

## **REEL-SEPARATOR DEVELOPMENT FOR OLIVE FRUITS GRADING**

**MAGDA M. A. MOSA \***

### **1-ABSTRACT**

It will be helpful for farmers and market dealers to determine their prices by more accurate ways accepted to the consumer. So grading plays an active role in the marketing attractiveness.

This research was intended to develop a mobile grading machine (reel-separator type) for grading the olive crops. Three machine parameters each of four levels were studied such as fruit feeding rates (350, 400, 450 and 500 kg/h), speed of reel sizer 20, 35, 50, and 65 rpm (0.419, 0.733, 1.047 and 1.361 m/s), and two types of mesh shape (square cells and parallel bars cells) on the machine grading capacity (kg/h), and efficiency (%), using two major olive varieties (picual and manzanillo). The mechanical damaged percentages of olives fruits were also determined.

Results showed that this machine is quite successful for grading olives crop. The best result was obtained at 400 kg/h fruit feeding rate, and 35 rpm reel speed using parallel bars cell shape. At these levels the maximum grading efficiency of 94.6 and 93.6 % were obtained with machine grading capacity of 328 and 315.7 kg/h for picual and manzanillo varieties, respectively. At the same feeding rate 400kg/h and by using square cells at rotating speed of the sieves of 50 rpm, the maximum grading efficiencies of 92.3 and 91.6 % which was coincided with machine grading capacity of 333 and 317 kg/h were obtained for picual and manzanillo varieties, respectively. The mechanical damage for the two olive varieties under study increased when grading process was carried by square cells compared with parallel bars cells. Grading picual and manzanillo olive varieties by the proposed machine at optimum grading conditions, produced olives defects (mechanical damaged) lower than the limits permitted for the market.

### **2- INTRODUCTION**

Olive crop is one of the most important crops in Mediterranean basin countries (Spain, Italy, Greece, Portugal, Morocco, Tunis, Palestine, Syria and Egypt). Concerning Egypt, olive cultivation succeeded in new-reclaimed area due to its limit need for irrigation water and it's growing in difficult circumstances.

The total cultivated area increased sharply through 1988-1994, from 22000 feddans in 1988 to 67523 feddans in 1994 and became 118697 feddans in 2003. The fruitful area developed from 14909 feddans in 1988 to 78555 feddans in 2003.

---

\*Rresearch, Agric. Eng. Res. Inst. (AEnRI), Giza.

The total production from the fruitful area was 30609 ton in 1988 and became 204722 ton in 2003. This increment in total production is not only due to the increment of fruitful area but also the production per feddan, it was 2.05 ton/feddan in 1988 and increased to 3.8 ton/fed in 2003 (**Ministry of Agricultural, 2004**).

The main purpose of grading is to segregate produce into different grades for canning and other converting process. Grading, according to well-defined national and international standards, is essential for modern marketing as pricing is tied to product quality.

Numerous researchers have designed and fabricated grading machines for grading various fruits and vegetables by shape, size, and or by weight.

**Ryall and Lipton (1983), and Michael et al. (1983)** reported that machines that grade by diameter tend to have higher throughputs, to be rather less expensive for a given throughput, than those, which grade by weight. They added that sizing operations involve passing the fruits over diverging belts having holes, wire mesh belting, drop roll sizes, or volumetric size. The belts with holes and the wire mesh sizes separate the fruit into two sizes while the others provide up to five or six sizes by gradual widening of the sizing members that support the fruit.

**Peleg (1985)** mentioned that placing several machines with consecutively larger perforation in the packing house line affects the necessary sizing of the products into several size groups. The sizer conveyor belt is usually made rubber, plastic or steel links. The sizing parameter is usually determined by the shape of the fruit and the perforations. When the perforations are circular, sizing is according to circular projection area if perfectly spherical fruits are assumed. For spheroidally shaped fruits, sizing is according to diameter or length or something in between. This is so, since the fruit will not fall through unless its largest projection dimension to the hole (diameter of inscribing circle) is smaller than the hole in the belt. In spherical fruits, however, there will be preference of the fruit diameter lining up with the hole in the belt, because the center of gravity of the fruit will-tend to hole as low as possible.

**Balls (1986)** showed that the size grade of an item might be determined by one, two or three linear dimensions or its mass (weight). Single dimension is determined by the minimum distance apart of a pair of parallel bars between which the produce can pass. Two dimensions are determined by the distance between the sides of a square hole or diameter of a circular hole, through which the produce can pass. The third dimension will often be taken in addition to a square or circular hole standard, by a separate measurement using parallel bar gabs.

**Ladaniya and Dass (1994)** indicated that manual size grading was still more accurate, although mechanical grading operated at a rate of 1 ton

of fruit per hour. Manually processed fruits showed higher decay as a result of bruising.

**Amin (1994)** developed and tested a grading machine consisting of rotating cylinder and perforated concave to grade potato, onion and orange crops. The machine was tested in grading potato crop. The obtained results showed that crop parameters such as (tubers dimensions and mass) and machine parameters such as (cell area and shape, drum speed, slope of drum axle and drum length) have a significant effect on grading efficiency. The capacities of machine at optimum drum speed of 25 rpm and slop of zero degree was 1.2 t/h with tuber damage of 0.23%.

