Journal of Soil Sciences and Agricultural Engineering

Journal homepage & Available online at: www.jssae.journals.ekb.eg

Quality Evaluation by Using Laser of Red Grapes during Microwave Drying

Shaimaa R. Ali[1] and O. A. Abdel Hameed[2]*

[1] National Institute Of Laser Enhanced Sciences (NILES), Cairo University, Egypt.
[2]Agricultural Engineering Research Institute, Agricultural Research Center, Egypt

Cross Mark

ABSTRACT

Raisins are one of the methods of preservation of grapes to increase the shelf life of fruits. The present study focused on the microwave drying of grapes, to produce raisins and determine its effect on Physico-chemical and optical properties of raisins during the drying process. To measure the main dimensions, mass, acidity, and total soluble solids as Physico-chemical, while the optical properties such as reflection and absorption of grapes using laser technique. Also, to find the relationship between the laser reflection of grapes during microwave drying and changes in shrinkage, moisture content, mass, acidity, and total soluble solids during the grape drying process. Obtained results showed that there is an inverse relationship between the percentage of reflection of the laser beam from the surface of the grape fruits and the percentage of loss moisture, TSS, pH, and volume of fruits. Relationship between laser reflection of grapes and physic-chemical properties at drying time of 10, 20, 30, 40 and 50 min, the percentage laser reflected from the surface decreases, of about 38, 32, 23, 21, and 15%, due to the moisture loss percentage of 14, 32, 63, 75, and 80%., increasing the TSS percentage of 6, 18, 37, 49, and 61%, increasing the pH percentage of 4, 11, 15, 21 and 26%, and increasing the volume percentage of 16, 41, 55, 67 and 74%, respectively. The microwave drying showed a better quality profile. This can be useful for farmers and small-scale farmers to produce good quality raisins.

Keywords: Microwave, grapes, laser, quality, physic-chemical

INTRODUCTION

After wine and table grapes, dried grapes (raisins) are the third most common method that grapes are used. Grapes are dried by being exposed to sunlight, drying in the shade, or artificially using certain techniques to produce raisins (Jairaj *et al*., 2009). It takes a long time and lowers the quality of the finished product to dry grapes using a mechanical hot air dryer. The drying of grapes takes place throughout the period of declining rates (Esmaiili *et al*., 2007).Due to their bioactive contents, nutritional value, and usefulness as snacks, dried fruits are widely used (Ishiwata *et al*., 2004).

Raisins are a preferred dried fruit all over the world because they are a great source of essential vitamins and minerals, are free of fat and cholesterol, and contain 70% fructose, an easily digestible sugar (Sanz *et al*., 2001).

Moreover, raisins are the solid fruit product with the highest level of total phenolic components and antioxidant activity (Pastrana-Bonilla *et al*., 2003).

The grape is one of the first fruit species known to have been produced in Egypt. The area planted with grapes makes up around 14% of the overall area grown with various sorts of fruits because the fruit crop is the second-largest in terms of importance and area. Grapes are a favorite and popular fruit for Fresh grapes are extremely susceptible to microbial deterioration due to their relatively high sugar and moisture content. To prevent economic losses, they must be consumed immediately after harvesting or processed into a variety of goods within a few weeks, including wine, grape juice, jam, and raisins. [Adiletta *et al*., 2016].

According to Wang *et al*. (2021) and Uzun and Hallac (2021), table grapes account for roughly 51 percent of production, while drying grapes account for 38 percent (27 percent for seedless raisins and 10 percent for seeded raisins) and 11 percent of wine production. Raisins are widely consumed worldwide as a snack or as a food ingredient in the cooking, baking, and brewing industries due to their alluring flavour, texture, and high nutritional content (Kedage *et al*., 2007). Many conventional drying techniques have drawbacks such slow drying rates and high temperatures during periods of slow drying, which ultimately lead to subpar dried food items.

A better drying option is microwave vacuum drying (MVD), which combines the benefits of microwave (MW) and vacuum drying by lowering the process temperature and promoting water evaporation, resulting in a quick drying time and high-quality output.

It is difficult to turn grapes into high-quality raisins because there are issues with grape drying, like one that is related to the structure of the grape skin. The regulation of the drying process depends heavily on the grape peel. According to Lecas and Brillouet (1994), the grape's skin is made up of an epidermis and six to ten layers of tiny cells with thick walls.

When a high throughput is required, mechanical drying—which is secure, quick, and controllable—is chosen (Esmaiili *et al*., 2007). The most popular drying method is traditional hot air drying, although there are significant downsides to this process, including its high energy consumption and requirement for high drying temperatures. The energy requirements for drying techniques like freeze

*** Corresponding author.**
E-mail address: basmalasama@gmail.com
DOI: 10.21608/jssae.2023.194058.1148

drying, hot air and oven drying, vacuum drying, microwave drying, and infrared drying are all higher. On the other hand, because they often have hard skin and are seeded, fresh eating of these grapes is rather constrained in terms of consumer approval (Kambiranda *et al*., 2020).

In three different stages of the drying process, microwave heating can be mixed with hot air. As the dehydration process first starts, microwave heating is used, which causes the interior to heat up quickly. An enhanced drying rate causes a steady temperature profile to be established during a rapid drying period, forcing the vapour outdoors. This produces a porous structure known as "puffing," which can help the mass transfer of water vapour even further. When moisture is present at the centre of a product during the reduced drying rate period (last stage of drying), the drying rate starts to decline, and with the aid of microwave heating, vapour is driven outward in order to remove bound water.(Tavakoli *et al*., 2009).

When grapes are drying, hydrophobic waxes on the skin prevent water from evaporating quickly from the grapes' interior to exterior surfaces. According to Esmaiili *et al.* (2007), another issue is that the thermal conductivity of raisins varies from 0.126 to 0.392 W/(mK) with an increase in moisture content from 14 to 80% (wb). As a result, during the conventional method of drying, heat transfer in the inner section during the falling rate period is slow. Post-harvest losses are a significant issue (Prusky, 2011), both from an environmental and an economic standpoint (Yao *et al*., 2020).

Yet, this drying process could encourage nutritious components' partial disintegration as well as unfavourable product quality alterations, like changes in colour, appearance, and structural characteristics.

