Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 7, S. 210-216, 4, 2023

Araştırma Makalesi

IJANSER
https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 7, pp. 210-216, 4, 2023

Research Article

Investıgation of Drying Methods of Tarhana Produced in Çankırı Region by Taguchi Method

Rana Başataç [1], Zehra Gülten Yalçın[1*], Fatma Jale Gülen [2]

[1]*Department of Chemical Engineering, Engineering Faculty, Çankırı Karatekin University, Çankırı, Türkiye*
[2]*Department of Chemical Engineering, Engineering Faculty, YTÜ University, İstanbul, Türkiye*

[*]*Email of corresponding author: zaltin@karatekin.edu.tr*

(Received: 30 April 2023, Accepted: 13 May 2023)

(DOI: 10.59287/ijanser.702)

(1st International Conference on Recent Academic Studies ICRAS 2023, May 2-4, 2023)

ATIF/REFERENCE: Başataç, R., Yalçın, Z.G., Gülen, F.J., (2023) Investıgation of drying methods of tarhana produced in Çankırı region by taguchi method, *International Journal of Advanced Natural Sciences and Engineering Researches*, 7(4), 210-216.

Abstract **–** In this study, the drying behaviour of tarhana consumed in Çankırı region was investigated with various drying methods and optimum drying conditions were determined using experimental Taguchi design method. Solar, conventional oven and microwave oven methods were used for drying purposes. Different temperatures and microwave powers were used in the ovens and tarhana was also dried under sun light. The effective drying parameters were examined concerning the tarhana in the thickness and varying drying period. The data obtained were subjected to variance analysis. Statistical significance was determined in terms of strength, temperature, thickness and time parameters. Conventional oven drying optimization was found to be more successful with the lower p value than 0.01. After drying, tarhana was analysed from humidity, ash, protein and colour values. The results were evaluated for the solar, oven or microwave dried samples.

Keywords – Tarhana, Drying, Microwave, Taguchi Modelling, Physical and Chemical Properties

I. INTRODUCTION

Many kinds of drying techniques can be used for drying foods but sun can be employed from the sustainability, renewability and cheapness points. It has some disadvantages for example the mixing of undesired materials like dust and soil or keeping the samples in long drying periods due to the seasonal variations. On the other hand, drying with hot air has also some undesired effects such as the loss in food nutrient, the high energy consumption and the long drying periods. Microwave drying has more advantageous and common method among them due to the blocking away of undesired materials mixing, the quickiest drying periods and the least energy consumption [1].

Tarhana was known from the ancient time of Turks that migrated from Asia to Europe and during the Ottoman empires, it was also eaten in many countries such as Iraq, Persia and neighbouring countries and also Greece, Hungary and Finland through the Rumeli route [2,3], One study found that corn and kephir contributions were made to gluten-sensitive people [4].

Tarhana is usually stocked and consumed under the sun in Çankırı region and its constituent may be varied from the taste of spices [5, 6]. Some references were also found in the literature as bran, buckwheat, flour, [7,8].

Various drying techniques may be used for food drying such as conventional, infrared, osmotic, freze and microwave drying[9] were studied the advantages and disadvantages of solar drying, air blown, microwave, vacuum and freeze dryings and offered that the drying methods have ought to been selected pertaining to the product types[10]. was stated the advantages of microwave drying from the point of homogeny heating and investigated the product properties as chemical composition, sizes, dryer medium and air speed variances[11]. Studied the tarhana drying in various mediums like tunnel, freeze, industrial, microwave and small scale dryers [12].

Karaaslan and Sarı et al. were studied the juicy fruit drying via microwave oven and modelled their results related to the oven power and temperature. The increase in the oven temperature and microwave power has positive effects on the drying periods of the samples [13-14].

Işık et al. were mixed the residues of tomato paste with tarhana and investigated the chemical properties of the product such as total phenolic, antioxidant activity, peroxide number and p-anisidin values. Hayta et al and Dağlıoğlu et al. were studied the tarhana in microwave, industrial microwave, small scale microwave, hot air ovens and freeze dryer. They searched the humidity, colour, protein values, water and oil retention capacities, foaming capacity, bubbling stability, viscosity and emulsion capacities and sensitive characteristics[15-17].

TS was issued a standard concerning Tarhana (TS 2282). Tarhana is a highly nutrient food that is produced and fermented from wheat flour, semolina, yoghurt, salt, various vegetables, and aromatics [18].

