# FACTORS AFFECTING CRUSHING AND EXTRACTING OF OLIVE OIL

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***Abstract***

A laboratory oil extraction line was designed and fabricated to determine the operational parameters affecting crushing and oil extracting of different olive varieties grown in Arish, Sahrawy (Cairo-Alexandria road) and Siwa areas. For crushing experiments, three different hammers shapes (flat, triangular and wing), three different screen holes diameters (4, 5 and 6 mm) and four different hammer speeds (1500, 2000, 2500, and 3000 rpm) were examined to determine the percentage of particles diameters of the olive paste at the range of 2.25-4 mm as an optimum size for oil extraction from olive paste. Hydraulic press extraction of oil for different crushed samples was also conducted at a pressure of 85 bar and remaining time of 60 minutes to determine the relationship between the percentage of particle diameters at the range of 2.25-4 mm and the percentage of remaining oil in the olive paste. The results show that for all studied varieties, the highest percentage of olive paste particles diameters at the range of 2.25-4 mm was obtained for the triangular hammer shape at hammer speed ranged from 2000 to 2500 for the varieties of Sahrawy area. At the same time, the proper screen holes diameter ranged from 4 to 5 mm. The oil extraction experiments showed that for all studied varieties, the lowest percentages of remaining oil in the olive pastes were obtained for the samples of particle diameters at the range of 2.25-4 mm.

## INTRODUCTION

Olive oil is the most ancient edible oil and is still one of the most important constituents of the Mediterranean diet. At the recent time it is also produced and consumed in many non-Mediterranean diet. In terms of production, Europe comes in the first place with 79.6% followed by Africa (11%), Asia (8.6%) and South America (0.8%). IOOC (1996).

There is strong evidence that a Mediterranean-style diet, in which olive oil is the principle source of fat, contribute to the prevention of cardiovascular risk factors, such as hypertension, diabetes and obesity, (European commission, 1997).

Di Gio Vacchino, (1991) mentioned that olive oil in the olive fruits is present as tiny drops of oil in the vacuoles of the mesocarp cells and too difficult to separate these tiny drops directly from olive fruits. Therefore, crushing should be carried out to help in separation of oil. After crushing of olives, mixing process is executed in order to prepare the obtained paste for the sub-sequent separation of the liquid phases from the solid phase with various extraction systems.

Types of size reduction machines or grinding machines included stone mill, metal toothed grinder and hammer mill. The stone mill is difficult to clean and green olives will prolong grinding time. The metal toothed grinder may form emulsion that impedes oil-water separation, the oil paste may heat up and oil can have stronger spicy taste. While, the hammer mill can produce more fine and uniform product from a wider range of materials than other types of grinders (OOS 2000, Owies 2003).

Deublin (1988), mentioned that after washing, olive fruits should be transported to a grinding device. The olives are grounded up together with their stones and mixed into a homogeneous pulp. This process is carried out either in stone mills (discontinuously) or in metal mills (continuously). In continuous plants, hammer mills are used where the olives are ground up and beaten at the same time.

Owies, (2003) stated that the single-stage grinders with free swinging beaters are particularly popular among millers as an all-purpose grinder. At this type of grinders, the beaters are pivoted to a revolving shaft in such a way that they are free to swing through an arc that is limited to their plan of rotation. They are, therefore, commonly referred to as "swing" hammer mill.

Brenuan *et. al.,* (1990) mentioned that, the hammer mill swinging heads are attached to a rotor which rotates at high speed inside a hardened casing. The material is crushed and pulverized between the hammers and the casing, and remains in the mill until it is fine enough to pass through a screen which forms the bottom of impact forces. Although, under choke feeding conditions attrition forces can also play a part in the size reduction.

The present work aims to study and determine the engineering parameters affecting crushing and extracting oil from different olive varieties. The obtained data may be used for designing and developing full-scale olive oil crushing and extracting machine.

## MATERIALS AND TEST PROCEDURE

A laboratory olive oil extracting line was designed and fabricated at local workshop in Damnhour city Behera governorate (Fig.1). The fabricated line was used for conducting a series of experiments to determine the operational parameters affecting crushing and oil extracting for different olives varieties grown in Arish, sahrawy road and Siwa areas.

