Dehydration the orange slicesby solar drying, and effects of thickness on moisture ratio

Teguia Mohamed Salah, Foued Chabane, Ali Arif,
Zouhair Aouissi, Djamel Bensahal, Noureddine Moummi and
Abdelhafid Brima

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Dehydration of the orange slices through solar drying and effect of thickness on moisture ration

Mohamed-Salah Teguia[1,2,*] , Foued Chabane[1,2], Ali Arif[3], Zouhair Aouissi[1,2]Djamel Bensahal[4], Noureddine Moummi[1,2], and Abdehafid Brima[1,2]

[1]Department of Mechanical Engineering, Faculty of Technology, University of Biskra 07000, Algeria
[2]Laboratoire de Génie Mécanique (LGM), Faculty of Technology, University of Biskra 07000, Algeria
[3]Department of Electrical Engineering, Faculty of Technology, University of Biskra 07000, Algeria
[4]Department of Mechanical Engineering, Faculty of Technology, University of Laghouat 03000, Algeria
*Corresponding author: E-mail address: teguia425@gmail.com, (Mohamed-SalahTeguia), Mechanical Department, Faculty of Technology, University of Biskra 07000, Algeria

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ABSTRACT

The purpose of the study is how to extract the water from the product of the sliced orange according to solar drying. The experimental study has been used the effect of condition work into dehydrated sliced orange by the selected dimension of thedrying chamber, solar collector, the geometry of the product like the diameter D = 80 mm,and the thickness ep = 3and 5 mm.The results give the moisture ratio of the orange slice as a function of time drying, and the mass flow rate, which takes three different values such as 0.019, 0.024, and 0.033 kg/s. In the experimental study, we fixed the distance between the support product and the heat source of the drying room which equal to 140 mm. The results give a good value of the moisture ratio of the sliced orange by low time drying, which the speed drying is very well related by the mass flow rate.

INTRODUCTION

Due to the near depletion of global reserves of underground resources such as petrol, gas and Uranium in many countries of the world and the high availability of them, many countries resorted to reviewing their energy policies, which mainly relied on converting underground resources such as oil and gas into kinetic energy such as electric energy and combustion energy such as diesel to be exploited in moving factories, where it moved from the exploitation of traditional energies to the exploitation of renewable energies such as solar energy [1].

In Algeria, according to the encouraging results obtained from the study conducted by (M. Ghadhban and his team), in which he explained that solar radiation in different regions of Algeria encourages the exploitation of this energy, especially in the field of drying [2]

Solar drying is the exploitation of solar energy in its raw form, i.e. in its thermal form in the agricultural field, where this heat is an important source in the generation of hot air for the purpose of drying agricultural products, which is called solar drying of vegetables and fruits. Drying helps in preserving agricultural products by reducing the percentage of water and moisture present in these products to the lowest possible percentage [3] and until reaching the minimum proportions of it that do not allow bacteria to multiply during preservation. Large sums of money, and that is why people resorted to using the sun as a more effective and cost-effective alternative compared to its low cost [4].

Energy consumption in indirect sun drying is considered less expensive, which motivated many researchers to conduct many studies in this field. Some of them have developed dryers such as (A. Farag, A. Malik, M. Badoud, R. Baaziz and S.A. Awi)Where did they improve and develop a bolin et al solar dryer and study the effect of some treatments on the kinetics and drying speed of the apricot plant [5]. Rachida Ouaabou and colleagues also studied the

