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Drying of Melons in a Solar Tunnel Dryer: The Effect of Ascorbic Acid Solution on Drying Kinetics and Color Parameters

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ABSTRACT

This study aims to present the performance of the solar tunnel dryer, which is required for the drying of two different types of melon with and without pretreatment. The solar tunnel dryer used in the study was built at Isparta University of Applied Sciences, Department of Agricultural Machinery and Technologies Engineering. The dryer consists of a flat plate solar collector, drying tunnel, solar cell module and a small axial fan. During the drying process, solar radiation, drying air temperature, relative humidity and air velocity were measured continuously in different parts of the dryer. At the same time, the mass loss of the melon slices was measured every two hours during the drying period. On the other hand, colour measurements were made on untreated and pre-treated melon slices, fresh and after drying, before and after the trials. Fresh melon samples were washed with tap water, and cut in half with a knife, the core in the middle was removed and sliced by hand in a half-moon shape without peeling before pre-treatment. 1% ascorbic acid was applied to the fruits as a pretreatment. After the preparations, the solar tunnel drying behaviour of untreated and pretreated sliced melon samples was investigated. Drying characteristic curves were evaluated according to five different mathematical models. In this study, it was determined that the L*, a* and b* values of melon varieties were preserved without pretreatment. The lowest total color change was observed in the bleached samples in both types of melon samples.

1. Introduction

Melon (*Cucumis melo*), which is from the cucurbitaceae family, is fragrant, aromatic, and pleasantly delicious, usually, It is an oval or round shaped, yellow, greenish-yellow or pinkish-orange fleshy, juicy large fruit. The origin of the melon is defined as Asia Minor (Anatolia) and Iran, and it is stated that it was cultivated in these regions 5000 years ago. According to FAOSTAT data, the production amount of melon produced in many regions of Turkey, especially with local varieties, was 1,724,856 tons in 2020.

Melon production is most intense in the Mediterranean, Western Anatolia and the Aegean. Turkey has taken its place among the dec melon producing countries in the world with its melon production. China (39%), the largest melon producer in the world, is followed by Turkey (9%). The majority of melon production in Turkey (85%) is made with Kırkağaç, Hasanbey, Yuva and Sarı Kışlık melon varieties, and the remaining part is with Cantalupensis (C. melo L. var cantalupensis) group melon varieties such as Ananas and Galia.

Solar drying has been used since ancient times to dry plants, seeds, fruits, meat, fish, wood and other agricultural and forest products. In recent years, various attempts have been made to benefit from solar energy, which is a free and renewable energy source, to protect agricultural and forest products, and to improve drying with solar energy. However, the limitations of open-field drying for large-scale production are well known. These include high labour costs, large space requirements, lack of ability to control the drying process, possible spoilage due to biochemical or microbiological reactions, insect infestation, etc. countable. Forced convection sun drying of agricultural products in closed structures is an important way to reduce post-harvest losses and poor-quality dried products compared to traditional open sun drying methods. In most developing countries and rural areas, grid-tied electricity and other non-renewable energy sources are difficult, unreliable and very expensive to supply. In such cases, solar dryers

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are becoming increasingly attractive in commercial spaces (Xingxing et al. 2012).

Fruits, vegetables, and dried agricultural products are good sources of energy, minerals, and vitamins. However, during the drying process, changes occur in the nutrient contents of the product (Sablani 2006). Product (colour, texture) and nutritional quality are becoming more and more important for dried fruits and vegetables. The improvement of these qualities can be achieved by pretreatments before drying. Pre-treatments suitable for agricultural products can improve the drying process by reducing drying time, providing higher quality products and energy savings.

When the previous studies are examined, it is seen that the studies on the drying characteristics of melon are insufficient, and the drying times of the melon are quite long in these studies. In this study, drying characteristics of two different melon varieties were experimentally investigated by using parameters such as different drying air temperatures, melon slice thickness and drying air velocity in a tunnel type solar dryer located in the field environment. In addition, the mathematical thin layer drying model was determined by comparing five different model equations that best describe it based on experimental data.

The main purpose of this study is to evaluate the solar tunnel dryer for thin layer drying of Galia and Kırkagac melons. In addition, the effects of pretreatment with 1% ascorbic acid solution and 3 different slice thicknesses on drying properties were determined. The best explanatory mathematical thin layer drying model to the experimental data is determined by comparing 5 different models. Finally, one of the aims is to determine the colour differences between dried and fresh fruit samples.