These characteristics are highly reliant on the drying environment (e.g., air temperature and velocity). In this regard, recent developments in revolutionary food processing technologies have drawn a lot of attention in an effort to reduce a variety of undesirable alterations and make dried items with fresh-like qualities.

In contrast to conventional heating, which requires moisture to leave a material against a temperature gradient, one of the main benefits of employing microwave heating is that the temperature and moisture gradients are in the same direction (Murthy and Prasad, 2005).

In their study, (Murugaiah and Al-Talib2017) examined the changes in shrinkage and density during microwave vacuum drying (MVD) under various operating circumstances. For the investigation, samples of two different kinds of fresh grapes were collected; the first was left untreated, while the second had a 30-second pretreatment with a solution of sodium hydroxide (0.5%) and ethyl oleate (2%) at 80°C.Grapes' apparent density and shrinkage ratio were evaluated as outcomes of the process variables microwave power (100, 110, 120, and 130 W) and pressure (200, 400, and 600 mm Hg). The drying time was reduced by 70 to 90% using microwave vacuum drying. Sun drying is connected with a number of losses, including colour deterioration brought on by intense solar radiation, physical microbiological deterioration brought on by rain, and environmental contamination brought on by dust and insect illnesses.

Measurement of the physical-chemical characteristics of grapes during microwave drying, including their primary dimensions, mass, acidity, and total soluble solids, is the first goal of this work. Also, to use laser technology to measure the optical characteristics of grape fruits, such as their reflection and absorption. The second goal is to determine the relationship between changes in the physical characteristics of grapes during the drying process and laser reflection technology in grapes during microwave vacuum drying under various operating settings.

MATERIALS AND METHODS

For the purpose of drying the grapes and determining their quality, this work was done in the main laboratory of the Agricultural Engineering Research Institute, Agricultural Research Center, while the optical characteristics of the grapes were measured in the Laboratory of Laser Applications in Agricultural Engineering at the National Institute of Laser Enhanced Science (NILES), Cairo University. In order to create dried grapes (raisins) in the season of 2022, this work intends to evaluate the quality of red grapes throughout drying stages.

Sample preparation

When grown between latitudes 30:51 North, grapes are regarded as a fruit of the temperate tropical climates. In order to conduct the experiment, raisins made from fresh grapes were microwave-dried and then placed in sterile plastic boxes in a suitable environment. Ripe grape fruits (Red Flame seedless type) were purchased and acquired from the local market in Giza, Egypt. The samples of grapes were chosen to have comparable sizes, shapes, and colours after the fruits had been cleaned in an air screen to remove any foreign objects, such as dust, dirt, and fragments of branches and leaves, prior to the testing.Five fresh grape groups with a combined fresh mass of 500gm were selected at various drying durations to examine whether the laser reflection of grapes itself changes their physico-chemical qualities after exposure times of (10, 20, 30, 40, and 50 min).

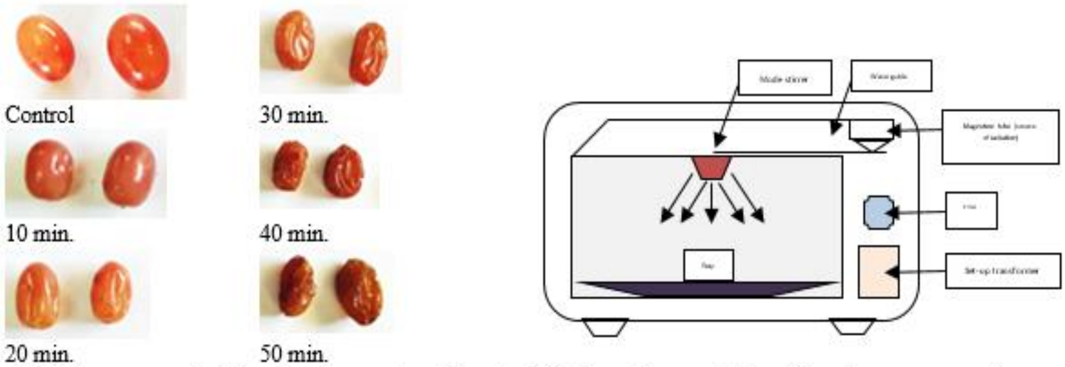
Microwave oven dryer

The magnetron tube (radiation source), oven cavity, filter, step-up transformer, power plug, waveguide, mode stirrer, and oven tray make up the majority of the microwave oven dryer (Fig.1). A thin layer of the fruits was applied to the chromium mesh. Manual adjustments were made to the heater's electric current and the fan's rotation in order to generate various temperatures and correct the velocity. A household microwave oven with programmable settings and a maximum output of 800W at 2450 MHz was used for the drying process. The microwave cavity has measurements of 230 by 350 by 330 mm. The turntable in the microwave features glass (325 mm diameter).

Drying Method

A relative humidity of 60% (±3) and a temperature of 20°C (±1) were used to operate the dryer. The heater warmed this air before directing it to the drying room. For the experiment, a temperature of 70 °C and a chosen air velocity of 0.30 m/s were used.

A microwave oven was employed as the drying method for this study. The initial moisture content of 500 g of grape samples was determined using a conventional method by the drying oven at defrosting 60º C for 10, 20, 30, 40, and 50 min to be 80% on the mass basis.

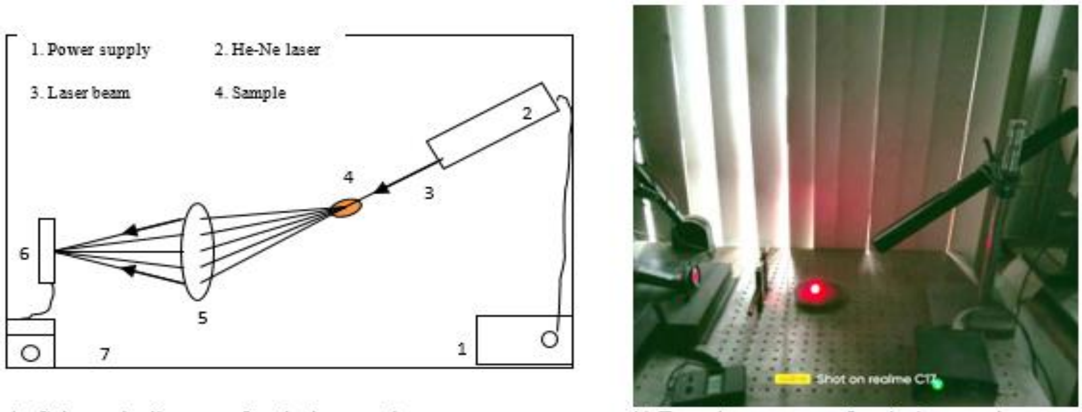


a) Dried grape samples from the rip grape to raisins at different drying time   b) Schematic presentation of the microwave oven dryer.

