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Full Length Research Paper

Effects of hot air and microwave drying on some physical properties of laurel berry

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In this study the influence of drying method on physical properties of laurel berry has been investigated. Drying air temperatures for hot air application were selected as 60, 70 and 80°C, respectively. The power levels for microwave application were 180, 360, 540, 720 and 900 W, respectively. The average length, width, thickness, the geometric mean diameter, sphericity index, unit mass, volume, projected area, coefficient of friction, angle of repose, rupture force and moisture content were studied. The fresh sample of average length, width and thickness were 14.26, 12.22 and 10.86 mm, respectively. Microwave drying at the power of 900 W, where length, width and thickness were 14.16, 11.39 and 11.01 mm, respectively. The rupture force of fresh laurel berries were 52.91 and 97.99 N at minor and major axis. By microwave drying at 360 W the minor and major axis values were 59.11 and 84.75 N, respectively.

Key words: Laurel berry, drying, physical properties.

INTRODUCTION

Laurel (*Laurus Nobilis* L.) is evergreen, large shrub tree that grows wild in the coastal area of Mediterranean and Blacksea regions. Laurel berries are used to produce fixed oil which is the main additive of daphne soap. The efficient procedure to gain laurel berry oil consisting of three steps which are drying, cold press and extraction has already been studied by Öztekin et al., 2010.

Although the physical properties of fresh and dried oil seeds have already been studied for some crops such as cherry laurel fruit (Calisir, Aydın, 2004), safflower seed (Erica et al., 2004), jojoba fruits (Đnce et al., 2008), Juniperus drupacea fruit (Akinci et al., 2004), flaxseeds (Coskuner et al., 2005), bambara groundnuts (Baryeh, 2001) and cowpea seeds (Kabas et al., 2007), there is no report on Laurel berries. Therefore, this study was conducted to study some physical properties of laurel berry which are average length, width, thickness, the geometric mean diameter, sphericity index, unit mass, volume, projected area, coefficient of friction, angle of repose and rupture force.

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MATERIALS AND METHODS

Laurel berries were provided from south-east Mediterranean part of Turkey. The moisture content of material was determined by standard oven method at 105°C for 24 h. Microwave drying tests were carried out by domestic microwave oven (Arcelik ARMD 586, Turkey) with a maximum output of 900 W at 2450 MHz. The available power outputs of microwave oven were 180, 360, 540, 720 and 900 W, respectively. The glass turn-table having a diameter of 325 mm in the microwave oven was filled up by 250 g of laurel berries. This quantity represents a thin layer of laurel berries having a crop density of 6 kg/m^2. Moisture losses in microwave drying were measured in 3 min intervals by precision balance (Sartorius, presicion: 0.01 g, maximum weighing capacity: 2000 g). For each microwave output level several tests were carried out to decide on optimum drying time. It could be defined as the duration to reach final moisture content of fewer than 10% (w.b.) where no burning traces on berries both in color and smell is recognized. After selecting optimum drying time three replications were carried out for each microwave output level.

In the hot air drying, the shortest drying time to reach the final moisture content under 10% (w.b.) were determined in selected temperature of 60, 70 and 80°C, respectively. After determining the drying time three replications were carried out for each selected temperature level. The presented parameters in Table 1 are calculated as the mean value of three replications.

In order to determine the size, weight and volume, 100 fruits were randomly selected. For each fruit three principal dimensions namely length, width and thickness as shown in Figure 1 were

Table 1. Some physical properties of laurel berry.

