

## Research Full Papers

### Impact of microwave-grill-drying (MWGD) on functional properties of berry Russian olive (*Elaeagnus angustifolia* L.)

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#### Abstract

Impact of microwave-grill -drying (MWGD) at different powers (300, 450 and 600 Watts) on functional properties of berry "Russian olive" was investigated. The effect of microwave's water and oil holding capacities, gelation, foaming and emulsifying, which will provide novel and applicable knowledge for the food industry, was determined. We specifically focused the kinetics drying. By increasing microwave -grill powers (300–600W), drying time decreased from 270 to 120 s. For dried Russian olive berry at each applied microwave-grill power, water holding capacity values were higher than oil holding capacity values. However, drying at 450W is the best method of retention of functional properties of fresh fruit of *E.angustifolia* L.

**Keywords:** *E.angustifolia* L., Power, Microwave-grill drying, Functional properties.

#### Introduction

Oleaster (*Elaeagnus angustifolia* L.) is a tree, and its fruit grows in various climatic and environmental conditions. It is also known as Russian olive, and native to western and central Asia, from southern Russia and Mediterranean environment (Anonymous, 2014).

The main *Elaeagnus* species in Algeria, Russian olive (*Elaeagnus angustifolia* L.), commonly called "Jijibe", grows spontaneously and it is located mainly in the highlands. It was introduced and planted in the regions of Djelfa, Biskra, Relizane, Mascara and South Tennes and Cherrhell (Journal of Agriculture, 1958).

The fruits are valuable intems of health and can be used as natural antioxidants (Durmaz, 2012), natural colors. Also, they are being used in the fields of medicine and pharmacy in both Asia and in Europe with legal certifications (Gulcu and Celik Uysal, 2010).

There are no toxic substances in oleaster fruits. Oleasteris is advised to be consumed by the people who have kidney disorders. It can be used as a diuretic and fever-reducing drug

(Baytop, 1984), for preventing intestine disorders and mouth rust, and its fruit extract can be used as anti-inflammatory and analgesic (Ahmedianiet *al.*, 2000) in traditional medicine. The oleaster fruit contains 12.33% protein (Akbolat *et al.*, 2008), vitamins (tocopherol, carotene, vitamin C, and thiamine), mineral substances (calcium, magnesium, potassium, iron, and manganese; Boudraa *et al.*, 2010). Dominant sugars in the plant are fructose and glucose (Ayaz and Bertoft, 2001). The size of the fruit is the same as olives and skin is hard, yellowish-brown in color.

Drying is the oldest and most popular preservation method for food and agricultural products. The fundamental concept of drying is to trim down moisture of products to a level, which will stop microbiological growth and keep the product's nutritive value and bioactive compounds in considerably higher levels (Kwok *et al.*, 2004; Changrue, 2006). Several drying methods have been developed in order to preserve different kinds of food materials

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because of myriad environmental, energy efficiency and economic concerns. Besides, all methods have something in common; the heat is applied by conduction, convection, radiation.

In order to prevent quality damage due to long drying time, microwave grill drying has been recently introduced. Microwave heating is a sort of dielectric heating, which uses electromagnetic radiation in the frequency ranging from 300 MHz to 300 GHz. According to Changrue (2006), the decrement of drying time due to volumetric heating of dielectric material increase the use of the microwave as a source of thermal energy.

Although studies have focused on the drying kinetics of *Elaeagnus angustifolia* L., the lack of published work on the effect of microwave grill drying at different power levels on functional properties (protein solubility, water and oil absorption capacity, emulsifying and foaming properties, density, viscosity and gelation) of Russian olive explains the interest for the present work.

## Materials and methods

### Fruit collections

Healthy mature hawthorn (*Elaeagnus angustifolia* L.) fruits were harvested between October-November (2018) in North-West Algeria. Russian olive had an initial moisture content of percentage-wet basis, which was determined by drying in a convective oven (Memmert DO 6836, Germany) at  $103 \pm 1^\circ\text{C}$  for 24 h (Anon, 1995). The fruit was conserved at  $-20^\circ\text{C}$  until used. Russian olive was sorted. After that, the total quantity was divided into three batches, one for each process Microwave grill drying.