2. Materials and Methods

Sample Preparation

Two types of melons, Galia and Kırkağaç, were obtained from a local market in Isparta, Turkey.Before starting the experiments, the melons were peeled and sliced into 2 mm, 4 mm and 6 mm thick half moons using a cutting machine.The initial moisture content of the melon slices was determined using the oven method at 105°C for 24 hours.

Table 1
The characteristics of melon varieties

The characteristics of melon varieties		
	Galia	Kırkagac
Fruit color	light green	cream color
Fruit peel color	yellow	orange, with black dots
Weight of fruit	2-2,5 kg	3-4 kg
Shape of the fruit	round	oval
Shelf life of the fruit	long	long

Triple samples were used to determine the moisture content of melon varieties and average values were reported as 83,7927 kg water/kg dry matter (w.b.) for Galia Melon variety and 88,1213 kg water/kg dry matter (w.b.) for Kırkağaç melon variety. Melon slices were pretreated with solution of ascorbic acid (0.1%) for 2 min. The other lot was untreated (control).The characteristics of melon varieties are given in Table 1.

Solar Tunnel Drying of Melons

The researchers used a tunnel-type solar dryer that was designed and built in the Department of Agricultural Machinery and Technologies Engineering at Isparta University of Applied Sciences. The dryer used in the study consisted of a drying tunnel, a flat plate solar collector, a small axial fan, and a solar cell module. All parts are located on a frame made of metal. The solar collector has hexagonal channels. Its base is painted black and is directly connected to the drying tunnel. The solar collector is covered with a transparent polycarbonate sheet. A 150-W solar cell module is installed in the dryer to move the air by means of fan support. The collector has a surface area that is 2 m long and 1.9 m wide. The area of the drying tunnel is exactly twice the area of the collector. The solar tunnel dryer faces south in the east-west direction and does not have shade between 9:00 am and 5:00 pm.

Figure 1
The experimental solar tunnel dryer

Moisture Content

The content of moisture was calculated by drying 50 grams of melon fruit in a hot air oven at 105°C for 24 h. The measurement was performed three times for each experiment and averaged.

Moisture Ratio

The moisture ratio (MR) of the melon samples is determined (1) using the Equation (1) below.

$$MR = \frac{M_t - M_e}{M_0 - M_e} \quad (1)$$

where MR is moisture ratio (dimensionless), M_t is the moisture content of the sample at any t time ($kg_{water}/kg_{dry\ solids}$), M_e is equilibrium moisture content ($kg_{water}/kg_{dry\ solids}$), and Mo is the initial moisture ($kg_{water}/kg_{dry\ solids}$). M_e is relatively small for a long drying time compared to M_t or M_0. Therefore, Me is accepted as numerically zero in this study. Thus, *MR* can be simplified as $MR=M_t/M_0$. (Tunckal Doymaz 2020).

Drying Rate

The drying rate was a highly significant parameter when it comes to drying kinetics. In order to reveal the association of the drying duration of melon and the drying rate, the drying rate of melon slices was determined as follows:

$$DR = \frac{M_{t+\Delta t} - M_t}{\Delta t} \quad (2)$$

where *DR* is the drying rate ($kg_{water}/kg_{dry\ solids}$ min), M_t and M_{t+dt} are the moisture contents at t and $t+dt$ respectively, and *t* is the drying time (min) (Beige 2016).

Mathematical Modeling

Continuous data on moisture content that were obtained according to different size characteristics were turned into moisture content. Table 2 shows five different mathematical models that are used for the moisture ratio of melon samples in the literature.

Table 2
Models employed for fitting of experimental data

No	Model name	Model Equation	References
1	Page	$MR=\exp(-kt^n)$	Diamente and Munro (1993)
2	Henderson and Pabis	$MR=a\exp(-kt)$	Yagcioglu et al. (1999)
3	Logarithmic	$MR=a\exp(-kt)+c$	Rahman et al. 1998
4	Midilli *et al.*	$MR=a\exp(-kt^m)+bt$	Midilli et al. 2002
5	Two-term	$MR=a\exp(-k_0t)+b\exp(k_1t)$	Rahman and Perera (1996)

a, b, c, g, k, k0 , k1 , m, n – empirical constants and coefficients in drying models

The non-linear regression analysis of equations was carried out with Sigma Plot 12.0 statistical software and the drying parameters and coefficients (a, b, c, k, k_1, k_2, n) of these equations were calculated. The determination of the best mathematical model was based upon three statistical values of the correlation coefficient R^2 obtained by the non-linear analysis under different drying conditions, the chi-square value of χ^2, and the root mean square error (RMSE) (Doymaz et al. 2015). The lower the $\chi 2$ and RMSE values and the higher the R^2 value, the better the goodness of fit (Falade & Ogunwolu 2014). They were chosen as the criteria for goodness of fit.

