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SOME PHYSICAL AND MECHANICAL PROPERTIES OF OLIVE FRUITS IN (Ryayna-Khrian-Libyan Arab)

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ABSTRACT

This study was carried out to investigate some physical and mechanical properties of fruit olive, such as fruit length, diameter, pit length pit diameter, flesh thickness, shape index, fruit weight, pit weight, volume, angle of repose, flesh hardness and pit hardness. The results indicated that, the relationship between fruits olives physical properties and corresponding pits were correlation with other, and the very important factor from this properties was, the increasing fruit pit weight increased the flesh hardness and also pit hardness and consequently increased the force used for fruit crushing during oil extraction. Average repose angle for fruit olive was 27.7°, average flesh hardness was 2.392 kg/cm^2, and average pit hardness was 265.843 N. From this study, found that the physical and mechanical properties for olive fruits were very important to design oil extraction machine.

INTRODUCTION

Olive fruit considered the first crop in Libyan Arab, and it considered one of the most important crops which grown in desert land for their superior ability to cope (antagonize) the deserts conditions like dryness, hard climate and shortage in water supply. Olive trees can grown in acrimony the nature and climate. The countries around the Mediterranean sea are original zones of olives trees. The total production of these countries are more than 94% of olive fruits and 98% of olive oil from the world production. There for both the olive fruits and olive oil play an important roles for supporting the economics situation of many countries. In Libyan, olive trees found in most area. They are reach more than 1.5 million trees. (Alaa A.El-Gily, 1989).

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Mohsenin (1970) reported that the physical properties of any material such as shape, volume and surface area are important in many problems associated with design or development of specific machine. Poppas et al. (1988) used multiple regression analysis to describe the shape cowpeas using the three principle dimensions i.e. length, width, thickness. Harmond et al. (1965) reported that, the size refers to characteristic of an object, which determines how much space it accupies and within limits, can be described in terms of length, width, and thickness. Kaleem et al. (1993) stated that, the angle of repose is very important in the determination of the inclination angle of the machine hopper tank. Ibrahim (1992) indicated that the processed materials vary considerably in their physical properties such as size, shape, density, volume, specific gravity, and surface texture. These characteristics are very important in many problems associated with design or development of specific machine, analysis of the behavior of the product and handling. Hatem et al. (2005) found that the olive fruit length, diameter and weight were directly proportional to its pit for the investigated varieties. Chakraveerty (1987) defined the sphericity as the ratio of surface area of sphere to the surface area of the particle. Sphericity (S) is defined as:

$$S = d_i / d_o$$

Where:

d_i = diameter of largest inscribed circle;

d_o = diameter of smallest circumscribed circle of the particle.

MATERIAL AND METHODS

This work was carried out to determine some physical and mechanical properties of olive fruits in Libyan Arab (kharian). The physical mechanical properties studied may help in choose, altering or design of a suitable machine for oil extraction.

Physical properties:

Physical properties (Volume, shape index, Flesh/fruit% and flesh/pit ratio) of the olive fruits were determined as follow:

1- Volume: The theoretical volumes of olive fruit were calculated by the following equation (Mohsenin, 1984):

$$V= (\pi/6)*L*D^2 \qquad V=(\pi / 6) \times L \times D^2$$

Where:

V: theoretical volume of individual fruit, mm^3;
L: length of the olive fruit, mm;
D: diameter of the olive fruit, mm;

2- Shape index:

A random sample of one hundred olive fruits. Shape index of the measured samples was calculated according to (Buyanov and Voronyuk 1985) as follows:

$$I = i/d$$

Where:

I: The shape index,
i: length of fruit, mm;
d: diameter of fruit at the middle of its length, mm;

3- Flesh/fruit% and flesh / pit ratio:-

These percentages or ratio were calculated for individual fruit using the weight of fruits and its pit according to (Mohsenin, 1984) as follows:

Flesh/Fruit% = $(W_f - W_p) * 100/W_f$, and,

Flesh/pit ratio = $(W_f - W_p) / W_p$

Where:

W_f: weight of the individual olive fruit, g;
W_p: weight of pit for the same olive fruit, g.