efficiency of an indirect drying system and reduce the drying time to a minimum and its effect on the quality of cherriesDesiccant [6].
Where the statistics of the Food and Agriculture Organization for the year 2020 indicate that 58.4 percent of the world's citrus production, estimated at 129 million tons, is oranges, followed by tangerines and lemons, with a ratio of 26.6 and 15 percent, respectively [7].
Algeria is located in the subtropical region, so it is famous for some agricultural crops such as dates, olives, wheat and citrus fruits such as lemons and oranges, which are often sold in their initial condition without being optimally exploited in the food manufacturing industries. And according to what was mentioned, the orange crop is very abundant and it is an important and basic material in the world of industry, which encouraged many researchers to study this product for use in drinks, juices, flavors, colorings and food dyes, as Taise Raquel Bechlin and his team studied the effect of The use of ozone gas and hot air after it on drying the orange parts and counting and knowing their effect on the fungal count, color, yield of oil and pectin, and knowledge of the antioxidant activity and secondary compounds of dried orange peel [7]. Shahin Rafiee and his researchers also conducted a study to calculate the calculation. And the modeling of the effective modulus of moisture diffusion in orange slices of 2, 4 and 6 mm thickness [8], and the effect of the change in the force of the flow drive temperature was studied. A share of the study was done by Hamid Khafejeh, Ahmad Benaker Barat Ghobadian et Ali Motevali, who dried orange slices. In a CHP dryer, where did they generate four levels of heat by changing the engine power by 25, 50, 75, 100 percent of power. These were conducted experiments on samples with thicknesses of 3, 5 and 7 mm. Where were the drying curves obtained based on pain? Attributed figures [9].
In our study, we focus on sun drying fruits, and for this we dry slices of oranges of different thicknesses (slices with a thickness of 3 mm and others with a thickness of 5 mm), as these slices are dried by a forced indirect solar dryer and stimulated by the force of drawing the air out, this force is caused byThe use of an air intake device with a speed of 0.019, 0.024 and 0.033 m / s, where the effect of these parameters on the drying speed of these slices is observed.

MATERIALS AND METHODS

Experimental study

The city of Biskra is considered a semi-arid region located in the southeast of Algeria. It enjoys a hot and dry climate in summer and almost a moderate climate in all seasons. Therefore, we conducted our experiment at the University of Biskra located according to lengths and widths, respectively, 5.75 and 34.85,see**Fig. 1**, representing the solar drying plate. The previously designated location, carried out in the period ofthe March2021.

Figure.1: University of Biskra located according to lengths and widths, respectively, 5.75 and 34.85

Experimental Procedure

The experimental study started from 08:00 to 16:00 at University of Biskra in March 2021. The preparing for the test begging to cut the orange sliced.

The experiment starts with preparing the different thickness of the sliced orange, and then put it on the holder product, which fix it with balance was out the drying room. The tests need the registered some temperature corresponding the drying chamber such as thetemperature of the product, temperature of the chamber, and theinlet temperature chamber, and then control the balance for each experiment for selected the remove water from the orange slice.

The heated air come from the solar collector, which take the hot temperature from the absorber plate, then transported the heat air an inlet drying chamber which estimatesat the same time the outlet temperature of the solar collector.

Figure.2: Experimental setup (solar collector with drying room)

Description of the drying device:

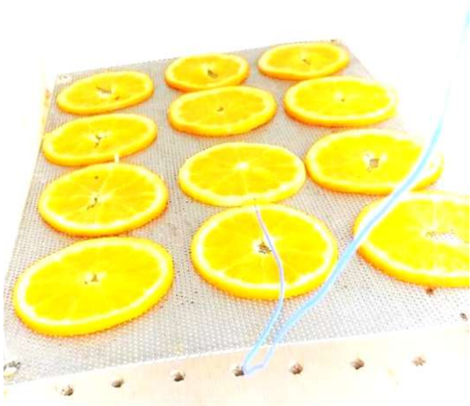
The forced indirect solar dryer consists of a solar collector connected to a drying room, which in turn is connected to an electric motor to suck the hot and humid air out of the drying room.