The equations of R^2, SEE, RMSE and χ^2 were given in (3), (4), (5) and (6), respectively:

$$R^2 = 1 - \frac{\sum_{i=1}^{N}\left(MR_{exp,i} - MR_{pre,i}\right)^2}{\sum_{i=1}^{N}\left(\overline{MR}_{exp} - MR_{pre,i}\right)^2} \quad (3)$$

$$SEE = \frac{\sum_{i-1}^{n}\left(MR_{exp,i} - MR_{pre,i}\right)^2}{d_f} \quad (4)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}\left(MR_{pre,i} - MR_{exp,i}\right)^2}{N}} \quad (5)$$

$$\chi^2 = \frac{\sum_{i=1}^{N}\left(MR_{exp,i} - MR_{pre,i}\right)^2}{N-z} \quad (6)$$

where MR_{exp} and MR_{pre} are experimental and predicted values of moisture ratio, respectively. The value z is the number of constants in the model and N is the total number of observations and d_f is the number of degrees of freedom of regression model.

Colour Parameters

Colour measurements of fresh and dried melon samples prepared with and without pretreatment were performed by reading L* (brightness/darkness), a* (redness/greenness) and b* (yellowness/blueness) values using Minolta Chroma CR-100 colour measuring device (Konica, Minolta, Tokyo, Japonya). The measurements were repeated 5 times and evaluated by taking the average of the obtained values. After the color measurement process; Chroma (C), hue angle (alpha) and ΔE values were also calculated from L*, a*, b* values. The equations used in the calculation of C, alpha and ΔE are given below (Vega-Galvez et al. 2009) (Eq.7-Eq.9).

$$C = \sqrt{(a^2 + b^2)} \quad (7)$$

$$\alpha^{\circ} = \tan^{-1}\left(\frac{b}{a}\right) \quad (8)$$

$$\Delta E = \sqrt{(L^* - L_0{}^*)^2 + (a^* - a_0{}^*)^2 + (b^* - b_0{}^*)^2} \quad (9)$$

Statistical Analysis

Sigma Plot (Scientific Graph System, version 12.00) software was used to perform the statistical analysis. Non-linear regression analysis was carried out by means of Sigma-Plot (version 12.00) in order to calculate equation parameters. The results of the regression analysis include of melon samples under solar tunnel drying; R^2, coefficient of determination; χ^2, chi-square value, and RMSE, the root mean square error.

All the samples were carried out in triplicate and all the data of the experiments were analysed by statistical software SPSS (Version 21.0, SPSS Inc., Chicago, IL, USA). The results of the experiments were expressed as mean ± standard deviation. Analysis of variance (ANOVA) was used to find the significant terms of each response in the model and values of $p \leq 0.05$ were considered statistically significant.

3. Results and Discussion

Figure 2 shows the panel inlet and outlet temperature as a function of drying time. The panel inlet temperature varied between 34.4°C and 47.1°C while the panel outlet temperature ranged from 39.3°C to 52.7°C. Figure 3 presents air velocity change as a function of time and days. According to Figure 3, the velocity values obtained from the fans reached a peak approximately in the middle of the day. The solar cell provided the fan with power; therefore, the velocity of air flow varied as a function of solar irradiation. Solar irradiance levels were low in the morning and afternoon as solar angles varied throughout the day.

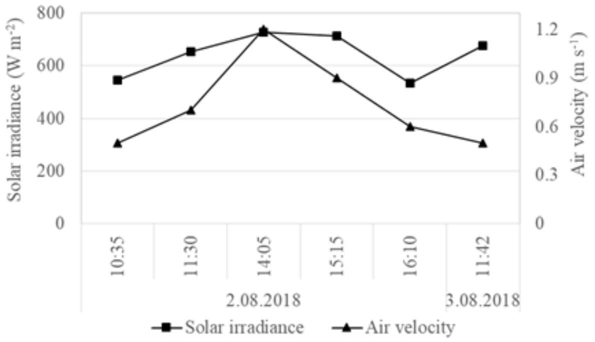

Figure 2
Change of solar irradiance and air velocity of drying air at the outlet of drying tunnel as a function of time

