# THE EFFECTS OF MICROWAVE DRYING COMBINED WITH OTHER APPROACHES ON NUTS QUALITY ATTRIBUTES: A REVIEW

Azizah Izzati Mohd Sabani[1] and Naemaa Mohamad[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: naemaa953@uitm.edu.my*

**Abstract:** Demand on nuts has been rising globally in recent years due to their good source of protein, healthy fats and nutrients hence providing many benefits to the body's health. To provide a better quality of nuts during processing, transportation and storage, nuts must be dried accordingly to reduce the moisture content, avoid microbial contamination and to avoid post-harvest losses. A suitable method of drying needs to be used to ensure the drying process occurs effectively and give better quality nuts. In this review, microwave drying had been selected due to its benefits of consuming less energy, reducing drying time yet providing an enhanced high-quality product when combined with other approaches for instance microwave drying with surface temperature control, intermittent microwave drying, microwave with ultrasound pre-treatment and microwave assisted solvent extraction. However, the drying method is known for its negative effects on dried product quality such as rancidity. That is why, the effects of microwave drying combined with other approaches on nuts quality attributes such as the drying rate, physicochemical properties, total phenolic content, antioxidant activity and sensorial properties of dried nuts have been discussed. High microwave power will lead to faster drying rate hence reducing the drying time. However, it will lead to higher shrinkage, increment in the total colour change and higher rate of rancidification for the dried nuts. In addition, the total phenolic content and antioxidant activity of nuts treated with microwave drying will increase in parallel with the increase of microwave power. Further study needs to be done regarding the optimizing of microwave drying combined with other drying methods to give a better quality of nuts.

*Keywords:* Nuts, microwave drying, quality, drying rate, physicochemical properties

## 1. Introduction

Nuts are high in essential amino acids, vitamins, minerals and nutritional fibres and are preferred among individuals of all ages. Tree nuts are in high demand due to their well-known health advantages, and their global demand has risen in recent years (Cuadrado et al., 2020). However, nuts have a short shelf life owing to their high susceptibility to rancidity due to their high unsaturated fatty acids and moisture content (Walton et al., 2017). The objectives of this report were to discuss the overview of nuts and to review microwave drying mechanisms combined with other approaches and the effects of microwave and other approaches on nut quality attributes on physicochemical properties, total phenolic content, antioxidant activity and sensorial properties. Hence, this report's findings will be useful to food industries that produce dried nuts by providing information in terms of the microwave drying treatment that may be used to dry nuts.

## 2. Discussion

### 2.1. Nuts

Nuts contain vitamins, minerals, healthy fatty acid composition, with low levels of saturated fat and high levels of monounsaturated and polyunsaturated fatty acids as well as other bioactive components like polyphenols. Drying of nuts is important to minimize the moisture content and thus limit microbial growth, and appropriate drying methods must be employed to assure the drying process is done properly. Nuts must be dried as soon as possible after harvest to achieve a moisture content of less than 6% and a water activity of less than 0.70 at 25°C in order to maximize storage life while maintaining their original quality (Giordano et al., 2019).

### 2.2. Microwave drying mechanism

Microwaves are sources of energy that interact with materials to produce heat as a result of their interaction and only heat the materials that are needed. Microwave heating works by converting alternating electromagnetic field energy into thermal energy by impacting a material's polar molecules. Non-contact heating, volumetric heating, selective heating and accelerated heating are several benefits of microwave heating (Zhao et al., 2019).

### 2.3. Other combination approaches with microwave drying

Food drying efficiency can be significantly enhanced by combining several approaches as this combination can be more beneficial compared to capability of each method alone (Junqueira et al., 2016). Some approaches that are always being combined with microwave drying are temperature-controlled systems, intermittent microwave drying, microwave with ultrasound pre-treatment and microwave solvent extraction method.

### 2.4. The effects of microwave drying on drying rate of dried nuts

Some factors affecting drying rate are the initial moisture content and the composition of the raw material, and temperature used for the drying process. Nuts dried using higher microwave power dried faster. This is due to the increment in heat transfer and mass rate when the microwave power increases (Jahanbakhshi et al., 2020).