**Yang and Liu (1997)** stated that a grading mechanism was designed and constructed in which the sizing plates are linked to the roller chain and the other side slides against the guide plate. The opening between sizing plates is gradually increased as the roller chain moves. Fruits enter the grading mechanism and lie on the gaps between sizing plates, dropping through the openings and into bins when the openings become large enough. Sorting efficiency and sorting purity were both 88%, while sorting efficiency and sorting purity decreased to 74 and 76%, respectively, when 3 grades of plum fruits were sorted.

**Mosa (1998)** designed and fabricated grading machine for orange using diverging bar or roller cylinder. The results show that the optimum speed of feeding conveyor was 70 rpm, the most suitable lines for the grading unit were the cylinder system, and the most suitable tilt angle of grading unit was ranged between 3 – 6 deg.

**Matouk et al. (1999)** designed and constructed a portable machine for sorting, cleaning and grading sphere-like crops such as orange and tomatoes. They concluded that, at any sieve slope in the range of 5 to 20 degree and all sieve rocking speed in the range of 150 to 300 rpm. Mechanical damage percentage of fruit increased as the speed of fruit feeding chain increased from 0.15 - 0.3 m/s. They added that, at high sieve rocking speed the grading efficiency of fruit decreased.

**Abd-Alla et al. (2000)** reported that the grading efficiency was decreased with increasing both fruit feeding speed and tilt angle of grading unit. The grading efficiency was increased with the increase of critical distance from 0.04-0.1 m and starts to decrease at critical distance of 0.13 m.

**Genidy (2003)** concluded that the machine grading capacity increased by 22.2 % when the cylinder speed of feeding cells was increased from 10 – 40 rpm (0.11- 0.42 m/s) at different levels of tilt angles during grading the muskmelon.

**El-Sayed (2004)** developed a two grading machines for olive grading. He concluded that the maximum grading efficiency were 93, 92, and 91% for Agiza, manzanillo and Picual at 8 rpm speed of rotating, and 3

degree of slope angles of roller sizer.

**Abd El-Rahman (2004)** tested and evaluated a portable shaker type-grading machine with garlic and onion bulbs. the results indicated that grading efficiency decreased as feeding rates and frequency levels increased. The best result was obtained at bulbs feeding rate of 800 kg/h and frequency levels of 30 freq/s for grading unit. At these levels, maximum grading efficiency and permissible mechanical damage were obtained for garlic and onions bulbs.

Many types of machines are available to do this work; most of them are complex and expensive since they incorporate devices to facilitate sorting for quality, accurate sizing mechanisms and devices to facilitate packing. The cheapness and simplicity of grading machines would encourage their use on national scale.

The main objective of this study is to develop, construct and test a prototype reel-separator for olive fruits grading, to evaluate the performance of the proposed machine and recommending specific improvements based on the results.

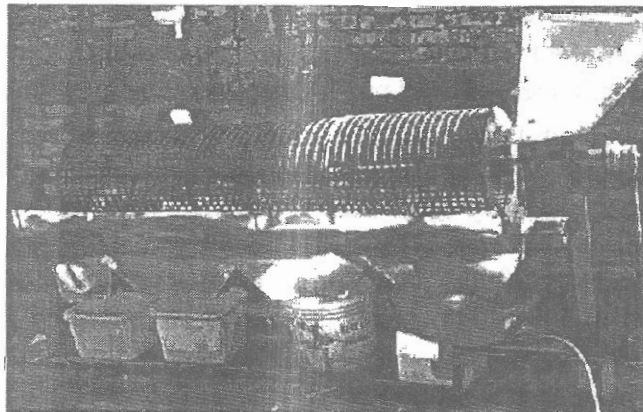
### **3- MATERIALS AND METHODS**

#### **3-1- Materials:-**

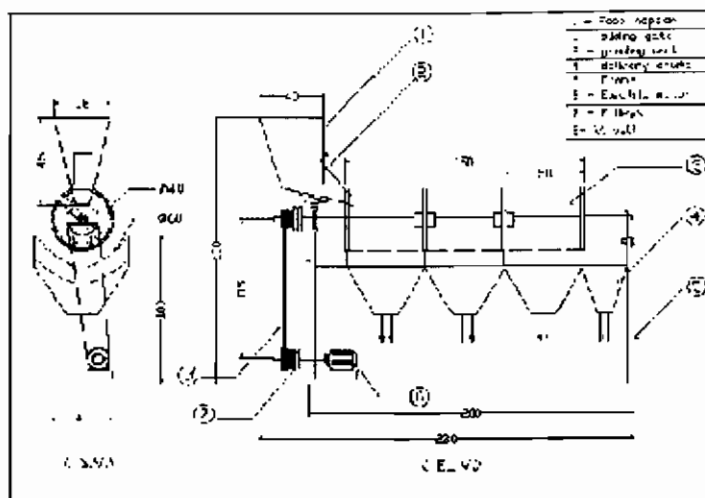
The experiments were carried out using two different double purpose varieties (Picual and Manzanillo) of olive crop. These varieties were obtained from Horticultural Research Institute, Olives Res. Dept., (A.R.C.) Giza, Egypt. These varieties were selected based on its recent coverage area and the expected future expansion according to Ministry of Agriculture yearly bulletins.

#### **3-2-The developed machine:-**

The proposed grading machine Figs. (1- A and B) used in this study, was developed, installed and tested at the workshop of Ag. Eng. Res. Inst. (ARC).



