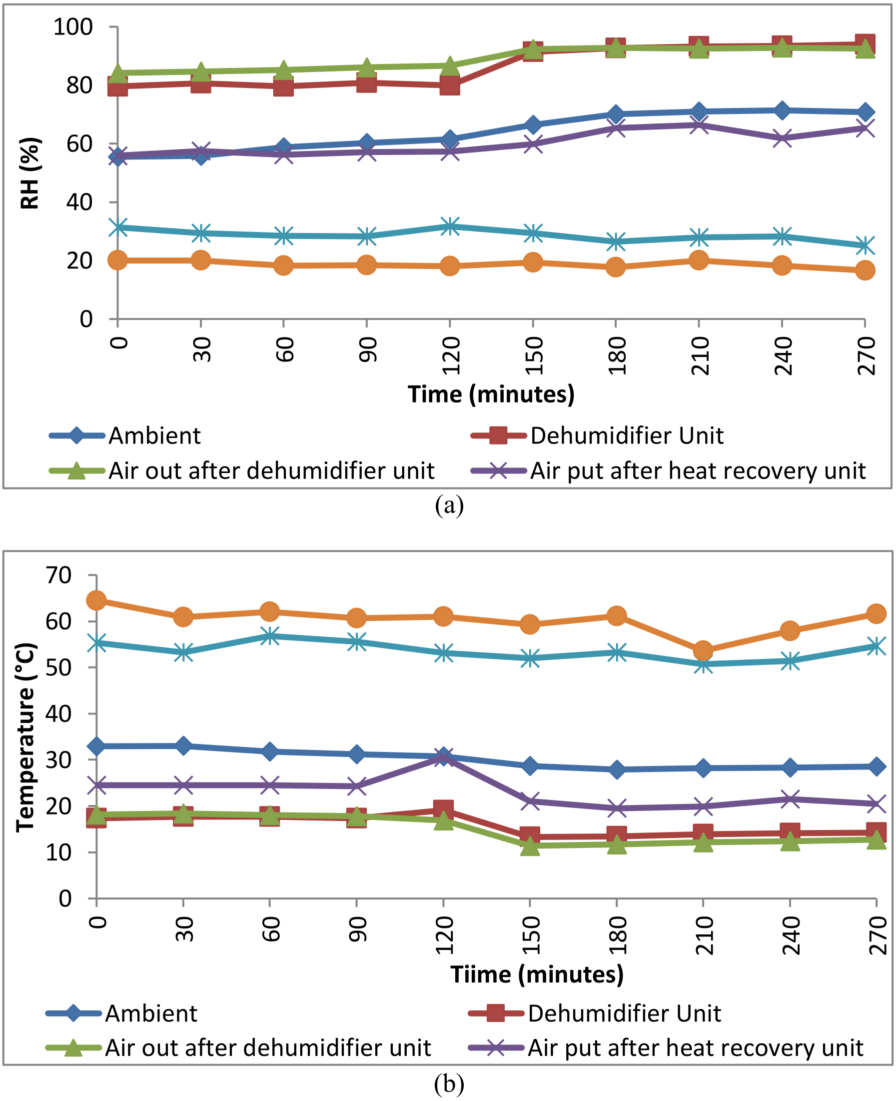
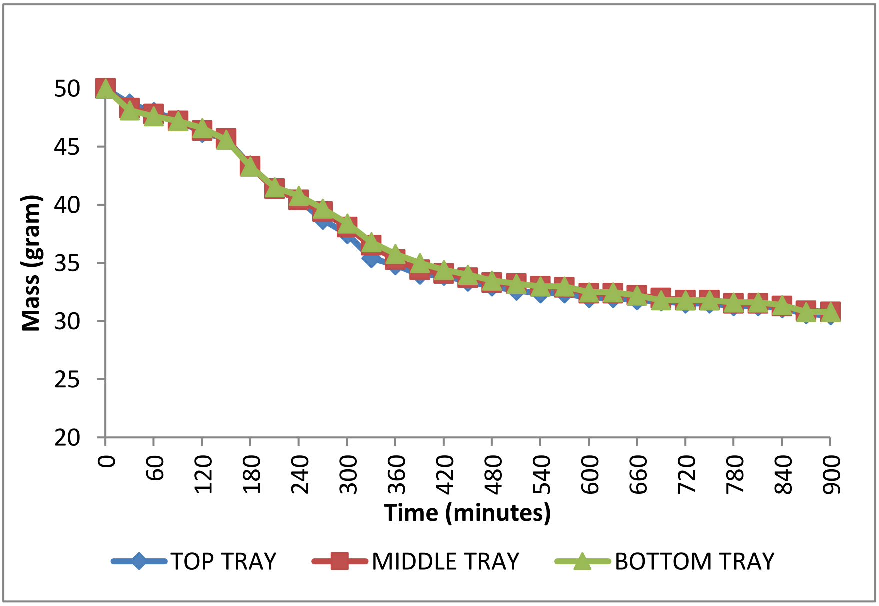