Fig. 1. Grape samples and drying grape fruits by microwave during 50 min at 70 ºC

Optical properties:

Laser Setup: To get high reflections and create standards for classifying the optical characteristics of grapes fruits, the experimental setup was placed at a 45º incidence angle, which is also the angle at which light is reflected. Figure (2-a) depicted the experimental configuration.



a) : Schematic diagram of optical properties.   b) Experiment setup of optical properties.

Fig. 2. Experiment schematic diagram of set up for measuring the optical properties of grape fruits.

Using aHe-Ne laser: a helium-neon (He-Ne) laser with a wavelength of 632.8 nm, and power of 4 mW, and an intensity of 4200 lux was used as the light source. The laser was supported by a stand. The following table displays the He-Ne laser's specifications (1).

Lens: A 75 mm-diameter convex silica glass lens with a 100 mm focal length was utilized. The lens was put between the fruit sample and the Luxmeter with an angle of 45 degree to focus the reflected light and collect it on the luxmeter detector.

Holders: Holders fabricated from copper were used to hold the lens, sample, luxmeter detector.

Digital luxmeter: A digital luxmeter with high accuracy and sensitivity was used to measure the intensity of light reflection from fruit surface and collected by a concave lens to luxmeter detector. Digital luxmeter with ranges of 0-50,000 Lux. Digital luxmeter specifications are shown in table (1).

Table 1. The specifications of Helium-Neon (He-Ne) laser and digital luxmeter

Specifications of Helium-Neon (He-Ne) laser			Specifications of digital luxmeter	
No.	**Item**	**Details**	**Items**	**Details**
1	Source of manufacture	USA	Source of manufacture	Japan
2	Model	05-LGR-173	Model	Lx-101
3	Type	Gas laser	Display	13 mm LCD (Liquid Crystal Display)
4	Wavelengths, nm	632.8	Ranges	0-50,000 Lux 3 ranges
5	Mode	Continuous wave	Over-input	Indication of "1"
6	Out put power, mW	4	Sampling time	0.4 second
7	Beam diameter, mm	0.75	Operating temperature	0ºto 50 ºC. (32 º – 122 º F)
8	Beam divergence, mrad	0.92	Operating humidity	Less than 80% R.H.
9	Polarization ratio	Random	Dimension	108 x 73 x 23 mm (4.3 x 2.9 x 0.9 inch)
10	Mass, kg	0.61	Mass	160 g (0.36 Ib) including battery
11	Input current, Ac, V, A	220 , 3	Power supply	006P DC 9V, 2 mA battery

The absorption of grape fruit was calculated from the following equation according to the energy conservation law:

$$I = R + A \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

I : The incident beam, lux; R - reflective beam, lux; and A- absorptive beam, lux.

Measurements:

Physical properties

Size of fruit

A ±0.01 mm sensitive digital calliper was used to measure the width, length, and thickness of 20% randomly selected samples of each treatment to determine the fresh fruit's physical properties (Al-Mahasneh and Rababah 2007; Demir and Kalyoncu, 2003).

Surface area and volume

100 replications of the measurements were created as a result. Using the properties of length (L), width (W), and thickness (T) before and after drying, the average was determined and represented in "centimetres" (cm) for the 100 fruits' surface areas (S) and volumes (V).

$$B = (W T)^{1/2}$$

$$S = (\pi * B * L^2) / (2*L - B)$$

$$V = (\pi * B^2 * L^2) / 6 (2*L - B)$$

Moisture content:

At the time of purchase, fresh fruit had a moisture level of about 80%. In order to determine the fruits' moisture content, a 105 °C air oven was used and maintained until the fruits reached a consistent mass (AOAC, 1984). The moisture content must ideally be less than 20% to ensure secure long-term storage (and the production of raisins). Due to this, the fresh grapes with an 80% initial moisture content were dried in a drier to a moisture content of 18–20%. The mass of the fruit samples was automatically weighed by the balance every 10, 20, 30, 40, and 50 min during the drying process. All experiments were repeated three times.

With a mortar and pestle, raisins were crushed into pulp. Two grams of this pulp were then spread out in a stainless steel dish, and dried at 80ºC until a constant mass was achieved. The following equation was used to compute the moisture content (%) gravimetrically:

$$\text{Moisture Content (\%)} = ((Wbd - Wad)/Wbd) * 100$$

Where:

Wbd is the mass of the sample before drying and Wad is the mass of the sample after drying.

Samples mass

Using an electronic digital balance (Shimadzu Ltd., Model ELB 300) with a ±0.01 gram sensitivity, the mass of each fruit was measured separately.

1000 grapes mass

To calculate the mass of 1000 grapes, the mass of 100 fruits was weighed on a top-loading electronic balance (EK 5350) with a resolution of 0.01 gram, by (Tavakoli *et al.*, 2009)

Bulk density:

By weighing a grape fruit with known mass and volume, bulk density—which is defined as the ratio of the sample's mass to its container volume—was assessed. The results are reported in g/cm^3 as follows.

$$\rho\ b,\ g/cm^3 = Mass / Volume$$

Where: **ρb (g/cm3) is bulk density, mass m(g) of the sample.**

Shrinkage measurement

- •Samples were chosen, and their precise starting masses were recorded, in order to calculate the shrinkage ratio in grapes during drying.
- •The shrinkage ratios were computed as the ratio of volume, length, width, and thickness to the corresponding original values at any moisture content level after 30 min.
- •For various moisture levels, the initial and final apparent densities—defined as the sample's total mass to apparent volume ratio—were calculated.

