Journal of Agriculture

Journal of Agriculture (JoA)
Volume: 3 | Number 3 | November 2024
E-ISSN: 2829-2421
https://doi.org/10.47709/joa.v3i03.4911

Optimization of Drying Models for Various Types of Turmeric Using A Tray Dryer

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Received: 2024-11-02
Accepted: 2024-11-13
Publication: 2024-11-13

Abstract
Turmeric (Curcuma domestica val) is one of the plants that has benefits including as spices, seasonings, herbs, to maintain health and beauty and utilization as traditional medicine. Drying is a method to extend the shelf life and maintain the quality of a post-harvest product before further processing. This study aims to optimize the thin layer drying model on various types of turmeric (white turmeric, black turmeric and yellow turmeric). Data obtained from drying results in the form of initial mass, mass during drying and the final mass of drying. Then processed to obtain the wet base moisture content, dry base moisture content and Moisture Ratio. The thin layer drying model is obtained by finding the constant value of k, a and n from each exponential form. Determination of constants using Solver Tool Microsoft Excel that automatically searches for constant values in each dryer model tested, then obtains the highest R^2 value as the best model that describes the drying model of black turmeric and yellow turmeric. From the test results of curcumin content in white turmeric, black turmeric and yellow turmeric where the content of yellow turmeric has a higher value than both turmeric because it has an almost perfect arrangement of chemical elements. In the pH test, the highest result was obtained in white turmeric, namely 4.8 where the less curcumin contained in the turmeric rhizome, the higher the level of acidity of the turmeric.

Keywords: curcumin, turmeric, mathematical model, drying, pH.

Introduction

Turmeric is an herb with the Latin name *Curcuma longa Koen* or *Curcuma domestica Val*. The main compounds contained in turmeric rhizomes are curcuminoid compounds, which give turmeric its yellow color. Curcuminoids are at the center of attention of researchers studying safety, antioxidant properties, anti-inflammatory, cancer-preventing effects, plus their ability to reduce the risk of heart attack (Asghari *et al*., 2009). The substances contained in turmeric are fat 1-3%, carbohydrate 3%, protein 30%, starch 8%, vitamin C 45-55%, iron, phosphorus, and calcium. *Curcumin* (1,7-bis(4-hydroxy-. 3-methoxyphenyl)-1E,6Eheptadiene-3,5-dione or diferuloyl methane), which is produced can be used as a medicine in diabetes and kidney failure (Trujillo *et al*., 2013).

Drying is the evaporation of water into the air due to the difference in water vapor content between the air and the material being dried (Yao, 2016; Xie *et al*., 2017). Drying also aims to reduce the moisture content of the material to the extent that the development of microorganisms and enzyme activities that can cause decay are inhibited or even stopped (Morgan *et al*., 2006;

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Lorentzen *et al*., 2015). Thus, the dried material has a longer shelf life (Sangwan *et al*., 2012; Chan *et al*., 2013).

The drying process is influenced by many factors including drying air conditions, internal properties of the material, drying kinetics controlled by the magnitude of the drying constant, moisture content, drying air velocity, diffusivity of water in the material and thickness of the material (Istadi, 2002).

Kinetics of drying models on some agricultural materials that describe changes in water content have been widely done, but the drying model of 3 types of turmeric has not been found. Based on this explanation, this study aims to optimize the thin layer drying model on various types of turmeric (white turmeric, black turmeric and yellow turmeric).

Literature Review

Turmeric (Curcuma domestica Val) is a spice and medicinal plant native to Southeast Asia. Turmeric is one type of herbaceous plant included in the Zingiberaceae family which has a pseudo-stem formed from the midrib of its leaves. The height of the plant can reach 1.0 -1.5 meters, the leaves are about 20-40 cm long and about 15-30 cm wide. The rhizome is broadly lancet-shaped, flat-edged, tapered at the tip and base. The skin of the rhizome is brownish in color and the inside is dark yellow, orange yellow, or reddish orange yellow to brown (Hartati 2013).