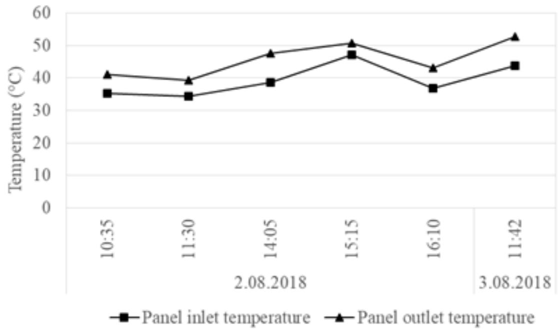

Figure 3
Change of panel inlet and outlet temperature as a function of time

In Figure 4 and 5, the effect of slice thickness of without pretreated and pretreated samples on the moisture ratio of two different melon varieties, Galia and Kırkagac, is given. As seen in Figure 4, the drying time of the melon increased significantly with the increase in slice thickness in both melon varieties. In both types of melons, the effect of pretreatment was seen at the end of drying. The pretreated samples were dried in shorter drying times than the without pretreated samples in both varieties. Samples with low slice thickness and pretreated were dried in the shortest time. Samples with a large slice thickness and without pretreatment were dried for the longest time. The drying time required for the drying of the Galia variety melon was found to be 3360, 4560 and 4800 minutes for 2mm, 4mm and 6mm slice thicknesses without pretreatment, respectively. However, the drying time required for drying the Galia variety melon was determined as 1680, 1680 and 3120 minutes for pretreated 2mm, 4mm and 6mm slice thicknesses, respectively. In another melon variety, Kırkağaç, the required drying time was found to be 2880, 3360 and 4560 minutes for slice thicknesses of 2mm, 4mm and 6mm without pretreatment, respectively. In the pretreated application, the drying times were determined as 1920, 2880 and 3360 minutes for 2mm, 4mm and 6mm slice thicknesses, respectively. The following study can be given as an example to show the effectiveness of preprocessing. According to a study on sliced persimmon, the samples were dried in a hot air dryer at three different temperatures (50 °C, 60 °C and 70 °C), respectively. It was stated that at the end of the drying processes, the pre-treated slices dried faster than the others (Doymaz 2012).

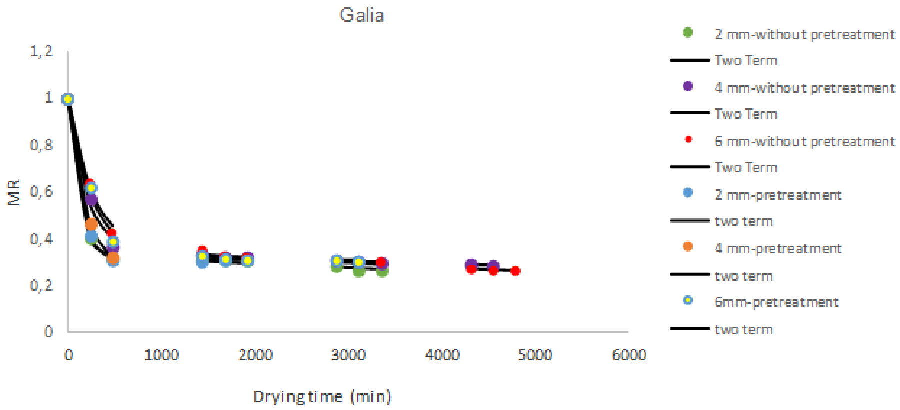

Figure 4
Drying curves of "Galia melon" dried with and without pretreatment at different slice thicknesses

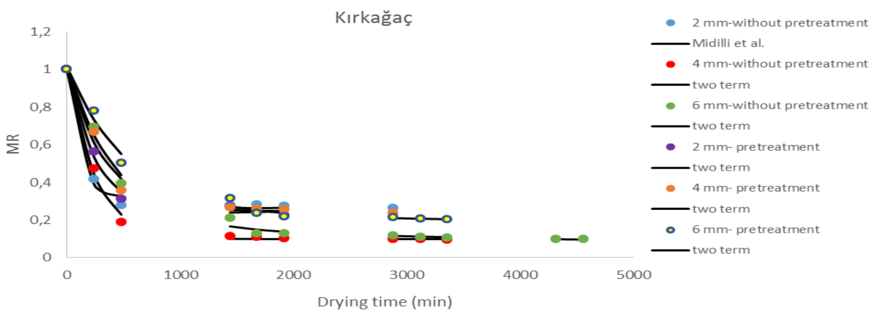

Figure 5
Drying curves of "Kırkağaç melon" dried with and without pretreatment at different slice thicknesses

Figure 6 and 7 show the variation of drying time and drying rate of Galia and Kırkagac melon samples dried with and without pre-treatment at different slice thicknesses in a solar tunnel drying system. Accordingly, the total drying rates were determined as 0.210333 kg [H_2O] kg-1dry solids.min for 2 mm sample thickness, 0,151 kg [H_2O] kg-1dry solids.min for 4 mm, and 0,12925 kg [H_2O] kg-1dry solids.min for 6 mm for the without pre-treatment of Galia melon varieties, respectively.