Physical properties	Fresh	Microwave drying 180 W	360 W	540 W	720 W	900W	Hot air drying 60°C	70°C	80°C
Moisture content (% w.b.)	40	8.55	7.57	8.48	9.2	7.18	8.3	9.36	9.81
Extracted oil		28^{a}	27.6^{ab}	27.4^{b}	25.8^{d}	25.8^{d}	25.8^{d}	27.8^{ab}	27^{c}
Length (mm)	14.26^{a}	14.08^{e}	14.23^{b}	14.18^{c}	14.18^{c}	14.16^{d}	13.78^{f}	13.49^{g}	13.78^{f}
Width(mm)	12.22^{a}	11.07^{f}	11.37^{d}	11.44^{b}	11.17^{e}	11.39^{c}	10.42^{i}	10.46^{h}	10.61^{g}
Thickness (mm)	10.86^{c}	10.65^{e}	10.99^{b}	10.99^{b}	10.75^{d}	11.01^{a}	9.94^{h}	9.98^{g}	10.08^{f}
Geometric mean diameter (mm)	12.36^{a}	11.87^{f}	12.11^{d}	12.18^{c}	11.93^{e}	12.24^{b}	11.25^{h}	11.20^{i}	11.37^{g}
Arithmetic mean diameter (mm)	12.44^{a}	11.97^{f}	12.20^{d}	12.27^{c}	12.03^{e}	12.35^{b}	11.38^{h}	11.31^{i}	11.49^{g}
Sphericity	0.86^{a}	0.84^{bc}	0.85^{ab}	0.85^{ab}	0.84^{bc}	0.84^{bc}	0.82^{d}	0.83^{cd}	0.83^{cd}
Mass (g)	1.27^{a}	0.74^{e}	0.73^{e}	0.67^{g}	0.70^{f}	0.70^{f}	0.80^{c}	0.76^{d}	0.82^{b}
Volume (cm^{3})	1.38^{a}	0.82^{d}	0.82^{d}	0.91^{b}	0.86^{c}	0.91^{b}	0.81^{d}	0.76^{f}	0.79^{e}
True density (g/cm^{3})	0.92^{d}	0.90^{e}	0.88^{f}	0.73^{i}	0.81^{g}	0.77^{h}	0.98^{c}	1.00^{b}	1.12^{a}
Projected area (mm^{2})	149.31^{a}	106.63^{e}	112.07^{b}	108.72^{c}	102.43^{f}	108.54^{d}	93.49^{g}	90.90^{i}	91.01^{h}
Rupture force major axis (N)	52.91^{a}	113.25^{f}	59.11^{b}	79.52^{e}	79.14^{d}	74.85^{c}	204.89^{g}	215.86^{h}	215.96^{i}
Rupture force minor axis (N)	97.99^{e}	125.74^{f}	84.75^{b}	85.17^{c}	85.37^{d}	79.04^{a}	179.17^{h}	177.87^{g}	209.94^{i}
Angle of repose (º)	29.54^{a}	24.15^{c}	21.61^{g}	22.59^{e}	22.01^{f}	23.62^{d}	19.96^{i}	21.54^{h}	25.04^{b}
Static coefficient of friction									
Galvanized steel	26.57^{a}	29.66^{d}	28.07^{b}	30.06^{f}	29.22^{c}	30.68^{h}	29.86^{e}	31.73^{i}	30.46^{g}
Chrome Steel	25.06^{a}	29.11^{e}	29.09^{d}	32.60^{i}	28.75^{c}	27.17^{b}	31.98^{h}	31.12^{f}	31.83^{g}
Plywood	25.32^{a}	30.94^{d}	31.25^{e}	32.36^{f}	29.22^{b}	30.68^{c}	33.48^{g}	37.00^{h}	37.53^{i}

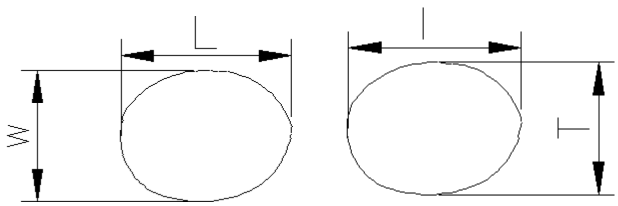

Figure 1. Principal dimensions of laurel berry fruits; L, W and T are the length (major axis), width (intermediate axis) and thickness (minor axis).

measured by using a digital vernier caliper with an accuracy of 0.01 mm. To weigh each fruit, precision balance (Sartorius, presicion: 0.01 g, maximum weighing capacity: 2000 g) was used.