**Fig. (1-A): Actual photo of a proposed reel separator.**



**Fig. (1-B): Side view and elevation view of the proposed reel separator.**

As shown in Fig. (1- A and B), the cylindrical reel-separator consists of frame constructed from steel hollow square bar ( $4 \times 4$  cm) 0.5 cm thick welded together. The frame dimensions (length, width and height) were 200, 40 and 110 cm, respectively.

The hopper of the machine was manufactured to feed the fruit into the reel-separator with the dimensions of 35x40x45 cm for length, width and height, respectively. It was made of iron sheet of 1 mm thickness. The sides of this hopper had a gradual slope to allow sliding of fruits.

Based on the physical properties of olive fruits under this study, and according to (U. S. STANDARDS, 1983), olive fruits are sized into four different categories (canned whole and pitted ripe olives) as follow:

- Size (1) < 17 mm in diameter ranked: Small.
- Size (2) 17 - 19 mm in diameter ranked: Medium
- Size (3) 19 - 20 mm in diameter ranked: Large
- Size (4) > 20 mm in diameter ranked: Extra large

Two different grading units (sieves) were made. The first unit of square cells, while the other has parallel bars cells Fig. (1- C).

Each grading unit of the reel-separator is furnished with three sieves (A, B and C); each of 40 cm for diameter and 50 cm for length. The sieves are arranged subsequently (one behind the other) according to the size, the small mesh sieve (A) being at the first (17 mm) while, the large mesh sieve (C) being at the end (20 mm). The sieves are mounted on the machine frame and the slope of the sieve needed is obtained by means of bolts and the adjustable holes.

The grading unit is set on two rotating rollers each one supported on two adjustable ball bearings with grease gun, which are attached on the

main frame with bolts. The grading unit slightly tilted downwards in the direction of crop travel to encourage the fruits to pass along the grading unit.

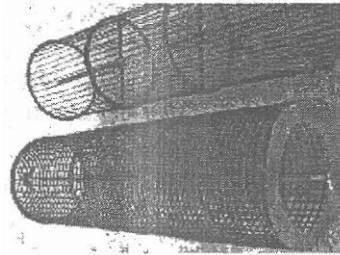


Fig. (1-C): Actual photo for two types of grading unites of the reel-separator.

### 3-3-Theoretical considerations of the cylindrical sieves:

The working process of a cylindrical sieve is given below. The fruit mix is delivered from one end of the rotating cylindrical sieve (inclined or horizontal). Then the fruits try to reach the other end of the cylinder.

During this action, particles located at the lower portion of the cylinder are lifted upward by the screen surface to some height after which they are again lifted along with it and slide down. They gradually move toward the opposite end of the cylinder. The particles are in contact with only a part of the cylindrical surface and have no relative velocity with respect to it during their lift for these reasons and because sieving of small particles is possible only when they have some finite relative velocity.

The nature of the motion of fruits over the surface of a cylindrical sieve depends upon the coefficient of friction on the given surface; the kinematics operating condition is governed by centripetal acceleration  $r\omega^2$ , the initial conditions of motion of the particles, the point at which they are delivered on to the sieving surface and their initial velocity.

Depending upon the relationship among the above factors, the fruit in the cylinder may slide along it, separate from its surface and perform a free flight or may move with the surface being at rest relative to it. In the last case the fruit material is not sieved (Bosoi et al. 1991).

The release of fruits (particles) in a cylindrical sieve depends upon their relative velocity and the forces acting on them. These forces are:

- The weight of the particle  $mg$ , directed downward.
- The centrifugal force  $m r \omega^2$

Where:

- $(m)$  is the mass of the particle;
- $(r)$  - radius of the cylinder;
- $(\omega)$  - particle angular velocity (at critical speed the angular velocity of particle  $\omega_p = \omega$ ).

The motion of the particle on the cylinder surface is not determined by the tangential forces alone. But, if the resultant of the normal forces ( $F_n$ ) is not directed towards the cylinder surface, the particle will loose contact with the cylinder.

To find the equations that describes the motion of the particle at a critical speed of the cylindrical sieve Fig. (2), it can be found that:

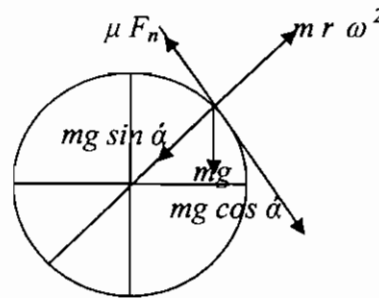
$$F_n = m r \omega^2 - mg \sin \alpha \dots\dots (1) \text{ in the normal direction}$$

$$mg \cos \alpha = \mu F_n \dots\dots\dots (2) \text{ in the tangential direction}$$

Where:

( $\alpha$ ) is the angular position of particle on the sieve surface measured from the horizontal axis in the direction of rotation;

( $\mu$ ) - coefficient of friction between the particle and cylindrical surface.