Additionally the total drying rates were determined as 0.203 kg [H_2O] kg-1dry solids.min for 2 mm sample thickness, 0.184583 kg [H_2O] kg-1dry solids.min for 4 mm, and 0,135 kg [H_2O] kg-1dry solids.min for 6 mm for the pre-treatment of Galia melon varieties, respectively.

In the Kırkağaç melon varieties, the drying rates differed as 0.211792 kg [H_2O] kg-1dry solids.min for 2mm slice thickness, 0,19575 kg [H_2O] kg-1dry solids.min for 4 mm slice thickness, 0.119167 kg [H_2O] kg-1dry solids.min for 6 mm slice thickness and 0,161375 kg [H_2O] kg-1dry solids.min for 2 mm, 0,124167 kg [H_2O] kg-1dry solids.min for 4 mm, 0,105583 kg [H_2O] kg-1dry solids.min for 6 mm respectively, according to without pretreated and pretreated applications.

Results showed that drying rate was between 0,001875 and 0.00033 kg [H_2O] kg-1dry solids.min both without pretreatment and pretreatment for Galia melon samples at the final stage of drying. In addition, drying rates for dried Kırkagac melon, for untreated and pre-treated samples varied between 0.001375 and 0.00075 kg [H_2O] kg-1dry solids.min.

Results showed that drying rate sharply increased within four hours and then decreased. In this study conducted with Galia and Kırkagac melon varieties, all drying methods were carried out in the period of falling drying rate. Also, there is no constant rate drying period in the drying rate curves. Parallel results were obtained in the study conducted with grape fruit by Yaldız et al. (2001).

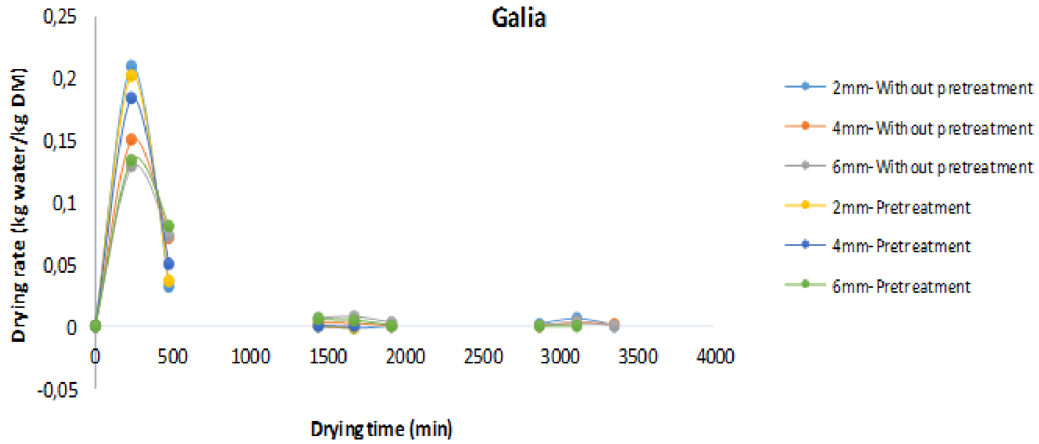

Figure 6
Drying rate curves of “Galia melon” dried with and without pretreatment at different slice thicknesses

