International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

Check for updates

Comparison of drying methods for agricultural products applying in traditional medicine

Nguyễn Văn Lực [1] and Trần Văn Hiếu [2,*]

[1] *President, Nha Trang College of Engineering Technology, Nha Trang 650000, Khanh Hoa, Vietnam.*
[2] *Head of Refrigeration Department - Faculty of Electrical – Electronics. Nha Trang College of Engineering Technology, Nha Trang 650000, Khanh Hoa, Vietnam.*

International Journal of Science and Research Archive, 2024, 11(01), 2540–2543

Publication history: Received on 03 January 2024; revised on 20 February 2024; accepted on 23 February 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.11.1.0222

Abstract

Drying medicinal herbs is one of the necessary methods to maintain a stable quality of medicinal herbs. Currently, there are many methods of drying medicinal herbs, such as sun drying, freeze drying, infrared drying, ultrasonic drying, microwave drying, and convection drying. Each method produces different quality medicinal materials with advantages and disadvantages in productivity, product quality, energy costs, and applications. Therefore, the paper focuses on other methods of drying agricultural medicinal herbs with the above issues, such as a basis for scientists and manufacturing enterprises to choose appropriate drying methods.

Keywords: Application; Agriculture; Drying; Medicine; Traditional

1. Introduction

The drying method of agricultural products is not mainly in traditional medicine, but it is applied in the preservation and processing of some herbs and medicinal foods. Here are some roles of drying methods in this context: Preservation of product quality through drying that is effective to remove water from agricultural products, preventing the growth of bacteria, mold and harmful bacteria [1-4]. The thing helps preserve the quality of herbs and medicinal foods, prevent decomposition and minimize nutrient loss. Convenience of use is enhanced. Dried products can be easier to store and transport than fresh products [5,6]. The creates convenience in the use and consumption of herbs and medicinal foods in traditional medicine. Risk reduction of contamination using drying method to help reduce the risk of environmental pollution and loss due to damage by bacteria and mold. Reducing water in the product also helps prevent the growth of harmful microorganisms to health [7]. Improvement of stability and durability of chemical components in herbs and medicinal foods also get effective using drying method. The help maintain the potency and effectiveness of products over time, which is necessary in traditional medicine [8-10]. However, the drying methods can also affect some nutritional and active ingredients in herbs and medicinal foods. The thing should also be noted. The drying should be considered to ensure for the maintain of the product quality and effectiveness.

Different drying methods can be found, such as convection drying [4], solar drying [11], infrared freeze drying [1-3, 12,13], IR drying [14], microwave combined drying [15,16], and ultrasonic combined drying [17,18]. However, no publications exhibit drying methods according to energy costs, production scale, operating principles, applications, wind speed, price, and product quality. Therefore, this article focuses on the issue just mentioned.

* Corresponding author: Trần Văn Hiếu; Email: vanhieutran79@gmail.com

2. Material and methods

Documents related to drying medicinal herbs from agricultural sources such as freeze drying, infrared drying, convection drying, ultrasonic drying, microwave drying with energy calculations, costs, production scale production, operating principles, applications, and product quality when applying the above drying method, were used in this study. Besides, the methods of expert and empirical are applied.

3. Results and discussion

Currently, many different agricultural drying methods applied to preserve and process medicine products from agricultural. Here are some common types:

- Sun drying: Using solar energy to dry agricultural products. Traditional and popular method in many rural areas.
- Convection freeze drying: Use cold air to absorb and remove moisture from the product. Suitable for agricultural products such as vegetables, fruits and processed foods. Drying temperature is from 125 °C to 50 °C with the drying time of 20 min to 116 min [1, 9,10].
- Infrared radiation drying: Infrared rays give heat energy to the product and evaporate water. Product quality could be maintain better than convection freeze drying. Drying temperature is from 40 to 60 °C [1,14].
- Ultrasonic drying: Mechanical sound waves create high temperature and pressure, evaporating water from the product. Suitable for products that are temperature sensitive and require speed.
- IR drying: Low frequency infrared waves transmit energy and dry products. Suitable for agricultural products and foods that require careful temperature control [14].
- Microwave drying: Microwaves using heat and dry the product from the inside, help dry quickly and maintain the original color and quality of the product. Drying power is about 8.0–11.2 W g^{-1} of mint [8, 14-16].
- Vacuum drying: Creates a vacuum environment to reduce pressure and the boiling point of water, evaporating water from the product. Suitable for products that need to preserve good taste and quality [5,16].