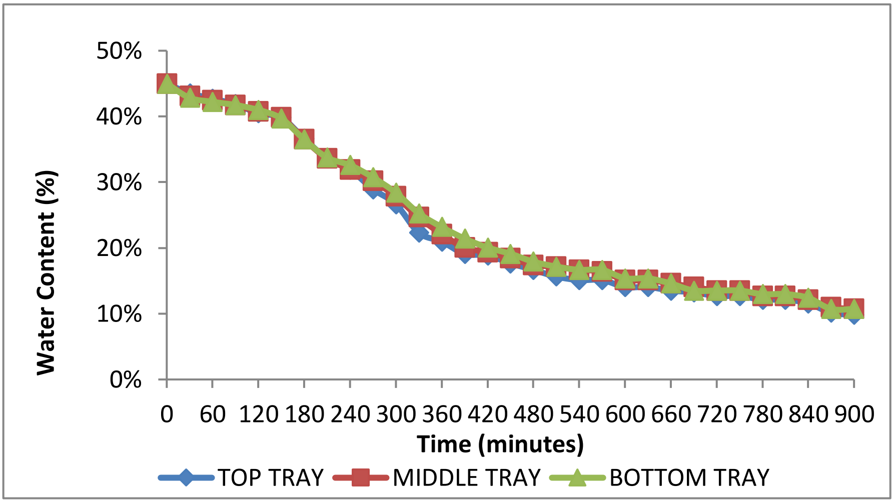
Fig. 4. The temperature (b) and relative humidity (a) at 50 °C

3.2 Moisture Content and Mass Reduction

Fig. 5, Fig. 6, and Fig. 7 shows the decreased moisture content rate with drying time for peanut seeds at 30 °C, 40 °C, and 50 °C. The drying temperature increased with decreasing the drying time. Total drying time from the initial moisture content to the final 9-11% (wet basis) were 15 h, 14 h, 4.5 h, samples dried at 30, 40, 50 °C, respectively. The temperature of 50 °C obtained the fastest drying time (4.5 h). The calculation of moisture content is based on the decrease in soybean mass during drying which is observed every 30 minutes. The initial moisture content of soybeans was 14.32% and drying conducted until 9-11%. All three drying temperatures show a steady decrease in moisture content. The fastest decrease in moisture content occurs in the upper tray due to the hot air flowing from the side and will gather at the top of the drying chamber. Figure 3 indicates a decrease in mass during drying time with the same temperature. The temperature of 50 °C possesses the fastest drying time (4.5 h) with the dried peanut seeds top tray, middle tray, and down tray, respectively containing 29.5 g; 30.4 g; 30.8 g. The temperature of 30 °C exhibited the slowest drying time (15 h) with the dried peanut seeds top tray, middle tray, and down tray, respectively containing 30.5 g; 30.8 g; 30.8 g.