Chemical composition

The grape and raisins were subjected to a conventional method of analysis for their near compositions, including, treatable acidity, total soluble solids and moisture content. The measurements were performed on grape juice samples in order to evaluate their chemical qualities. 100 cc of juice was squeezed and used for the chemical testing. These tests included:

pH value: was measured by using a digital pHmeter**.**

Total soluble solids (TSS)

Fresh grapes were utilized to assess the soluble solid content (TSS) in brix degrees of the samples using a digital refractometer (PAL-BX/ACID2, Atago Co. Ltd., Tokyo, Japan). The total sugars were calculated using AOAC (2007) producer.

The statistical model of the moisture content as a function of the shrinkage and reflection is developed from the experimental data on the assumption of a linear relationship existing between moisture content, shrinkage, and reflection

RESULTS AND DISCUSSIONS

Physical parameters of grape and raisin

Fruit's physical properties have a significant impact on both the quality of finished products and the advancement of processing technology. As grapes are a delicate fruit that can be quickly damaged when subjected to a little force, it is important to examine their physical properties before processing or using them to create other products (Table 2). The average dimensions of grapes and raisins were 2.23 and 1.44 cm, 1.52 and 0.94 cm, 1.34 and 0.87 cm, 6.7 and 2.2 gm, 16.076 and 1.753 cm^3, for length, width, thickness, mass of one fruit, and volume, respectively. While the ratios between grape and raisin for main properties were 0.4 and 1.2 gm/cm^3 for bulk density, and 1.467 and 1.532 for length to width ratios, respectively. The measurements of the fruit's length/width ratio, mass/bulk density, and length/width dimensions show the results were similar to the results reported by (Doymaz and Altıner, 2012).

Table 2. Physical properties of grapes and raisin fruits

Item	Grape	Raisin
Length of fruit, L (cm)	2.23	1.44
Width of fruit, W (cm)	1.52	0.94
Thickness of fruit, T (cm)	1.34	0.87
Mass of fruit (gram)	6.7	2.2
Moisture content (%)	81	16
W*T	2.04	0.82
Surface area of fruit (cm2)	3.57	1.14
Volume of fruit (cm3)	16.076	1.753
Bulk density ρ b, g/cm3	0.4	1.2
Fruit *L /W ratio*	1.467	1.532

Effect of drying time on main dimensions of fruits:

The measured data notes that the length of the grape samples gradually decreases with increasing drying time. It has been found that the length of the fruits decreases from 20.6, 1.83, 1.71 , 1.62 , and 1.44 cm compared to the sample of un-dried grapes (control), 2.23cm for drying times 10, 20, 30, 40 and 50 min, respectively. It is noticed from the measured data that the length shrinking of grape samples increases gradually with increasing drying time. It has been found that the shrinking in the length of the fruits increases of 7.62, 17.94, 23.32, 27.35 and 35.43%, for drying times 10, 20, 30, 40 and 50 min, respectively, as shown in Fig. 3.

The measured data notes that the length of the grape samples gradually decreases with increasing drying time. It has been found that the width of the fruits decreases from 1.45, 1.31, 1.17 , 1.02 , to 0.94 cm compared to the sample of un-dried grapes (control), 1.52 cm for drying times 10, 20, 30, 40 and 50 min, respectively. It is noticed from the measured data that the width shrinking of grape samples increases gradually with increasing drying time. It has been found that the shrinking in the width of the fruits increases from 4.61, 31.81, 23.03, 32.89to 38.16%, for drying times 10, 20, 30, 40 and 50 min, respectively, as shown in Fig. 3.

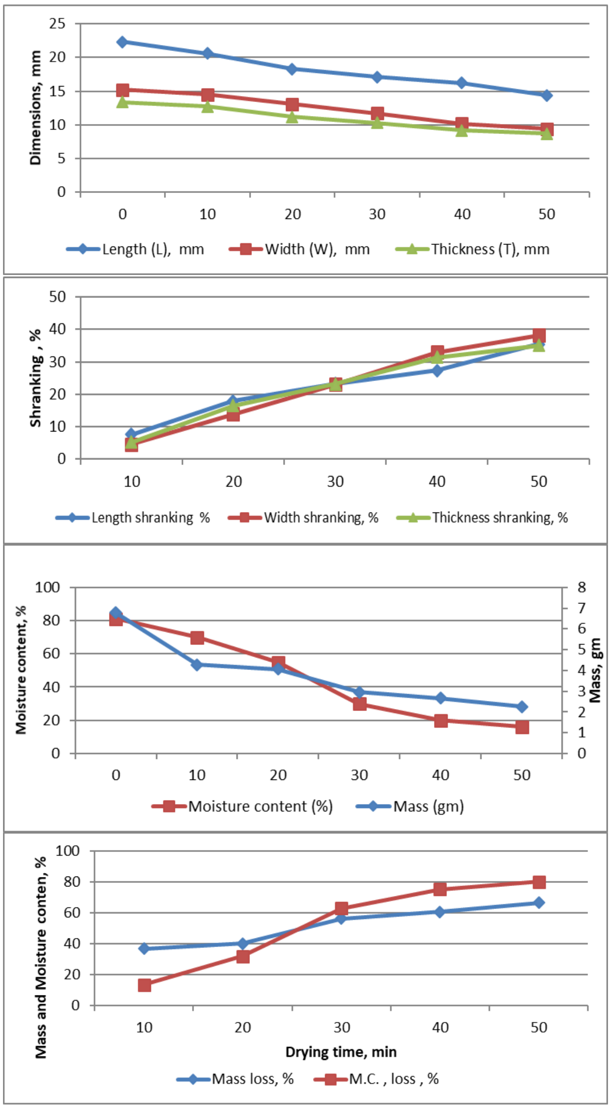


Fig. 3. Effect of drying time of some physical properties of grape at microwave drying

The measured data notes that the length of the grape samples gradually decreases with increasing drying time. It has been found that the thickness of the fruits decreases from 1.27, 1.12, 1.03, 0.92, to 0.87 cm compared to the sample of un-dried grapes (control), 1.34 cm for drying times 10, 20, 30, 40 and 50 min, respectively. It is noticed from the measured data that the thickness shrinking of grape samples increases gradually with increasing drying time. It has been found that the shrinking in the thickness of the fruits increases from 5.22, 16.42, 23.13, 31.34 and 35.07 %, for drying times 10, 20, 30, 40 and 50 min, respectively, as shown in Fig. 3

According to effect of drying time on relation between shrinking and main dimensions, the shrinkage is reported as the coefficients of determination in Fig.3 show that length, width and thickness are in an acceptable linear relationship with the shrinkage (R^2= 0.975), (R^2=0.973) and (R^2=0.991) as well with laser percentage (R^2= 0.982).