One of the postharvest handling efforts to extend the shelf life of turmeric is by drying. Drying is one of the most critical post-harvest handling stages in determining quality. So far, the drying that is usually done in Indonesia is traditional drying by drying or smoking. Natural drying under direct sunlight is highly dependent on fluctuating weather conditions so that the dried material is easily damaged, moldy and can be damaged by insects. The drying method needed to dry turmeric is using an artificial dryer or drying machine. Artificial drying is a drying method in which the drying operation uses the help of a dryer. Some factors that affect the drying speed are the temperature and humidity of the environmental air, the percentage size, the speed of the drying air flow, the water content, the drying power, the efficiency of the drying machine and its drying capacity.

Drying technology is a very promising alternative method in maintaining a longer shelf life, besides this technology is the simplest and easiest processing technique to do. Tray Dryer/Cabinet Dryer is a multilevel dryer using hot air in a closed space, this drying technology is suitable for drying noodles and other materials that are easily sensitive to heat and moldy materials. Tray dryers are convection dryers that use a stream of hot air to dry the product. The drying process occurs when this hot air stream is in direct contact with the surface of the product to be dried. The product is placed on each shelf arranged in such a way that it can be dried perfectly. Hot air as a working fluid for this model is obtained from burning fuel, solar heat or electricity. The relative humidity of the air, which is a limiting factor in the ability of the air to evaporate water from the product, is very much considered by regulating the entry and exit of air from this dryer (Thaib et al, 2008).

The drying process with a tray dryer is categorized as a process with a fairly efficient level of energy use efficiency, the energy used is only a little and is done using air temperatures that are not too high around (70^{o}C-80^{o}C) for the drying process of dry noodles, although it has not been widely utilized by large-scale industries, and this drying process is suitable for use in small-scale or home-scale industries (Thaib et al, 2008).

Research Method

The materials used in this study are white turmeric, black turmeric and yellow turmeric.

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The material used in the Antioxidant test and pH test is ethanol. The tools used in this study are knives, cutting boards, tray dryers, ovens, basins, spoons, digital scales, blenders and trays, 100 mL measuring cups, Petri dishes, spectophotometry, pH measuring instruments, test tubes and digutal scales. Determination of the coefficients of the model using Solver Tool Microsoft Excel.

The parameters observed in this study were changes in the weight of black turmeric and yellow turmeric to near constant. The mass change was converted into moisture content including wet base moisture content (Kabb, %) and dry moisture content (kabk, %).

Data obtained from drying results in the form of initial mass, mass during drying and the final mass of drying. Then processed to obtain wet basis moisture content, dry basis moisture content and Moisture Ratio.

The thin layer drying model is obtained by finding the constant values k, a and n of each exponential form. Determination of constants using Solver Tool Microsoft Excel that automatically searches for constant values in each dryer model tested, then obtains the highest R^2 value as the best model that describes the drying model of black turmeric and yellow turmeric.

Results and Discussion

Moisture Content During Drying

In the Thin Layer drying process carried out during research on white turmeric, black turmeric and yellow turmeric with temperatures of 40ºC and 50ºC. In the results of the study it was found that at every 30 minutes of weighing the results of the thin layer drying process of white turmeric, black turmeric and yellow turmeric experienced a continuous decrease in water content, so the gerafik results obtained are as follows:

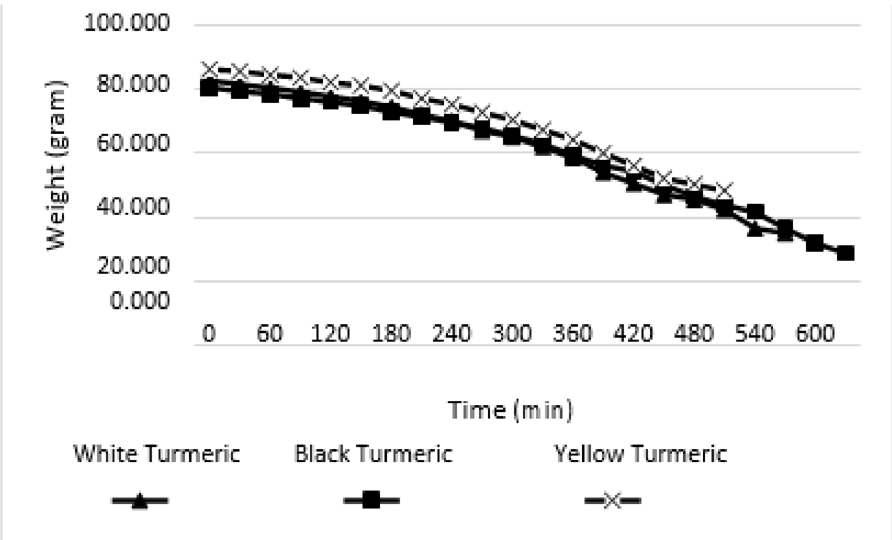

Figure 1. Graph of moisture content of wet base at 40ºC during the drying process of white turmeric, black turmeric and yellow turmeric.

In Figure 1. shows that turmeric with a thickness of 6 mm each and an initial weight of 50 grams obtained that in the drying process the three types of turmeric at 40ºC require different times to approach a constant value where white turmeric takes 570 minutes or 9.30 hours to approach a constant value, black turmeric takes 630 minutes or 10.30 hours to approach a constant value and yellow turmeric takes 510 minutes or 8.30 hours to approach a constant value.

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E-ISSN: 2829-2421
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At 40ºC white turmeric has an initial wet base moisture content value with an average of 82.667% and an average final wet base moisture content of 32.162%, black turmeric with an average initial wet base moisture content of 80.467% and an average final wet base moisture content of 28.883%, yellow turmeric with an average initial wet base moisture content of 82.6% and an average final wet base moisture content of 48.379%.

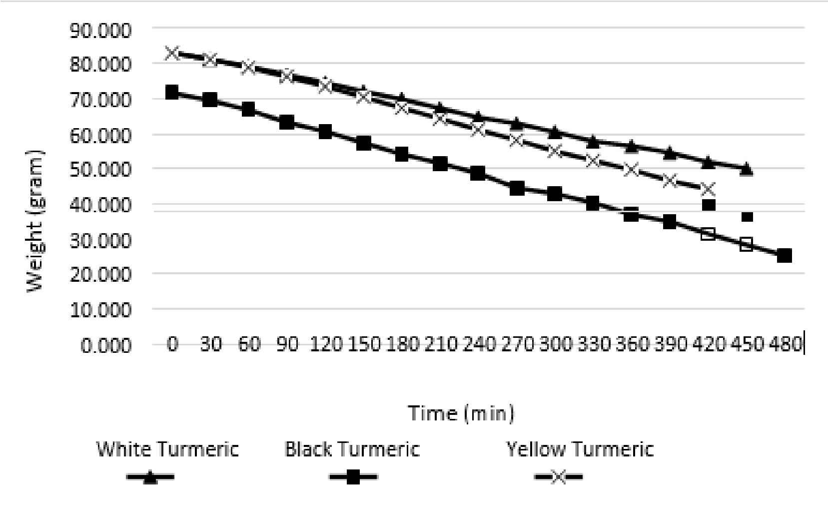

Figure 2. Graph of moisture content of wet base at 50ºC during the drying process in white turmeric, black turmeric and yellow turmeric

Figure 2. shows that at 50ºC yellow turmeric takes 450 minutes or 7.30 hours to approach a constant value, black turmeric takes 480 minutes or 8 hours to approach a constant value and yellow turmeric takes 420 minutes or 7 hours to approach a constant value. According to Istadi (2002), the higher the temperature used results in a small relative RH which becomes an increase in the thrust force between the surface of the material and the heat of the air so that there is an increase in water vapor in the material. According to Aslam (2015) drying takes place quickly to get equilibrium moisture content is also influenced by the thinness of the material used.

At 50ºC, white turmeric has an initial wet base moisture content value with an average of 83.067% and an average final wet base moisture content of 50.196%, black turmeric with an average initial wet base moisture content of 71.667% and an average final wet base moisture content of 25.439%, yellow turmeric with an average initial wet base moisture content of 83.067% and average final wet base moisture content of 44.298%.