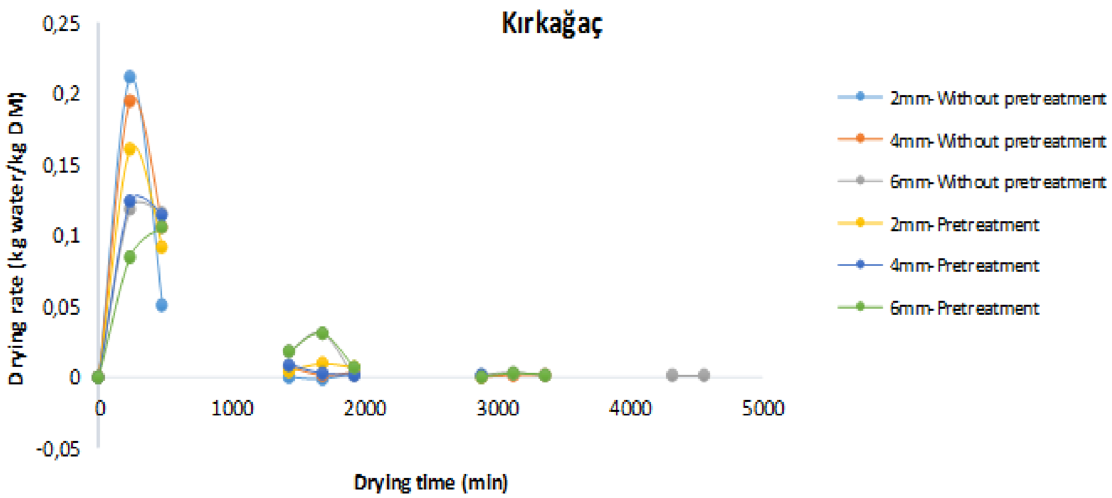

Figure 7
Drying rate curves of “Kırkağaç melon” dried with and without pretreatment at different slice thicknesses

Table 3 shows the model constants and statistical analysis data including R2, SEE, RMSE and χ2 values for all thin layer drying models suitable for moisture content data.

For the Galia melon variety, statistical parameter estimates in both conditions showed that the values of R^2, SEE, RMSE and χ2 ranged from 0,4743 to 1,0000, 0,0006 to 0,2148, 0,00027 to 0,17768 and 0,00002 to

0,092203, respectively. When a comparison was made between the 5 models and the statistical values, the Two Term model showed the greater R^2 and the lesser RMSE and χ 2 values with respect to other drying models at without pretreatment and pretreatment conditions.

On the other hand, statistical parameter estimates in both conditions showed that the values of R^2, SEE, RMSE and $\chi 2$ ranged from 0,5227 to 0,9961, 0,0221 to 0,2045, 0,01801 to 0,1728 and 0,00134 to 0,36968, respectively for the kırkagac varieties.

The drying characteristic curves were estimated against five mathematical models, and all other data showed that the Two Term model equation was the best descriptive model, except for the experiments of untreated thin-layered Kırkağaç melon samples with a slice thickness of 2 mm. On the other hand, in the untreated Kırkagac melon sample with a slice thickness of 2 mm, Midilli et al. model equation was found to be the best descriptive model.

Colour Measurement

Colour values of fresh and dried Galia and Kırkagac melon samples are shown in Tables 4 and 5. The brightness values (L*) of the melon samples (Pineapple and Kırkağaç) dried in the solar tunnel dryer increased compared to the fresh samples. While the L* values were 61.98 before drying in the Galia variety melon samples, it was determined that this value changed between 62.84 and 73.15 after drying. On the other hand, the Galia melon samples treated with ascorbic acid were compared with the untreated samples and it was determined that the brightness values (L*) after the pretreatment applications were the closest to fresh. Likewise, the same is true for dried Kırkagac melon samples. While the L* values before drying were 61.38 in Kırkagac variety melon samples, it was determined that this value changed between 66.9 and 80.71 after drying. In other words, it was observed that the brightness values of the samples dried with the pre-treatment drying method were closer to the brightness values of the fresh product (L*). In general, the brightness values of both melon cultivars dried by the application of ascorbic acid solution decreased and the values closest to fresh were obtained. Color changes often take place in dried foods due to non-enzymatic browning reactions (Sroy et al. 2022).

The a* value on the color scale means red or green. An increase in a* means a redder chroma, known as an indicator of the browning reaction. Also, the b* value on the color scale indicates yellowness or blueness. An increasing b* value ($P < 0.05$) indicates the more yellow sample. While no significant change was observed in b* values of Galia melon samples, an increase was detected in pretreated applications of a* values. The a* (redness) value was affected by the applied pretreatment. It was determined that higher a* values ($P < 0.05$) were obtained in the pretreated samples compared to the untreated samples.

Another criterion used to compare the color qualities of the samples is their b* values. It is desired that this value be as low as possible in quality dried melon varieties. When the samples were compared in terms of b* values, the lowest value was determined in the products dried without pretreatment. When the Kırkağaç melon samples are examined in terms of b* (yellowness) values, the situation is slightly different compared to a* values. b* values decreased in applications without pretreatment. However, in preprocessed applications, results closer to the fresh value were obtained. On the other hand, in a* (redness) values, the closest results to the fresh value were obtained in applications without pretreatment. As in the Galia melon samples, an increase in the a* values obtained as a result of the drying process applied with the pretreatment was observed in the Kırkagac melon samples.