The geometric mean diameter (D_e), arithmetic mean diameter (D_a) and sphericity (Φ) of the fruits were calculated using the following equations:

$$D_e = (LWT)^{1/3} \quad (1)$$

$$Ø = \frac{(LWT)^{\frac{1}{3}}}{L} \times 100 \quad (2)$$

$$D_a = \frac{L+W+T}{3} \quad (3)$$

A scanner was used to project the image of the fruit in its natural rest position. Then, the projected area was calculated by using the Auto-CAD. The volume and true density of each fruit were determined by the water displacement method explained by Mohsenin (1978). The true density was then computed by dividing the weight to volume.

The static coefficient of friction of Laurel berry against three surface materials namely, galvanized sheet, chrome steel and plywood was determined. A group of bound berry was placed on the tilting surface. The surface was gradually raised up by the screw. Vertical and horizontal height values were read from the ruler when the fruit started the sliding, then, the static friction coefficient were calculated (Ertekin et al., 2006).

For the determination of angle of repose (θ) of berry, a specially constructed prism in dimensions of 300x190x130 mm with a movable wall was used. After filling the box with fruits, the movable wall was pulled carefully. Therefore the fruits flowed along the horizontal line in the volume and the angle between static bulk main line and horizontal plane was measured (Akcali et al., 2006)

Quasi-static compression tests were done with a Lloyd Material Testing Machine (model LRX Plus) equipped with a 5000 N load cell and computer. Two loading positions which are parallel to the principal dimensions of the fruit were used in the compression tests. Each sample was placed between two plates and compressed at 8 mm min^{-1} speed until the fruit was initiated. Rupture force was read directly from graphics. Each test was repeated 20 times.

RESULTS AND DISCUSSION

Table 1 shows the physical properties of the Laurel berry depending on drying procedure and moisture content. According to these results dimensions of laurel berry were between 14.26 and 13.49 mm in length, 12.22 and

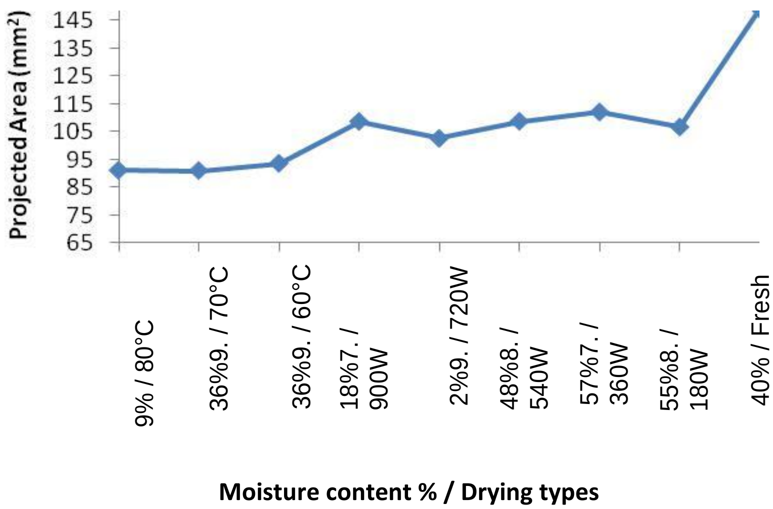

Figure 2. Effect of moisture content/ drying types on projected area of laurel berry.

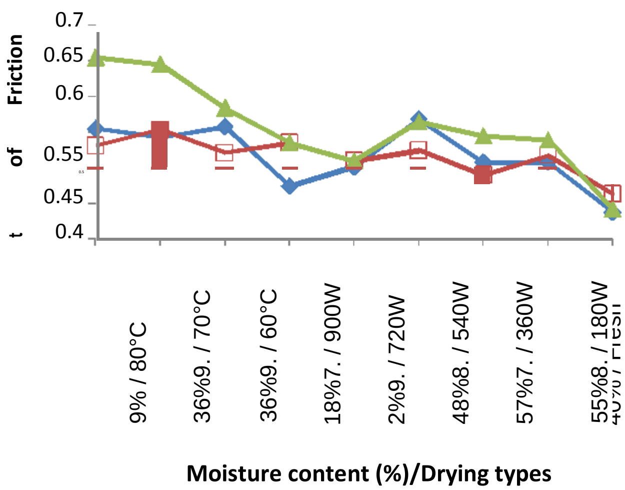

Figure 3. Effect of moisture content on coefficient of friction of laurel berry with chrome steel (♦); galvanized steel (■); plywood (▲).

