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Impact of microwave-grill-drying (mwgd) on functional properties of berry russian olive (*Elaeagnus angustifolia* L.)

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Highlights: The paper addresses the "Impact of microwave-grill-drying (MWGD) at different powers (300, 450 and 600 Watts) on functional properties of berry "Russian olive". The microwave grill have potential use in food and pharma products.

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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 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, 450W and 600W), drying time decreased from 270 to 120s. 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: Russian olive. Fruit. Power. Microwave-grill. Kinetics 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 Kazakhstan to the Mediterranean environment (Çakmakçı, 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 Cherchell (Journal of Agriculture & le Botanique Appliquée, 1958).

Fruits are valuable in terms of health and can be used as natural antioxidants (Durmaz, 2012), and for their natural color. Also as used in the fields of medicine and pharmacy and in Asiaand in Europe is certified (Çakmakçı, 2014).

There are no toxic substances in oleaster fruits. Oleasteris 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 intestinedisorders and mouth rust, and its fruit extracts can be used as anti-inflammatory and analgesic (Ahmediani et al., 2000) in traditional medicine. The oleaster fruitcontains 12.33% protein (Akbolat et al., 2008), vitamins (tocopherol, carotene, vitamin C, and thiamine), mineral substances (calcium, magnesium, potassium, iron, and manganese) in Boudraa et al., 2010). Dominant sugars are in the plant fructose and glucose (Ayaz & Bertoft, 2001). The size of the fruit is the same as olives and skin is hard, yellowish-brown in color (Çakmakçı et al., 2014).

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 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 introduced (Movagharnejad et al., 2019). 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 levels power 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.

MATERIAL AND METHODS

a) 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±1 °C for 24 h (Anon, 1995). The fruit was conserved at -20 °C until used. Russian olive was sorted. After that, the total quantity was divided into three batches, one for each process Microwave grill drying.

b) Drying Methods

Microwave- grill drying

The drying apparatus used 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 mm × 330 mm × 195 mm. Drying trials were carried out at different microwave generation powers 300, 450 and 600W. Drying was performer per cycle (30 s ON / 30 s OFF); each cycle corresponds to the application of microwaves for a given 30 s power and 30 s power off. We took three glass capsules, previously cleaned and dried, the pulp of Russian olive. The capsules containing the samples are then placed in the microwave and for the study of the drying kinetics by this system; six different powers were used (100, 180, 300, 450, 600 and 900W). After 30 s of drying, the capsules are removed from the microwave and placed in a desiccator to cool them down. Then weighed each sample with a precision balance of 0.001g (model: GL-300). This operation is repeated regularly for each 30 second interval.

Until a constant weight of three successive cycles is obtained. During the drying process, we followed the evolution of the loss of mass of the products and thus established the drying kinetics. The drying kinetics was thus determined by the evolution of the mass of the products after each cycle.

Drying was run until the moisture content of about 10 % w.b. the water was attained; the Mass of the material was recorded continuously during drying with the accuracy ±0.1 g. By the equation below it can be determined the variation of the dry base moisture content (X) versus time (s).

$$X = (Ww - Wd)/Wd \qquad \text{Eq. (1)}$$

Were:
X: Moisture content on a dry basis (kg H_2O/ kg dry matter)
Ww: Weight of the sample on a wet basis (g)
Wd: Weight of dry matter of the sample (g)

Russian olive was placed inside the MWGD oven. For all the power levels studied, samples (5 ± 0.5 g) were taken from the MWGD oven every 120s for 600 W, up to 180s for 450 W, and up to 270s 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, we realized the average of ten repetitions for each power.