### Drying methods

#### Microwave- grill drying

The drying apparatus used in this study consisted of a laboratory microwave grill oven (GE107Y, SAMSUNG Electronics) with technical features of 230 V, 50 Hz with a frequency of 2,450 MHz. The dimension of the microwave cavity was  $335 \text{ mm} \times 330 \text{ mm} \times 195 \text{ mm}$ . Drying trials were carried out at different microwave generation powers 30, 450 and 600W. Drying was performer per cycle (30 sec

ON / 30 sec OFF); each cycle corresponds to the application of microwaves for a given 30-sec power and 30-sec power off. At the end of each cycle, the products are weighed on a scale of precession model: GL-300. The drying kinetics was thus determined by the evolution of the mass of the products after each cycle.

Drying was carried out until the moisture content of 10 % w.b. was reached; the mass of the material was recorded continuously during drying with the accuracy of  $\pm 0.1 \text{ g}$ . Using the equation below it can be determined the variation of the dry base moisture content (X) versus time (S).

$$X = \frac{W_w - W_d}{W_d} \quad (1)$$

X: Moisture content on a dry basis (kg  $\text{H}_2\text{O}$ / kg dry matter)

$W_w$ : Weight of the sample on a wet basis (g)

$W_d$ : Weight of dry matter of the sample (g)

In the MWGD, Russian olive was placed inside the MWGD oven. For all the power levels studied, samples ( $5 \pm 0.5 \text{ g}$ ) were taken from the MWGD oven every 120 Sec for 600 W, up to 180 Sec for 450 W, and up to 270 Sec for 300 W. The total drying time was determined as the passing time until no discernible weight change for each sample was observed in each MWGD power level.

Given the heterogeneity of the microwave heating, the average of ten repetitions for each power was recorded.

The drying process was performed in three independent repetitions. The fruit was kept at  $-20^\circ\text{C}$  and ready for further analysis.

## Functional properties analyses

### Water and oil absorption capacity

Measurements of water and oil retention capacity are performed according to the method of Phillips et al. (1988). 1g of the dried Russian olive is mixed ( $m_0$ ) in 10 ml of water or oil and the whole was mechanically stirred for 30 min using a stirrer. The mixture was then centrifuged at 4500 rpm/ min for 30 min in a centrifuge (Model: SIGMA 3K20). The pellet after centrifugation is weighed ( $m_1$ ), but for measuring the water retention capacity, it is first

dried at 105°C in an oven for 8 h (m<sub>2</sub>). The water retention capacity (WAC) and oil retention capacity (OAC) is calculated by the following formulas:

$$\text{WAC (\%)} = \frac{m_2 - m_1}{m_1} \times 100 \quad (2)$$

(WAC) was expressed as g water pound by 100 grams materials.

$$\text{OAC (\%)} = \frac{m_1 - m_0}{m_0} \times 100 \quad (3)$$

(OAC) was expressed as g oil pound by 100 grams materials.

### Solubility properties

0.1 g of the dried Russian olives were placed into a centrifugal tube (known weight) then dissolved with 10ml of 1% acetic acid for 30 min, using an incubator shaker operating at 240 rpm and 25°C. The solution was then immersed in a boiling water bath for 10 minutes, cooled to room temperature and centrifuged at 10,000 rpm for 10 min. The supernatant was decanted. The undissolved particles were washed in distilled water (25ml) then centrifuged at 10,000 rpm. The supernatant was removed and undissolved pellets dried at 60°C for 24 hr. Finally, the particles were weighed and the percentage of solubility was determined (Fernandez-Kim, 2004).

$$\text{solubility (\%)} = \frac{iw - fw}{iw} \times 100 \quad (4)$$

iw: Initial weight of the sample (g)

fw: Final weight of the sample (g)