**Fig. (2): Forces acting on a particle of fruit in a rotating cylinder.**

By substituting ( $F_n$ ) from equation (1) into equation (2) then:

$$mg \cos \alpha = \mu (m r \omega^2 - mg \sin \alpha) \dots\dots(3)$$

$$g \cos \alpha = \mu r \omega^2 - \mu g \sin \alpha$$

$$\mu r \omega^2 = g \cos \alpha + \mu g \sin \alpha$$

$$\omega^2 = \frac{g \cos \alpha' + \mu g \sin \alpha'}{\mu r} \dots\dots\dots (4)$$

$$\omega = \sqrt{\frac{g}{\mu r} (\cos \alpha' + \mu \sin \alpha')} \dots\dots\dots (5)$$

But

$$\omega = \frac{2\pi N}{60} \dots\dots\dots(6)$$

From equation (5) and equation (6) we get:

$$N = \frac{60}{2\pi} \sqrt{\frac{g}{\mu r} (\cos \alpha' + \mu \sin \alpha')} \dots\dots\dots (7)$$

At  $\alpha = 90^\circ$  ;  $r = 20 \text{ cm}$ .

$$N = \frac{60}{2\pi} \sqrt{\frac{g}{r}} \dots\dots\dots (8)$$

The previous equation (8) shows the number of rotations per minute (critical speed). Under this study, and by substituting in equation (8) the number of rotation per minute (*N*) for sieve should be lower than 66.8 rpm.

The sieves are set inclined to the horizontal plane, to improve the internal pressure forces during the rotation of the particles mass. According to **Klenin et al. (1985)** the angle of sieve inclination ( $\theta$ ) was selected from the condition  $\theta \leq \phi$ . Where ( $\phi$ ) is the friction angle between the fruits and the sieve surface.

In this study, the slope angle of the cylindrical sieves on the horizontal plane was selected experimentally as (9°).

**3-4- The studying factors:**

The experiments were designed and carried out to study the effect of the following parameters:

1. Four different fruits feeding rates (350, 400, 450 and 500 kg/h).
2. Four different speeds for grading unit 20, 35, 50 and 65 rpm, (0.419, 0.733, 1.047 and 1.361 m/s).
3. Two types of wire mesh cell shape (square cell and parallel bars cells).

The number of rotations per minute (*N*) and the slope angle of cylindrical sieves ( $\theta$ ) on the horizontal plane were considered according to the theoretical consideration as described above.

**3-5- Calibration of the feeding mechanism:**

The following steps were carried out to calibrate the feeding mechanism to give the required feed rates of olive fruits.

- The hopper was filled with bulbs.
- The gate opening was adjusted to control the output of the olives.
- The machine was run for two minutes in each test. This period was measured from the instant of full dropping the olives through the hopper opening.
- The discharged olives were collected in plastic bags to determine the feeding rate of olives (kg/h).

**3-6-Test Procedure:-**

- Before carrying out the tests, the samples were manually cleaned to remove impurities and the unwanted materials.
- The machine was installed on level ground. The fruits were put into baskets and manually discharged into the feeding hopper.
- The fruits were dropped from the feeding unit to the grading unit either square perforations or parallel bars to grade fruits into 4 sizes. Then the fruits were discharged to the collecting baskets.
- During grading process, the consumed time of operation from the moment of olives dropping until the end time was measured, and the

amount of graded olives was recorded. Then the machine productivity (kg/h), machine grading efficiency (%) and olives mechanical damage (%) were calculated for each test.

### 3-7- Measurements:-

#### 3-7-a) Fruit physical and mechanical characteristics

##### - Fruit principal dimensions:

To design the machine hopper and cells of the cylindrical sieves, the data reported by **Fouad et al. (1992)** and **Owies (2003)** were used as a source of fruit length, diameter, shape index, weight and the angle of friction as shown in Table (1).

Table (1): Physical and mechanical properties of two olive varieties.

property	varieties	Range		Average (Mean)
		Min.	Max.	
Fruit length, mm	Picual	17.90	31.53	25.851
	Manzanillo	17.96	29.34	24.029
Fruit dia., mm	Picual	14.96	24.01	19.851
	Manzanillo	13.50	23.91	19.584
Sphericity (shape index)	Picual	1.141	1.501	1.302
	Manzanillo	1.068	1.514	1.232
Friction angle on galvanized sheet, degree.	Picual	18.8		
	Manzanillo	19.1		

#### 3-7-b) Machine grading capacity and efficiency:

The grading capacity for the developed machine was determined according following formula:

$$\text{Machine capacity (M}_p\text{)} = M_w / t \text{ , (kg/h) ..... (9)}$$

Where:

$M_w$  = Mass of classified fruits from the whole unit in kg;

$t$  = The time consumed in operation, h.

The total grading efficiency of the machine was estimated according to **Klenin et al., (1985)** using the following formula:

$$\text{Machine grading efficiency } (\eta) = (m_1 + m_2 + m_3 + m_4) / m \text{ , (\%)} \dots(10)$$

Where:

$m$  = Total mass of fruits, kg;

$m_1 + m_2 + m_3 + m_4$  = Averaged mass of different sizes, kg.

#### 3-7-c) Mechanical damaged percentage:

Mechanical damaged percentage for the two types of olive varieties was measured during olives grading as follows.