Mechanical properties:

Mechanical properties (repose angle, hardness) of the olive fruits were determined as follow:

4- Fruit repose angle:

The repose angle was measured according to the formula,

$\Phi = \tan^{-1} h/0.5x$ (Mohsenin, 1970):

Where:

H: height of the cone formed by the olive fruits,
X: diameter of the base of the cone.

5- Hardness:

- Flesh hardness: fifty olive fruits were used for flesh measurements by using digital hardness meter.
- Pit hardness: The force required to break the pit olive "F" (N) was measured using the lever setup with digital force gauge. Lever setup: it was used for amplifying the force measured by the digital force gauge. The digital force is a small range of the force measured by (2200g). Fig. 1 shows the lever setup and the force acting on their arms. A total force (F_2) on the short arm end can be determined as follows: (Zoolouk et al. 2005)

$$F_2 = C (F_1 L_1/L_2)+P$$

$$= 0.054 F_1 + 4.2$$

Where:

F_1: Force exerted by the gauge sensor, g;

F_2: Total force exerted by the lever on the pit, g;

P: reaction caused by the lever weight at zero F1, g;

L_1: length of the long arm of the lever = 54 cm;

L_2: length of the short arm of the lever = 10 cm;

C: conversion factor.

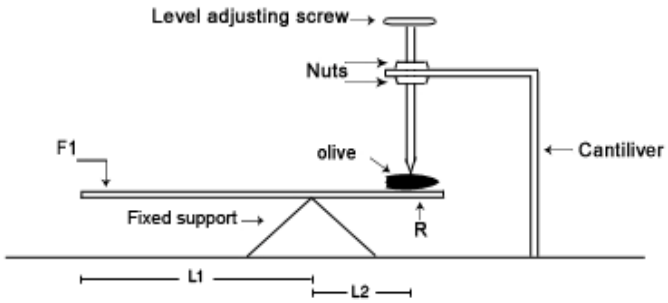
Measuring instrumentation:

1- Digital Vernier calipers with accuracy of 0.01 mm was used for measuring length, diameter and flesh thickness.

2- Electrical balance: sartorius type, accuracy of 0.001g.

3- Hardness force: A digital force gauge with accuracy of 0.2% was used for measuring the hardness force. It has a maximum reading of 2200g, so, a lever construction was used for amplifying force reading fig.(1), reaction due to lever weight was take in

consideration.



F_1 = force exerted by the gauge sensing element, g,
R = Reaction force exerted by the lever arm due to its weight at F_1 = zero, g and the lever at horizontal position.

Fig.(1): lever setup used for amplifying the force measured by the digital force gauge.

RESULTS AND DISCUSSION

Physical properties of the investigated fruits and their pits:

Physical properties (length, diameter, flesh thickness, shape index, weight and volume) of olive fruit were determined shown in table (1).

Table (1): physical properties for the investigated of olive fruit and its pits.

Property	Average (X)	Rang, Min.-Max.
Fruit length, (mm)	20.32	19.3 – 20.8
Fruit Diameter, (mm)	12.44	11.6 – 13.04
Pit length, (mm)	15.78	15.2 – 16.5
Pit Diameter, (mm)	6.63	6.2 – 7.4
Flesh thickness, (mm)	2.64	2.55 - 2.8
Shape Index	1.64	1.44 – 1.89
Fruit weight, (g)	1.758	1.654 – 1.895
Pit weight, (g)	0.393	0.342 – 0.513
Volume, Cm^3	1.645	1.465 – 1814
Flesh/fruit percentage	66.914	62.216 70.664
Flesh/pit ratio	2.802	2.228 – 3.187

The relation ship between fruit length, diameter and weight and their corresponding pits:

The obtained results in figs. (2,3 and 4) showed that the fruit length, diameter and weight were directly proportional to their pits length, diameter and weight. These parameter was a liner functions had been drawn using the Excel program as Follow:

$$y = 0.6519x + 10.348$$

The independent parameter (x) is the pit length (mm) and dependent parameter (y) is the fruit length (mm) and correlation factor (R^2) was 0.831 .

