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STUDY OF DRYING PROCESS OF JERUSALEM ARTICHOKE

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ABSTRACT

Slices of Jerusalem artichoke (Helianthus tuberosus L.) might be dried using a microwave approach, according to research into the subject. The findings showed that using a microwave oven would improve the drying qualities of the artichoke slices. In addition to improved dried artichoke slice look, using microwave technology increased drying rate and decreased drying time by about 155 folds and more than 200 times, respectively. Furthermore, it was discovered that the microwave drying process was highly influenced by the process circumstances. In particular, the power effect was significant because of its positive and negative effects on the process and product quality, respectively. For a better knowledge and description of the drying processes used in both conventional and microwave ovens, kinetic analysis was conducted. The regression results indicated the similar success of three models, Page, Logarithmic and Midilli equations, for these purposes.

Key Words: Microwave drying, Jerusalem Artichoke, Drying kinetics, Midilli equation.

INTRODUCTION

The Jerusalem artichoke (Helianthus tuberoses L.) is gaining popularity due to its potential as a feedstock for the synthesis of a wide range of novel products as well as public knowledge of its major health advantages. The above- and below-ground components of the Jerusalem artichoke can be used for a variety of purposes. For example, the tops can be used as biomass or animal feed, and the tubers can be used as a feedstock for food- and non-food-related chemical compounds. The Jerusalem artichoke's structural variation from other crops has had a significant impact on its economic worth and utilization. In contrast to most crops that store carbon as starch, Jerusalem artichokes store carbon as inulin, a fructose polymer. This carbon is largely found in the tubers of the plant. Distinctive properties and particular value of inulin is attributed to its nutritional contributions and low-calorie sweetener property. This carbohydrate form is also included in diabetic foods, since inulin ingestion slightly influences blood sugar compared to other carbohydrates. Besides to its positive contributions in food industry, inulin stands as a limiting constituent towards to the shelf-life of this plant material and its storage. It has been reported that storage of tubers promoted the degradation of inulin to some extent depending on the storage conditions. Additionally, the degradation of inulin has also been observed as a result of the activity of inulase. As a consequence, the processing of this plant material has gained high importance. In this extend preservation techniques have become key points. One of the oldest and most cost-effective preservation methods for grains, crops and foods of all varieties is drying technology, which has been extensively examined in a wide range and new techniques have been developed. Microwave, relatively a new addition to the existing techniques, has been considered as a potential method for obtaining high quality dried food products, including fruits, vegetables and grains in this extent. Current studies have exhibited that drying of food material with microwave technology offers rapid, more uniform process and significant energy savings with a potential reduction in drying times of up to 50% and additionally avoiding undesired excessive surface temperature of treated material. Some fruits and grains have been successfully dried by microwave technique and by a combination of microwave with other ones. Studies have continued to improve and to optimize possible microwave applications in drying of food materials due to its high potential. The objective of the present study was to examine one of the potential application areas of microwave energy, which was the drying of Jerusalem artichoke tubers. Drying characteristics of treated material were evaluated. Conventional oven drying of tuber was carried out to compare microwave with this method to establish the feasibility of replacing existing system with microwave drying.

MATERIALS and METHODS

The market supplied fresh Jerusalem artichoke tubers, which were kept in a storage area at 4°C. Before the dehydration process, tubers were properly hand peeled. The slices were then cut with an adjustable knife to the required thickness. The dried tubers were weighed right away after being cut. To prevent the impact of a change in an upper surface on the process, all slices were sized in the 30 mm 40 mm dimensions. Jerusalem artichoke tubers were placed in a standard oven at 105°C until no further change in sample weight was noticed. This was done to determine the initial moisture content of the plant. Jerusalem artichoke tubers had an initial average moisture content of 81.77 ± 0.89%.

Conventional Oven Drying- Jerusalem artichoke slices (2 mm thickness) were placed into the preheated oven (Nüve EN 400, Ankara, Turkey) at air temperature of 50, 70, 80, and, 90°C to evaluate the influences of temperature on drying process. Tuber samples were sliced at 2, 4 and 6 mm in thickness and dried in the preheated oven at 70°C to evaluate the influences of slice thickness on the drying characteristics of treated material. Tuber slices were spread as a single layer on the tray attached to the balance (KERN (EW) EW-1500-2M with sensitivity of 0.01g, Germany). During drying, weight of sample was recorded at a regular time interval. Drying process continued until desired moisture content was achieved (<10%).