The following are operating principle, drying speed, drying capacity, cost and energy efficiency, product quality, and application of drying methods to each condition.

3.1. Operating principle

Convection Freeze Drying: Uses cold air to absorb and remove products moisture. Radiation-infrared freeze drying uses infrared rays to transmit heat energy to the product and evaporate water. Microwave drying: Generates microwaves to excite water molecules in the product, increasing the temperature and evaporating water. Ultrasonic-assisted drying creates the sound waves to form variable pressure points in the liquid, causing a cavitational effect and generating high temperature and pressure that evaporates the water. Low-frequency infrared drying: Uses low-frequency infrared waves to transmit energy and dry products. Vacuum drying: Creates a vacuum environment to reduce the pressure and boiling point of water, evaporating water from the product [19].

3.2. Productivity

Convection freeze-drying often apply large quantities of product and do more quickly than infrared radiation freeze-drying. Infrared Radiation Freeze Drying: Suitable for applications requiring precise temperature control and gentleness to the product. Suitable for large scale and can handle large quantities of products. Microwave drying is suitable for small to medium scale and used for household applications.

3.3. Drying speed

Infrared radiation freeze drying: Usually requires longer drying time than microwave drying and ultrasonic drying. Microwave drying: Can dry quickly due to direct effect on water molecules. Ultrasonic drying could dry quick and effective, especially in drying products with good water absorption. Low-frequency infrared drying depend on the specific device, rapid and uniform more. Vacuum drying is possible rapid drying more. It depend on the drying conditions and the product characteristics.

3.4. Cost and energy efficiency

Convection freeze drying usually has a higher initial investment cost, but can be more energy efficient in the large drying scale. Infrared radiation freeze drying could be more energy efficient in some cases, but may require high investment.

Infrared radiation freeze drying: Good energy efficiency can be achieved, especially in drying products with large thicknesses. Microwave drying is energy efficient, but temperature control and temperature uniformity in the demanding products in the complex control technology. Ultrasonic drying often more energy efficient in other applications because it can dry quickly and does not require direct exposure to high temperatures. Low-frequency infrared drying could have good energy efficiency, especially in drying products that require careful temperature control. Special equipment is demanded and is more expensive than some other methods. Vacuum drying: Usually good energy efficiency due to the reduction of the boiling point of water in a vacuum environment [20].

3.5. Product quality

Convection freeze drying reduce product quality due to the impact of cold air. Infrared radiation freeze-drying usually gives better results in terms of product quality because of non-cold air. Microwave drying cause changes in the structure and quality of the product, especially for temperature-sensitive foods. Ultrasonic drying provide good product quality, but performance may depend on specific product characteristics. Low-frequency infrared drying often maintains good product quality, especially in color and flavor. Vacuum drying also maintains product quality, keeping color and quality intact. Requiring special vacuum equipment and may have higher investment costs [21].

3.6. Application

Convection freeze drying is suitable for applications in the large scale products, such as in the food and chemical industries. Infrared radiation freeze-drying: Suitable for temperature-sensitive applications, such as organic foods or medical products. Ultrasonic drying: Suitable for small to medium applications, especially in the medical and research fields. Low-frequency infrared drying is suitable for drying products that need to maintain color and quality, such as processed foods, herbs, and medical products. Vacuum drying is suitable for a variety of products, for example, processed foods, pharmaceuticals, and industrial raw materials. Each method has its own advantages and limitations, and the choice between them often depends on the specific requirements of the drying process and the processed product.

4. Conclusion

The article analyzed and compared the advantages and disadvantages of infrared freeze drying, convection drying, sun drying, microwave drying, and ultrasonic drying in energy costs, product quality, production scale, operating principle, drying speed, and application of each drying method. This article will be valuable for analyzing and choosing methods of drying medicinal herbs from agricultural sources, which will minimize time and investment costs for the operation of medicinal herbs drying.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Kirsti P, Jukka H, Bertalan G, Markus P. Infrared drying of herb. Agricultural and Food Science in Finland. 1999; 8(8):19-27.

[2] Kemal ÇS. Investigating the influence of infrared drying method on linden (*Tilia platyphyllos* Scop.) leaves: Kinetics, color, projected area, modeling, total phenolic, and flavonoid content. Plants. 2020;9(7):916; https://doi.org/10.3390/plants9070916.