MODELLING STUDIES IN THE LITERATURE

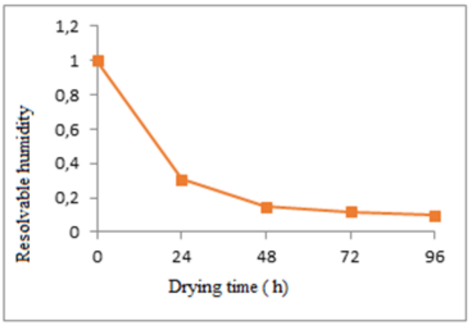
Karaaslan, Sarı et al. have some papers concerning the drying of vegetables and fruits via microwave, hot air and conventional ovens. Midilli and Küçük model was found the best one to represent the drying behaviour of the samples among the Newton, Page, Midilli-Küçük, Henderson-Pabis, logarithmic, Wang-Singh, logistic, two termed, Vema, two termed exponential, diffusion, etc.[19, 13].

Taguchi method, the least experiment can give the best and optimized results. The studies have used taguchi method for drying the folic acid via spray dryer in order to transfer folic acid easily [20,21].

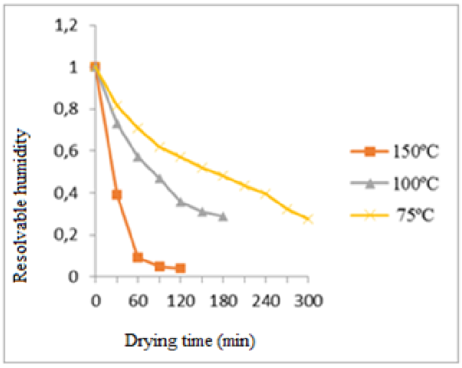
EXPERIMENTAL METHOD

Humidity amount of tarhana

The following graph depicts the sun drying results and the moisture amount decreased to 0.19 values after passing the few days which is consistent to TS 2282 standard.



a



b

Fig 1a. Humidity versus time graph for an 8 cm tarhana slice under the sun.

Fig 2b. Depicts the hot air drying at three temperature levels (75, 100 and 150 ºC).

The drying times will be varied related to the less drying times of samples. As seen from the Figure 1.a. and Figure 2.b. The long drying periods in the high oven medium cause the burning of samples.

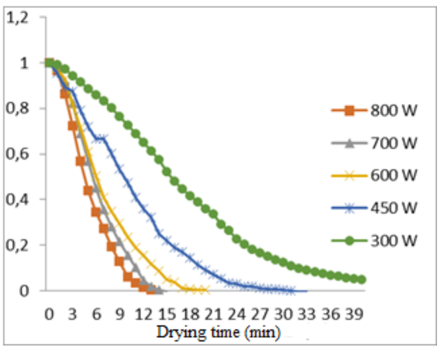


Fig 3 Tarhana, 8 mm thick, moisture change graph for microwave drying.

The drying periods were decreased by increasing microwave powers.

The humidity of samples was discharged rapidly as raising the microwave oven power but the time period was delayed as decreasing the power of microwave. As seen from the Figure 3, the humidity amount has not reached the desired value in the 300 W powers, but other powers have sustained those standard values.

The effect of thickness of samples on the drying period is shown in Figure 4. Microwave drying has given better drying values than air drying. As seen from Figure 4, the increase in sample thickness is a positive effect on the drying and time period, but the drying velocity is decreased related to the moisture of the samples[12].