The chroma value is one of the most effective factors in the appearance of the products and is effective in product preference. The chroma value shows the tone of the color in the products, and the values are low in pale colors and high in bright colors (Çetin, 2019). C values, b* (yellowness) values of both dried melon samples closely followed. However, the highest C values for both melon varieties were determined as 33.89 for Galia variety with 2mm thickness pre-treated and 28.46 for Kırkagac variety with 2mm thickness pre-treated, respectively. This showed us that the 2mm thick pretreated samples in both varieties were significantly ($P<0.05$) more vivid in color than any of the other dried and fresh samples.

Kırkagac melon without preprocessing samples, the hue angle decreased while the total color difference increased. On the contrary, in the pretreated samples, the hue angle increased while the total color difference decreased. On the other hand, no significant difference was observed in the total color difference values in Galia melon samples in both applications.

In this study, it was determined that better results were obtained when the L*, a* and b* values of melon varieties were dried without pretreatment.

Table 3
Statistical results obtained from the selected drying models

		Melon varieties											
		Galia						Kırkağaç					
		Without pretreatment			Pretreatment			Without pretreatment			Pretreatment		
		2mm	4mm	6mm	2mm	4mm	6mm	2mm	4mm	6mm	2mm	4mm	6mm
Page	R^2	0,9940	0,9712	0,9746	0,9918	0,9842	0,9625	0,9864	0,9732	0,9732	0,9718	0,9520	0,9672
	SEE	0,0195	0,0385	0,0363	0,0316	0,0432	0,0520	0,0345	0,0535	0,0518	0,0568	0,0699	0,0569
	RMSE	0,017215	0,034874	0,033101	0,024477	0,033494	0,045045	0,029144	0,04719	0,046839	0,046358	0,059086	0,050138
	χ^2	0,000874	0,002788	0,002411	0,001681	0,00292	0,004699	0,0024664	0,011921	0,015767	0,005125	0,008337	0,007742
Henderson and Pabis	R^2	0,4743	0,5548	0,6626	0,5674	0,6099	0,6739	0,5227	0,9195	0,9266	0,7765	0,7983	0,9053
	SEE	0,1824	0,1515	0,1322	0,2294	0,2148	0,1534	0,2045	0,0927	0,0858	0,1597	0,1433	0,0966
	RMSE	0,160889	0,13701	0,120655	0,177685	0,166393	0,132879	0,172834	0,08178	0,07756	0,130388	0,121083	0,085172
	χ^2	0,050281	0,039565	0,032246	0,092203	0,073338	0,041401	0,074784	0,23778	0,369689	0,047849	0,055081	0,036018
Logarithmic	R^2	0,9943	0,8605	0,7741	0,9996	0,9985	0,9950	0,9607	0,9961	0,9922	0,9927	0,9855	0,9898
	SEE	0,0206	0,0899	0,1140	0,0085	0,0164	0,0208	0,0656	0,0221	0,0297	0,0333	0,0429	0,0343
	RMS	0,016823	0,076707	0,098725	0,00539	0,01041	0,016471	0,049602	0,018019	0,025347	0,023593	0,032452	0,02798
	χ^2	0,000981	0,017439	0,028768	0,00009	0,000314	0,000599	0,008218	0,001343	0,002676	0,001632	0,002219	0,001876
Two-term	R^2	0,9981	0,9958	0,9968	1,0000	0,9998	0,9950	0,9790	0,9961	0,9930	0,9929	0,9855	0,9899
	SEE	0,0131	0,0167	0,0143	0,0006	0,0081	0,0203	0,0553	0,0242	0,0299	0,0403	0,0495	0,0374
	RMSE	0,009769	0,013349	0,011708	0,00027	0,003295	0,016467	0,036188	0,018033	0,023884	0,023238	0,032426	0,027866
	χ^2	0,000315	0,000429	0,000309	0,00002	0,00004	0,00060	0,003904	0,001365	0,002015	0,001692	0,002107	0,00183
Midilli *et al.*	R^2	0,9940	0,9802	0,9840	0,9995	0,9988	0,9832	0,9909	0,9896	0,9894	0,9888	0,9734	0,9878
	SEE	0,0231	0,0362	0,0321	0,0132	0,0208	0,0427	0,0365	0,0394	0,0369	0,0505	0,0672	0,0409
	RMSE	0,017221	0,028887	0,026246	0,005896	0,009308	0,030169	0,023887	0,029355	0,02943	0,029129	0,043948	0,030524
	χ^2	0,000873	0,00191	0,00153	0,000115	0,000282	0,002001	0,001769	0,012353	0,002855	0,003421	0,004657	0,002016

Table 4
Colour measurements of "Galia"melon fruit in different slice thicknesses (Statistical analysis conducted by one-way ANOVA)