- The solar collector is characterized as a wood box with an open-top surface; its outer dimensions are (1550 x 850 x 100) mm3. Its upper surface is a plate of plexiglass, and its lower face is made up of an iron plate facing the sun (with a thickness of 0.5 mm) colored in black color.Glossy, a layer of thermal insulation is placed under this plate (white polyester, 3 cm thick), then a plate of wood is placed under it.
- The drying room has internal dimensions see Fig.3, a wooden box with a rectangular shape, its dimensions are (850 x 450 x 450)mm^3 and internal dimensions are (75 x 35 x 35) cm^3 with an open side, where the inside is isolated from the outer periphery with a layer of thermal insulation that prevents heat leakage and isolates the outer environment from the innerThe bottom base of the drying chamber shall be equipped with small openings connected to a duct for the introduction of hot air from the solar collector, and the drying chamber shall be connected to a 50 mm diameter plastic duct connected to the vacuum motor.

Figure.3: Experimental setup (drying room internal view)

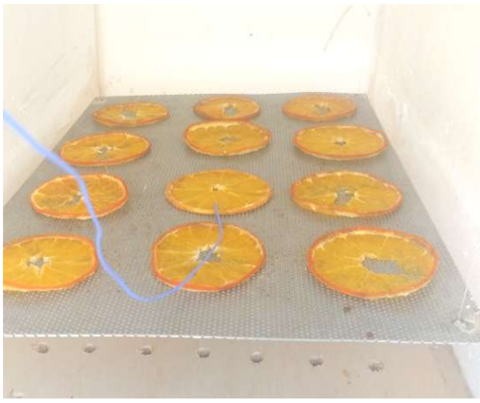
PARTI: EFFECT OF THE THICKNESS

Wet orange slices with 5mm thickness



Wet orange slices with 3mm thickness

Figure.2.a: Wet sliced orange with 3 and 5 mm thickness before drying



Dried slices, orange with 5mm thickness

Dried slices, orange with 3mm thickness

Figure.2.b: Dried sliced orangewith 3 and 5 mm thickness after drying

Figure 3 shows the distribution of the sliced orange onto the support of the product which situated in the drying room, before the dry system and after drying.

PARTII: EFFECT OF THEMASS FLOW RATE

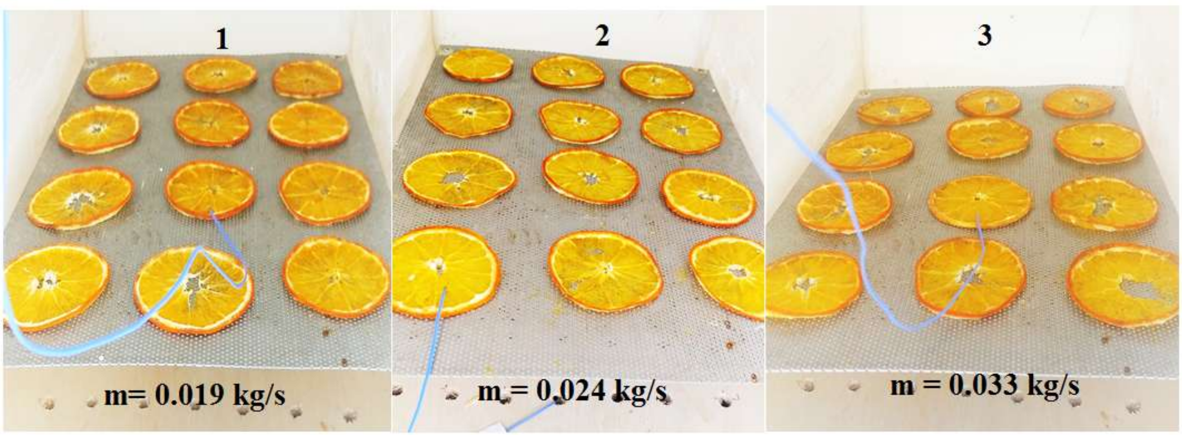


Figure.4: Dried sliced orangecorresponding to mass flow rate

Figure4 representsthe visualization of the sliced orange, according to three different mass flow rate.