The relationship between fruit diameter and its pit diameter had been given a linear functions as follow:

$Y = 1.3807x + 2.7243$

And correlation factor $R^2 = 0.9733$

The relationship between fruit weight and its pit weight give function as follow:

$Y = 0.7984x – 0.9118$

And correlation factor $R^2 = 0.9092$

Mechanical properties:

Mechanical properties (repose angle, flesh hardness, and pit hardness) for the studied were measured as shown in tables (2 and 3)

Table (2): Repose angle for olive fruits

Property	**Average (x)**
Repose angle (0º).	27.7

Table (3): Flesh hardness and pit hardness for olive fruits.

Property	**Average (x)**	**Range Min- Max**
Flesh hardness, (kg/cm2)	2.392	2.236 – 2.497
Pit hardness, (N).	265.843	235.54 – 301.230

Table (3) indicates that the increasing fruit pit weight increased the flesh hardness and also pit hardness,and consequently increased the force used for fruit crushing during oil extraction.

Form fig. (5), The relationship between fruit pit weight and its pit hardness give function as follow:

Y = 426.85x + 53.083 and correlation factor R^2 = 0.9768.

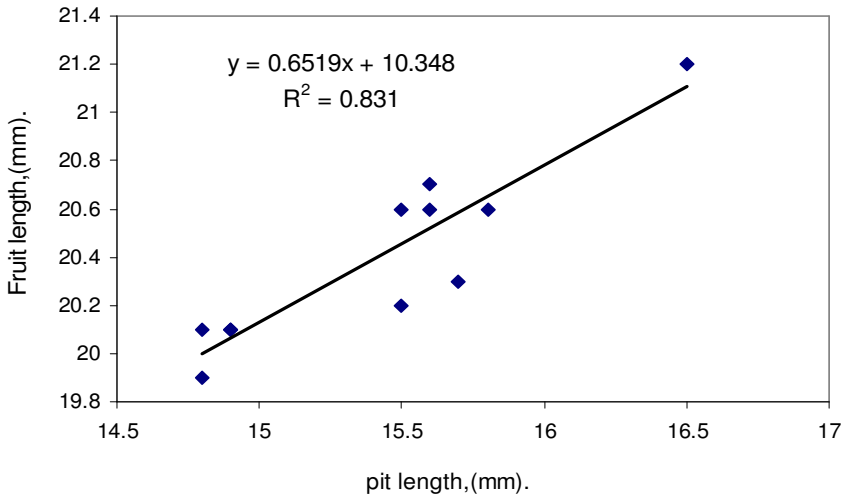


Fig.(2):The relationship between fruit length and its pit length.

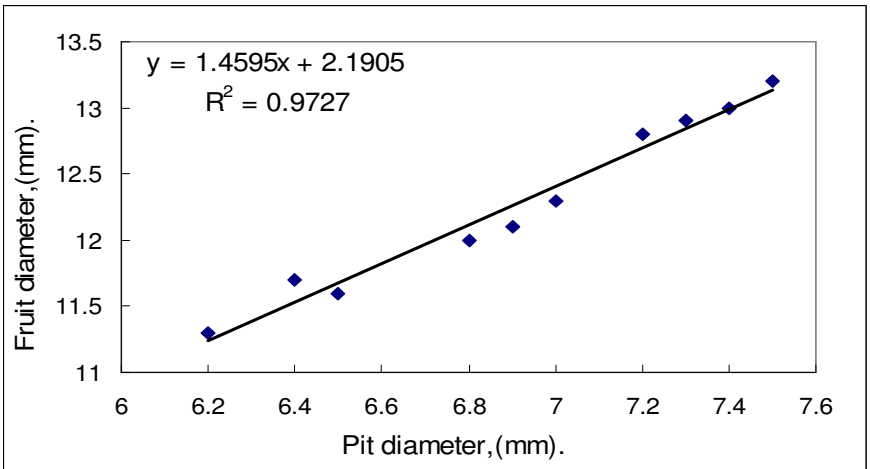


Fig.(3): The relationship between fruit diameter and its pit diameter.