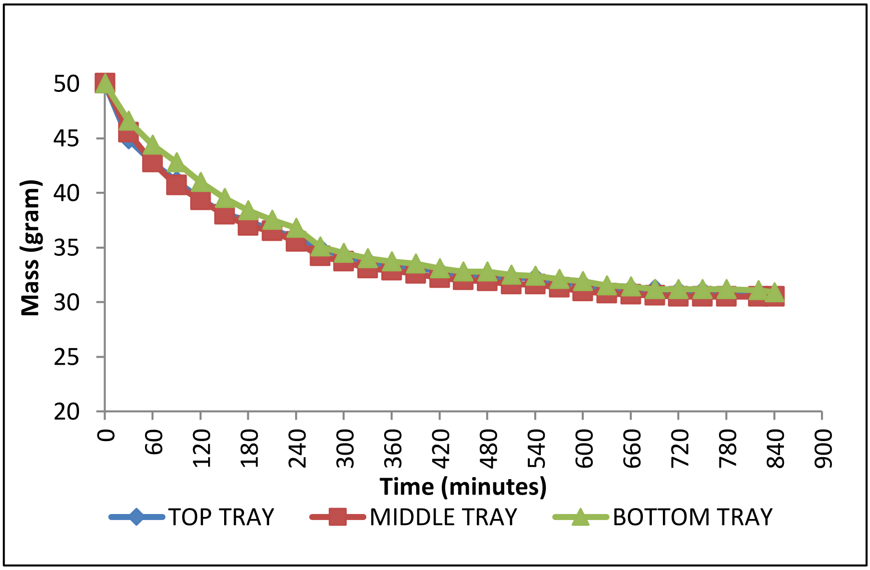


(a)

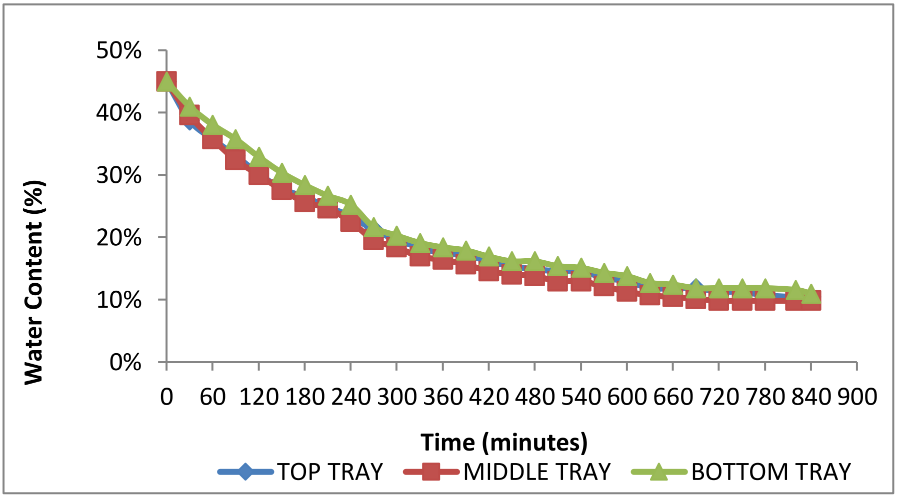


(b)

Fig. 5. Mass reduction (a) and water content (b) during drying at 30 °C

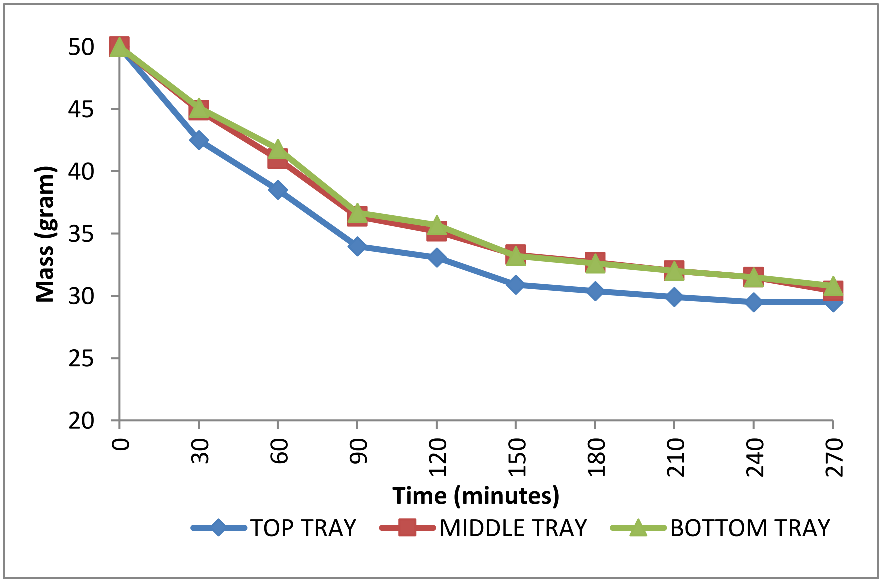


(a)