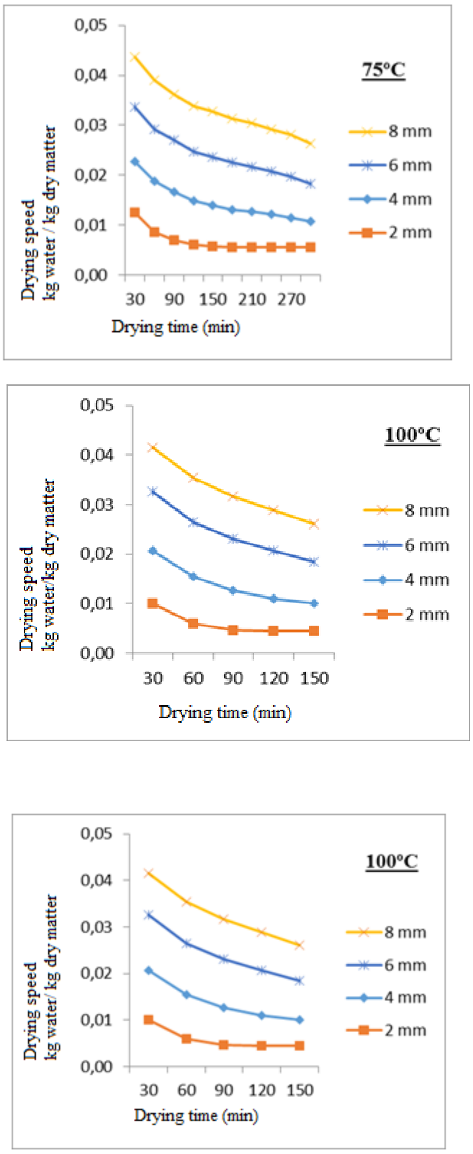


Fig 4 Drying speed chart for Tarhana by oven temperature and thickness.

As seen from Figure 4 and 5, there are rather drastic variations from the points of temperature, drying velocity, drying periods.The increase in the thickness of the sample, the increase in the sample drying; the decrease in sample thickness, the decrease in drying periods. By comparing the two mentioned methods, microwave drying has given better results than conventional drying.

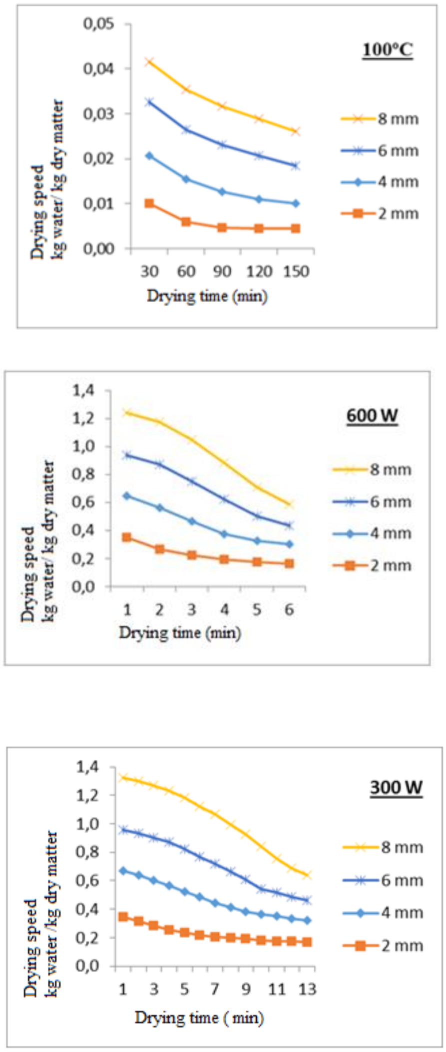


Fig 5 Drying speed graph for microwave power and thickness for Tarhana.

The humidity variations are given in Table 1 and 2 as separable (volatile) humidity ratios that is determined from Taguchi modelled experiments. The variance analyses of experimental results obtained from the conventional oven have given sensible values in all effective factors such as temperature, thickness, time) lower than 0.05 p value ($p<0.05$). This shows the important effects on the tarhana drying. The data obtained in oven drying have given 95% confidence limit ($p=0.0005$). The effective parameters were in the range of temp (0.010), thickness (0.018) and time period (0.006). The regression equation was given in Eq 1. The variance analyses of p values of the drying experiments obtained in microwave oven were lower than 0.05 for all factors such as power, thickness and time. The modelling of microwave drying was found in 95% confidence limit (p=0.10). The effective parameters were power (p=0.032), thickness (p=0.028) and time (p=0.008). The regression equation is seen in Eq 2. Both drying methods have shown that the time period to be more effective than the others. Taguchi modelling was given R=0.908 and R=0.8789 values for conventional and microwave ovens, respectively and conventional one was given much more effective results. Table 1 and 2 were given the relationship among the temperature (ºC), thickness (mm), time and volatile humidity values.