Effect of drying time on mass of fruits:

The measured data notes that the mass of the grape samples gradually decreases with increasing drying time. It has been found that the mass of the fruits decreases from 4.2, 4.0, 2.9, 2.6 to 2.2 gram compared to the sample of un-dried grapes (control), 67.79 gram for drying times 10, 20, 30, 40 and 50 min, respectively. It is noticed from the measured data that the mass loss of grape samples increases gradually with increasing drying time. It has been found that the loss in the mass of the fruits increases from 37.01, 40.21, 56.34, 60.83 and 66.71 %, for drying times 10, 20, 30, 40 and 50 min, respectively, as shown in Fig. 3. When microwave vacuum drying was used to measure the shrinkage ratio and apparent density of Thompson seedless grapes, the shrinkage ratio of the grapes decreased linearly with the moisture content, ranging from 80 to 20% (wb). Experimental results demonstrated that during microwave vacuum drying, system pressure had a more substantial impact on shrinkage and density variations than power level.Murugaiah and Al-Talib (2017)

Effect of drying time on moisture content of fruits:

The measured data notes that the moisture content of the grape samples gradually decreases with increasing drying time. It has been found that the moisture content of the fruits decreases from 70, 55, 30, 20 to 16% compared to the sample of un-dried grapes (control), 81% for drying times 10, 20, 30, 40 and 50 min, respectively. It is noticed from the measured data that the moisture content loss of the grape samples gradually increases with increasing drying time. It has been found that the loss in moisture content of the fruits increases from 13.58, 32.09, 62.96, 75.31 and 80.25%, for drying times 10, 20, 30, 40 and 50 min, respectively, as shown in Fig. 3. When the drying period increases, the moisture content falls first quickly and then gradually. At a temperature of 70 °C, the longest drying time (50 min) was also discovered. Because MVD causes the sample to become porous, it is seen that apparent density drops when the water is removed from the grapes.

Effect of drying time on relation between shrinking and volume, mass and moisture content:

Here, MV is used to determine the quality and shrinkage of the fruit samples. The moisture content of the fruit will be anticipated using linear connections between moisture content, mass, and either shrinkage. The drying operation will be stopped once the moisture content reaches the required level. As seen in Fig. 4, the quality of the drying grapes can be observed in stages during the entire drying process.

It was noticed that by increasing drying time from 10 to 50 min, the volume shrinking percentage was increasing from 16 to 74 % resulted in moisture content loss from 14 to 80%, which mean the shrinking percentage was 74 at moisture content 20%. While, It was noticed that by increasing drying time from 10 to 50 min, the volume shrinking percentage was increasing from 16 to 74 % resulted in mass loss from 37 to 67%, that mean the shrinking percentage was 74 at mass 2.2gm.

According to the coefficients of determination for shrinkage percentage in Fig. 4, mass and moisture content have adequate linear relationships with shrinkage (R2 = 0.946 and R2 = 0.936, respectively). The relationship between the moisture ratio and the shrinkage ratio for the two types of sample, dry and control, is shown. According to a linear relationship, the amount of food product lost during drying is equal to the amount of water removed. The apparent densities at various moisture contents were estimated using the shrinkage data. Azzouz *et al.* (2002) reported thatthe area ratio of grapes' changes with temperature during the drying time. It shows that the area ratio decreases with an increase in the drying temperature. A gradual overall shrinkage of grape cells during the drying process, and an increase in the rate of cellular shrinkage with an increase in temperature.

The changes (reduction) in the samples volume with moisture content:

The amount of moisture in the grapes and their characteristics as they dried were examined. The findings suggested that the moisture content and quality may be predicted during the drying process by evaluating shrinkage and moisture content or reflection values, as shown in Fig. 4. Finally, it was discovered that applied measuring for control of the grape drying process based on shrinkage and laser was highly beneficial. McMinn and Magee (1997), reported a shrinkage and moisture content during the drying of cylindrical potato tuber samples in a tunnel dryer were linearly correlated. Researchers who used MV to measure shrinkage discovered a linear link between the moisture content and shrinkage characteristic.

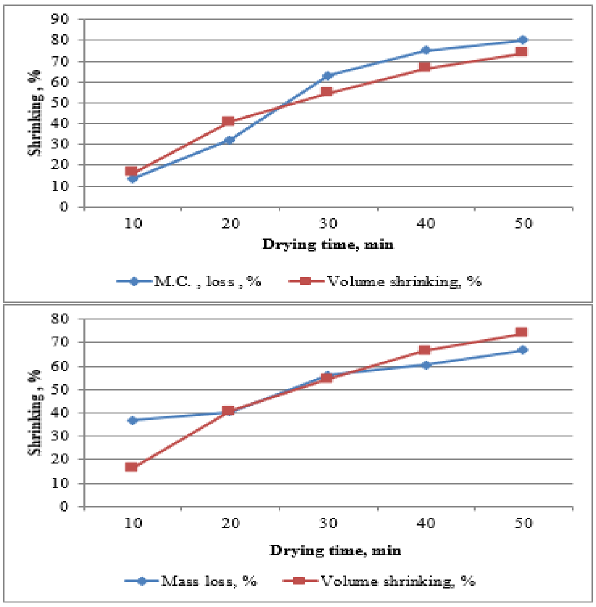


Fig. 4. Effect of drying time on relation between shrinking and both of mass and moisture content:

The changes (reduction) in the volume of the samples with moisture content areshown in Figure 4 for both dried and control samples. These figures show the mechanism of shrinkage during drying. When water is extracted from the material, a pressure imbalance; that is variation in pressure between the inner of the material and the external pressure, is produced generating contracting stresses that lead to the material shrinkage.