Olive's bruises were evaluated, immediately as visible damage, which can be seen by bare eye. Scuffed fruits (with surface abrasion damage to skin) and those with flesh damage were separated from each fraction and there percentages based on the weights of the corresponding fractions were

taken as olives mechanical damage. Then the mechanical damage of fruits was classified according to (Kader, 1992) into the following categories:

<u>Bruising score</u>	<u>% of fruit area affected</u>
1- No symptoms	Zero
2- Slight	< 2 %
3- Moderate	2 - 5 %
4- Severe	5 - 10%
5- Extreme	> 10%

| Unmarketable

#### 4- RESULTS AND DISCUSSION

##### **4-1- Machine grading capacity:**

Figs (3 and 4) illustrates the effect of different speeds of cylindrical sieve (rpm) and different sieves feeding rates (kg/h) using two types of cell shape (parallel bars and square cells) on the machine grading capacity during the grading process of two olive varieties (picual and manzanillo variety).

It can be seen from Figs (3 and 4) that increasing sieve speed during grading process of two olive varieties using parallel bars and square mesh from 20 to 65 rpm at any fruit-feeding rate in the range of 350 to 500 kg/h cause a corresponding increase in machine grading capacity.

Similarly, it can be observed that increasing sieve rotating speed during the grading process of olive fruits using parallel bars mesh causes higher machine grading capacity compared with square cells at both fruit varieties under study. This increase in machine grading capacity by using parallel bars mesh may be due to the less probability of sieves clogging compared with the square mesh.

In addition, it can be seen that increasing sieve-rotating speed from 20 to 65 rpm at all fruits feeding rates from 350 to 500 kg/h causes a higher increase in machine grading capacity for picual fruit variety over the manzanillo variety.

On the other hand, the values of grading capacity for picual variety were higher than that of manzanillo variety when using the same grading treatments. These increments in grading capacity may be due to the increase in the spheroid of picual variety compared with manzanillo variety, which in turn may be decrease, the sieve clogging openings.

The low capacity values were 272.2, 265.0 kg/h for square cells, and 279.9, 272.9 kg/h for parallel bars cells were obtained during grading picual and manzanillo fruits, respectively at 350 kg/h fruit feeding rate and 20 rpm sieve rotating speed. The higher values were 444, 434 kg/h, for picual variety and 425.6, 415 kg/h for manzanillo fruits at 500 kg/h fruits feeding rates and 65 rpm sieves speed using parallel bars and square cells respectively.

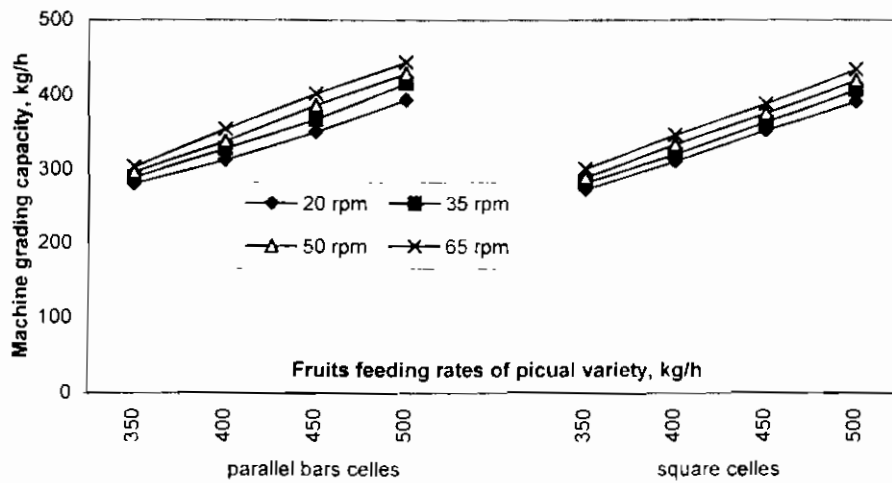


Fig. (3). Machine grading capacity as affected by different sieve rotating speeds, different fruits feeding rates for both types of sieve cells using picual fruit variety

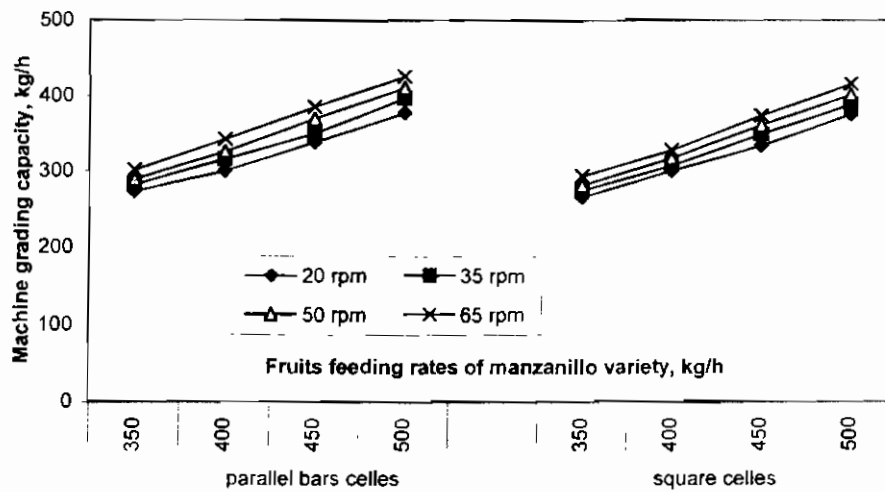


Fig. (4): Machine grading capacity as affected by different sieve rotating speeds, different fruits feeding rates for both types of sieve cells using manzanillo fruit variety.

#### 4-2- Machine grading efficiency:

Data tabulated in Figs (5 and 6) show the effect of grading parameters and their interactions on the machine grading efficiency.