10.42 mm in width, 11.01 and 9.94 mm in thickness. The geometric mean diameter was between 12.36 and 11.20 mm. The arithmetic mean diameter varied between 12.44 and 11.31 mm

The mass of fruit was varied depending on the moisture content between 1.27 and 0.67 g. As a function of moisture losses the volume of the fruit is giving an interesting result at 900 W microwaves drying which differs from all drying process. As the fresh fruit volume was 1.38 at the 900 W microwave drying volume was 0.91 but the volume at 70°C hot air drying was 0.76 which has higher moisture content than 900 W drying processes. This results show that the shrinkage is the highest at 70°C hot air drying in all drying process.

True density of laurel berry at different drying process varied from 1.12 to 0.73 g/cm^3. It increases by increasing microwave power. Similar tendency could be identified on hot air drying where the density increases by increasing drying air temperature. Maximum density was measured on hot air drying at 80°C. Projected area decreased as a function of volume decreases. The values of projected area were between 149.31 and 90.90 mm^2 at fresh and 70°C hot air dried, respectively (Figure 2).

Stiffness affects the mechanical press process. Therefore the rupture force of laurel berry is an important factor to reduce the load on screw which is rotated by electric motor. The rupture force of laurel berry changed with moisture content and drying process. As the result of shrinkage and density the stiffest product occurred at 80°C hot air drying. On the other hand 900 W microwave dried products has a smaller rupture force. This parameter should be taken seriously to reduce load and also the oil temperature which is occurred during the press.

Static coefficient of friction for laurel berry fruits determined with respect to Galvanized, chrome steel and plywood surfaces are presented in Figure 3. In all surfaces hot air dried fruits of coefficient of friction were higher than the microwave dried ones. Among the surfaces plywood material has higher values respect to hot air dried products. Angle of repose changed between 29.54 and 19.96 º for fresh and 60°C hot air dried, respectively (Figure 4).

Conclusion

The results show that microwave drying has positive effects on physical properties of laurel berry. The rupture force could play an important role on oil temperature,

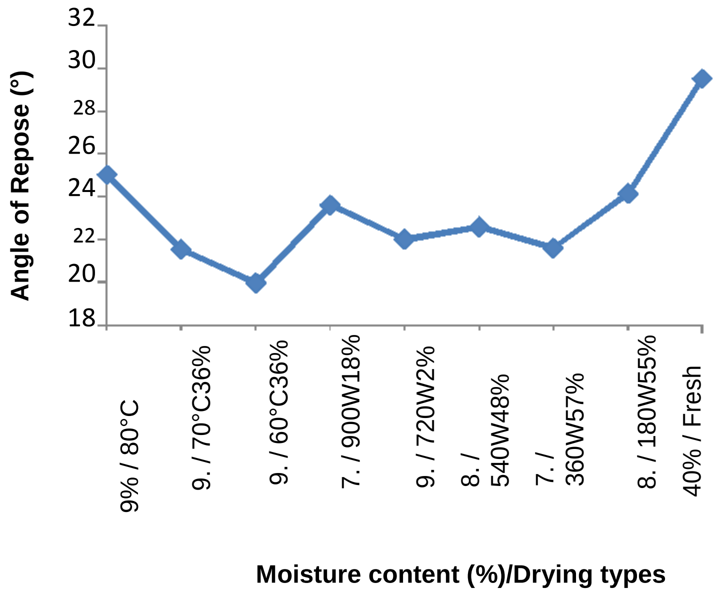

Figure 4. Effect of moisture content/ drying types on angle of repose of laurel berry.

reduced electricity and spare part fees. The hot air drying influences the product with more shrinkage and rupture force. The shrinkage results smaller angle of repose and higher coefficient of friction. Thus microwave drying is a good drying process to get higher extracted oil with fewer loads on screw and electric motor. From the economic view, the product market value is important but the cost of production must be considered to get more profits.

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