Table 1 The taguchi modelling of tarhana obtained in oven

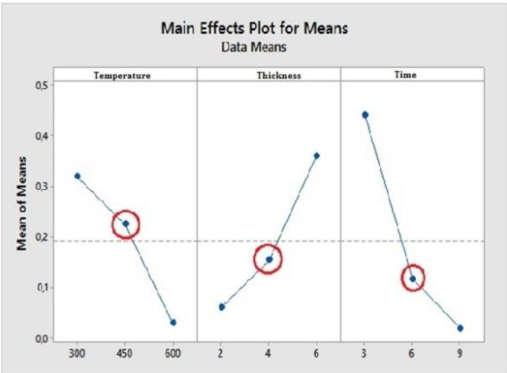
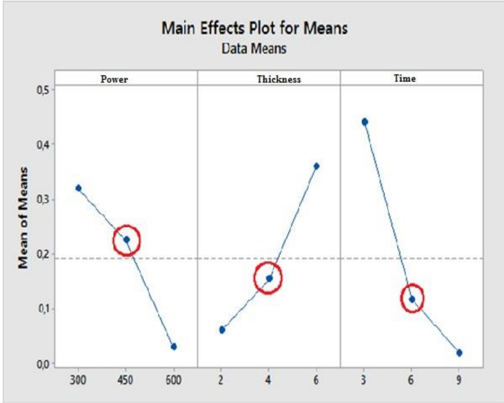


Table 2 The taguchi modelling data of tarhana drying obtained in microwave oven

Oven drying				
Experment al no	Temperature (ºC)	Thickness (mm)	Time (min)	Resolvable humidity
1	150	6	150	0,01
2	150	4	90	0,02
3	150	2	30	0,06
4	100	6	90	0,33
5	100	4	30	0,59
6	100	2	150	0,04
7	75	6	30	0,76
8	75	4	150	0,18
9	75	2	90	0,11



Microwave drying				
Expermental no	Power (Watt)	Thickness (mm)	Time (min)	Resolvable humidity
1	600	6	9	0,00
2	600	4	6	0,00
3	600	2	3	0,09
4	450	6	6	0,26
5	450	4	3	0,41
6	450	2	9	0,01
7	300	6	3	0,82
8	300	4	9	0,05
9	300	2	6	0,09

$$\text{Detachable humidity} = 0{,}718 - 0{,}003278\ t + 0{,}0742\ m - 0{,}00449\ T \quad (1)$$

$$\text{Detachable humidity} = 0{,}747 - 0{,}000964\ W + 0{,}0748\ m - 0{,}0702\ t \quad (2)$$

The least ANO values were related to the low value of sample thickness and high values of temperature-power and time were not selected due to the burning of the samples in Table 2. The high ANO values were also not selected due to the weak drying condition.

So, the nominal value line is given an idea of the drying process, upper line shows the low drying medium and lower line shows the burning of sample due to the high drying one. The data of tarhana close to the nominal line were given 100 ºC, 4 mm plus 90 min and 450 W, 4 mm plus 6 min for conventional and microwave ovens, respectively. The physical and chemical properties of the dried products were given in Table 1 in those mentioned optimum conditions.

Physical and chemical analysis results

Table 3 Chemical analysis results for Tarhana

	Tarhana					
	Humidity %	Ash %	Protein %	Colors		
				L	a	b
Sun drying	9,45±0,125^{b}	2,35±0,117^{a}	13,81±0,225^{a}	70,96±0,603^{a}	7,99±0,076^{c}	32,19±0,226 ^{a}
Oven drying	10,17±0,031^{a}	2,31±0,067^{a}	13,46±0,230^{a}	58,47±1,027^{b}	10,71±0,161^{b}	31,67±0,538^{a}
Microwave drying	4,75±0,165^{c}	2,37±0,068^{a}	13,51±0,199^{a}	39,76±0,517c	12,30±0,219^{a}	23,70±0,592^{b}

The humidity value must be about 10% according to TS 2282. The humidity values were 9.45 %, 10.17 % and 4.75 % for sun, oven and microwave dryings, respectively. Microwave drying was given the worst result among them. The humidity results calculated from Eq 1 and 2 in the optimum conditions were given close results with the humidity values of the samples.

The ash amount is calculated as the dissolved ash in HCl according to TS 2282. Those results were not compared but Cağındı et al were stated the ash values between 1.14% - 7.93 % values. In this study, the highest and least ash amounts were found in microwave and oven dryers as 2.37% and 2.31% respectively[18]. They were defined the ash values as an unimportant factor with higher than 0.05 p ($p>0.05$) value depending upon the drying process.