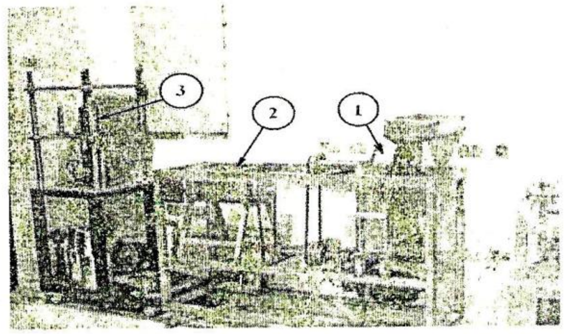


Fig 1. A general view of the laboratory oil extraction line

1- Crushing unit 2- Mixing unit 3- Hydraulic press unit

**Experimental set-up**

Detailed structure of different units of the laboratory extraction line included crushing; mixing and pressing units are described as follow:

**Crushing and mixing units**

Crushing and mixing units were assembled on one frame to get on the power transmission from one engine. The frame of the two units was constructed from iron steel of square shape (4 × 4 inches) with dimensions of 108 × 51.5 × 105 cm for length, width and height. Four wheels were assembled on the frame base to carry and move the frame during transportation. The crushing unit consists of the following parts:

**Fruits feeding box**

The fruit feeding box was manufactured from 3 mm thick stainless steel sheets. The dimensions of the box were (30 x 20 x 25cm) for length, width and height. The upper part of the box has a rectangular cross section while the bottom part takes a semicircular shape to accommodate a screw conveyor with 2cm clearance for smooth transfer of the fruits. The sides of the box sloped at an angle of 35° to keep continuous flow of fruits.

**Hammers and screens**

The hammers were constructed of an edible grade stainless steel and assembled on a steel shaft revolving inside a perforated metal jacket. To study the effects of hammer shapes on crushing process three different shapes of hammers (flat, triangle and wing) were tested. The crusher screen was made of a perforated stainless steel sheet convolutes to form a circle shape rounded the hammers revolving zone. The tested screens were percolated with three different hole diameters of (3, 4 and 5mm).

**Olive paste mixture**

The olive paste mixture consists of a main body with two sides made of 3mm thick stainless steel sheet convoluted in a semicircle shape and welded to form a tank for accommodating the crushed olive. A double blade mixing auger made of solid stainless steel was installed at the bottom of the mixture tank in order to coalescing the small oil drops into larger drops, thereby facilitating the separation of liquid phase.

It should be mentioned here that, both crushing and mixing units were powered by a 0.3 hp electric motor with gearbox to get different rotational speeds. The power was transmitted from the source of power to all parts of the unit using pulleys and V-belts. Figure (2) presents a cut drawing for both crushing and mixing units.

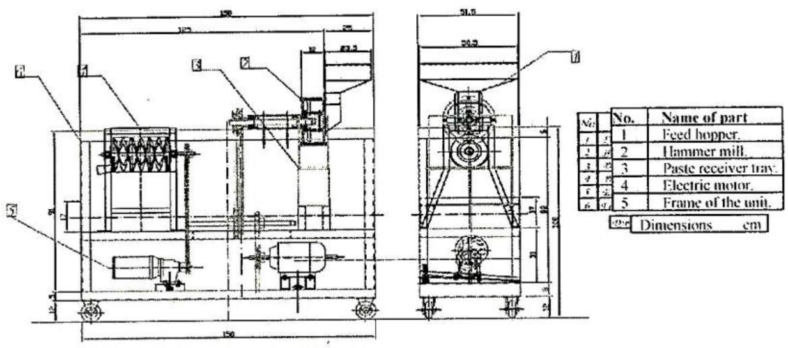


Fig 2. Schematic diagram for crushing and mixing units.

**Hydraulic press unit**

The frame of the hydraulic press unit consists of an iron base with dimensions of 90 x 51.5 x 20 cm welded to a vertical frame with dimensions of 72 x 51.5 x 51.5 cm made of an angle iron 7 x 4cm. A 32 tons manual hydraulic piston with pressure gauge was carried out at the center of 3cm thick horizontal iron plate welded with the top surface of the vertical frame. For smooth movement of the pressing piston, four iron steel shafts (3.5cm diameter and 90cm high) were vertically welded at the horizontal iron plate and attached with two pressing plates made of steel iron 2.5cm thick. The lower pressing plate was rested on the surface of the hydraulic piston and allowed to slide up and down through the four vertical shafts using a hydraulic press arm. While the upper plate was fixed at the top of the four shafts using a set of nuts and washers.