It can be seen from Figs (5 and 6) that increasing the speed of sieves from 20 to 35 rpm at any fruit feeding rate in the range of 350 to 400 kg/h with parallel bars and square cells cause a positive increase in the machine grading efficiency for both fruit varieties under study (picual and manzanillo) comparing with square cells. This increase in the machine grading efficiency was followed by a decrease in grading efficiency as the sieve rotating speed increased from 35 to 65 rpm. Whereas, increasing the speed of sieves from 20 to 50 rpm at any fruit feeding rate in the range of 450 to 500 kg/h using square cells cause a corresponding increase in the machine grading efficiency for both fruits variety under study (picual and manzanillo). This increase was followed by a decrease in machine grading efficiency as the sieve rotating speed increased from 50 to 65 rpm. This decrease in machine grading efficiency by increasing rotating speeds of sieves may be due to the increase in the fruits movement that made the fruit bounce on the sieve and this in turn decreases the fruit separation.

The same trend of increase in the machine grading efficiency due to increasing fruits feeding rates from 350 to 400 kg/h was also noticed at all sieve speeds in the range of 20 to 35 rpm and at both grading varieties and mesh types (parallel bars and square shapes), respectively.

This increase was followed by a decrease in machine grading efficiency as the fruits feeding rates increased from 450 to 500 kg/h. This may be attributed to the fact that at higher fruit feeding rates, the amount of fruits conveyed to the grading unit reached to a high value and this caused a rick of fruits on this unit, thus some fruits passes without grading.

This decrease in grading efficiency by increasing feeding rates from 450 to 500 kg/h may be due to the increase in the fruit movement giving it more ability to jump on the sieve and this in turn increased the ratio of fruit mixing. These results were in line with **Bosoi et al., (1991) Abd-Alla et al. (2000) El- Sayed (2004), and Abd El-Rahman (2004).**

Under the same conditions, it can also be seen that parallel bars cell shape caused an improvement in grading efficiency compared with square cell shape. The reason of depression of grading efficiency with square cell shape may be due to the increase in clogging of sieves openings compared with parallel bars cell.

It should be mentioned that the data of grading process at feeding rates 450 and 500 kg/h should be excluded from the efficiency calculation since it was found that grading efficiency decrease at these levels of feeding rates as shown in Figs (5 and 6).

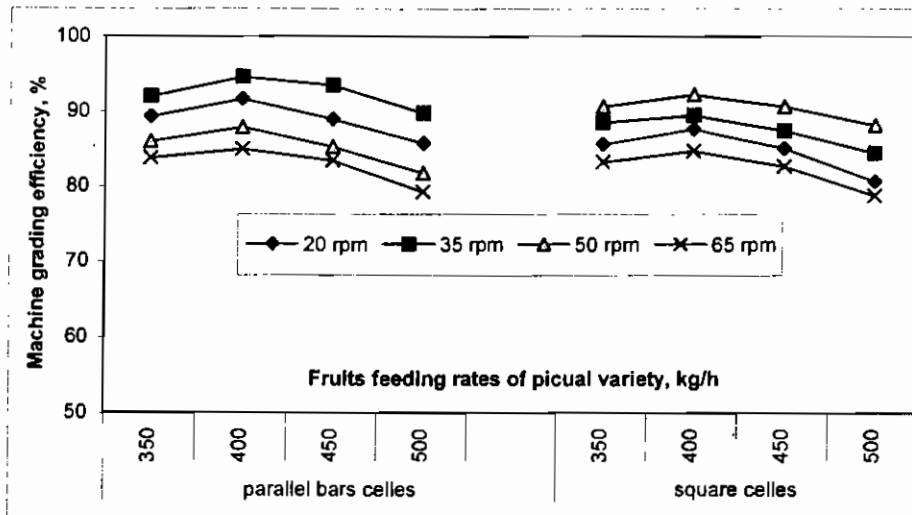


Fig. (5): Machine grading efficiency as affected by different sieve rotating speeds, different fruits feeding rates for both types of sieve cells using picual fruit variety.

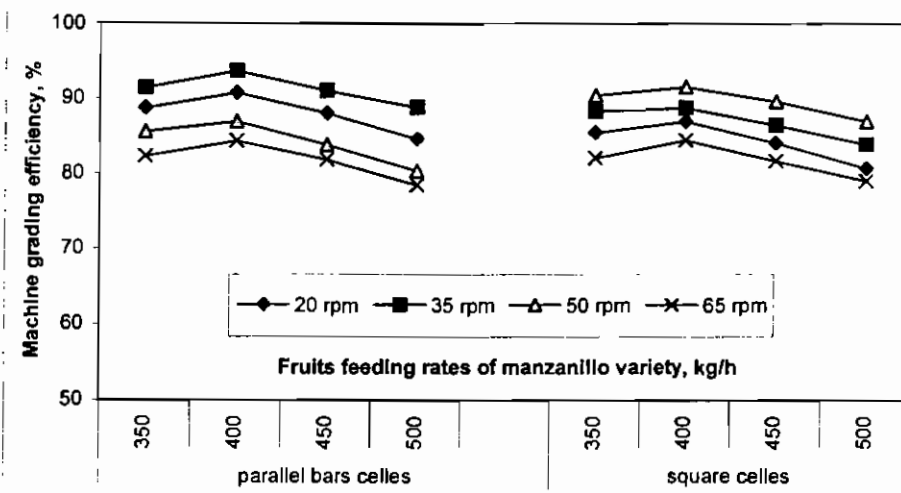


Fig. (6): Machine grading efficiency as affected by different sieve rotating speeds, different fruits feeding rates for both types of sieve cells using manzanillo fruit variety.

