DEVELOPMENT OF A GRADING MACHINE FOR APRICOT FRUITS

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ABSTRACT

The main objective of the present study is to develop, construct and evaluate the performance of a small-scale grading machine to suit grade fresh fruit like apricot (Canino variety).

The performance of the grading machine was carried out to investigate some engineering parameters such as: four different grading speeds 5, 8, 11 and 14 rpm (0.05, 0.08, 0.12 and 0.15 m/s), fruit batch of 5, 10, 15 and 20 kg and two type of grading cylinder (PVC and rubber coated cylinder) using constant grading tilt angle of 7^{o} on grading efficiency, fruit damage and grading productivity.

Physical and mechanical properties of apricot fruits (Canino variety) under study, was studied to evaluate the performance of developed a small-scale grading machine.

The optimum conditions of grading machine to be operated at the maximum efficiency are: Grading speed of. 8 rpm. (0.08 m/s), fruit batch of 10 kg and rubber coated cylinder. Achieved grading efficiency of 98.41 %, fruit damage of zero %, and productivity of 610.17 kg/h. Operation costs was 7.37 L.E./h and 12.1 L.E./Mg.

INTRODUCTION

Cultivated area of fruits in Egypt is 1.20 million fed. Apricot is the major horticultural crops in Egypt. It is cultivation area is about 17.786 fed, production of apricot in Egypt is about 5.3 ton/fed. and the total production is about 62.613 ton. **(Agric. Statistics Economic Affairs Sector, 2006)**. Apricot considered from fruits with stone-fruits, as known, the fruit of apricot is not only consumed fresh but also used to produce dried apricot, frozen apricot, jam, jelly, marmalade, pulp, juice, nectar, extrusion products etc. Moreover, apricot kernels are used in the production of oils, benzaldehyde, cosmetics, active carbon, and aroma perfume **(Yıldız, 1994)**.

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Apricot has an important place in terms of human health. Apricot is rich in minerals such as potassium and vitamins such as β-carotene. β-carotene is the pioneer substance of mineral “A”, is necessary for epithelia tissues covering our bodies and organs, eye-health, bone and teeth development and working of endocrine glades. Moreover, vitamin “A” plays important role in reproduction and growing functions of our bodies, in increasing body resistance against infections. **(Haydar et al 2007)** mentioned that properties are necessary for the design of equipments for harvesting, processing, and transportation, separating and packing. Technological properties such as length and diameter of fruit, mass, volume of fruit, geometric mean-diameter, sphericity, bulk density, fruit density, porosity, projected area, static and dynamic coefficient of friction were determined at 83.27 %, 77.79 %, 82.1 %, 79.79 %, 82.31 % and 77.37% moisture content. The values of length, mass, geometric mean-diameter and sphericity of six different apricot fruits were established between 29.26 and 46.98 mm, 14.35 – 41.48 g, 28.99 – 41.15 mm, 0.876 – 0.991 %, respectively. **Hojat et al (2008)** study some physical and mechanical properties such as dimensions, geometric mean diameter, sphericity, surface area, bulk density, true density, porosity, volume, Mass, 1000-unit mass, coefficient of static friction on various surface and rupture force in 3 axes, were determined at 84.19, 17.01 and 17.46% moisture contents for apricot fruits, apricot pits and apricot kernels respectively. Bulk densities of fruits, pit and kernels were 449.5, 440.78 and 406.79 kg/m3, the corresponding true densities were 1037.5, 892.63 and 983.38 kg/m3 and the corresponding porosities were 56.66, 50.62 and 52.32%, respectively. The volumes, mass and surface area of fruits were larger than those of nuts and kernels. The static coefficient of friction of fruit on all surfaces studied (wood, glass, galvanize sheet and fiber glass sheet) were the highest as the surface is viscous and hardness is less. Rupture force of fruit, pit and kernel were 8.23, 372.75 and 16.20 N through length, 6.31, 297.34 and 32.25N through width and 5.87, 300.45 and 91.22N through thickness. **Amin (1994)** developed and tested a grading machine consisting of rotating cylinder and perforated concave to grade potatoes 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, slop of drum axle and drum length) have a significant effect on grading efficiency. The specifies of machine at drum speed of 25 rpm and slop of zero degree was 1.2 Mg/h with tuber damage of 0.23 %. **El-Raie et al (1998)** designed and fabricated grading machine for orange using diverging bar and roller cylinder. The results showed that, the optimum speed of feeding conveyor was 70 rpm., the most suitable lines for the grading unit were the cylinders system, and the most suitable tilt angle of grading unit ranged between 0.052-0.105 rad. (3-6 degree).**Mousa (1998)** found that the mean values of diameter ranged from about 69 to 84 mm; height ranged from about 57 to 87 mm; mass ranged from about 160 to 208 g; volume ranged from 188 to 241 mm for Navel, Baladi, Acidless and Valencia orange varieties. The height values limited the distance between grading lines and shape and size of the distributed buckets on the conveyor belt. According to that, the bucket design was: length of 650 mm and diameter of 100 mm more than the biggest height of orange fruits. **Matouk et al (1999)** designed and constructed a portable chine for sorting, cleaning and grading sphere-like crops such as orange and tomatoes. They concluded that, at any sieve slop the range of 0.87-0.349 rad. (5-0 deg) and all sieve king speed in the range of 150-300 rpm mechanical damage percentage of fruits increased as the speed of fruits 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 to open the pivoted beam from 0.04-0.1 m and start to decrease at critical distance of 0.13 m. **Patrick (2002)** mentioned that there are many methods of grading (grading system) were used:

-Lift roller seizer. The product is sized by lifting alternate rollers to vary the gap between rollers. Screen grader.

-The product is sized by passing over a series of mesh screen.

Genidy (2003) stated that the machine grading capacity increased by 22.2 % when the cylinder speed of feeding was increased from 10-40 rpm (0.11-0.42 m/s) at different levels of tilt angles during grading the muskmelon. **Mostafa (2003)** developed and fabricated an appropriate system for grading onion bulbs by size. He showed that, the optimum operational conditions at 0.23 m/s and zero gerundial angles achieved maximum grading efficiency of 9 % for giza-20 onion variety. **Xiaoyang et al. (2003)** developed a prototype automated pectin ayatem to classify apples based on bruising in real. The results show that the Raman spectroscope permits non-structive bruise determation with good results.

There are two specific objectives of this study:

1- Study the physical and mechanical properties of apricot are important for the design of equipment for grading.

2- Develop a small-scale machine for grading for fresh fruits and evaluate the performance of machine to be used after that in small horticultural handling.

MATERIALS AND METHODS

A) Materials:

In the present investigation, a small handling machine was developed and tested at Agricultural Engineering Research Institute (EnRI), Dokki, Giza, Egypt. The grading machine consists of frame, feeding box, Fruit bin, grading revolving-drums, fruit cutoff and chute and power transmition system as shown in fig.1.

A-1) Fruits used in this investigation:

Ripe fresh apricot fruit (variety of Canino) was used for all the experiments in this study. The sample of fruits was obtained from Horticultural Research Institute (H.R.I), Agricultural Research Center (A.R.C) Giza, Egypt Apricot fruits transport to the laboratory. The fruits were cleaned to remove all foreign matter such as dust, dirt, immature and damaged fruits and all measurements were taken in the same day.

A-2) Grading machine specifications (designed by EL-Raie, et al, 2012):

General: Overall length, width, and height are 860, 960, and 1070 mm, respectively, and power inputs from electrical motor.

Frame: Made of angle iron sections 30 x 30 x.3 mm, with 760 mm length, 660 mm width and rear height of 550 mm and front height of 460 mm. The frame is inclined to front direction (grading-direction) by 7^0.