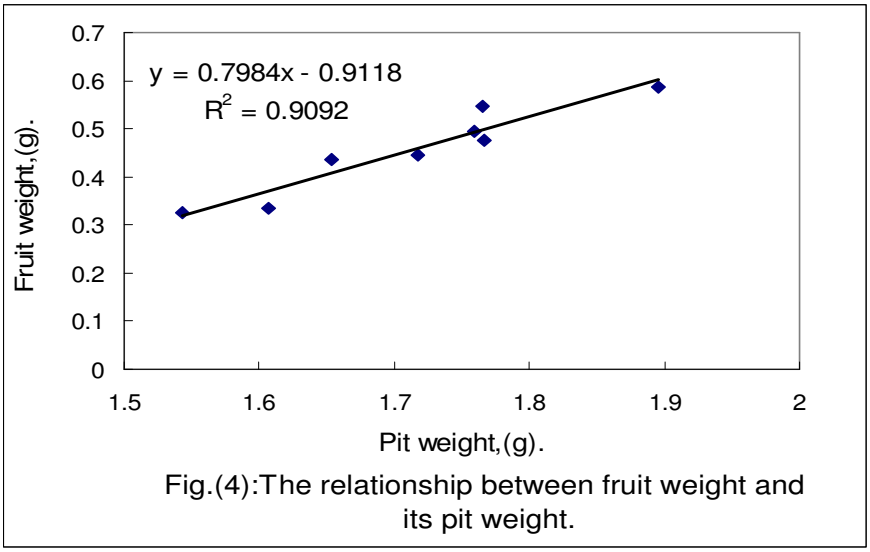


Fig.(4):The relationship between fruit weight and its pit weight.

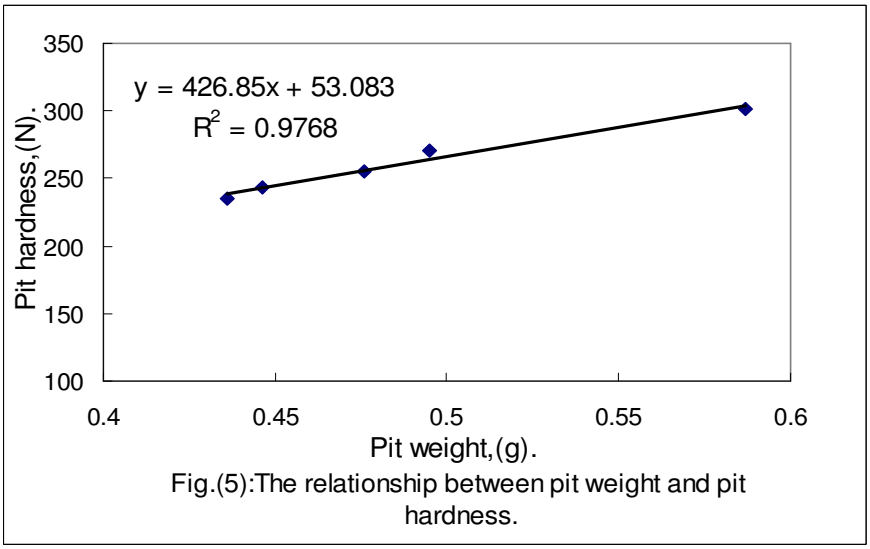


Fig.(5):The relationship between pit weight and pit hardness.

CONCLOSION

This study was carried out to investigate some physical and mechanical properties of olive fruits commonly cultivated in Libyan Arab, (in Ryayna- Khrian). Studied physical and mechanical properties can help in chossing and design suitable machine to extraction oil from olive fruits. The properties studied are: main dimension: fruit length, diameter, weight, volume, shape index, pit weight pit length, pit diameter, flesh thickness, shape index, angle of repose, flesh hardness and pit hardness.