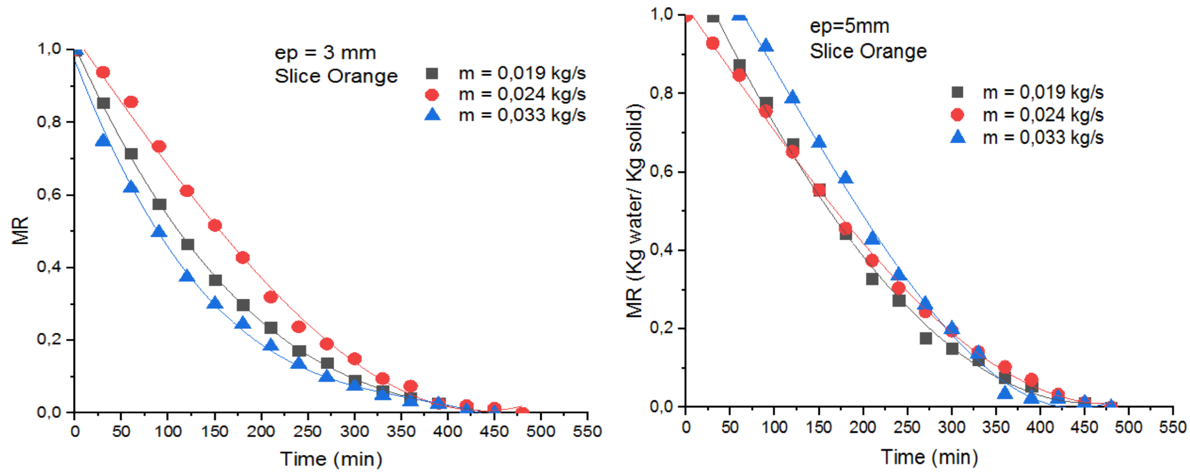


Figure.5: Moisture ratio versus time, according to the mass flow rate of the sliced orangecorresponding to 3and 5 mmthickness

Figure 5 shows the variation of the moisture ratio according to three different mass flow ratem = 0.019, 0.024, and 0.033 kg/s, corresponding to 3, and 5 mm thickness of the sliced orange. The result shows that the curve of the moisture ratio takes the high acceleration in an evolution with the mass flow rate equal to 0.033 kg/s, and in the second setup with m = 0.019 kg/s, and in the last with low speed but with important has acceptable by m = 0.024 kg/s. In this part of the discussion, we must take into the consideration the condition of work, because the speed wind and the type of the sky effected directly in the different parameters of the solar collector and the drying room.
All the curves begging with MR = 1 kg of the water per kg of the dried product and decreasing to MR approximated zero, which meaning the product of the sliced orange stoped to extract the water in the out.
The curve with the mass flow rate equal to 0.024 kg/s gives the discord between another curve, the original order of the curve corresponding to m = 0.024 kg/s must be become between 0.019 and 0.033 kg/s, that back to the condition of the work, when the thickness of the product equal to 5 mm. The result gives a different evolution of the moisture ratio because the result of the experiment in real changing the weather, which sometime cloudy and sometime clear, but with height velocity wind, this part means the lost heat from the solar collector.