### Emulsion activity (EA) and emulsion stability (ES)

Emulsifying activity and stability were determined using the method reported by Neto et al. (2001). Five milliliters portion of dried Russian olive dispersion in water (10 mg·ml<sup>-1</sup>) was homogenized with 5ml oil for 1 min. The emulsions were centrifuged at 1100g for 5 min. The height of emulsified layer and that of the total contents in the tube was measured. The emulsifying activity was calculated as:

$$\text{Emulsifying property (\%)} = \frac{h_1}{h_2} \times 100 \quad (5)$$

h<sub>1</sub>: height of emulsified layer in the tube (ml)

h<sub>2</sub>: height of total content in the tube (ml)

Emulsion stability (ES) was measured by recentrifugation followed by heating at 80°C for 30 minutes and subsequently cooled to 15°C. After centrifugation, the emulsified poured into 50 ml measuring cylinders and stay a few minutes until the emulsified layer was stable. ES was expressed as the percent of the total volume remaining emulsified after heating.

$$\text{Emulsifying stability (\%)} = \frac{h_1}{h_2} \quad (6)$$

h<sub>1</sub>: height of emulsified layer heating (ml)

h<sub>2</sub>: height of emulsified layer before heating (ml)

### Foaming properties

#### Foam capacity (FC) and foam stability (FS)

The method of Coffman and Garcia (1977) was used for the determination of the foaming capacity and stability of dried Russian olive. A weighed amount of flour is dispersed in 100 ml distilled water, after which the suspension was whipped vigorously for 2 min using a Phillips kitchen blender set at speed 2. Volumes were recorded before and after whipping. FC was expressed as the percentage increase in volume. After 30 min, the volume of foam was measured and expressed as FS.

$$\text{FC} = \frac{\text{Volume after whipping} - \text{Volume before whipping} \times 100}{\text{Volume before whipping}} \quad (7)$$

$$\text{FS} = \frac{\text{foam volume after time (t)} \times 100}{\text{Initial foam volume}} \quad (8)$$

### Viscosity

Rheology studies the phenomena of deformation and flow of solids and fluids under the influence of mechanical forces. Viscosity characterizes the resistance to flow.

Viscosities of fresh, dried fruit extracts were determined

using a Gemini 150 digital Rheometer; three pascal-second reads (mPa · s) were taken per sample and recorded on the computer.

### pH

1 g of the dried Russian olive is homogenized in 3 ml of distilled water. The pH of the solution obtained was determined using a pH-meter (Model: HANNA HI 2210) (AFNOR NF V 50-108).

### TSS Measurement of the refractometric index (°Brix)

The percentage of soluble solids was determined using a refractometer. The separation limit, between the light and dark areas on the scale of the refractometer, indicates the refractive magnitude of the light, which is a function of the percentage of soluble dry matter contained in the extracts, called refractometric refractive index (IR) (Refracto 30PX) or Brix degree (AFNOR NF V 50-109).

### Gelation properties

Gelation properties were studied by employing the method of Coffman and Garcia (1977). Sample suspensions of 2 – 20% were prepared in distilled water. Ten milliliters of each of the prepared dispersions was transferred into a test tube. The test tubes were heated in a boiling water bath for 1 h, after which they were cooled in a bath of cold water. The test tubes were further cooled at 4°C for 2 hr. The least gelation concentration was taken as the concentration when the sample from an inverted test tube did not fall or slip.

$$\text{Gelation properties} = \frac{h_1}{h_2} \times 100 \quad (9)$$

h1: height of gelation layer in the tube (ml)

h2: height of the total content in the tube (ml)

### Statistical analysis

The experimental data were expressed as means ± standard deviations. All determinations were carried out in triplicates. A statistical analysis of the results was performed using the 2009 XLStat software. An equal average hypothesis was tested by analysis of variance (ANOVA). The medium was significantly different when compared with the method of Newman-Keuls ( $p \leq 0.05$ ).

## Results and discussion

### Moisture

The samples moisture content changed between 15.20 and 23.14 %. These results were similar to dried fruits, such as fig (30.00 %), prune (30.92 %), cranberry (16.00 %) and apricot (30.89 %) (Cansev et al., 2011). This low water content results in the low water activity and low of biochemical and microbiological chemical alterations. These fruits have the advantage of being easily preserved, so they can be consumed for several months and thus be used for industrial purposes.