The Drying process was performed in three independent repetitions. The fruit was kept at −20 °C and ready for further analysis.

c) ***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). One gram 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 (SIGMA 3K20). The pellet after centrifugation is weighed (m_1), but for measuring the water retention capacity, it is first dried at 105 °C an oven for 8 h (m_2). The water retention capacity (WAC) and oil retention capacity (OAC) is calculated by the following formulas:

$$WAC(\%) = (m2 - m1)/m1 \times 100 \qquad \text{Eq. (2)}$$

$$OAC(\%) = (m1 - m0)/m0 \times 100 \qquad \text{Eq. (3)}$$

Were:
WAC is water retention capacity (g water / 100 g materials).
OAC is oil retention capacity(g oil / 100 g materials).

d) Solubility properties

One hundred micrograms (0.1 g) of the dried Russian olives were placed into a centrifuge 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 min, cooled to room temperature 25 °C and centrifuged at 10.000 rpm for10 min. The supernatant was decanted .The undissolved particles were washed in distilled water (25 mL) then centrifuged at 10.000 rpm. The supernatant was removed and undissolved pellets dried at 60 °C for 24hr. Finally, weighed the particles and determined the percentage solubility (Fernandez-Kim, 2004). Calculation:

$$Solubility(\%) = (iw - fw)/iw \times 100$$

Eq. (4)

Were:
iw: Initial weight of the sample(g)
fw: Final weight of the sample (g)

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

Emulsifying activity and stability were determined using the method of Neto et al. (2001). Five milliliters portion of dried Russian olive dispersion in water (10 mg /·mL) was homogenized with 5mL oilfor1min. The emulsions were centrifuged at 1100*g* for 5 min. The height of emulsified layer and that of the total contents in the tube was measured. The emulsifying activity (EA) was calculated as:

$$EA(\%) = h1/h2 \times 100$$

Eq. (5)

Were:
h_1 is height of emulsified layer the tube (mL)
h_2 is height of the total content the tube (mL)

Emulsion stability (ES) was measured by re-centrifugation 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.

$$ES(\%) = h1/h2$$

Eq. (6)

Were:
h_1 isheight of emulsified layer heating (mL)
h_2 isheight of emulsified layer before heating (mL)

f) Foaming properties

Foam capacity (FC) and foam stability (FS)

The method of Coffman and Garcia (1977) is 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 Philips HR2052/91 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.

$$FC = [(V1 - V2)/V2]x100$$

Eq. (7)

Were:
V_1 is Volume after whipping (mL)
V_2 is volume before whipping (mL)

$$FS = (Foam\ volume\ after\ time(t)/Initial\ foam\ volume)x100$$

Eq. (8)

g) Viscosity

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

h) pH

One gram 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) in according the method AFNOR NF V 50-108 (AFNOR, 1982).

i) Total soluble solids (TSS)

The percentage of soluble solids is 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 refractive index (IR) (Refracto 30PX) or Brix degree in according the method AFNOR NF V 50-109 (AFNOR, 1982).

i) Gelation properties

Gelation properties were studied by employing the method of Coffman & 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.

$$Gelationproperties = (h1/h2) \times 100$$

Eq. (9)

Were:
h_1 is height of gelation layer in the tube (mL)
h_2 is height of the total content in the tube (mL)

j) 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 means was significantly different when compared with the method of Newman-Keuls ($p \leq 0.05$).

RESULTS AND DISCUSSION

a) Moisture

The moisture content change between 15. 20 and 23.14 % for fruits. 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.

b) 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.