### 2.5. The effects of microwave drying on physicochemical properties of dried nuts

Moisture content of dried nuts decreases with the increasing drying time and longer duration of ultrasound pre-treatment helps to reduce the moisture content of dried nuts. However, microwave drying increases the fat content of dried nuts and leads to higher rancidity. Meanwhile, higher microwave power leads to a higher amount of shrinkage due to the higher mass transfer that ruins the cell structure of dried nuts (Jahanbakhshi et al., 2020). Colour is a significant criterion for quality assessment. Higher microwave power will make the colour of dried nuts worsen. In addition, ultrasonic-microwave drying shows lower total colour change compared to ultrasonic-convection drying due to uniform heating in the ultrasonic-microwave dryer (Abbaspour-Gilandeh et al., 2019).

### 2.6. The effects of microwave drying on total phenolic content, antioxidant activity and sensorial properties of dried nuts

Antioxidant activity and total phenolic content of dried cashews are at the highest when treated with the highest microwave power due to the liberation of phenolics by the solvents applied due to preheating treatment received (Carvalho et al., 2018). Nuts can be dried using microwave drying but with a shorter drying time to avoid the shell of the dried nuts darken. Nevertheless, the taste of the dried nuts can still be maintained.

## 3. Conclusion

Microwave drying combined with other approaches results in a higher drying rate, total phenolic content and antioxidant activity. Microwave drying alone, on the other hand, has been shown to enhance the fatty acid composition of dried nuts, therefore increasing the rate of rancidity. Additionally, due to high shrinkage and total colour change, this method does not produce better quality dried nuts in terms of texture and colour. Microwave drying will darken the shell of the nuts but the taste will still be maintained. As a result, more research is needed to improve microwave drying conditions by combining with other approaches to improve the quality of dried nuts.

## References

Abbaspour-Gilandeh, Y., Kaveh, Mohammad., & Jahanbakhshi, Ahmad. (2019). The effect of microwave and convective dryer with ultrasound pre-treatment on drying and quality properties of walnut kernel. *Journal of Food Processing and Preservation*, 1-17.

Carvalho, L., C., Leite, Marcondes., L., Morais, Camilo., L., M., Lima, Kassio., M., G., & Teixeira, Gustavo., H., A. (2018). Non-destructive assessment of the oxidative stability of intact macadamia nuts during the drying process by near-infrared spectroscopy. *LWT - Food Science and Technology, 103*, 101-107.

Cuadrado, C., Sanchiz, Africa., Vicente, Fatima., Ballesteros, Isabel., Linacero, & Rosario. (2020). Changes induced by presure processing on immunoreactive proteins of tree nuts. *Molecules, 25*, 1-11.

Giordano, M., Ghirardello, Daniela., Bertolino, Marta., Locatelli, Monica., Bardone, Davide., Zeppa, & Giuseppe. (2019). *Effect of drying conditions and storage time on compositional and sensory characteristics of unshelled hazelnuts.* Paper presented at the 7th European Drying Conference Proceedings, Torino, Italy.

Jahanbakhshi, A., Kaveh, Mohammad., Taghinezhad, Ebrahim., Sharabiani, Vali., & Rasooli. (2020). Assessment of kinetics, effective moisture diffusivity, specific energy consumption, shrinkage, and color in the pistachio kernel drying process in microwave drying with ultrasonic pretreatment. *Journal of Food Processing and Preservation*, 1-15.

Junquiera, J., Renato., de Jesus., Correa, Jefferson., Luiz., Gomes., Ernesto, Dovel., & Branquinho. (2016). Microwave, convective, and intermittent microwave–convective drying of pulsed vacuum osmodehydrated pumpkin slices. *Journal of Food Processing and Preservation, 41*(6), 1-8.

Walton, D., A., Randall, B., W., Poienou, Matthew., Nevenimo, Tio., Moxon, John., Wallace, & Helen., M. (2017). Shelf life of tropical Canarium nut stored under ambient conditions. *Horticulturae, 31*(1), 1-10.

Zhao, P., Liu, Chenhui., Qu, Wenwen., He, Zhixiu., Gao, Jiyun., Jia, Lijuan., Ji, Siping., Ruan, & Roger. (2019). Effect of temperature and microwave power levels on microwave drying kinetics of Zhaotong lignite. *Processes, 7*(74), 1-18.