### Drying Kinetics

#### Microwave grill drying Kinetics

The variations of the water content (X) versus time (S) for three powers of the microwave grill oven are shown in Figure 1. A regular decrease in resulted curves can be seen, which is due to the high evaporation of free water existed in all samples.

The drying time was reduced with increasing power and energy delivered by the microwave grill. The power of 600 W showed the shortest time (120 Sec).

Obviously, drying time reduced with the increasing microwave drying power levels from 300 W to 450 W and lastly to 600 W. According to figure 1, the time required to reduce the moisture content of the Russian olive stem from 1 kg H<sub>2</sub>O/kg dry solid to 0.2 kg H<sub>2</sub>O/kg dry solid varied between 120 Sec to 270Sec subjected to the microwave grill power level.

At the beginning, the water content is important, which results in an acceleration of evaporation of water under the heating of the samples by the microwave rays and convection.

Trade is less important as drying takes place because the amount of water remaining in the product is low and difficult to remove.

The observed drastic or sudden drying curve at the initial stages of microwave drying may be triggered by the opening of the sample's structure physically which allowing rapid vaporization and passage of water molecules (Kostaropoulos and Saravacos, 1995).

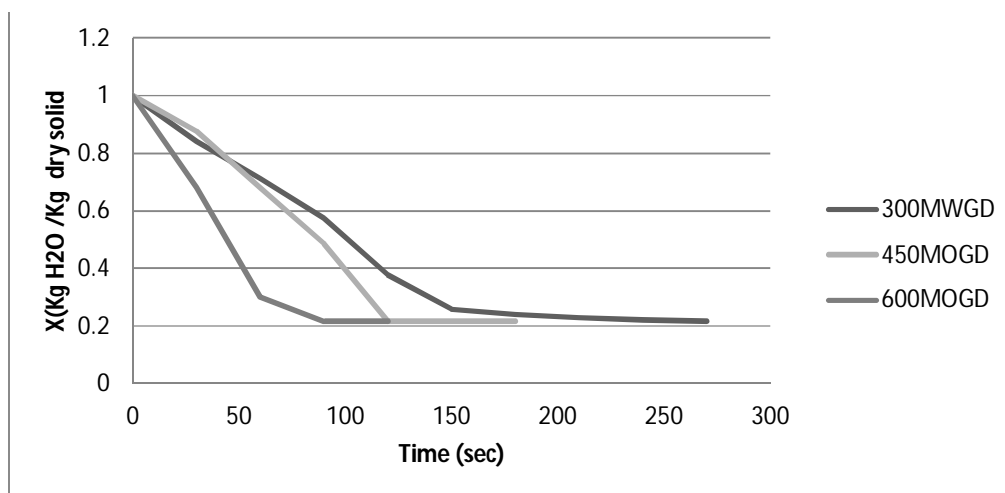


Figure 1. Variation in moisture content X (kg H<sub>2</sub>O/ kg dry matter) versus time (sec) of dried Russain olive in microwave grill at different power.

### Effect microwave-grill drying on the functional properties of Russain olive pulp

#### Water and oil absorption capacity

Water and oil absorption capacity are very important in the food system because of their effects on the flavor and texture of foods. As shown in Table 1.

Water and oil absorption capacity of the Russain olives samples ranged ( $203.06 \pm 6.00\%$  and  $256.23 \pm 5.00\%$ ), microwaved grill at 300 and 600 W. Subjecting of Russian olives to microwave reduced the water and oil capacity. Water absorption capacity is relevant in ensuring that food products possess good texture, which invariably reduces retrogradation and syneresis during storage, retorting and freezing (Odedeji and Adeleke, 2010). Oil absorption capacity is useful in food preparations that involve like bakery products where oil is an important ingredient (Princewill-Ogbonna and Ezembaukwu, 2015).

Robertson and Eastwood (1981) suggested that WAC is considered to be a function of fiber structure rather than a chemical composition. The power levels of microwave grill drying were reported to affect the fiber structure, which is related to the changes in a water absorption capacity. They reported the water absorption capacity is increasing from 300 W to 600 W ( $203.06 \pm 6.00\%$ ,  $236.12 \pm 0.30\%$ , and  $256.23 \pm 5.00\%$

respectively), while their dietary fiber contents were only slightly different. They also observed the compression of cellular appearance in MWG-dried sample at 600W.