The protein level must be less than 12 % according to TS 2282. The protein results were almost in the same range for all dried samples. The protein content was found as 13.81 % and 13.46% for sun drying as the highest and oven drying as the lowest ones, respectively. The statistical values were rather unimportant in the level of higher than 0.05 p value ($p> 0.05$) [18].

The samples were compared from the colour image points. L, a, b values were found as 70, 96, 7, 99, 12, 19 and 39.76, 12, 30, 23, 70 for sun drying (the lightest) and microwave drying (the darkest), respectively[11]. a found the L and b values as 75.3-33.4 and 83.8-24.3 for microwave and tunnel dryings, respectively. The similar results could not have been obtained from the variations in tomatoes and red pepper contents due to the low L and high values, respectively. Our products were given more reddish colour due to the low L and b values and high a values. The less similarity of colour was obtained from the sun-dried products. This may be originated from the colour oxidation of the tomatoes. The colour images of microwave drying were given darker than the other methods, but the lower humidity content may be explained as keeping them in the microwave medium much. The colour value variations have more important factor on the drying periods due to the lower than 0.01p ($p<0.01$).

Techniques

Tarhana was prepared from flour tarhana, göce tarhana and/or full wheat flour in Cankırı as explained in Turkish standard (TS 2282) [18]. The parsley was the plant that was chosen for production of Tarhana in Çankırı area. The common tarhana recipient was given below: 3 kg tomatoes, 1 kg of onion, 1 kg sour apple, 1.5 kg red pepper, 3 bunch of parsley, 3 bunches of mint, 3 kg of yoghurt and 20 g fine Çankırı salt rock. All the ingredients were mixed in home type mixer. The mixture was kept at 25-30 ºC during 3 days for fermenting the sample. The mixture was stirred every day, after the third day, 7 kg wheat tarhana and a bunch tarhana plant were also added to that mixture.

The mixture cake was kept at 30-35 ºC temperature during 5 days and was stirred for 5 min every day. After the fifth day, the tarhana were kept in a refrigerator for keeping its freshness [12].

Drying methods

The experiments being done in the sun were done in the June month at 19 ºC temperature [23]. The microwaves drying were managed in Samsung IMJ23F301 brand microwave at five different powers such as 300, 450, 600, 700 and 800 W. The conventional type drying experiments were managed in BEKO BSUF 5000 brand M6 JJ conventional oven at 75, 100 and 150 ºC temperatures with a digital temperature measuring thermometer.

The tarhana samples of having 10x10 cm areas with an 8 thickness were kept in conventional oven at the predetermined temperatures such as 75, 100 and 150 ºC and the loss (%) were observed. The tarhana samples of having 2 mm, 4 mm, 5 mm and 8 mm thicknesses were kept at 75 and 100 ºC temperatures. The experiments performed at 150 ºC temperatures were not given well results due to the burning of the samples and this temperature was not selected as an experimental effect from this point of view. The samples having 10x10 cm areas and 8 cm thickness were kept in microwave oven at predetermined power levels such as 300 W, 450 W, 600 W, 700 W and 800 W with a 1 min interval [21]. The graphs of time versus humidity loss were prepared [19]. The tarhana samples of having 2, 4, 6 and 8 cm thickness were dried at three different power levels such as 300 W, 450 W and 600 W powers.

Physical and chemical analyses

The characteristic physical and chemical properties of tarhana such as humidity loss, protein amount and ash and colour values were evaluated. At the beginning, the samples were kept in a autoclave at 105 ºC during 24 hours and the humidity losses of dried samples were measured at 105 ºC via Sartorius humidity analyser brand MA 150. The protein amount of tarhana samples were calculated by Kjehdahl method of TS 2282. The nitrogen amount was multiplied with 6.25 factors for determining total protein. [19]. The ash amount of all dried samples was measured at 900 ºC after 4 hours later in Şimşek technique ash oven brand KF908. The general colour values of (L, a, b) were turned into numerical values for Tarhana samples by using Hunter colour scale. L value ranges between 0-100 numbers. 0 and 100 mean the totally lightness and opaqueness (black), respectively. A and b can be ranged between negative and positive values. The negative values are shown greenish colour whereas positive values reddish colour. The negative and positive values of b depict bluish and yellowish colours.

Statistical Analysis

Statistical analysis and taguchi modelling were managed by Minitab170 statistical programme. The data related to the samples were evaluated with variance analysis. The middle values of the variance analysis were explained by Tukey test in 95% confidence limit.