A stainless steel oil receiving tray and a perforated stainless steel cylinder filled with the mats of the olive paste were rested over the surface of the lower sliding plate and allowed to move up facing a pressing flange welded to the upper fixed plate until reaching the required pressure for the extraction process. The extracted oil discharged through a valve of 2.5cm diameter welded at the side of the oil receiving tray. Figs (3) and (4) present a photo and a cut drawing for the hydraulic press unit.

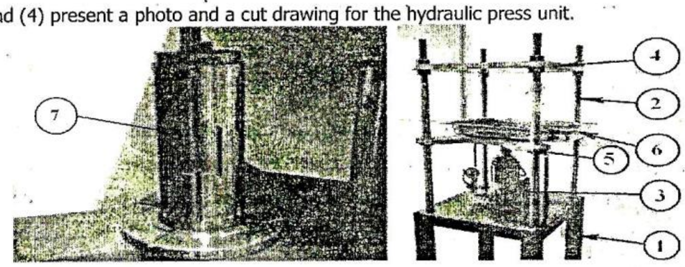


Fig 3. Over view of the hydraulic press unit

1- Iron frame 2- vertical shafts 3- Hydraulic press unit 4- Upper fixed plate
5- Lower sliding plate 6- Stainless steel tray 7- Perforated cylinder

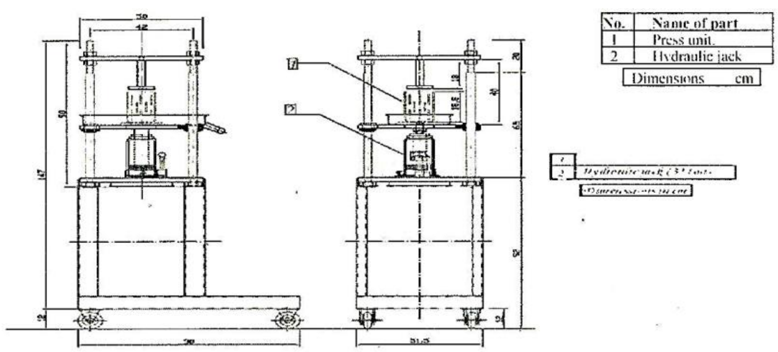


Fig 4. Schematic diagram for the hydraulic press unit

**Olive varieties**

The studied varieties of olive fruits were divided into two different categories (oil producing and dual purpose varieties) representing different olive producing areas, as shown in table (1).

Table 1. Oil producing and dual purpose varieties representing different olive producing areas

| Producing area of olives | Oil producing varieties | Dual purpose varieties |
|---|---|---|
| Arish | Coratina – Kronaki | Picual |
| Cairo – Alexandria Sahrawy road | Coratina – Kronaki – Arab-queen | Picual |
| Siwa | Maraki | Watiken |

The collected samples of each variety were loaded inside a 30kg vented plastic boxes and stored in commercial refrigerator at 5°C. Prior to the experimental work the required amount of olive fruits was taken out from the refrigerator and left to attain room temperature.

**Experimental treatments**

The main objective of the experimental work was to determine the percentage of particles diameters of olive paste at the range of (2 to 4 mm) as an optimum size for the olive oil extraction. Pressure/unit area; thickness of olive paste and pressing time were fixed all over the experimental runs while, the experimental treatments included:

Three different shapes of hammers (flat, triangular and wing), three different screen holes diameters (4, 5 and 6 mm) and four different hammer mill speeds (1500, 2000, 2500 and 3000 rpm). Figure (5) presents a photo for different studied hammer shapes.

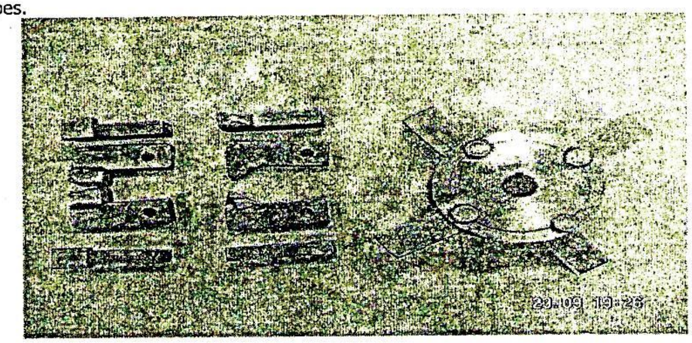


Fig 5. Photo for different hammer shapes used for the experimental work

**Test procedure and measurements**

**Crushing experiments**

For testing the effect of different hammer shapes, hammer speeds and screen holes diameter, the olive samples of each variety were divided into three groups each one having 36 samples.