It was noted that the volume was reduced more quickly in the early stages of drying than in the latter stages. Volume variations were minimal for dried samples and the control once the moisture content reached approximately 30% (wb).

Ramo Azzouz *et al.* (2002), mentioned the same findings regarding the shrinkage of grapes throughout the drying process. These findings showed that MV can forecast moisture content based on shrinkage and laser percentage changes during the course of a fruit's drying process, and that this capability may be used to control and evaluate the moisture content and quality of grapes. At 20% moisture content (wet basis), it was found that there was a 67.5% drop in volume. The impact of system settings on the shrinkage ratio is depicted in Figures 4 and 5.

Chemical composition of grapes

Theacidity, and soluble solid contents of fresh grapes and their raisins are following:

The measured data notes that the total soluble solid content of the grape samples gradually increases with increasing drying time. It has been found that the total soluble solid content of the fruits increases from 24.8, 28.4, 37.0, 45.3 to 60.2% compared to the sample of un-dried grapes (control), 23.3% for drying times 10, 20, 30, 40 and 50 min, respectively. It is noticed from the measured data that the total soluble solid content of the grape samples gradually increases with increasing drying time. It has been found that the increases in total soluble solid content of the fruits increases from 6.04, 17.96, 37.07, 48.57 and 61.18% , for drying times 10, 20, 30, 40 and 50 min, respectively. As shown in Fig.5.

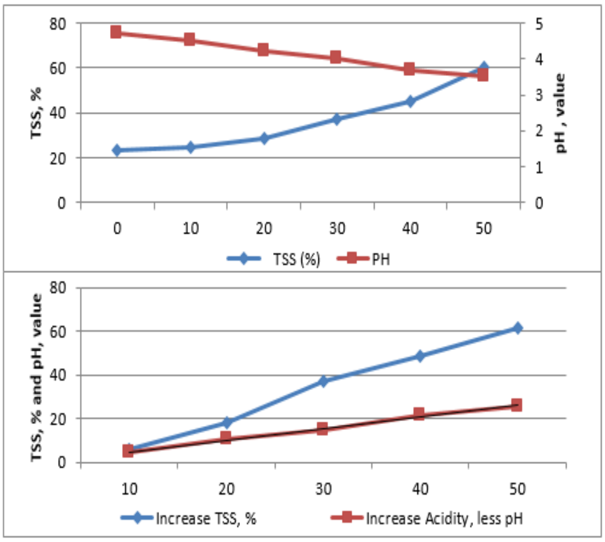


Fig. 5. Effect of drying time on some chemical properties of grape fruits

The measured data notes that the acidity (pH) content of the grape samples gradually decreases with increasing drying time. It has been found that the acidity (pH) content of the fruits decreases from 4.5, 4.2, 4.0 , 3.7 , to 3.5 value compared to the sample of un-dried grapes (control), 4.7 value for drying times 10, 20, 30, 40 and 50 min, respectively, the reduction of pH value of the grape samples gradually increases with increasing drying time. It has been found that the reduction in pH value of the fruits increases from 4.26, 10.64, 14.89, 21.28 to 25.53% , for drying times 10, 20, 30, 40 and 50 min, respectively.

Microwave drying has the advantages of achieving fast drying rates and improving the quality of some food products. The energy absorption level is controlled by the wet products which can be used for heating the interior parts of the sample containing moisture without affecting the exterior parts. Microwave drying is considered very useful during a falling rate period, resulting in the shrinkage of the structure and reduced surface moisture content.

Optical properties:

Laser reflection of the grape samples gradually decreases with increasing drying time, the moisture content of the fruits decreases from 38, 32, 23, 21 to 15 Lux compared to the sample of un-dried grapes (control), 65 Lux for drying times 10, 20, 30, 40 and 50 min, respectively. Laser reflection of the grape samples gradually decreases with increasing drying time, the reduction in laser reflection of the fruits increases from 41.54, 50.78, 64.62, 67.69 to 76.92% , for drying times 10, 20, 30, 40 and 50 min, respectively.

Laser absorption of the grape samples gradually increases with increasing drying time,922, 928, 937, 939 to 945 Lux compared to the sample of un-dried grapes (control), 895 Lux for drying times 10, 20, 30, 40 and 50 min, respectively. The reduction of laser absorption of the grape samples gradually increases with increasing drying time, the increases in laser absorption of the fruits increases from 2.93, 3.56, 4.48, 4.86 to 5.29% , for drying times 10, 20, 30, 40 and 50 min, respectively. As shown in Fig.6.

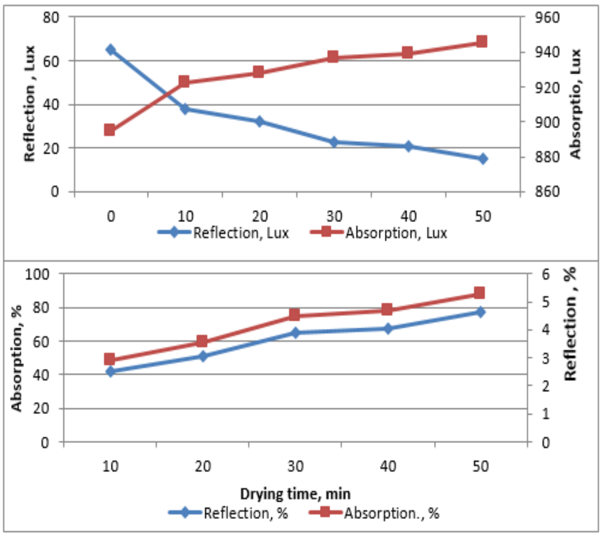


Fig. 6 . Optical properties of grape fruit at different drying times by microwave drying

Relationship between laser reflection and the moisture content of samples:

Figure 7 shows the relationship of the percentage of loss in moisture content of grape fruits and the percentage of laser rays reflected from the surface of the fruits during the drying process at different drying times. The results showed that there is an inverse relationship between the percentage of loss in moisture and the percentage of reflection of the laser beam from the surface of the grape fruits, as it is noticed that by increasing the percentage of loss in moisture from 14, 32, 63, 75, to 80%, the percentage of laser beams reflected from the surface of the grape fruits decreases. From 38, 32, 23, 21, to 15%, this is due to an increase in the drying time from 10, 20, 30, 40 and 50 min, respectively.