Microwave Drying A programmable domestic microwave oven (Samsung- MW71E, Malaysia) with maximum output of 800 W and wavelength of 2450 MHz was used for drying of slices. The dimensions of the microwave cavity were 307x185x292 mm. Reweighed tuber slices were spread in a glass dish (dried and weighed before use) as a single layer and placed on the center of a turntable of microwave cavity. The sample was hold in the microwave oven under determined conditions for a specified time interval, while drying took place. The sample was taken out at every 60 s interval by switching off the microwave oven and after weight of sample was recorded, it was replaced in the oven. Drying process proceeded until desired moisture content was achieved (<10%, w/w). Three slice thicknesses (2, 4, and 6 mm) and three power level (100, 200, and 300 W) were examined to determine their effects on drying.

RESULTS and DISCUSSION

Drying of Jerusalem artichoke was investigated and microwave oven drying and conventional one were compared to represent the potential application of microwave technology in drying of artichoke tubers. Compared to the conventional process, microwave technology exhibited high potency as a drying technique with valuable results like shorter drying time, higher drying rate and product quality. Drying time required to reduce moisture content of artichoke slice under 10% was decreased almost 155 folds by operating microwave oven at power of 300 W compared to drying in conventional oven at 50°C. The improvement of drying rates by microwave technique varied from 20- folds to more than 200-folds relative to conventional one. Visual examination also displayed that microwave technology was superior to conventional oven drying in terms of the appearance of dried material. Color, brightness and structure of dried tubers were found to be better. Color of the dried material was found to be similar to raw material with maintained brightness, whereas tubers dried in conventional oven was exposed to color change like cooked color and even burned regions. For product quality, shrinkage is an important structural change which takes places in drying process and not desirable due to its negative effect on drying and rehydration processes. As a part of shrinkage, size reduction in pore dimensions might be significant handicap for the movement of water molecules throughout the solid matrix. Microwave technique also exhibited a succeeding improvement in the plant structure having weak shrinkage.

Conventional Drying

Four levels (50, 70, 80, and 90°C) were examined to figure out the temperature influence on drying. Dehydration process of raw material (2 mm thickness) continued till moisture content dropped under 10% (w/w). Drying times of Jerusalem artichoke slices in the conventional oven system were measured as 540 min, 300 min, 240 min, and 210 min for temperature levels of 50, 70, 80, and 90°C, respectively (Figure 1). The improvement in drying period could be attributed to the temperature effect on drying rate. Faster heat flux through the solid matrix, in other words faster water diffusion to the drying surface occurred as a consequence of the vapor pressure increase in the solid matrix with temperature. However the superior effect of temperature was found to be limited. In other words a reduction in process time remained less than expectation when varying from moderate to elevate temperatures (Figure 1). This might be due in part to a surface hardening effect as a consequence of quicker initial rate of evaporation of moisture from the surface occurred at elevated temperatures

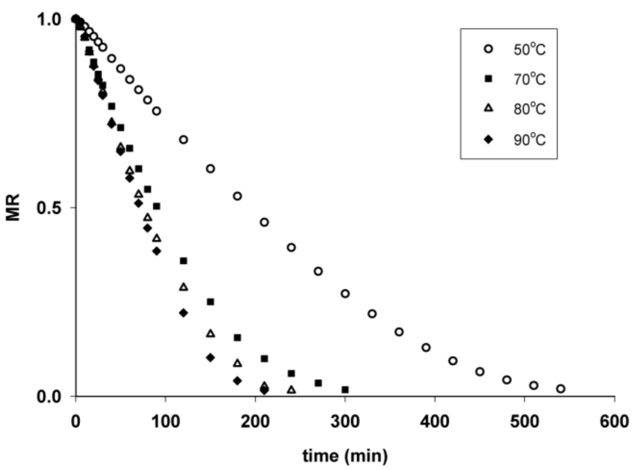

Figure 1. Moisture profile for conventional oven drying of Jerusalem artichoke slices under the effect of temperature change