#### 4-3-Mechanical damage percentage:

Mechanical damage percentage for the two types of olive varieties was measured during olives grading under optimum operation condition {35 rpm (0.733 m/s) cylinder speed and 400 kg/h feeding rate, using parallel bars cell shape. And 50 rpm (1.047 m/s) cylinder speed when using square cells at the same feeding rate of olive fruits.

It can be seen from Table (2) that the mechanical damaged percentage of olives fruits increased for the two olives varieties under study when grading process was carried by square cells compared by parallel bars cells. The values of mechanical damage percentage for both olives fruit were lower than the maximum defects permitted for marketable olives, so it should be excluded.

In other words, grading picual and manzanillo olive varieties by the proposed machine at optimum grading conditions, produced olives defects (mechanical damaged) lower than the limits permitted for marketable olive's yield as described in the mechanical damage classification (**Kader, 1992**).

Increasing the percentage of mechanical damage using the square cells shape may be attributed to increase the impact time for fruits with cell sides during the grading process, and that led to increase the mechanical damage.

So, one can say that, it is quite safe to use the developed separator from the damage point of view at the optimum parameters causing the higher grading efficiency and capacity.

Table (2): Olive's mechanical damaged at optimum grading conditions.

Olive variety	Cell type	Maximum defects permitted for marketable olives, %.	Mech. Damage, %	Grading Effie, %
Picual	Parallel bars	5.0	2.37	94.6
	squares		3.77	92.3
Manzanillo	Parallel bars		2.35	93.6
	squares		3.82	91.6

#### 5- COCLUSION

The optimum operating parameters for the modified reel separator by using the parallel bars cells were 400 kg/h for fruit feeding and 35 rpm for sieves rotating speed. At these levels the maximum grading efficiency of (94.6 and 93.6 %) were obtain which was associated with machine grading capacity of (328 and 315.7 kg/h) for picual and manzanillo varieties respectively.

At the same feeding rate (400 kg/h) and by using square cells the rotating speed of the sieves should be 50 rpm. At these levels the maximum grading efficiency of (92.3 and 91.6 %) which was coincided with machine grading capacity of (333 and 317 kg/h) were obtained for picual and manzanillo varieties respectively.

The mechanical damage of the two olive varieties under study increased when grading process was carried by square cells compared with parallel bars cells. Grading picual and manzanillo olive varieties by the developed machine at optimum grading conditions, produced olives defects lower than the limits permitted for marketable olive's.

## **6. LITERATURE CITED**

- Abd-Alla, H. El-Sh; S. M. Radwan; M. M. El-Kholy and M. S. Radwan, (2000). A weight grading machine for different fruits and vegetables. *Misr J. Ag. Eng.*, 17 (3): 675 – 696.
- Abd El-Rahman, M. M., (2004). Improving the field performance of a portable bulbs grader. *Misr J. of Ag. Eng.* 21 (2):199-211.
- Amin, E.E.A.A., (1994). Development of a grading machine for some horticulture farm crops. *J. Ag. Sci. Mansoura Univ.* 19 (7): 2399-2411.
- Balls, R.C. (1986). Horticultural engineering technology fixed equipment and buildings. Published by Macmillan education LTD. Houndmills, Basingstoke, Hampshire RG21 2 × 5 and London.
- Bosoi, E.S.; O.V. Verniaev; I.I. Smirnov and E.G. Sultan-Shakh, (1991). Theory construction and calculations of agricultural machines Vol. (2) Mashinostroenie Publishers, Moscow.
- El-Sayed, S. E. M., (2004). Mechanization of grading olive as one of the most important desert crops. Unpublished M. Sc. Thesis (Ag. Eng. Dept.) Fac. of Ag. Mansoura Univ.
- Fouad, M. M.; Omima A. Kilany and M. E. Elsayed, (1992) Comparative studies on fruit characters of some olive cultivars under Giza conditions. *Egypt. J. Appl. Sci.*, 7 (5): 645-656.
- Genidy, S. K. A., (2003). Manufacturing and performance evaluation of a locally machine grading of some vegetables and fruits. Ph.D. Thesis (Ag. Eng. Dept), Fac. of Ag. Kafr El-Sheikh, Tanta Univ.
- Kader, A.A., (1992). Postharvest technology of horticultural crops. Publication 3311 University of California Division of agriculture and natural resources.
- Klenin, N.I.; I.F. Popov and Sakun V.A., (1985). Agricultural Machines (Theory of operation, computation of controlling parameters and the conditions of operation). Amerind Publishing Co. PVT. LTD. New York pp. 633.
- Ladaniya, m. s. and H. C. Dass, (1994). Manual versus mechanized storing, washing, waxing and size grading of Nagpur mandarin. *J. of Maharashtra Ag. Uni.* 19 (1): 159 – 160.
- Matouk, A.M.; A.M. El-Gendy; Y.M. El-Hadidi; E.A. Amin, and Abd M.M. El-Rahman, (1999). Evaluation the effect of some mechanical