Sangnark and Noomhorm, (2003) reported that particle size reduction of dietary fibers has been associated with a lower ability to retain water and a lower oil binding capacity. Lario *et al.*, (2004) reported that the high WHC of fiber concentrate could be used as a functional ingredient to avoid syneresis, modification of texture and viscosity and reduce calories of food formulations.

The reduction of water absorption capacity by both treatments could be as a result of hydrothermal treatment which blocked the tissue pores, thereby hindering water slippage and retention.

From Table 1, it can be seen that the oil absorption capacity is inversely proportional to the water absorption capacity. This makes sense. The ability of water and oil retention to respond to the structure of protein and polysaccharide macromolecules; the interactions between the water and the constituents are established at the level of acid groups and amine groups present in the polysaccharides or at the level of the uncharged polar groups capable of forming hydrogen bonds with water, while the groups that are apolar in character can contribute to the

structure of the water in their environment. According to Cloutour (1995), heat treatments such as microwave-grill-drying can alter the polysaccharide and protein content and consequently the water and oil absorption capacity.

It was noted that the capacity of water retention is clearly higher than that of the oil.

This could be explained by the abundance of the hydrophilic groups by adding to the hydrophobic groups, the Russian olive of which is rich in polysaccharides (pectins 1.43% and cellulose 3.92%) and low in lipid (0.55%) (Saadoudi, 2008; Ferhat, 2008).

**Table 2. Gelation properties (%) of dried Russian olive in microwave grill at different power**

Power (W)	Gelation Capacity Concentrations (%)					
	2	4	8	12	16	20
Fresh	13.63±0.03 <sup>s</sup>	18.18±0.01 <sup>r</sup>	36.36±0.01 <sup>k</sup>	54.74±0.01 <sup>e</sup>	81.71±0.01 <sup>b</sup>	100±0.00 <sup>a</sup>
300	28.81±0.01 <sup>o</sup>	30.72±0.01 <sup>n</sup>	46.36±0.01 <sup>j</sup>	54.45±0.01 <sup>g</sup>	72.09±0.01 <sup>d</sup>	100±0.00 <sup>a</sup>
450	27.27±0.00 <sup>q</sup>	31.2±0.01 <sup>m</sup>	48.81±0.01 <sup>i</sup>	54.45±0.01 <sup>g</sup>	72.09±0.01 <sup>d</sup>	100±0.00 <sup>a</sup>
600	28.18±0.01 <sup>p</sup>	33.18±0.01 <sup>l</sup>	50.36±0.01 <sup>h</sup>	56.45±0.01 <sup>f</sup>	79.43±0.01 <sup>c</sup>	80±0.00 <sup>b</sup>

a, b, c, d...: In each column, means followed by a different letter are significantly different at the threshold of  $P < 0.05$  (Method of Newman and Keuls).

### Solubility

Solubility is an important characteristic for powdered ingredients that will be incorporated into dry mixes that must be reconstituted. To satisfy the normality assumption during the statistical analysis. The average solubility values for the Russian olive powder is Table 1. The samples dried by microwave-grill at 300 W had the highest average percentage of solubility ( $66 \pm 0.11$  %).

In general, Russian olive components such as pectin and sugars are soluble in water, while proteins and lipids are readily soluble in acidic solutions diluted below pH 6 (pH4), which explains the use of Acetic acid in this technique (a 1% acetic solution is equivalent to pH 4).

According to table 1, the solubility of dried by microwave grill at different powers is acceptable without significant difference ( $\geq 50$ %). The solubility of the macromolecules is influenced by several parameters (pH, ionic strength, drying, concentration, temperature, etc.).

Linden and Lorient. (1994) show that the property of solubility has major consequences on other functional properties (Emulsification, gelling ...). On the other hand, depending on the results obtained, the microwave grill drying does not have a negative effect; On the other

hand, it retains this property. As a result, the other properties will be more or less conserved.