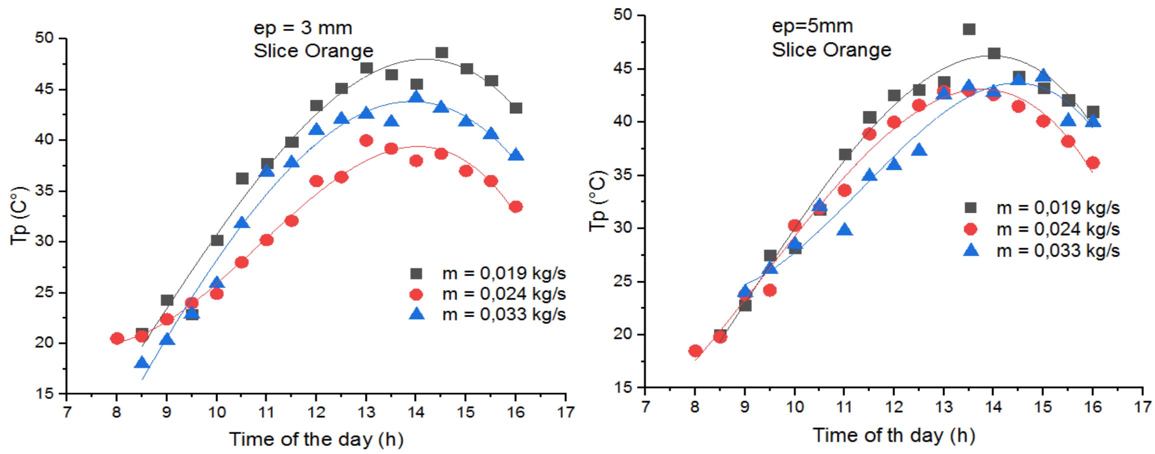


Figure.6: Temperature of the sliced orange versus time of the day,according to ep = 3, and 5 mm

Figure 6 shows the variation of the temperature of the product as a function of time of the day, corresponding to three different mass flow rate 0.019, 0.024, and 0.033 kg/s. We remark that the temperature of the sliced orange takes a maximum value at the midday corresponding to our site of the Biskra at 13:00, and decreasing between the 8:00 and 16:00.Through the curve, we notice that the temperature of the tested is closely related to the weather condition, as we notice that the curves for the temperature of the product on the first and third days were high due to the fact that the weather was somewhat stable, while the temperatures on the second day were somewhat low because the weather was volatile It was overcast and the wind was strong, which made the temperature drop.

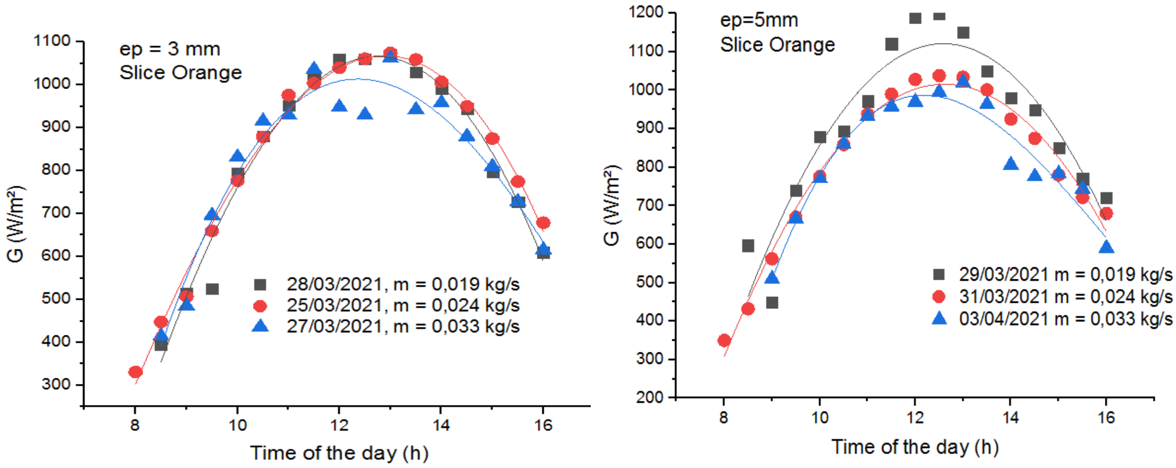


Figure.7: Global solar radiation versus time of the day, corresponding to test of ep = 3, 5 mm

Figure 7 shows the variation of global solar radiation as a function of the time of the day, according to six different days. We see the figures opposite the right, and lift, which have the different test of the experimental study, are realized in 3, and 5 mm thickness of the product, respectively.We can see that the global solar radiation takes a maximum value in the midnight which are selected 1200 W/m², and decreasing approximated in the sunset and sunrise, with a minimum value of global solar radiation equal to 300 W/m².