For each experimental run two kg of olive fruits were poured into the feeding box of the crushing unit then, the machine was operated up to the full crushing of the sample. The crushed olive paste was collected in plastic bag and weighted using a digital electric balance (0.1g accuracy) and then divided into two sub samples. The first one used for determining the moisture content using the oven method at 105 °C for 24 h.(Owies, 2003) and the second was used for oil extraction process. The samples used for determining the moisture content were manually crushed and sieved by specific sieves of (2.25 – 4mm) holes diameter to classify the olive paste into three different categories (< 2.55mm, from 2.25 – 4mm and > 4mm). The percentage of each category was calculated by dividing the weight of each category by the total weight of dried sample.

**Oil extracting experiments**

The extracting process was conducted at fixing pressure of 85 bar and remaining time of 60 minutes. For each studied variety, 180g of olive past was divided and dispersed inside three cotton mats. The mats were placed inside the perforated stainless steel cylinder and the hydraulic press was operated to increase the pressure load gradually over the mat surface for separating the liquid phase from the solid.

The resulted solid olive past was mixed and a sample of about 30g was dried inside the oven at 105°C for 24 hours. To determine the remaining percentage of oil, 5g of the dried sample was rolled inside a filteration paper (12.8 Watman) and installed inside a soxhlet unit using petroleum ether at 40 - 60°C for 16 complete circles and then it was allowed to dry in an electric oven at 70°C for two hours in order to completely evaporate the remaining solvent from the sample. The obtained samples were again weighed to determine the percentage of remaining oil in each sample which used for calculating the percentage of remaining oil in the original sample using the following equation:

% of $O_r = (O_r / O_t) \times 100$ ...................... (1)

Where:

$O_r$ = Weight of remaining oil, g.

$O_t$ = Weight of total oil in sample, g.

## RESULTS AND DISCUSSION

The engineering parameters affecting the performance of the crushing unit such as hammer velocity, hammer shape and screen hole diameter were studied for different oil producing and dual purpose olive varieties. It should be mentioned that, based on the previous reviews, the optimum particles diameter of olive past for olive oil extraction was ranged from (2.25 – 4 mm), (Owies, 2003). Therefore, the interactions between the studied parameters were analyzed principally according to the variations in particle size of olive paste in the above mentioned range. On the same time, to insure the results obtained from the crushing experiments, hydraulic extraction of oil under a constant pressure of 85 bar and pressing time of 60 minutes was conducted to determine the lowest remaining oil percentage in the olive paste for different treatments. The obtained results could be presented as follows:

**A. Crushing experiments**

**1- Olive varieties of Arish area**

Figure (6) shows the effect of different hammer shapes and speeds on the percentage of particle size at the range of (2.25 – 4 mm). The presented figures were only for the proper screen holes diameter as obtained from the analysis of results for each studied variety.

For the oil producing varieties of Arish area, the highest percentage of particle diameter at the range of (2.25–4 mm) was obtained for variety Coratina Arish (62.57%) using the triangle hammer at 3000 rpm and screen holes diameter of 4 mm. However, for variety Cronaki Arish the highest percentage of particles diameter at the same range (56.71%) was obtained using the same hammer shape at 2000 rpm and screen holes diameter of 4 mm.