- parameters on handling characteristics of sphere-like crops. *Misr J. Ag. Eng.*, 16(4): 701-719.
- Michael, O.; F.C. Burtion and B.F. Robert (1983). Principles and practices for harvesting and handling fruits and nuts. AVI published company, INC. Westport, Connecticut.
- Mosa, M. M. A., (2003). Engineering factors affecting the development of grading machine for citrus. Ph.D. Thesis (Ag. Eng. Dept), Fac. of Ag. Cairo Univ.
- Ryall, A.L. and W.J. Lipton, (1983). Handling, Transportation and Storage of Fruits and Vegetables. Vol. 1 2<sup>ed</sup> Ed. AVI publishing company, INC. Westport, Connecticut.
- Owies, T. R., (2003). Developing a machine for extracting olive oil. Ph.D. Thesis (Ag. Eng. Dept), Fac. of Ag. Mans. Univ.
- Peleg, K., (1985). Produce handling, packing and distribution. AVI Pub. Comp. INC. Westport, Connecticut (91-103).
- United States Standards for grades of canned ripe olives (1983). Fruit and vegetables division, Agricultural Marketing Service. United States Department of Agriculture.
- Yang, C. and K. Y. Liu, (1997). Design and analysis of grading mechanism for plum sizing machine. *J. of Ag. Res. of China*, 46 (3): 294 – 304.
- المراجع العربية:  
- وزارة الزراعة واستصلاح الأراضي، (2004). الإحصاءات الزراعية (الجزء الثاني) يونيو 2004.

### الملخص العربي

## تطوير فراز اسطوانتي لتدريج ثمار الزيتون

\* د. ماجدة محمد أمين موسي

يعتبر الزيتون واحد من أهم محاصيل دول حوض البحر الأبيض المتوسط وتنتج زراعة الزيتون في الأراضي الجديدة المستصلحة نظراً لقدرته على تحمل الظروف المناخية الصعبة كالجفاف والملوحة. وقد تزايدت المساحة المنزرعة في مصر من 22000 فدان عام 1988 إلى 67523 فدان عام 1994 ثم أصبحت 118697 فدان عام 2003. وتطورت المساحة المثمرة من 14909 فدان عام 1988 إلى 78555 فدان عام 2003. و الزيادة ليست فقط في المساحة المثمرة ولكنها أيضاً في إنتاجية الفدان حيث زادت من 2.05 طن/فدان عام 1988 إلى 3.8 طن/فدان عام 2003 (وزارة الزراعة، 2004)

أجريت هذه الدراسة بهدف تطوير وتصنيع ماكينة صغيرة من النوع الأسطوانتي لتقوم بتدريج ثمار الزيتون. بهدف نشرها داخل القرى المصرية كآلة بسيطة يمكن نقلها بين الحقول أثناء حصاد

هذه الثمار مما يساعد على تقليل نسبة الفاقد والتالف من الثمار خلال مراحل التداول المختلفة وتوفير العملات الصعبة التي تنفق في استيراد هذه الآلات وتشجيع التصنيع المحلي لهذه النوعية من الآلات بخامات مصرية متوفرة بالسوق المحلي.

- تم إجراء التجارب العملية باستخدام الآلة المصنعة لدراسة تأثير بعض العوامل الهندسية مثل معدل تغذية الثمار (350، 400، 450، 500 كج/س)، سرعة دوران الغرابيل 20، 35، 50، 65 لفة/د (0.419، 0.733، 1.047 و 1.361 م/ث)، شكل خلايا الغرابيل (قضبان متوازية، خلايا مربعة) والتي تؤثر بدورها على سعة وكفاءة وأداء الآلة المقترحة باستخدام صنفين مختلفين من أهم أصناف الزيتون الثنائية الغرض والتي تنتشر زراعتها في مصر (البيكوال - المنزائلو).

ويمكن تلخيص أهم نتائج هذه الدراسة في النقاط التالية:

-العوامل المثلى لتشغيل الآلة باستخدام الخلايا ذات القضبان المتوازية كانت عند سرعة 35 لفة/دقيقة (0.733 م/ث) ومعدل تغذية للثمار قدره 400 كج/س حيث أعطت أعلى كفاءة تدرج (94.6 و، 93.6%) والتي توافقت مع سعة للآلة قدرها (328 و 315.7 كج/س) للصنف البيكوال والمنزائلو على التوالي.

بينما كانت العوامل المثلى لتشغيل الآلة باستخدام نفس معدل التغذية للثمار مع الخلايا المربعة وسرعة 50 لفة/دقيقة (1.047 م/ث) لغرابيل التدرج حيث كانت أعلى كفاءة تدرج (92.3 و 91.6%) والتي توافقت مع سعة للآلة قدرها (333 و 317 كج/س) للصنف البيكوال والمنزائلو على التوالي.

-انخفضت نسب التلف الميكانيكي للثمار صنفى البيكوال والمنزائلو عند تدرجها باستخدام الخلايا ذات القضبان المتوازية عند مقارنتها بالخلايا المربعة الشكل عند تدرجها تحت ظروف التشغيل المثلى للآلة، وكانت نسب التلف الميكانيكي للثمار منخفضة عن النسبة المسموح بها دولياً (5%).

\* باحث بمعهد بحوث الهندسة الزراعية - الدقي - جيزة.