Relationship between laser reflection and the total soluble solid content (TSS) of grape fruit samples:

Figure 7 shows the relationship of the percentage of loss in moisture content of grape fruits and the percentage of laser rays reflected from the surface of the fruits during the drying process at different drying times. The results showed that there is an inverse relationship between the percentage of loss in moisture and the percentage of reflection of the laser beam from the surface of the grape fruits, as it is noticed that by increasing the percentage of loss in moisture from 6, 18, 37, 49, to 61%, the percentage of laser beams reflected from the surface of the grape fruits decreases from 38, 32, 23, 21, to 15%, this is due to an increase in the drying time from 10, 20, 30, 40 and 50 min, respectively.

Relationship between laser reflection and the acidity (pH) of grape fruit samples:

Figure 7 shows the relationship of the percentage of loss in moisture content of grape fruits and the percentage of laser rays reflected from the surface of the fruits during the drying process at different drying times. The results showed that there is an inverse relationship between the percentage of loss in moisture and the percentage of reflection of the laser beam from the surface of the grape fruits, as it is noticed that by increasing the percentage of loss in moisture from 4, 11, 15, 21 to 26%, the percentage of laser beams reflected from the surface of the grape fruits decreases from 38, 32, 23, 21, to 15%, this is due to an increase in the drying time from 10, 20, 30, 40 and 50 min, respectively.

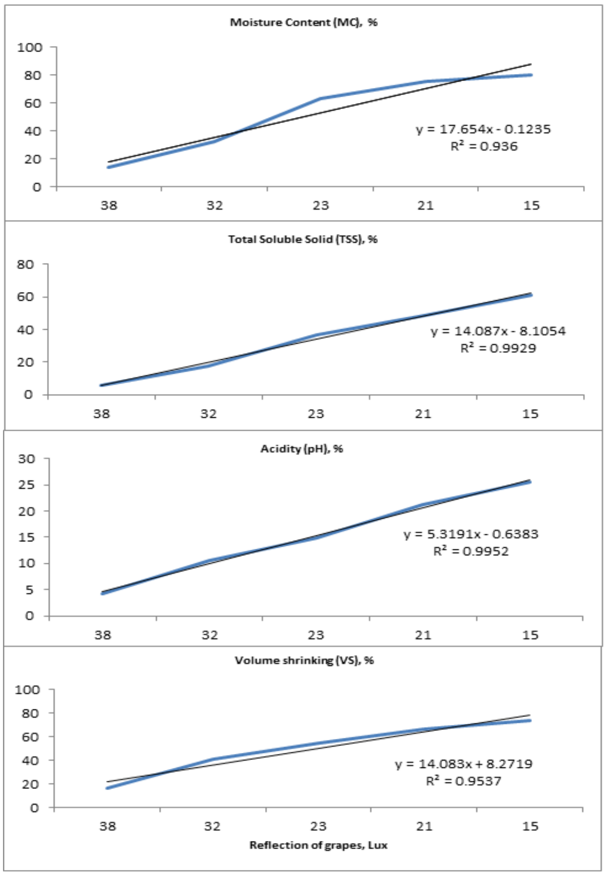


Fig. 7 . Relationship between laser reflection of grapes and some physic-Chemical properties at microwave drying

Relationship between laser reflection and the main dimensions (volume) of samples:

Figure 7 shows the relationship of the percentage of loss in moisture content of grape fruits and the percentage of laser rays reflected from the surface of the fruits during the drying process at different drying times. The results showed that there is an inverse relationship between the percentage of loss in moisture and the percentage of reflection of the laser beam from the surface of the grape fruits, as it is noticed that by increasing the percentage of loss in moisture were of 16, 41, 55, 67 and 74%, the percentage of laser beams reflected from the surface of the grape fruits decreases were of 38, 32, 23, 21,and 15%, this is due to an increase in the drying time from 10, 20, 30, 40 and 50 min, respectively.

CONCLUSION

- There is an inverse relationship between the percentage of reflection of the laser beam from the surface of the grape fruits and the percentage of loss moisture, TSS, pH, and volume of fruits
- Relationship between reflection laser of grapes and some physic-chemical properties at drying time of 10, 20, 30, 40

and 50 min by microwave dryer, the percentage of laser beams reflected from the surface of the grape fruits decreases, of 38, 32, 23, 21, and 15%, respectively, resulted to increasing the percentage of loss in moisture of 14, 32, 63, 75, and 80%. Increasing the percentage of TSS from 6, 18, 37, 49, to 61%, increasing the percentage of pH were of 4, 11, 15, 21 and 26%, and increasing the percentage of volume of 16, 41, 55, 67 and 74%.

ACKNOWLEDGMENTS

The authors are grateful for the support of Agricultural Engineering Research Institute, Agricultural Research Center and National Institute of Laser Enhanced sciences, Cairo University in Egypt, for measurements and analyses were performed.

REFERENCES

Adiletta, G.; Russo, P.; Senadeera, W. and Di Matteo, M. (2016). Drying characteristics and quality of grape under physical pretreatment. J. Food Eng. 172, 9–18.

Al-Mahasneh, Majdi A., and Rababah, Taha M. (2007). Effect of Moisture Content on Some Physical Properties of GrenWheat.*Journal of Food Engineering,* 79, 1467-1473.

AOAC.(1984). Official methods of analysis of the association of official analytical chemists.*14th Ed., Arlington : Virginia.* 22.013, USA.

Azzouz, S., Guizani, A., Jomaa, W. and Belghith, A. (2002). Moisture Diffusivity and Drying Kinetic Equation of Convective Drying of Grapes.*J. Food Eng.*, 55: 323– 330.

Demir, F., and Kalyoncu, H. (2003). Some nutritional, pomological and physical properties.*Jounal of Food Engineering*, 60, 335-341.

Doymaz, I., and Pelin Altiner (2012). Effect of PretreatmentSolution on Drying and Color Characteristics of Seedless Grapes Food Sci. Biotechnol. 21(1), 43-49.