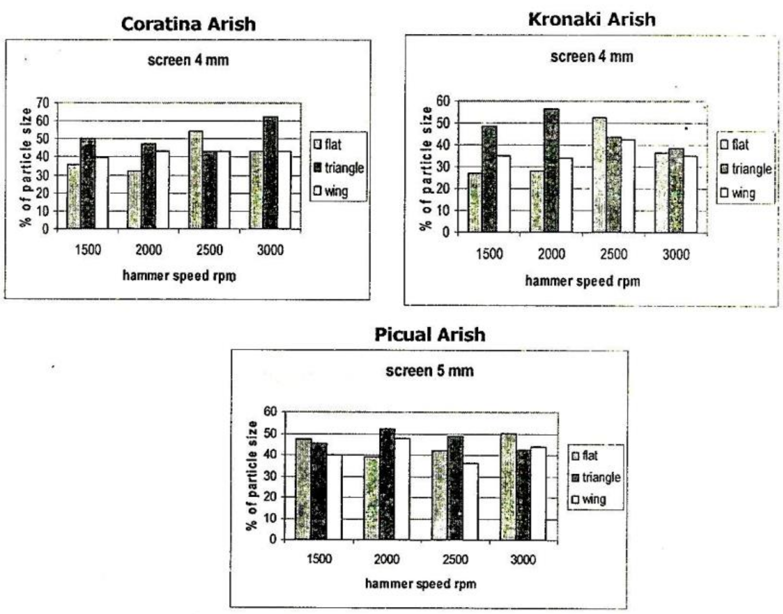


Fig 6. Effect of hammer speed and shape on the percentage of particle size at the range of 2.25 – 4 mm for varieties of Arish area.

Meanwhile, for the dual purpose variety Picual Arish, the highest percentage of olive paste particles diameter at the range of (2.25-4 mm) was found to be (51.99%) and it has obtained using the triangle hammer at 2000 rpm and screen holes diameter of 5 mm.

This means that, for different varieties of Arish area, the highest percentages of olive past particles diameter at the range of (2.25 – 4 mm) were obtained using the triangle hammer shape at speed ranged from 2000 – 3000 rpm and screen holes diameter ranged from 4 – 5 mm.

**2- Olive varieties of Sahrawy area**

Figure (7) illustrates the variation in olive past particles diameters at the range of (2.25 – 4 mm) for varieties of Sahrawy area. For the oil producing variety Coratina Sahrawy, the hieghest percentage of particle size (60.94%) was obtained using the triangle hammer at 2500 rpm and screen holes diameter of 5 mm.

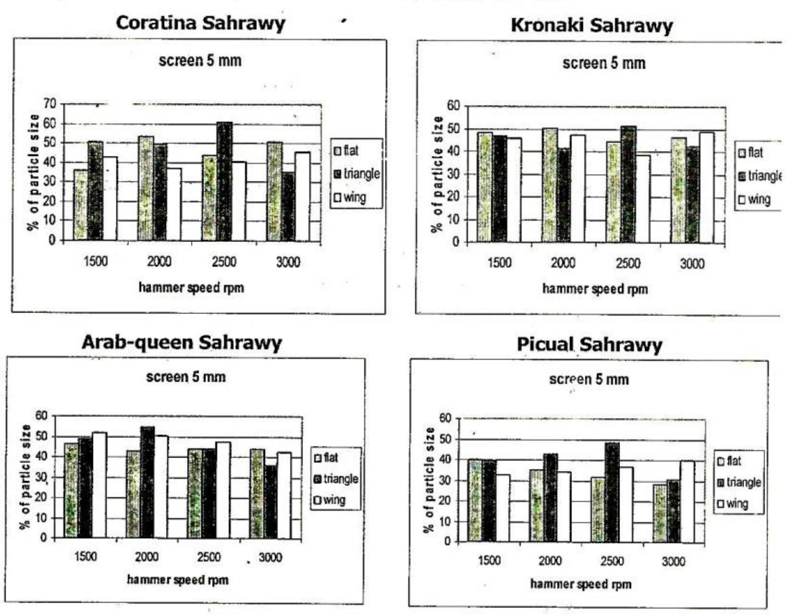


Fig. 7. Effect of Hammer speed and shape on the percentage of particles diameter in the range of (2.25 – 4mm) for varieties of Sahrawy area.

On the same time, the highest percentage of particle size at the same range (51.31%) was obtained for variety Kronaki Sahrawy using the triangle hammer at 2500 rpm and a screen holes diameter of 5 mm and it was obtained for variety Arab queen, (54.82%) using the triangle hammer at 2000 rpm and screen holes diameter of 5 mm.

Fig (7) also shows that, the highest percentage of particle size (48.34%) at the range of (2.25 – 4 mm) was obtained using the triangle hammer at 2500 rpm and screen holes diameter of 5 mm for the dual purpose variety (Picual). This value was very close with the value (48.12%) which obtained using the same hammer shape at 2000 rpm and screen holes diameter of 4 mm.

In general, it can be said that, for varieties of Sahrawy area the highest percentages of particles diameter at the range of (2.25 – 4 mm) were obtained using the triangle hammer at a speed ranged from 2000 – 2500 rpm and screen holes diameter of 4 – 5 mm.