RESULTS AND DISCUSSIONS

In this study, tarhana drying was performed in conventional oven at 75, 100 and 150 ºC temperatures, microwave oven of 300, 450, 600, 750 and 800 W and under the sun effect.

The more tarhana thickness increase, the less drying rate of tarhana lying in the sun. The similar results were found in conventional and microwave ovens. The drying rates were found less in conventional oven than microwave one. The variance analysis of dry drying experiments performed in conventional and microwave ovens have given rather important values in the range lower than 0.05 p ($p<0.05$) for all the factors such as temperature-power, thickness, time.

The optimum conditions of tarhana were determined for conventional and microwave drying via Taguchi modelling. Those conditions were 100 ºC, 4 mm, 90 min and 450 W, 4 mm and 6 mm for conventional and microwave dryings, respectively.

Ash and protein values were given the similar results for all the methods applied. The samples were compared from the colour point. The sun drying has given the lightest color whereas microwave drying darkest. The results were explained with statistical way. The ash and protein contents of tarhana were given unimportant values with higher than 0.95 p ($p> 0.95$), but the humidity content and colour values unimportant lower than 0.01 p value ($p< 0.01$). That means that the drying method has not affected on the ash and protein amount but on the colour and humidity amount of the samples.

The humidity values of tarhana samples calculated from Eq 1 and Eq 2 have given similar results to the experimental samples. The minor difference in linear regression may be originated from linear regression.

The L, a and b values of tarhana samples were found as the lightness (70.96-7.94-32.19) and the darkest (39.76-12.30-23.70) for sun and microwave dryings, respectively. Hayta et al [11] was found L and b values of tarhana as (75.3-33.4) and (83.8-24.2) for microwave and tunnel drying, respectively. The similar results could not have been reached due to the various ingredients of tomato and red pepper contents of Çankırı tarhana. Our samples were given low L and b values but high a values. Çağındı et al [17] was determined the L, a and b values as (54.61-0.14-1.43) and (88.75-28.10-52.18) for the lowest and highest values, respectively. Our dried samples under the sun were given the similar colour oxidation of tomatoes. Those colour values for microwave drying was given darker value due to keeping them in more drying medium. The statistical investigation of colour can be affected depending upon the drying methods as lower p value than 0.01($p<0.01$).

CONCLUSION

As a summary, when comparing the sun, conventional and microwave dryings, the microwave drying was given the quickest drying but the sun the slowest one. The more increase in sample thickness is direct proportional to the drying period and drying rate. The drying rates of microwave are more important than the conventional drying.

The effect of drying methods of tarhana samples was compared from physical and chemical ways. The ash and protein contents of tarhana were found unimportantly higher than 0.05 ($p>0.05$) but colour and humidity values were affected from the medium seriously with lower than 0.01 p values ($p<0.01$).

Optimum conditions are rather important in selecting the temp, sample thickness and drying rates of the samples. The correct time and energy values for sample drying are directly related to the optimum temperature and sample thickness. The temp-power, time and thickness relationships of tarhana were compared with the data obtained in conventional and microwave ovens and the results were explained via Taguchi modelling. Conventional oven drying is more important than microwave with lower than 0.01 and higher than 0.05 p values, respectively. The experimental trials were found as 9 experiments from Taguchi modelling and the correlation equation among temperature-time and thickness were given, too.

.

REFERENCES

[1] Çelen, S., *Effect of microwave drying on the drying characteristics, color, microstructure, and thermal properties of Trabzon persimmon.* Foods, 2019: 8(2), 84.

[2] Coşkun, F., *Derleme (Review) history of tarhana and varieties of tarhana in Turkey food technologies*, Electronic Journal of Food Technologies,2014: 9, (3), 69-79. E-ISSN: 1306-7648.

[3] Altundağ, O. Ö., Kenger E. B., & Ulu, E. K. ., *A study on theevaluation of different tarhana species in terms of health*. Health Academy Kastamonu, 2020: 5(2), 143-157.

[4] Avcı, A., Akcay, F. A., Can, C., & Demir, S. *Determination of some properties of tarhanas produced by using corn flour and kefir*. Food and Health, 2019: 5(3), 168-174.