[3] Kathy A, Lisa G, Eric Y. The effect of freeze-drying and its implications for botanical medicine: a review. Phytotherapy Research. 2005; 19(8):655-60.

[4] Sultanova ShA, Safarov JE. Experimental study of the drying process of medicinal plants. International Journal of Psychosocial Rehabilitation. 2020; 24(08):962-1968.

[5] Akbudak N, Akbudak B. Effect of vacuum, microwave, and convective drying on selected parsley quality. International Journal of Food Properties. 2013; 16:205–215. doi: 10.1080/10942912.2010.535400.

[6] Guiné RPF, Pinho S, Barroca MJ. Study of the convective drying of pumpkin (*Cucurbita maxima*) Food and Bioproducts Processing. 2011; 89:422–428. doi: 10.1016/j.fbp.2010.09.001.

[7] Duygu A, Özcan B. The microbiological quality of various foods dried by applying different drying methods: A review. European Food Research and Technology. 2021; 247(6):1333–1343.

[8] Albert H, Joachim M. Microwave drying of medicinal and aromatic plants. Stewart Postharvest Review. 2007;3(4): 1-6.

[9] Grant T, Ingegerd S, Federico GG. A review of drying methods for improving the quality of dried herbs. Critical Reviews in Food Science and Nutrition. 2021; 61(11):1763-1786.

[10] Aneta K-S, Anna K, Katarzyna R, Magdalena L, Bogusław B. Modern methods of pre-treatment of plant material for the extraction of bioactive compounds. Molecules. 2022; 27(3):730. doi: 10.3390/molecules27030730.

[11] Thota SSBR, Murugan S. Solar drying of medicinal herbs: A review. Solar Energy. 2021;223: 415-436.

[12] Jiang GH, Lee KC, Ameer K, Eun JB. Comparison of freeze-drying and hot air-drying on Asian pear (*Pyrus pyrifolia* Nakai 'Niitaka') powder: Changes in bioaccessibility, antioxidant activity, and bioactive and volatile compounds. Journal of Food Science and Technology. 2019; 56:2836–2844. doi: 10.1007/s13197-019-03700-1.

[13] Armansyah HT, Yudistira, Kisdiyani, Hernani. Freeze drying characteristics of medicinal herbs. Drying Technology. 2001; 19(2):325-331.

[14] Karata F, Kamışlı F. Variations of vitamins (A, C and E) and MDA in apricots dried in IR and microwave. Journal of Food Engineering. 2007; 78:662–668. doi: 10.1016/j.jfoodeng.2005.10.040.

[15] Shafanaa J, Kandasamy S, Meghana S, Kavivarshini K. A study on the effect of microwave drying of herbs for determination of antioxidant activity. AIP Conference Proceedings 2387, 020004 (2021); https://doi.org/10.1063/5.0068563 Published Online: 01 November 2021.

[16] Therdthai N, Zhou W. Characterization of microwave vacuum drying and hot air drying of mint leaves (*Mentha cordifolia* Opiz ex Fresen). Journal of Food Engineering. 2009; 91:482–489. doi: 10.1016/j.jfoodeng.2008.09.031.

[17] Hay N, Quang-Huy L, Thanh-Dat L, Van-Kien P. Experimental research to determine the effect of ultrasound in drying bo chinh ginseng by ultrasound-assisted heat pump drying method. Applied Sciences. 2022; 12(22):11525; https://doi.org/10.3390/app122211525.

[18] Naiara CZ-S, Evandro dCM, Michelle ILdS, Maira CMF, Diego AG, Mariane BRdÁ, Antônio JD, Marília CV, Ana CVL. Effect of drying with ultrasonic pretreatment on the yield and quality of the essential oil of *Varronia curassavica* Jacq. and *Ocimum gratissimum* Linn. Industrial Crops and Products. 2020; 147:112211.

[19] Veerakumar M, Vijayakumar KCK, Navaneethakrishnan P. Different Drying Methods for Agriculture Products and Eatables – A Review. International Journal of Mathematical Sciences and Engineering (IJMSE). 2014;3(2):53-71.

[20] Ali M, Saeed M, Mohammad HK. Evaluation of energy consumption in different drying methods. Energy Conversion and Management 2011;52(2):1192-1199. DOI:10.1016/j.enconman.2010.09.014.

[21] Isaac DB, Xiao-Ming Y. Effect of different drying methods on product quality, bioactive and toxic components of Ginkgo biloba L. seed. Journal of the Science of Food and Agriculture. 2021; 101(8):3290-3297.