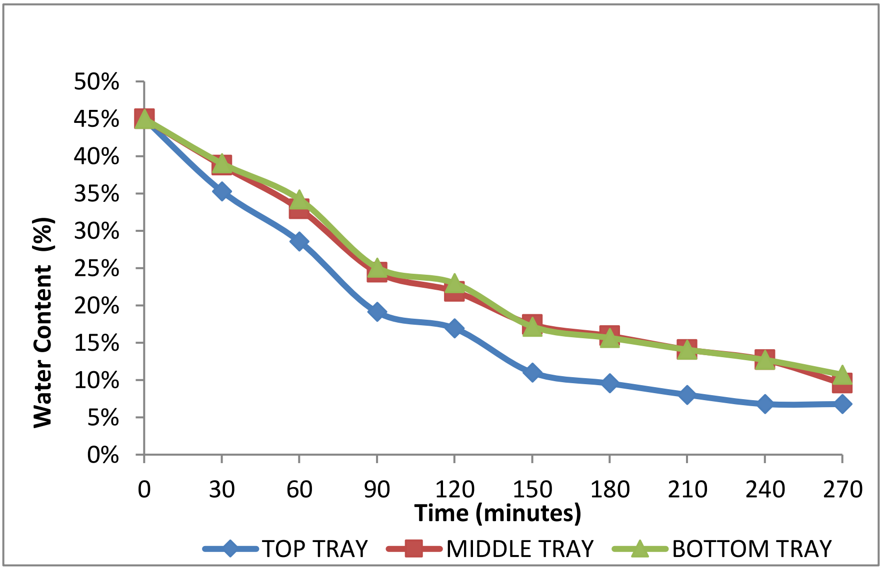


(b)

Fig. 6. Mass reduction (a) and water content (b) during drying at 40 °C



(a)



(b)

Fig. 7. Mass reduction (a) and water content (b) during drying at 50 °C

3.3 Energy Consumption

Energy use is obtained from the total power of components such as heaters, dehumidifiers/AC, fan, blowers, and electronic circuits used during the drying process and the results are multiplied by the length of drying time. The total electric power which is 1,98781 kWatt is then multiplied by the drying time in hours. The results of the total electric power at each drying temperature will be different, because the drying time is different too. In drying with a temperature of 50 °C, the drying time is 4.5 hours so that the energy produced by the dryer is 8.945145 kWh or 7961.482928 kcal. In drying with a temperature of 40 °C, the drying time is 12 hours and the total energy yield is 23,85372 kWh or 20510,62114 kcal. Meanwhile, drying at 30 °C requires a drying time of 15 hours with a total energy of 29.81715 kWh or 25638.27643 kcal.

3.4 Peanut Seeds Drying Energy

Peanut Seeds Heating Energy. Calculation of heating energy of peanut seeds is used to determine the amount of heat needed to raise the temperature of the material to the drying air temperature. The mass of groundnut seeds before drying is 0.15 kg. It is known that the Cp or specific heat of peanuts is 2.7 kJ/kg°C [12]. The energy yield of peanut (Qkpeanut) seed heating for drying temperatures of 30 °C, 40 °C, and 50 °C was 2,09876 kcal, respectively; 3.14819 kcal; and 4.19753 kcal.

Peanut Seeds Water Energy. Calculation of heating energy of peanut seed water is used to determine the amount of energy used to heat the water contained in peanut seeds. or the specific heat of water used is 1 kCal/°C or 4200 J/Kg°, and t is the difference between the average temperature of the drying air and the temperature of the material. The energy yield of heating peanut seed water for drying temperatures of 30 °C, 40 °C, and 50 °C was 1.115537696 kcal, respectively; 1.670857 kcal; and 2.2309 kcal.