Drying Rate

The Thin Layer drying process was carried out on white turmeric, black turmeric and yellow turmeric with temperatures of 40ºC and 50ºC, each material has a different drying rate and every 30 minutes experienced different increases and decreases, this is because during the drying process the water content (evaporation) unity time fluctuations in electrical voltage occur (Tulliza, 2010), but at the end of drying the drying rate began to slow down which indicates that the material began to approach the weight or constant value. The drying rate can affect the evaporation of bound water in the material or unbound water from the material which results in a decrease until it reaches a constant weight or value (Ismadari, 2008).

Modeling

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Modeling was carried out on research on white turmeric, black turmeric and yellow turmeric with the Newton, Page, Modified Page, Henderson Pabis, Logarithmic, and Midilli et al. mathematical models. In determining the drying model where to determine the constants first using the Solver tool Ms.excel which can minimize the difference of constants k, a and n in MR predictions and MR observations (Aslam, 2015).

The appropriate drying model for white turmeric, black turmeric and yellow turmeric at 40ºC and 50ºC is the Page model with a R^2 value of 0.99115 white turmeric, 0.98718 black turmeric and 0.98878 yellow turmeric. At a temperature of 50ºC with a R^2 value of 0.9953 white turmeric, 0.9989 black turmeric and 0.9991 yellow turmeric. The graph above can show that the greater the value of R^2 or the coefficient of determination where the model is said to be perfect if $R^2 = 1$ or $0.8 < R^2 < 1$ as a benchmark (Humair, 2014). The closer the MR value of observation and MR prediction indicates the relationship between the models used (Aslam, 2015).

Antioxidant Test

Antioxidants are widely contained in turmeric rhizomes which include phenolic compounds where the higher the phenolic compound, the higher the curcumin content in turmeric rhizomes (Malahayati, 2021).

Yellow turmeric rhizome has a high curcumin content value compared to the other two kuyit, namely yellow turmeric 14.24, white turmeric 13.46 and black turmeric 0.2. Yellow turmeric has a complex chemical composition that causes the high antioxidant content in yellow turmeric to be higher, while white turmeric has elements of alkaloid compounds, phenolics and saponins where not all alkaloids have antioxidant abilities (Malahayati, 2021).

The difference in phenolic content in the three types affects the height of the antioxidant compounds possessed by each turmeric which is influenced by differences in several factors such as soil content, photosynthesis, light availability and others (Malahayati, 2021).

pH test

The test results show that at 40 ºC, yellow turmeric has an acidity value of 4.2, white turmeric 4.8 and black turmeric 4.4. at temperature 50 ºC yellow turmeric had an acidity value of 4.1, white turmeric 4.4 and black turmeric 4.3. The pH test was conducted to see the effect of drying temperature on the acidity level of turmeric at the standard of public consumption. According to Sutrisna in Rahardianti (2022) the level of acidity in turmeric rhizomes generally bacteria can develop at pH 6-8, while the results of the pH test conducted were the highest at 4.8. Turmeric has a pH level of acidity where if it undergoes a drying process, turmeric releases vanillin, ferulic and vanillic acids which cause turmeric to become acidic (Ananingsih, 2017).

Conclusion

From the calculation of water content in the three types of turmeric, it was found that at 40ºC white turmeric had an initial wet base water content value with an average of 82.667% and the final wet base water content averaged 32.162%, black turmeric with an average initial wet base water content of 80.467% and an average final wet base water content of 28.883%, yellow turmeric with an average initial wet base water content of 82.6% and an average final wet base water content of 48,379%. and at 50ºC white turmeric has an initial wet base moisture content value with an average of 83.067% and an average final wet base moisture content of 50.196%, black turmeric with an average initial wet base moisture content of 71.667% and an average final wet base moisture content of 25.439%, yellow turmeric with an average initial wet base moisture content of 83.067% and an average final wet base moisture content of 44.298%.

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From the results of the adjustment of the calculation model carried out, it is found that in the three types of turmeric, namely white turmeric, black turmeric and yellow turmeric at a mathematical model of 40ºC temperature and 50ºC temperature according to the page model.

From the test results of curcumin content in white turmeric, black turmeric and yellow turmeric where the content of yellow turmeric has a higher value than the two turmeric because it has an almost perfect arrangement of chemical elements. In the pH test, the highest result was obtained in white turmeric, namely 4.8.