[5] Cebeci, A., Polat, M. F., & Çalış, B. *Isolation of lactic acid bacteria from tarhana.* ÇOMÜ Journal of the Faculty of Agriculture,2020:8(1), 51-59.

[6] Gurbuz, O., Gocmen, D., Ozmen, N., & Dagdelen, F., *Effects of yeast, fermentation time, and preservation methods on tarhana. Preparative* Biochemistry & Biotechnology, 2010:40(4), 263-275.

[7] Bilgiçli, N., *Effect of buckwheat flour on chemical and functional properties of tarhana*. LWT-Food Science and Technology, 2009: 42(2), 514-518.

[8] Bilgiçli, N., Elgün, A., Herken, E. N., Türker, S., Ertaş, N., & İbanoğlu, Ş. (2007). *Corrigendum to "Effect of wheat germ/bran addition on the chemical, nutritional and sensory quality of tarhana, a fermented wheat flour-yoghurt product*, Journal of Food Engineering, 2007:680–686].

[9] Jia, Y., Khalifa, I., Hu, L., Zhu, W., Li, J., Li, K., & Li, C., *Influence of three different drying techniques on persimmon chips' characteristics: A comparison study among hot-air, combined hot-air-microwave, and vacuum-freeze drying techniques*. Food and Bioproducts Processing, 2019:118, 67-76.

[10] Salehi, F., *Recent applications and potential of infrared dryer systems for drying various agricultural products: A review*. International Journal of Fruit Science, 2020:20(3), 586-602.

[11] Goencue, A., & Çelik, İ., *Investigation of some properties of gluten-free tarhanas produced by red, green and yellow lentil whole flour*. Food Science and Technology,2020: 40, 574-581.

[12] Oduola, A. A., Bruce, R. M., Shafiekhani, S., & Atungulu, G. G., *Impacts of industrial microwave and infrared drying approaches on hemp (Cannabis sativa L.) quality and chemical components*. Food and Bioproducts Processing, 2023: 137, 20-27.

[13] Kutlu, N., Pandiselvam, R., Saka, I., Kamiloglu, A., Sahni, P., & Kothakota, A., *Impact of different microwave treatments on food texture.* Journal of Texture Studies, 2022:53(6), 709-736.

[14] Elik, A., Yanık, D. K., & Göğüş, F., *Microwave-assisted extraction of carotenoids from carrot juice processing waste using flaxseed oil as a solvent.* Lwt, 2020:123, 109100.

[15] Huang, D., Men, K., Li, D., Wen, T., Gong, Z., Sunden, B., & Wu, Z., *Application of ultrasound technology in the drying of food products.* Ultrasonics Sonochemistry,2020: 63, 104950.

[16] Oyinloye, T. M., & Yoon, W. B., Effect of freeze-drying on quality and grinding process of food produce: A review. Processes,2020: 8(3), 354.

[17] Başataç, R., Yalçın, Z.G., Dağ, M., & Aydoğmuş, E. *Optimization of Parameters Affecting Noodle Drying by Taguchi Method*. European Journal of Science and Technology, 2022:(34), 34-41.

[18] Konuray, G., & Erginkaya, Z., *Traditional Fermented Food Products of Turkey*. In Fermented Food Products, 2019: pp. 55-6). CRC Press.

[19] Vega-Gálvez, A., Poblete, J., Rojas-Carmona, R., Uribe, E., Pastén, A., & Goñi, M. G., *Vacuum drying of Chilean papaya (Vasconcellea pubescens) fruit pulp: Effect of drying temperature on kinetics and quality parameters*. Journal of Food Science and Technology, 2021:58, 3482-3492.

[20] Puente-Díaz, L., Spolmann, O., Nocetti, D., Zura-Bravo, L., & Lemus-Mondaca, R., *Effects of infrared-assisted refractance window™ drying on the drying kinetics, microstructure, and color of physalis fruit purée*. Foods, 2020:9(3), 343.

[21] Tagnamas, Z., Bahammou, Y., Kouhila, M., Hilali, S., Idlimam, A., & Lamharrar, A., *Conservation of Moroccan truffle (Terfezia boudieri) using solar drying method.* Renewable Energy,2020: 146, 16-24.

[22] Nimbkar, S., Leena, M. M., Moses, J. A., & Anandharamakrishnan, C.,. *A modified 3-fluid nozzle spray drying approach for co-encapsulation of iron and folic acid.* Chemical Papers,2023: 1-14.