**Olive varieties of Siwa area**

Figure (8) presents the variation in particles diameter at the range of (2.25 – 4 mm) for different oil producing and dual purpose varieties of Siwa area.

For the oil producing variety Maraki Siwa, the highest percentage of particles diameter (66.03%) at the range 0f (2.25 – 4 mm) obtained using the triangle hammer speed of 3000 rpm and screen hole diameter of 4 mm.

While, for the dual purpose variety Watiken Siwa, the highest percentage of particles diameter (49.11%) was obtained using the triangle hammer at 2000 rpm and screen holes diameter of 4 mm.

This means that, for varieties of Siwa area, the highest percentages of particle size at the range of (2.25 – 4 mm) were obtained using the triangle hammer at speed ranged from 2000 – 3000 rpm and screen holes diameter of 4 mm.

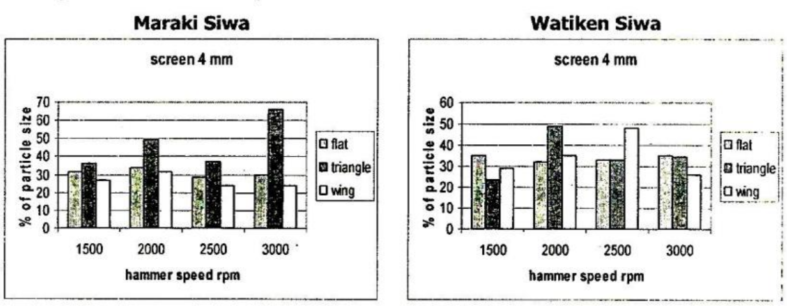


Fig. 8. Effect of Hammer speed and shape on the percentage of particle size in the range of (2.25 – 4mm) for varieties of Siwa area.

**Extraction experiments**

As presented in table (2) through (4), the results of oil extraction experiments show that, after the pressing process of olive pastes of different studied varieties, the lowest percentages of remaining oil were very corresponding with the highest percentages of particle diameters at the range of (2.25 – 4 mm).

For varieties of Arish area, table (2) shows that, the lowest percentages of remaining oil (20.72, 22.46 and 22.05 %) were corresponding with the highest percentages of particles diameter at the range of (2.25 – 4 mm) which equal to (62.5, 56.71 and 51.99%) for varieties Coratina, Picual, and Kronaki, respectively.

Also, for varieties of Sahrawy area, table (3) shows that, the lowest percentages of remaining oil for oil producing varieties Coratina, Kronaki and Arab queen were (22.31, 13.32 and 12.12%) which were in corresponding with the highest percentages of particles diameter at the range of (2.25 to 4 mm) 60.94, 51.31 and 54.82% respectively. Similarly, for dual purpose variety (Picual), the lowest percentages of remaining oil was (16.18 %) corresponding with the highest percentages of particle diameters at the same range which equal to 48.34 %.

For Siwa area, table (4) shows that, varieties Maraki and Watiken Siwa, recorded the lowest percentages of remaining oil (16.21 and 17.23%) at the highest percentages of particles diameter at the range of (2.25 to 4 mm) which were equal to 66.03 and 49.11% respectively.

Table 2. percent of remaining oil for different studied varieties of Arish area

| Olive varieties | Hammer Speed, rpm | Screen Size: 4 mm | | | Screen Size: 5 mm | | | Screen Size: 6 mm | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Flat | Trian. | Wing | Flat | Trian. | Wing | Flat | Trian. | Wing |
| Coratina Arish | 1500 | 29.24 | 44.16 | 24.8 | 33.41 | 42.4 | 21.56 | 52.56 | 42.63 | 53.9 |
| | 2000 | 30.44 | 40.24 | 29.47 | 35.61 | 30.51 | 29.81 | 56.81 | 35.27 | 52.58 |
| | 2500 | 30.51 | 29.88 | 42.74 | 36.46 | 34.07 | 51.97 | 46.4 | 51.24 | 48.46 |
| | 3000 | 37.5 | 20.72 | 36.89 | 38.46 | 35.52 | 49.62 | 45.39 | 49.24 | 48.79 |
| Kronaki Arish | 1500 | 28.57 | 22.69 | 19.19 | 29.36 | 22.96 | 18.23 | 35.16 | 18.23 | 34.02 |
| | 2000 | 32.37 | 22.05 | 24.28 | 24.56 | 24.28 | 25.85 | 31.79 | 20.01 | 30.61 |
| | 2500 | 29.02 | 17.12 | 33.23 | 25.34 | 27.39 | 34.37 | 26.13 | 23.34 | 37.11 |
| | 3000 | 27.73 | 28.88 | 31.95 | 26.99 | 19.97 | 33.67 | 21.73 | 31.37 | 31.37 |
| Picual Arish | 1500 | 24.8 | 24.11 | 29.81 | 25.62 | 36.65 | 32.23 | 43.44 | 37.31 | 34.97 |
| | 2000 | 24.52 | 40.47 | 28.58 | 28.58 | 22.46 | 45.01 | 33.19 | 32.37 | 39.12 |
| | 2500 | 23.52 | 47.3 | 38.64 | 27.79 | 29.67 | 55.16 | 40.76 | 62.76 | 36.18 |
| | 3000 | 24.8 | 51.56 | 27.66 | 30.31 | 25.27 | 61.3 | 35.9 | 50.87 | 30.68 |