References

Asghari, G, A., Mostajeran, A., dan Shebli, M. 2009. Curcuminoid and Essential Oil Components of Turmeric at Different Stages of Growth Cultivated. Research in Pharmaceutical Sciences. 4(1):55.

Chan, E, W, C., Lye, P, Y., Eng, S, Y., dan Tan, Y, P. 2013. Antioxidant Properties of Herbs with Enhancement Effects of Drying Treatments: A Synopsis. Free Radicals and Antioxidants. 3(1):2-6.

Hartati, 2013. Analisis Mutu Kimia Simplisia Kunyit Turina (Curcuma Longga L) dengan Lama Pengeringan Berbeda. Skripsi. Agroteknologi. Pekanbaru: Fakultas Pertanian dan Ternak Universitas Islam Sultan Syarif Kasim Riau.

Ismadari T, Lukmanul H, Chusnul H. 2008. Pengeringan Kacang Tanah (Arachis hypogeae, l) Menggunakan Solar Dryer. Jurnal Teknik Pertanian. Yongyakarta: Universitas Gadjah Mada

Istadi, Sumardiono, Soetrisnanto. 2002. Penentuan Konstanta Pengeringan dalam Sistem Pngeringan Lapis Tipis (Thin layer drying). Jurnal Teknologi Proses Kimia. Semarang: Universitas Diponegoro.

Lorentzen, G., Breiland, M, S, W., Ostli, J., Wang, A, J., dan Olsen, R, L. 2015. Growth Of Halophilic Microorganisms And Histamine Content In Dried Saltcured Cod (Gadus morhua L.) Stored At Elevated Temperature. LWTFood Science and Technology. 60(1):598-602.

Malahayati N, Tri W.W, Anita F. 2021. Karaktiristik Ekstrak Kurkumin dari Kunyit Putih (Kaemferia rotunda l.) dan Kunyit Kunning (Curcuma domestica val.). Jurnal AgriTECH. Palembang: Universitas Sriwijaya.

Morgan, C, A., Herman, N., White, P, A., dan Vesey, G. 2006. Preservation of Micro-Organisms By Drying; A Review. Journal of Microbiological Methods. 66(2):183-193.

Rahardianti F. P, Laras R, Eko N. D. 2022 Penggunaan Konsentrasi Kunyit yang Berbeda terhadap Mutu Bekasam Ikan Nila. Jurnal Pangan dan Gizi. Semarang: Universitas Diponegoro.

Sangwan, A., Kawatra, A., dan Sehgal, S. 2012. Nutrient Composition of Mint Powder Prepared From Various Drying Methods. Nutrition & Food Science. 42(1):21- 25.

Tulliza I. S, Armansyah H, Tambunan, Usman A. 2010. Pengaruh Penyusutan Temu Putih (Curcuma zedoaria (Berg) roscoe) Terhadap Karakteristik Pengeringan Lapis Tipis.Jurnal Keteknikan Pertanian. Makassar: Universitas Hasanuddin.

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E-ISSN: 2829-2421
https://doi.org/10.47709/joa.v3i03.4911

Thaib, G., G. Said., dan S. Wiratmadja. 2008. Operasi Pengeringan Pada Pengolahan Hasil Pertanian. Jurnal Pangan. Bandung.

Trujillo, J., Chirino, Y, I., Moliana, Jijon, E., Anderica, Romero, A C., Tapia, E T., Pedraza, dan Chaverri, J. 2013. Renoprotective Effect of the Antioxidant Curcumin: Recent Findings. Redox Biology. 1(1):448- 456.

Yao, Y. (2016). Enhancement of mass transfer by ultrasound: Application to adsorbent regeneration and food drying/dehydration. Ultrasonics Sonochemistry, 31, 512–531. https://doi.org/https://doi.org/10.1016/j.ultsonch.2016.01.039

Xie, Y., Gao, Z., Liu, Y., dan Xiao, H. 2017. Pulsed Vacuum Drying of Rhizoma Dioscoreae Slices. LWT-Food Science and Technology. 80:237-249.

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