ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 4 (4): 308-310, 2005
ISSN 1812-5379

Determination of Some Physical Properties and Static Friction Coefficient of Olive (*Olea europea* L., Ayvalik and Memecik)

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Abstract: In order to design equipment for harvesting and improved processing of olive that is used to produce oil, some of the physical properties were determined. Ayvalik and Memecik cultivars which were used for olive production were used in these experiments. The average mass and some of dimensions such as length, and width of olive cultivars were determined as 3.11 g, 19.05 mm, 15.22 mm for Ayvalik cultivar and 4.37, 22.28, 16.97 mm for Memecik cultivar, respectively. The average geometric mean diameter and sphericity were calculated as, 16.39 mm and 80.18% for Ayvalik cultivar and 18.56 mm and 79.90% for Memecik cultivar, respectively. The static friction coefficient of olive varieties against galvanized sheet metal, wood, net, painted metal sheet and textile surfaces were determined. The highest coefficient of friction for both cultivars was found against net surface and the lowest one was found against wood surface.

Key words: Olive, physical properties, static friction coefficient, *Olea europea* L

INTRODUCTION

Olive (*Olea europea* L.) is an evergreen tree that been traditionally cultivated for olive oil and table consumption. Although olive trees are distributed all continents, 97% of the world production of olive is concentrated in the Mediterranean basin countries including Turkey. Total world olive production area and production were given as 8,554,964 ha and 17,168,915 Mt, respectively[1].

It is a symbol of the peace and it is produced mainly at upper Mesopotamia and South Forepart of Asia including south East region of Turkey[2]. Turkey is the one of the most important olive producer in world with 93,500,000 olive trees and 1,750,000 t production[3]. Big part of total olive production (1290,000 t) is used to produce olive oil[3].

Olive that is evaluated for oil or table consumption has got many problems in its production, harvesting and post harvest processes in respect of mechanization. Many olive oil producers consider several factors on the effective oil quality. In addition cultivar of olives, one of important factor is the harvesting and post harvest mechanization processes. A broad range of data about olive cultivar such as physical and mechanical properties must be investigated and these data must be used in sector for these processes to solve some problems.

Olive harvesting is performed by hand type and mechanical type shakers. Especially mechanized harvesting increased harvesting efficiency to 1.33 kg min^{-1}, but percentage of damaged fruits increased to 30%[4].

Friction coefficients were determined for rubber, plywood, galvanized steel and chrome stain steel[5]. Maximum average static friction coefficient was found for rubber surface as 0.62. It is followed by plywood, galvanize steel and chrome stain steel as 0.49, 0.43 and 0.41, respectively.

Some psycho-mechanical properties such as average press resistance, deformation, projection area, terminal velocity and friction coefficient for only one surface were determined for 2 different olive cultivars[6]. Terminal velocity was determined as between 6.51-7.41 m s^{-1}. They found that while terminal velocity increases, projection area decreases.

This study was performed with two common types olive cultivars (Ayvalik and Memecik) that are produced to get olive oil. Determination of some physical properties and friction coefficients of olives against different material surfaces are important, in order to obtain data for designing post harvest mechanization equipments in olive oil production.

MATERIALS AND METHODS

Ayvalik and Memecik olive cultivars, that were produced in Ayvalik and Aydin cities in Turkey for oil production, were used in all experiments in this study.

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Olives were stored about 15 days in refrigerator until experiments were finished. Fifty olives were selected randomly from every cultivars and physical properties and coefficient of friction were determined as 3 repetitions. Some of determined properties were given in Table 1.

A digital slide calliper that has 0.05 mm accuracy was used for measurement of length and width of olives. Measurements of olive mass were performed by using Shinko Denshi model electronic balance with 0.1 g accuracy and 5600 g capacity.

The geometric mean diameter values (G_{md}) were calculated according to Eq. 1[7]:

$$G_{md} = (a*b*c)^{1/3} \quad (1)$$

Where, a is length of olives, b is width of olives and c thickness of olives in mm. Width and thickness of olives were found equal each other.

Sphericity of olives was calculated by values of length and width according to Eq. 2[8]:

$$S = \frac{b}{a}*100 \quad (2)$$

The static coefficient of friction of olive on five different structural materials, namely galvanized sheet metal, wood, net, painted sheet metal, and textile surfaces were determined by using experimental setup. In this system platform was inclined gradually with a screw device until the olive just started to slide down and the angle of tilt was read from a graduated scale. The coefficient of friction was calculated from the following relationship[9].

$$\mu = tg\alpha \quad (3)$$

where (μ) is the coefficient of friction and α is the angle of tilt in degree.

RESULTS AND DISCUSSION

Mean values of measured physical properties have been shown in Table 2. According to Table 3 these measured physical properties (for every properties 50 olive was used as 3 repetition), showed that difference between cultivars is found significant as statically for 0.01 importance level in respect of volume, sphericity and geometric mean diameter.