Table 3. percent of remaining oil for different studied varieties of Sahrawy area

| Olive varieties | Hammer Speed, rpm | Screen Size: 4 mm | | | Screen Size: 5 mm | | | Screen Size: 6 mm | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Flat | Trian. | Wing | Flat | Trian. | Wing | Flat | Trian. | Wing |
| Coratina Sahrawy | 1500 | 29.01 | 37.36 | 24.43 | 30.1 | 35.88 | 26.34 | 40.78 | 40.01 | 36.57 |
| | 2000 | 27.02 | 24.5 | 26.96 | 29.12 | 24.32 | 34.38 | 34.73 | 39.65 | 39.03 |
| | 2500 | 52.22 | 26.8 | 24.68 | 29.96 | 22.31 | 34.41 | 31.28 | 38.4 | 38.07 |
| | 3000 | 32.39 | 25.46 | 24.74 | 30.74 | 42.23 | 30.27 | 32.81 | 39.37 | 39.64 |
| Kronaki Sahrawy | 1500 | 22.39 | 31.67 | 14.78 | 23.59 | 20.16 | 20.41 | 30.19 | 19.8 | 27.05 |
| | 2000 | 22.67 | 37.68 | 13.68 | 25.23 | 31.22 | 17.43 | 21.32 | 24.66 | 24.9 |
| | 2500 | 19.51 | 27.54 | 24.84 | 19.8 | 13.32 | 29.07 | 36.5 | 38.48 | 30.5 |
| | 3000 | 23.65 | 28.84 | 20.94 | 21.45 | 18.67 | 25.26 | 24.39 | 32.35 | 29.2 |
| Arabqueen | 1500 | 18.52 | 30.28 | 15.39 | 17.14 | 25.5 | 25 | 34.17 | 28.1 | 28.6 |
| | 2000 | 18.15 | 27.38 | 12.12 | 28.17 | 12.12 | 19.05 | 27.18 | 24.31 | 32.16 |
| | 2500 | 20.56 | 18.42 | 22.85 | 23.01 | 29.26 | 31.54 | 25.5 | 28.17 | 29.92 |
| | 3000 | 20.38 | 25.06 | 23.46 | 25.28 | 21.63 | 23.8 | 23.69 | 25.1 | 30.13 |
| Picual Sahrawy | 1500 | 18.7 | 23.24 | 16.67 | 25.87 | 24.53 | 20.58 | 26.62 | 19.18 | 29.1 |
| | 2000 | 23.6 | 20.64 | 15.07 | 23.46 | 30.49 | 20.17 | 26.91 | 21.97 | 33.83 |
| | 2500 | 17.91 | 21.12 | 29.49 | 18.16 | 16.18 | 36.32 | 29.49 | 28.57 | 28.8 |
| | 3000 | 15.53 | 15 | 20.69 | 22.2 | 23.02 | 37.05 | 30.75 | 27.89 | 32.36 |