### Emulsifying properties and emulsion stability

Table 1 shows the emulsifying capacity and the stability of emulsions Russian olive dried by microwave grill at different powers. Good capacity is observed for all samples (over 30%). Precisely the best capacity is given for the power 300W ( $62.32 \pm 0.01$ %).

Drying by microwave grill at different power (300,450 and 600 W) decreased caused significant ( $p < 0.05$ ) decrease in emulsion capacity of Russian olive berry when compared with the non-dried (control) samples. Drying by microwave grill at different power (300,450 and 600 W) decreased emulsion capacity Russian olive berry. The decrease in emulsion property may be attributed to protein aggregation as well as surface hydrophobicity and change the characteristics, which affect emulsifying properties in different ways (Cheftel *et al.*, 1985).

Firstly these results show that the applied power has an effect on this property, a moderate assay power (300W) is sufficient to have a good emulsion. On the other hand drying by microwave, the grill does not have a dramatic effect negative vis-à-vis the emulsifying capacity. Drying by microwave grill at different

power (300,450 and 600 W) decreased emulsion capacity Russain olive berry.

Emulsion capacity denotes the maximum amount of oil that can be emulsified by protein dispersion. The high emulsion capacity could be as a result of high content of free fatty acid which leads to increased oil absorption (Ihekoronye and Ngoddy, 1985).

The emulsifying properties are due to the reduction of inter-facial trying among the hydrophilic groups are hydrophobic groups, they are often linked to the protein solubility in water (Roudot, 2002; Chandi and Sogi, 2006). According to Table 1 excellent emulsion stability can be seen (> 60%) for all dried Russain olive by microwave grill at different powers. nevertheless dried Russain olive at (600, 450 and 300 W respectively ( $60 \pm 0.09$ ,  $76.32 \pm 0.00$  and  $64.61 \pm 0.01\%$ ).

#### **Foaming properties**

The results gathered in Table 1 show that non-foam for Russain olive raw and dried by microwave grill at different powers. According to Lorient *et al.* (1988), the formation of foams is based on the presence of proteins in quantity and quality, thus the low Russain olive protein content (0.29%) (Abdeddaim, 2016) is insufficient to form stable foam. The shape, size, concentration, and hydrophobicity of the particles have been identified as the main factors in the formation of foams.

#### **Viscosity**

In general, the processdrying resulted in a decrease viscosity of Russain olive viscosity (Table 1).

In our study, the viscosity of Russain olive in microwave-grill at different power ranged from mPa.s 1.17 to 1.45 MPa.s. Viscosity, which is the desired parameter, is one of the qualities that characterize the flow behavior. It is a measure of the ability of the fluid to resist movement when shear stress is applied. All data show that viscosity generally decreases with drying techniques with increasing microwave grill power.

Significant changes in viscosity may be due to the significant impact of the process drying on the biochemical composition Russain

olive fruit. As also explained by Simas-Tosin *et al.* (2010), the presence of oligosaccharides with free reducing functions, phenolic compounds and inorganic salts and polysaccharides in the structure of the Russain olive fruit. The effect of drying on the polysaccharide viscosity of Russain olive fruit could be due to the different proportions of soluble materials compared to insoluble materials.

#### **pH**

The average pH value of the raw berry Russian olive was  $5.22 \pm 0.00$  which is within the acceptable range of pH (5.21-5.22) for Russians olive. The average pH values for the Russain olive powder dried using microwave-grill-dring at three different powers (300, 450 and 600 W) are shown in Table 1. Generally, the recorded pH is acid at the vicinity of 5; this is explained by the presence of free organic acids in the Russain olive (Sahan *et al.*, 2015) such as malic acid (0.67 mg/ 100 g), oxalic acid (0.08 mg/ 100 g), ascorbic acid (0.08 mg/ 100 g), acetic acid (0.52 mg /100 g), citric acid (0.59 mg /100 g), tarttric acid (0.52 mg /100 g) and formic acid (0.05 mg /100 g) .