Tubers sliced at different thicknesses were also processed in conventional oven system at 70°C to lower their moisture level under 10% (w/w). Drying times for this purpose were measured as 300 min, 480 min and450 min for 2, 4, and 6 mm thicknesses, respectively (Figure 2). Diffusional movement of water molecules throughout the solid surface was adversely affected by an extension in pathway as a result of a change in the slice thickness. However, a slight decrease in drying time was observed in the case of drying of 6 mm –slices relative to 4 mm ones. This case could be attributed to the change of surface area from which drying took place. As slicing Jerusalem artichoke tubers in 6 mm thickness instead of 2 mm, collateral area of slice was extended by 3 folds corresponding to 70% of its upper surface area (30_40 mm), whereas that proportion remained only at the level of 23% in the case of 2 mm. As a consequence of this extension in the drying areas of 6 mm-slices possible side diffusion might occur, and taking this effect into account, the removal of moisture in thick slices might be enhanced, whereas the edge effect was negligible in the case of thinner slices (2 and 4 mm). In addition, the hardening effect on drying phenomena might take into account, when thin slices (4 mm) were considered relative to thick slices (6 mm).

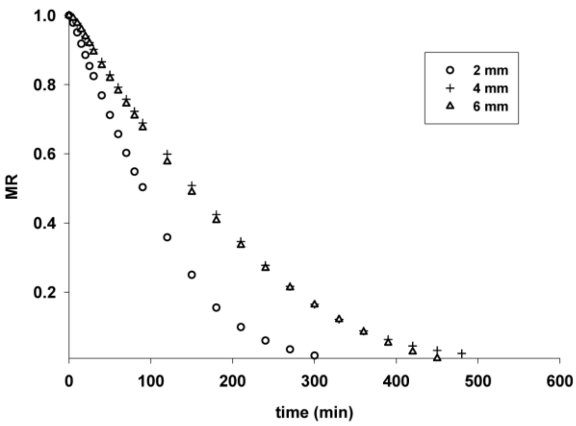

Figure 2. Moisture profile for conventional oven drying of
Jerusalem artichoke slices under the effect of slice thickness change

CONLUSION

The present study indicated that microwave technique can be used to dry Jerusalem artichoke slices as an alternative to conventional oven drying system. The results showed the improved drying characteristics of artichoke slices dried by microwave. Additionally, process conditions had a significant effect on the microwave drying rate, so they should be carefully considered to achieve optimal drying results. As a result optimization of microwave drying of Jerusalem artichoke slices are needed for improvement of this technique.

References:

1.Kays, S.J., Nottingham, S.F., 2008. Biology and chemistry of Jeruslaem artichoke: Helianthus tuberosus L. New York: CRC Press Taylor and Francis Group, Boca Raton, London.

2.Van Loo, J., Coussment, P., Leenheer, L., Hoebregs, H., Smits, G., 1995. On the presence of inulin and oligofructose as a natural ingredients in the western diet. Critical Reviews in Food Science and Nutrition 6: 525-552.

3.Watherhouse, M.L., Chatterton, N.J., 1993. Glossary of fructan terms, In: Suzuki M., Chatteron N. J. (Eds.), Science and technology of fructans. CRC Press, Boca Raton, FL, pp. 2-7.
4.Tungland, B.C., Meyer, D., 2002. Non digestible oligo- and polysaccharides (dietary fiber): their physiology and role in human health and food. Comprehensive Reviews in Food Science and Food Safety 1: 73-92.
5.Narziyev, M.S; Beshimov, M.X. Theoretical Foundations and Analysis of the Jerusalem Tubers. Texas Journal of Engineering and Technology. Vol 8 2022, 05, 30, 168-173
6.Narziyev, M.S; Beshimov, M.X. A mathematical model of the drying plate. Zamonaviy mashinasozlikda innovatsion texnologiyalarni qo'llashning ilmiy asoslari: tajriba va istiqbollar. 2022, 23, 09, 491-494.
7.t.f.d., prof. N.R. Barakayev, dots. M.S. Narziyev, tayanch doktorant M.X. Beshimov Impulsli elektr maydon ta'sirida quritish jarayonini tadqiq qilish. innovations in technology and science education. ilmiy jurnali. volume1 issue 5 www.humoscience.com
8.Narziyev M.S., Beshimov M.X. PHYSICO-CHEMICAL AND HEALTH PROMOTING PROPERTIES OF DRIED JERUSALEM ARTICHOKE POWDER journal of new century innovations Volume 23 Issue 2 http://www.newjournal.org