Table 4. percent of remaining oil for different studied varieties of Siwa area

| Olive varieties | Hammer Speed, rpm | Screen Size: 4 mm | | | Screen Size: 5 mm | | | Screen Size: 6 mm | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Flat | Trian. | Wing | Flat | Trian. | Wing | Flat | Trian. | Wing |
| Maraki Siwa | 1500 | 26.1 | 25.59 | 16.14 | 20.11 | 16.06 | 15.49 | 18.62 | 20.4 | 18.89 |
| | 2000 | 16.79 | 25.41 | 18.7 | 17.52 | 16.02 | 20.25 | 19.21 | 18.89 | 19.94 |
| | 2500 | 22.03 | 17.32 | 21.98 | 22.14 | 16.41 | 20.97 | 17.87 | 19.21 | 20.63 |
| | 3000 | 18.57 | 16.21 | 22.44 | 21.4 | 16.75 | 21.63 | 26.73 | 16.72 | 21.11 |
| Watiken Siwa | 1500 | 19.4 | 55.48 | 16.55 | 19.18 | 25.92 | 29.07 | 27.88 | 18.24 | 28.7 |
| | 2000 | 22.51 | 17.23 | 15.95 | 48.78 | 31.14 | 18.53 | 28.63 | 17.15 | 36.6 |
| | 2500 | 25.75 | 40.32 | 26.54 | 26.84 | 43.64 | 36.09 | 40.42 | 25.99 | 40.32 |
| | 3000 | 32.94 | 28.77 | 22.97 | 30.67 | 28.84 | 31.76 | 18.73 | 29.38 | 35.45 |

## CONCLUSION

1- The highest percentage of olive paste particle diameters at the range of 2.25-4 mm was obtained using the triangular hammer shape for all studied varieties.

2- The proper screen holes diameters ranged from 4 to 5 mm for all studied varieties.

3- The proper hammer speeds varied from 2000 to 3000 rpm for varieties of Arish and Siwa areas and from 2000 to 2500 for varieties of Sahrawy area.

4- The lowest remaining percentages of oil in the olive paste of different studied varieties were very close to the percentage of particles diameter at the range of 2.25-4 mm for all studied varieties.

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# العوامل المؤثرة علي عمليتي الطحن والاستخلاص لزيت الزيتون

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تم تصميم وتصنيع خط معملي لاستخلاص زيت الزيتون يشمل وحده للطحن والخلط الميكانيكي ووحدة للإستخلاص بنظام الكبس الهيدروليكي لاستخدامها في اجراء مجموعة من التجارب المعملية لدراسة العوامل المؤثرة علي عمليتي الطحن والاستخلاص لزيت الزيتون.

وقد اجريت التجارب المعملية علي اصناف الزيتون المنتجة للزيت والاصناف ثنائية الغرض والتي تمثل مناطق زراعة الزيتون في العريش وطريق مصر-الإسكندرية الصحراوي وواحة سيوه.

وشملت التجارب الخاصة بعملية الطحن دراسة تأثير ثلاث اشكال لشواكيش الطحن (المستوي، المثلث، المجنح)؛ ثلاث اقطار لشبكة وحدة الطحن (٤، ٥، ٦مم) واربع سرعات لشواكيش الطحن (١٥٠٠، ٢٠٠٠، ٢٥٠٠، ٣٠٠٠ لفة /الدقيقة) علي نسبة اقطار الحبيبات في العجينة في المدى من (٢,٢٥ -٤ مم) والتي تعتبر النسبة المثلي لزيادة كفاءة عملية الاستخلاص لزيت الزيتون.

بينما شملت التجارب الخاصة بعملية الاستخلاص دراسة العلاقة بين زيادة نسبة الحبيبات في المدى من (٢,٢٥ – ٤ مم) في العجينة الناتجة عن عمليتي الجرش والخلط وكمية الزيت المتبقي في العينة بعد عملية الكبس عند ثبات كل من ضغط الكبس عند ٨٥ بار وزمن الكبس عند ٦٠ دقيقة.

أظهرت النتائج ان الشاكوش ذى الشكل المثلث قد اعطى اعلي نسبه للحبيبات في المدي من (٢,٢٥ -٤ مم) وذلك عند سرعة تراوحت بين (٢٠٠٠- ٣٠٠٠ لفة/الدقيقة) وقطر فتحات شبكة الطحن بين (٤ – ٥ مم) وذلك لجميع الأصناف موضوع الدراسة.

من ناحية اخري اظهرت نتائج التجارب الخاصة بعملية الاستخلاص تطابق زيادة نسبة الحبيبات في العجينة في المدي من (٢,٢٥ – ٤ مم) مع انخفاض نسبة الزيت المتبقي بها بعد عملية الاستخلاص أو بصورة أخرى زيادة كمية الزيت المستخلص بزيادة تلك النسبة.