#### **Total soluble solid (TSS)**

Significant changes in TSS after microwave drying were obtained due to variation power level. Decreased moisture content in fruits is generally accompanied by an increased percentage of TSS since TSS is the main component of dry matter (Malundo *et al.* 1995). Thus, the value of TSS is significantly ( $P < 0.05$ ) decreased after drying (Table 1). This decrease was up to 21 expansionl ower compared to fresh fruit (42.4 Brix°). Although there is a significant difference in the TSS value between the drying power levels, the value decreased with increasing power 300 W (1.17 Brix°), then increased to 450 W ( 1.45 Brix °) then decreased to 600 W (1.29 Brix°).

According to our results, we found that the temperature and the treatment time had no effect on pH and Brix°.

#### **Gelation properties**

The gelation concentration for Russain olive fruit raw and dried is shown in table 2. It formed

a weak gel at 2 %, strong gel at 16 and 20% and very strong gel.

The least gelation capacity results for microwave grill at 300 W dried Russain olive is 2%, and microwaved grill at 600 W samples ranged from 12% to 16%. The gel-forming ability is reported to be influenced by the nature of the protein in the sample as well as their interaction during heat treatment (Enujiugha *et al.*, 2003).

According to Table 2, the gelling power for the apple dried at 300 and 450 W and for the concentrations 16 and 20% is excellent it reaches 100%, these results are explained by the richness of Russain olive in (pectins 1.43% and cellulose 3.92%) (Saadoudi, 2008).

In general, the concentration expresses the percentage of the gelling agents (proteins, polysaccharides, etc.), a proportional increase in the gelling power with the increase of the concentration, the better is the gelating ability of the protein ingredient (Akintayo *et al.*, 1999). Variations in gelling properties may be ascribed to the ratios of different constituents, such as proteins, carbohydrates, and lipids.

Gelatinization influences the textural quality when powder of Russain olive fruit is incorporated in food products such as creams, soups, puddings, pie fillings and many sauces in viscosity.

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## Conclusions

Moreover, the kinetics of the dehydration of Russain olive fruit shows that microwave drying time is short in supply to other drying methods. This reveals the economic importance of dehydration by microwave of the fruits of the Russain olive.

In the drying process, power and long exposure time contribute significantly to the decreasing of emulsifying property content present in the Russain olive fruit. At 600W occurs its lowest decreasing.

The effect microwave–grill-drying at different level (300, 450 and 600 W) on the functional properties of Russain olive fruit has a relatively low water absorption capacity compared to Russain olive fruit raw. The higher functional properties of Russain olive fruit dried in a microwave–grill-drying at 450 W are very important.

These results showed the important role of this fruit in the food industry, such as the manufacture of beverages on the basis of solubility and its ability to retain water, the manufacture of jellies and creams for its ability it's related to emulsifying and gelling, and any other applications, especially in confectionery and pastry.



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## تأثیر خشک کردن میکروویو-گریل (MWGD) بر خصوصیات عملکردی زیتون روسی (*Elaeagnus angustifolia* L.)

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### چکیده

در این پژوهش تأثیر خشک کردن به روش میکروویو-گریل (MWGD) در میزان انرژی‌های مختلف (300، 450 و 600 وات) بر خصوصیات عملکردی "زیتون روسی" مورد بررسی قرار گرفت. همچنین اثر عوامل جدید و کاربردی در صنعت غذا مانند ظرفیت نگهداری آب و روغن توسط میکروویو، تشکیل ژل، کف و امولسیون نیز با تمرکز بر خشک کردن سینتیکی مورد ارزیابی قرار گرفت. نتایج نشان داد با افزایش انرژی میکروویو، زمان خشک کردن از 270 به 120 ثانیه کاهش می‌یابد. همچنین مشخص شد در خشک کردن زیتون روسی در هر میزان انرژی الکتریکی میکروویو، ظرفیت آب بالاتر از روغن می‌باشد. بنابراین خشک کردن در 450 وات انرژی میکروویو بهترین روش خشک کردن با حفظ خواص عملکردی میوه تازه *Elaeagnus angustifolia* L است.

واژه‌های کلیدی: *Elaeagnus angustifolia* L، انرژی، خشک کردن میکروویو-گریل، خواص عملکردی

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