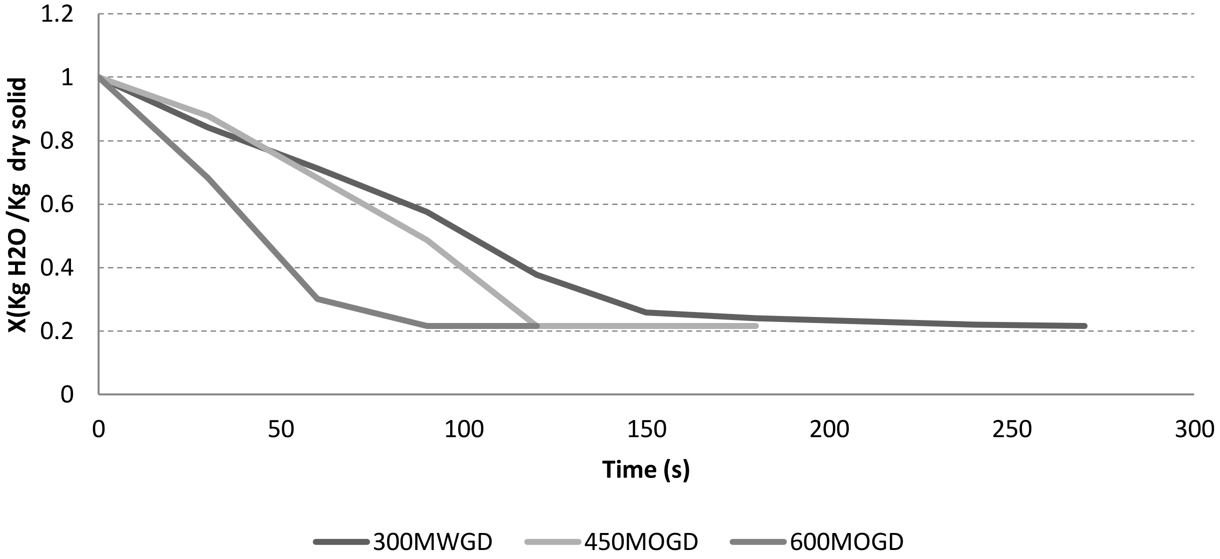

Figure 1 Variation in moisture content X (kg H_2O / kg dry matter) versus time (s) of dried Russian olive in microwave grill at different power.

Overall we see regularly decreasing curves (Figure1), this is due to the high evaporation of water free of all samples.

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

Obviously, drying time reduced with the increasing microwave drying power levels from 300 W to 450 W and lastly to 600 W. Based on Figure1, the time required to reduce the moisture content of the Russian olive stem from 1 kg H_2O/kg dry solid to 0.2 kg H_2O/kg dry solid varied between 120 s to 270 s subjected to the microwave grill power level.

In 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.

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 & Saravacos, 1995).

c) Effect microwave-grill drying on the functional properties of Russian 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 (Amadou et al., 2010; Kisambira et al.,2015). As shown in Table 1.

Table1. Effect of microwave-grill drying at different powers on the water and oil absorption capacity, solubility, emulsifying capacity, emulsion stability, foaming power, viscosity, pH and total soluble solidof Russian olive.

Methods	WAC (%)	OAC (%)	Solubility (%)	EA (%)	ES (%)	FC (%)	Viscosity (mPa.s)	pH	TSS [°Brix]
Drying methods									
Fresh fruit	220.93±0.93^{c}	160±0.40^{c}	89± 3.00^{a}	43.47±1.04^{b}	83.33±2.0^{a}	0	2.45±0.0^{a}	5.23±0.0^{a}	42±5.0^{a}
Microwave grill drying									
300W	203.06±6,0^{d}	201.03±5.1^{a}	61±0.30^{c}	42.38±0.04^{b}	64.61±0.01^{c}	0	1.17±0.0^{d}	5.22±0.0^{a}	2.4±0.0^{d}
450W	236.12±0.3^{b}	165.22±1.0^{b}	66±0.11^{a}	62.32±0.01^{a}	76.32±0.00^{b}	0	1.45±0.0^{b}	5.22±0.0^{b}	4.9±0.0^{b}
600W	256.23±5.0^{a}	130.13±0.0^{d}	52±3.00^{d}	30.33±0.02^{c}	60.00±0.09^{d}	0	1.29±0.0^{c}	5.21±0.0^{b}	3.5±0.0^{c}

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).

The water and oil absorption capacity of the Russian olives samples ranged (203.06±6.00% and 256.23±5.00%, microwaved grill at 300 and 600 W. Subjection 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 & Adeleke, 2010). Oil absorption capacity is useful in food preparations that involve like bakery products where oil is an important ingredient (Princewill-Ogbonna & Ezembaukwu, 2015).