Peanut Seeds Water Evaporation Energy. The calculation of the amount of evaporation energy of peanut seed water is obtained from the product of the weight of the water displaced (Wr) and the enthalpy of evaporation (hfg). The energy yield of peanut water evaporation (Ql) on drying with drying temperatures of 30 °C, 40 °C, and 50 °C, respectively, was 67.91725 kcal; 67.80339 kcal; and 68,18311 kcal.

4 Conclusion

The distribution of temperature and humidity in the dehumidifier drying machine showed stable results at six observation points for the three temperatures. The average temperature in the drying chamber with drying temperatures of 30 °C, 40 °C, and 50 °C, respectively, was 31.81±3.41°C; 31.81±3.41°C, and 53.61±1.85 °C, then the RH in the drying chamber with drying temperatures of 30 °C, 40 °C, and 50 °C were 34.45±3.02, respectively; 38.97±3.46 and 28.63±3.15. The drying temperature increased with decreasing the drying time. Total drying time from the initial moisture content to the final 9-11% (wet basis) were 15 h, 14 h, 4.5 h, samples dried at 30, 40, 50 °C respectively. The temperature of 50 °C obtained the fastest drying time (4.5 h). The higher the drying temperature, the faster the time required. Drying using a dehumidifier machine takes a faster time than natural drying with the sun.

References

1. Siregar, S. H., Mawarni, L., Irmansyah. : Growth and production of peanut (Arachis hypogea L.) with multiple cultivation systems soil and microbial association. Journal Agroekoteknologi FP USU, 5(1), 202-207 (2017).
2. Safira, N., Sibarna, S., Sonbardini, D. : Increasing result and quality components of peanut (Arachis Hypogaea L.) through bokashi and p fertilization. Journal Agroteknologi, 11(1), 55-60 (2017).
3. Ningsih, N. N. D. R., Raka, I. G. N., Siadi, I K. : Testing the quality of seeds of several types of plants horticulture circulating in Bali. E-Journal Agroekoteknologi Tropika, 7(1), 64-72 (2018).

4. Kolo, E., Tefa, A. : Effect of storage conditions on viability and vigor of tomato seed (Lycopersicum esculentum, Mill). E-Journal Agroekoteknologi Tropika, 7(1), 64-72 (2016).
5. Dewi, N. N. T. K., Nyana, I. D. N., Raka, I. G. N. : Effect of rhizobacteria on yield and seed quality peanut (Arachis hypogaea L.). E-Journal Agroekoteknologi tropika, 7(4), 593-603 (2018)
6. Wahyuni, A., Simarmata, M. M., Isrianto, P. L., Junairiah, J., Koryati, T., Zakia, A., Andini, S. N., Sulistyowati, D., Purwaningsih, P., Purwanti, S., Indarwati, L.K., Herawati, J. : Teknologi dan produksi benih. Yayasan Kita Menulis, Medan (2021).
7. Handayani S. U., Rahmat, R., Darmanto S. : Uji unjuk kerja sistem pengering dehumidifier untuk pengeringan jahe. AgriTECH, 34, 232-238 (2014).
8. Susilo, B., Hermanto, M.B., Mujahidin, A., Djoyowasito, G., Damayanti, R. : Performance of drying machine with air dehumidifying process for sweet corn seed (Zea mays saccharata). In: IOP Conference Series: Earth and Environmental Science: IOP Publishing, 1-10 (2020).
9. Association of Official Analytical Chemists – AOAC : Official methods of analysis (16th ed.). Washington, DC: AOAC (1995).
10. Corbin, F. T. : World Soybean Research Conference II. CRC Press, Vienna (2019).
11. Kudra, T. : Energy aspects in drying. Drying Technology Journal, 22(5), 917-932 (2004)
12. Bitra, Venkata S.P., Banu, Shamina, Ramakrishna P., Narender G. : Moisture dependent thermal properties of peanut pods, kernels, and shells. Biosystems Engineering, 106(4) (2013).