The study concluded to:

1- The relationship between fruit length, diameter and weight and their corresponding pits:

- The relationship between fruit length, and its pit length had been given as follow:

$y = 0.6519 x + 10.348$ and $R^2 = 0.831$

- The relationship between fruit diameter and its pit diameter given by equation:

$y = 1.3807 x + 2.7243$ and $R^2 = 0.9733$

- The relationship between fruit weight and its pit weight give function as follow:

$y = 0.7984 x - 0.9118$ and $R^2 = 0.9092$

2- The mechanical properties (repose angle, flesh hardness, and pit hardness) for the studied were measured as:

- Average repose angle was 27.7°.
- Average flesh hardness was 2.392 kg/cm^2
- Average pit hardness was 265.843 N.

3- The relationship between fruit pit weight and its pit hardness give as follow:

$y = 426.85x + 53.083$ and $R^2 = 0.9768$.

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الملخص العربى

الخواص الطبيعية والميكانيكية لثمرة الزيتون بـ (الرياينة – غريان- العربية الليبية)

د/ إبراهيم سيف أحمد*

يعتبر الزيتون من المحاصيل الاقتصادية والاستراتيجية الهامة التى تتميز بها الجماهيرية العظمى ، يعتبر المحصول الاول بها ، ويوجد بها أكثر من 1.5 مليون شجرة (علاء – الجيلى 1989). ومن خلال الدراسة (حيث تم عمل استبيان) وجد أن هناك فى منطقة الرياينة بغريان بمقاطعة الجبل الغربى بالجماهيرية نسبة كبيرة من ثمار الزيتون توجد عند المزارعين بين مواسم الحصاد ، لايمكن استغلالها فى العصر لإنتاج زيت الزيتون إلا فى الموسم التالى لعدم توفر المعاصر، لذا طرأت فكرة تصميم ميكنة صغيرة لعصر الزيت فى المنزل للمزارع وكان لابد من دراسة الخواص الطبيعية والميكانيكية لثمرة الزيتون بهذه المنطقة كمثال يحتذى به ، ولهذا تم دراسة هذه الخواص سواء كانت :

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- طبيعية (حجم الثمرة – شكل الثمرة – سمك شحم لب الثمرة – وزن الثمرة – وزن نواة الثمرة – أبعاد الثمرة .....)

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- ميكانيكية (زاوية مكوث الثمار – قوة صلابة الثمرة- قوة وصلابة نواه الثمرة .....)

<u>وقد أوضحت النتائج مايلى:-</u>

- أن هناك تناسب طردى بين خصائص الثمرة والبذرة (الطول – القطر – الوزن)
- وجد أن هناك علاقة بين طول الثمرة وطول البذرة يمكن ايجادها من العلاقة $Y = 0.6519x + 10.348$ بقيمة ارتباط $R^2 = 0.831$.
- كما وجد أن هناك علاقة بين قطر الثمرة وقطر البذرة يمكن ايجادها بالعلاقة $Y = 1.4595 + 2.1905$ بإرتباط $R^2 = 0.9727$.
- كما وجد أن هناك علاقة بين وزن الثمرة ووزن البذرة يمكن ايجادها بالعلاقة $Y = 0.7984x - 0.9118$ وارتباط $R^2 = 0.9092$.
- ووجد أيضاً أن متوسط زاوية المكوث الثمار الزيتون $27.7°$ وهذا يستفاد به فى حالة التكويم لثمار الزيتون لمعرفة المساحة المطلوبة.
- كما تم معرفة متوسط قوة صلابة الثمرة كاملة = 2.392 كجم/سم^2 وكذلك قوة صلابة بذرة الزيتون 265.843 N ، وهذا يفيد فى معرفة قدرة الموتور اللازم لتصميم آلة العصر.
- وقد وجد أيضاً أنه كلما زاد وزن بذرة الثمرة كلما زادت القوة اللازمة لكسر الثمرة كاملة أثناء استخراج الزيت.

وذلك بالعلاقة $Y = 426.85\ C + 53.083$ ، $R^2 = 0.9768$