Galia	L*	a*	b*	C*	α*	ΔE
Fresh	61,98^{b} (±5,29)	1,991^{b}(±1,113)	26,23^{ab}(±6,36)	26,32^{b}(±6,4)	85,744^{a}(±2,049)	-
2 mm-Without pretreatment	73,15^{a}(±2,42)	1,872^{b}(±1,191)	27,5^{ab}(±2,93)	27,58^{ab}(±2,99)	86,27^{a}(±2,159)	11,61(2,31)
4 mm-Without pretreatment	69,36^{ab}(±5,89)	2,008^{b}(±1,508)	27,144^{ab}(±1,739)	27,248^{ab}(±1,813)	85,85^{a}(±2,94)	8,77(3,6)
6 mm-Without pretreatment	69,27^{ab}(±5,76)	1,52^{b}(±0,87)	23,832^{b}(±1,164)	23,893^{b}(±1,176)	86,379^{a}(±2,069)	8,78(3,58)
2 mm-Pretreatment	65,22^{ab}(±8,46)	5,86^{a}(±3,03)	33,24^{a}(±3,05)	33,89^{a}(±2,54)	79,68^{b}(±5,87)	11,64(3,72)
4 mm-Pretreatment	62,84^{ab}(±4,22)	6,07^{a}(±1,232)	29,92^{ab}(±2,78)	30,55^{ab}(±2,87)	78,564^{b}(±1,896)	6,81(2,79)
6 mm-Pretreatment	63,04^{ab}(±4,89)	5,27^{a}(±1,322)	28,47^{ab}(±4,32)	28,96^{ab}(±4,46)	79,617^{b}(±1,401)	7,08(1,63)

The statistics of each color parameter column were applied separately, and the differences between the means with different letters in the same column were significant ($p<0.05$).

Table 5
Color measurements of "Kırkagac"melon fruit in different slice thicknesses (Statistical analysis conducted by one-way ANOVA)

Kırkagac	L*	a*	b*	C*	α*	ΔE
Fresh	61,38^{d}(±5,82)	-1,255^{b}(±1,981)	24,4^{ab}(±4,23)	24,51^{ab}(±4,18)	-41,7^{b}(±4,6)	-
2 mm-Without pretreatment	80,718^{a}(±1,546)	-1,244^{b}(±0,23)	15,148^{c}(±0,549)	15,201^{c}(±0,528)	-85,277^{b}(±1,044)	21,45^{a}(1,31)
4 mm-Without pretreatment	76,16^{ab}(±2,91)	-0,89^{b}(±0,501)	14,596^{c}(±2,011)	14,634^{c}(±1,976)	-86,26^{b}(±2,49)	17,78^{ab}(3,32)
6 mm-Without pretreatment	73,96^{abc}(±5,8)	-0,7^{b}(±0,289)	15,12^{c}(±2,49)	15,14^{c}(±2,48)	-87,186^{b}(±1,411)	15,77^{abc}(5,94)
2 mm-Pretreatment	66,9^{cd}(±4,6)	2,79^{a}(±2,24)	28,28^{a}(±4,6)	28,46^{a}(±4,81)	84,78^{a}(±3,34)	9,46^{cd}(3,59)
4 mm-Pretreatment	68,05^{bcd}(±4,05)	0,826^{ab}(±0,856)	21,224^{abc}(±1,861)	21,254^{abc}(±1,865)	51,8^{a}(±1,902)	8,44^{d}(2,29)
6 mm-Pretreatment	71,72^{bc}(±3,09)	-0,084^{ab}(±0,513)	20,128^{bc}(±1,8)	20,134^{bc}(±1,796)	-17,7^{b}(±1,291)	11,40^{bcd}(2,99)

The statistics of each color parameter column were applied separately, and the differences between the means with different letters in the same column were significant ($p<0.05$).

4. Conclusions

The solar tunnel dryer produced in our department can be used for drying melon fruit as well as drying different agricultural products under the climatic conditions of Isparta. In this study, a constant drying rate period was not observed, on the contrary, all drying processes took place in a decreasing rate period. However, the moisture content values were determined as

83.7927 kg water/kg dry matter (w.b.) for the Galia variety and 88.1213 kg water/kg dry matter (w.b.) for the Kırkagac variety, 10.78% and 12.52%, respectively. The trials lasted only two days, depending on the weather conditions, in the solar tunnel dryer. At the same time, the melon samples dried in the solar tunnel dryer were completely protected from birds, insects, dust and bad weather conditions due to the closed system. Dried melon variety samples were brighter and more yellow when dried with without pretreatment compared to drying pretreatment. No significant effect of the slice thickness applications carried out within the study directly on the final product was detected.

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