As seen in Table 4 relationship between volume and sphericity was found significant for 0.05 importance level. While volume increases, sphericity decreased for both cultivars. Namely shape of big volume olive is not close to sphere. Also there is similar negative relationship between sphericity and geometric mean diameter. This relationship was found also significant as statically for 0.05 importance level. Positive relationship between geometric mean diameter and volume was found very significant as statically for 0.01 importance level.

Difference between cultivars (5.615) was found significant as statically for 0.05 importance level, the

Table 1: Some properties of olive cultivars

Cultivar	Ayvalik			Memecik		
Moisture content(%)	38			22		
Total solid amount(%)	62			78		
Sphericity(%)	80.18			76.90		
100 olive mass (g)	318.8			548.3		
Length (mm)	Min.	Max.	Mean	Min.	Max.	Mean
	14.92	22.64	19.05	20.24	30.34	22.28
Width (mm)	Min	Max.	Mean	Min.	Max.	Mean
	12.57	17.57	15.22	14.45	20.76	16.97

Table 2: Mean physical properties of Ayvalik and Memecik cultivars (For three repetition, values of every repetition for 50 olives)

	Ayvalik			Mean of repetition	
	1st	2nd	3rd		
Volume	3.14	2.66	2.72	2.84	
Sphericity	79.16	80.62	80.77	80.18	
G_{md}	16.81	16.32	16.05	16.39	
	Memecik			Mean of repetition	General average
	1st	2nd	3rd		
Volume	5.84	5.56	5.00	5.47	4.16
Sphericity	76.45	71.77	72.60	73.61	76.90
G_{md}	21.51	20.50	20.17	20.73	18.56

Table 3: Variance analysis of physical properties

Source	df	S.S.	M.S.	F-ratio	p-value
Volume	1	10.349	10.349	82.353	0.001**
Error	4	0.5030	0.1260		
General	5	10.852			
Sphericity	1	64.879	64.879	18.466	0.013**
Error	4	14.053	3.5130		
General	5	78.932			
G_{md}	1	28.167	28.167	88.593	0.01**
Error	4	1.2720	0.3180		
General	5	29.438			

**0.01, *0.05

Table 4: Interaction between physical properties

	Volume	Sphericity	Geometric mean diameter
Volume	1.000		
Sphericity	-,854*	1.000	
Geometric mean diameter	-,995**	-,834*	1.000

**0.01, *0.05 (- shows that negative relationship between physical properties)

Table 5: Variance analysis of static friction coefficients for different surfaces

Source	df	S.S.	M.S.	F-ratio	p-value
Variety	1	0.00533	0.00533	5.615	0.028*
Factor	4	0.375	0.0937	98.591	0.000**
Variety X Factor	4	0.00217	0.00054	0.570	0.687

**0.01, *0.05

Table 6: Mean static friction coefficients of Ayvalik and Memecik cultivars (For three repetition, values of every repetition for 50 olives)

	Ayvalik				Memecik				
	1st	2nd	3rd	Mean of repetition	1st	2nd	3rd	Mean of repetition	General average
Painted sheet metal	0.33	0.34	0.33	0.33b	0.31	0.41	0.33	0.35b	0.34
Wood	0.13	0.15	0.16	0.15a	0.13	0.18	0.13	0.15a	0.15
Textile	0.36	0.40	0.38	0.38b	0.44	0.40	0.45	0.43b	0.41
Net	0.45	0.48	0.46	0.47b	0.50	0.49	0.50	0.50b	0.49
Galvanized sheet metal	0.34	0.41	0.35	0.36b	0.34	0.42	0.44	0.40b	0.38
Average	0.32	0.36	0.34	0.34	0.34	0.38	0.37	0.37b	0.35

a, b: groups according to Duncan test

difference between friction surfaces (98.591) was found very significant for 0.01 importance level. Interaction between cultivars and surfaces was found nonsignificant as statically (Table 5).

Mean friction coefficient of Ayvalik and Memecik cultivars were calculated as 0.34 and 0.37, respectively. Mean friction coefficients of painted sheet metal, wood, textile, net and galvanized sheet metal surfaces were calculated as 0.34, 0.15, 0.41, 0.49 and 0.38, respectively (Table 6). If interaction between variety and surface taken into consider, the smallest friction coefficient was determined for wood surface as 0.15 for both cultivars and the biggest one was determined for 0.50 at net surface for Memecik cultivar (Table 6). Static friction coefficient against wood surface was found surprisingly lower than others (Table 6). This situation can be explained that wood surface was smoothed by emery during wood reduction and absorbing oil from olives into wood during experiments.

CONCLUSIONS

Some physical properties and friction coefficient of olives against 5 different surfaces were determined. Difference between cultivars was found important in respect of volume, sphericity and geometric mean diameter. Relationship between volume and sphericity was found significant and negative for both cultivars. Also there was similar negative relationship between sphericity and geometric mean diameter. On the other hand positive relationship was found between geometric mean diameter and volume. The smallest friction coefficient was determined surprisingly for wood surface as 0.15 for both cultivars and the biggest one was determined as 0.50 at net surface for Memecik cultivar. The smallest friction coefficient at wood surface can be explained that wood surface was smoothed by emery during wood production and absorbing oil from olives into wood during experiments.

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