Robertson & 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 capacityis increasing from 300 W to 600 W (203.06±6.00%, 236.12±0.30%, and 256.23±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 & 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) and Mohammad et al. (2015) 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 (Enujiugha et al., 2012).

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 is noted that the capacity of water retention is clearly higher than that of the oil. This is 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).

d) 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 (66.00± 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 (≥ 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.

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

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±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;Enujiugha et al., 2012).

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 Russian 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 & Ngoddy, 1985; Enujiugha et al., 2012).

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 (Alain & Roudot, 2001; Chandi & Sogi, 2006). According to Table 1 excellent emulsion stability can be seen (> 60%) for all dried Russian olive by microwave grill at different powers nevertheless dried Russian olive at (600, 450 and 300 W respectively (60±0.09, 76.32±0.00 and 64.61±0.01%).

f) Foaming properties

The results gathered in Table 1 show that non-foam for Russian 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 Russian 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.

g) Viscosity

In general, the process drying resulted in a decrease viscosity of Russian olive viscosity (Table 1).

In our study, the viscosity of Russian olive in microwave-grill at different power ranged from 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 dryingon the biochemical composition Russian 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 Russian olive fruit. The effect of drying on the polysaccharide viscosity of Russian olive fruit could be due to the different proportions of soluble materials compared to insoluble materials.

h) pH

The average pH value of the raw berry Russian olive was 5.22 ±0.00 which is within the acceptable range of pH (5.21-5.22) for Russians olive. The average pH values for the

Russian olive powder dried using microwave-grill-drying 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 Russian olive (Sahan et al., 2015) such as malic acid (0.67mg/100g), oxalic acid (0.08mg/100g), ascorbic acid (0,08mg/100g), acetic acid (0.52mg/100g), citric acid (0.59mg/100g), tartaric acid (0.52mg/100g) and formic acid (0.05mg/100g).

i) 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 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 450W (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.

j) Gelation properties

The gelation concentration for Russian 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.

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

Parameters	Gelation Capacity - Concentrations (%)					
	2	4	8	12	16	20
Fresh fruit	13 .63±0.03^{s}	18.18±0.01^{r}	36.36±0.01^{k}	54.74±0.01^{e}	81.71±0.01^{b}	100±0.00^{a}
300 W	28.81±0.01^{o}	30,72±0.01^{n}	46.36±0.01^{j}	54.45±0.01^{g}	72.09±0.01^{d}	100±0.00^{a}
450 W	27.27±0.00^{q}	31.2±0.01^{m}	48.81±0.01^{i}	54/45±0.01^{g}	72.09±0.01^{d}	100±0.00^{a}
600 W	28.18±0.01^{p}	33.18±0.01^{l}	50.36±0.01^{h}	56.45±0.01^{f}	79.43±0.01^{c}	80±0.00^{b}

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).

The least gelation capacity results for microwave grill at 300 Wdried Russian olive is 2%, and microwaved grill at 600 W samples ranged from 12% to16%.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., 2012).

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 Russian 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 (Maninder, Sandhu & Sinth, 2007).

It is incorporated into food products such as creams, soups, puddings, pie fillings and many sauces in viscosity (Osman, 1967).

CONCLUSION

The kinetics of the dehydration of Russian olive fruit shows that microwave-grill- drying time is short in supply to other drying methods. This reveals the economic importance of dehydration by microwave of the fruits of the Russian olive.

In the drying process, power and long exposure times contribute significantly to the decreasing of emulsifying property content present in the Russian 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 Russian olive fruit has a relatively low water absorption capacity compared to Russian olive fruit raw.

The values of the functional properties vary according to the powers used during microwave-grill-drying. Higher values of WAC, OAC, solubility and emulsifying power, emulsifier stability and gelation are found in Russain olive fruit dried by microwave-grill-drying at 450W.

These results show the important role of this fruit dried by microwave-grill-drying 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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