Esmaiili, M.; Sotudeh-Gharebagh, R.; Cronin, K.; Mousavi, M.A.E. and Rezazadeh, G. (2007). Grape Drying: A review. Food Rev. Int., 23, 257–280.

Ishiwata, K.; Yamaguchi, T.; Takamura, H. and Matoba, T. (2004). DPPH radical-scavenging activity and polyphenol content in dried fruits. Food Sci. Technol. Res., 10, 152–156.

Jairaj, K.S., Singh, S.P. and Srikant K. (2009). A review of solar dryers developed for grape drying. Solar Energy, 83: 1698–1712.

Kambiranda, D.; Obuya, J. and Snowden, J. (2020). Grapevine Improvement through Biotechnology. In GeneticTransformation in Crops; IntechOpen: London, UK.

Karakaya, S., El, S., and Tas, A. (2001). Antioxidant activity of some foods containing phenolic compounds. Intl. J. Food. Sci.Nutr. 52, 501–508

Kedage, V.V.; Tilak, J.C.; Dixit, G.B.; Devasagayam, T.P. and Mhatre, M.A (2007). Study of antioxidant properties of some varieties of grapes (Vitisvinifera L.). Crit. Rev. Food Sci. Nutr., 47, 175–185.

Lecas M, and Brillouet J. M. (1994). Cell Wall Composition of Grape Berry Skins. Photochemistry 35: 1241-1243.

McMinn, W.A.M., and Magee, T.R.A. (1997). Quality and physical structure of a dehydrated starch-based system. Drying Technology 15 (6), 1961–1971.

Murthy, G.S., and Prasad, S. (2005). A completely coupled model for microwave heating of foods in microwave oven. An ASAE Meeting Presentation Paper Number: 05-6062.

Murugaiah C and Al-Talib H (2017). Study of Changes in Shrinkage and Density as a Function of Moisture Content during Microwave Vacuum Drying under Various Operating Conditions.Nutrition in Children with Cholera.J Food NutrPopul Health. Vol. 1 No. 2: 1-6

Pastrana-Bonilla, E., Akoh, C. C., Sellappan, S., and Krewer, G. (2003). Phenolic content and antioxidant capacity of muscadinegrapes.J.Agric.Food Chem. 51, 5497–5503.

Yao, L.; Fan, L.; and Duan, Z. (2020). Effect of different pretreatments followed by hot-air and far-infrared drying on the bioactive compounds, phsicochemical property and microstructure of mango slices.Food Chem., 305, 125477.

Sanz, M. L., Del, Castillo M. D., Corzo, N., and Olano, A. (2001). Formation of amadori compounds in dehydrated fruits. J. Agric. Food Chem. 49, 5228–5231.

Tavakoli M, Tavakoli H, and Ahmadi H. (2009). Moisture-dependent physical properties of barleygrains. International Journal of Agricultural and Biological Engineering 2: 341-350.

Uzun, T. and Hallaç, B. (2021). Physicochemical characteristic of the organic raisins served to markets in Midyat town of Mardin province and Be¸siri town of Batman province in Turkey. Erwerbs-Obstbau, 63, 61–69.

Wang, J.; Mujumdar, A.S.; Wang, H.; Fang, X.M.; Xiao, H.W. and Raghavan, V. (2021). Effect of drying method and cultivar on sensory attributes, textural profiles, and volatile characteristics of grape raisins. Dry. Technol, 39, 495–506.

تقييم جودة باستخدام الليزر للعنب الأحمر أثناء تجفيفه بالميكروف

شيماء ربيع على[1] وأسامة أنور عبد الحميد[2]*

[1]المعهد القومي لعلوم الليزر ، جامعة القاهرة ، مصر
[2]معهد بحوث الهندسة الزراعية ، مركز البحوث الزراعية ، مصر

الملخص

صناعة الزبيب هو أحد طرق حفظ العنب لزيادة العمر الاستهلاكي للفاكهة. تركز الدراسة الحالية علي تجفيف العنب بالميكروويف لإنتاج الزبيب وتأثيره علي الخصائص الفيزيائية والكيميائية والبصرية لزبيب العنب أثناء عملية التجفيف. قياس الأبعاد الرئيسية والكتلة والحموضة والمواد الصلبة الذائبة الكلية مثلا للخصائص الفيزيائية والكيميائية ، والخصائص البصرية مثل الانعكاس والامتصاص الضوئي باستخدام تقنية الليزر. ايضًا ، لإيجاد العلاقة بين انعكاس الليزر للعنب أثناء التجفيف بالميكروويف والتغيرات في الانكماش ، ومحتوي الرطوبي ، والكتلة ، والحموضة ، وإجمالي المواد الصلبة الذائبة أثناء عملية تجفيف العنب. أوضحت النتائج أنه توجد علاقة عكسية بين نسبة انعكاس شعاع الليزر علي سطح ثمار العنب ونسبة فقدان الرطوبة ، والمواد الصلبة الذائبة ، ودرجة الحموضة ، وحجم الثمار. العلاقة بين انعكاس الثمار لليزر وبعض الخواص الفيزيائية والكيميائية تم التجفيف لزمن 10 و 20 و 30 و 40 و 50 دقيقة بواسطة مجفف الميكروويف ، تنخفض النسبة المئوية لأشعة الليزر المنعكسة من 38 ، 32 ، 23 ، 21 ، إلى 15٪ ،علي التوالي ، أدي زيادة نسبة فقدان الرطوبة من 14 ، 32 ، 63 ، 75 ، إلى 80٪ ، وزيادة نسبة المواد الصلبة الذائبة من 6 ، 18 ، 37 ، 49 ، إلى 61 ٪ ، زيادة نسبة الأس الهيدروجيني من 4 ، 11 ، 15 ، 21 إلى 26٪ ، وزيادة النسبة المئوية الإنكماش في للحجم من 16 ، 41 ، 55 ، 67 إلى 74٪. أظهر التجفيف بالميكروويف مظهرًا أفضل لمؤشرات الجودة. يمكن أن يكون هذا مفيدً للمزارعين وصغار المزارعين لإنتاج زبيب عالي الجودة.

الكلمات الداله : ميكرويف ، العنب ، الليزر ، الجودة ، فيزوكيميائية.