The solar radiation is representing an important factor in our studies, because we need the field of the solar radiation to heat the absorber plate and then the air takes the heat to the room drying.

CONCLUSION

After carrying out the solar drying of orange slices experiments, through which the humidity factor was calculated and the effect of the thickness of the sample and the speed of the withdrawal of moist air from the drying chamber on the drying time of the orange slices, this is by using a forced indirect sun dryer, where we find that the greater the thickness of the strip, the greater the drying time, It was also noted that the faster the drying room was emptied of humid air, the drying time decreased, and it was also concluded that choosing the drying times and days is of great importance so that the days of testing should be chosen where the natural conditions are favorable, the sky is clear and free of clouds And the winds are somehow gentle, and the most important thing is the strength of solar radiation and the intensity of the sun's brightness.

References:

[1] Y. Mohana, R. Mohanapriya, T. Anukiruthika, K.S. Yoha, J.A. Moses, C. Anandharamakrishnan: Solar dryers for food applications: Concepts, designs, and recent advances, Solar Energy (208), 2020, 321–344.

[2] M. Ghodbane, B. Boumeddane, N. Moummi, S. Largot, H. Berkane: Study and numerical simulation of solar system for air heating, J.Fundam Appl Sci. 8(1), 2016, 41-60.
[3] Ángel Calín-Sánchez, Leontina Lipan, Marina Cano-Lamadrid, Abdolreza Kharaghani, Klaudia Masztalerz, Ángel A. Carbonell-Barrachina and Adam Figiel : Review, Comparison of Traditional and Novel Drying Techniques and Its Effect on Quality of Fruits, Vegetables and Aromatic Herbs, Foods 2020, 9, 1261; doi:10.3390/foods9091261
[4] A. Belghit, M. Kouhila et B. C. Boutaleb: Approche Expérimentale de la Cinétique de Séchage de la Verveine (Lippia Citriodora), Rev. Energ. Ren. (Vol. 2) 1999, 87-97.
[5] A .Ferradji, A. Malek, M. Bedoud, R. Baziz et S.A. Aoua : Séchoir solaire à convection forcée pour le séchage des fruits en Algérie, Rev. Energ. Ren. (Vol. 4) 2001, 49 – 59.
[6] Rachida Ouaabou, Bouchra Nabil, Mourad Ouhammou, Ali Idlimam, Abdelkader Lamharrar, Said Ennahli, Hafida Hanine, Mostafa Mahrouz, Impact of solar drying process on drying kinetics, and on bioactive profile of Moroccan sweet cherry, Renewable Energy (2019), https://doi.org/10.1016/j.renene.2019.11.078
[7] Bechlin TR, Granella SJ, Christ D, Coelho SRM, Paz CHdO, Effects of ozone application and hot-air drying on orange peel: moisture diffusion, oil yield, and antioxidant activity, Food and Bioproducts Processing (2020), https://doi.org/10.1016/j.fbp.2020.06.012
[8] Shahin Rafiee , Mohammad Sharifi, Alireza Keyhani, Mahmoud Omid, Ali Jafari, Seyed Saeid Mohtasebi et Hossain Mobli: Modeling Effective Moisture Diffusivity of Orange Slice (Thompson Cv.), International Journal of Food Properties, (13) 2010, 32–40.
[9] Hamid Khafajeh, Ahmad Banakar, Barat Ghobadian, Ali Motevali: Drying of Orange Slices in CHP Dryer, Advances in Environmental Biology, 7(9) 2013, 2326-2331.
[10] M. Ssemwanga, E. Makule, S.I Kayondo: Performance analysis of an improved solar dryer integrated with multiple metallic solar concentrators for drying fruits, Solar Energy (204) 2020, 419–428.