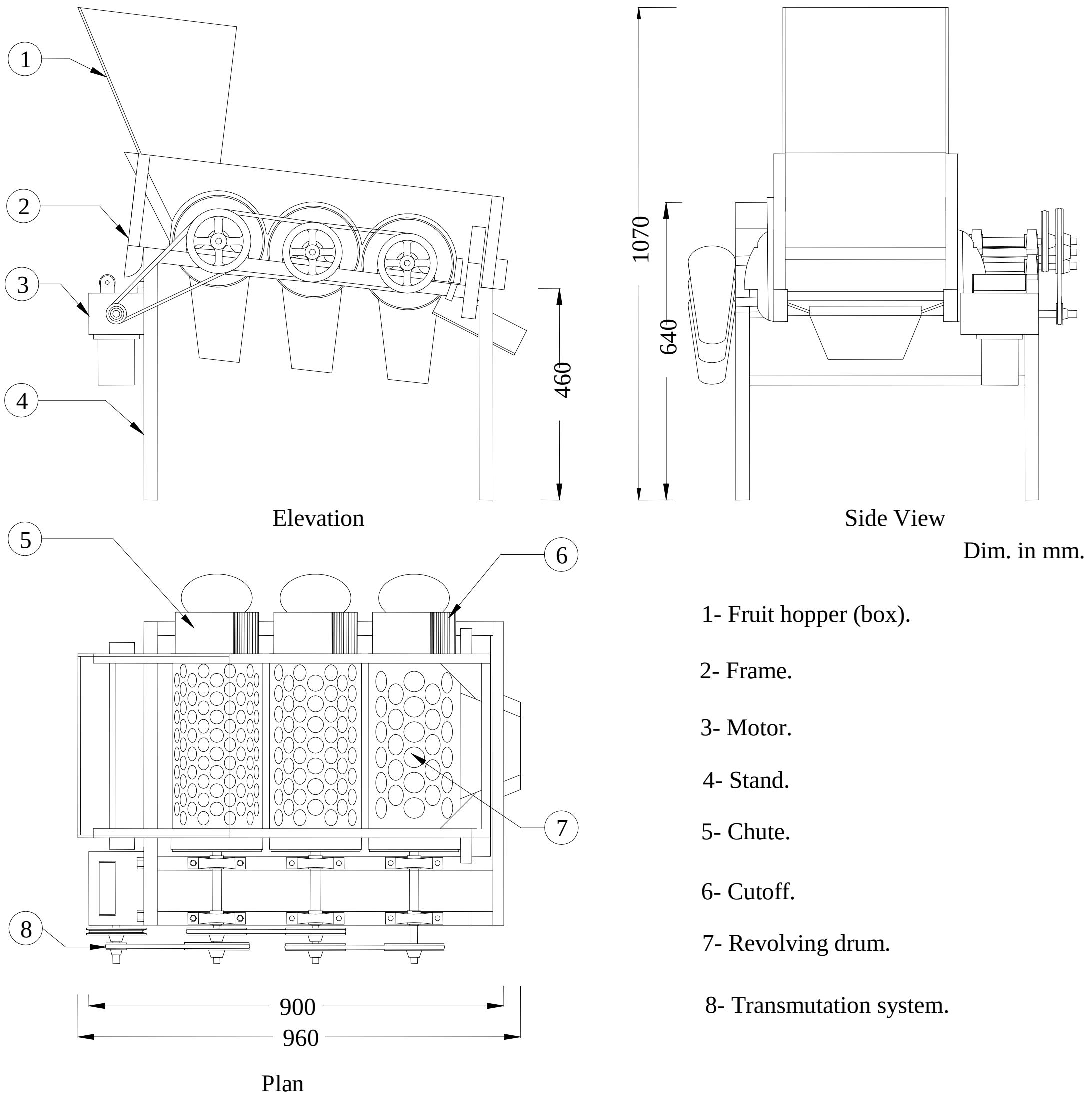
Feeding box: Made of wood sheet of 6 mm thickness, top dimensions of 350 x 330 mm and bottom dimensions of 350 x 80 mm. It was constructed in such a way to give suitable slope of 60 degree for the materials to slide smoothly to grading unit. The slope angle was determined according to friction angle. The capacity of feeding box is about 20 kg of apricot fruits.

Fruit bin: made of wood sheet with thickness of 24 mm and dimensions of 800 x 525 x 270 mm. The fruit box was supported with rear side of fruit bin by two bolts. The rear side of the fruit bin is inclined with horizontal plane by 7^0.

Grading revolving drums: Three cylinder rolls made of PVC have 6 mm spacing and 4 mm thickness (fig. 2a). All rolls have 200 mm diameter and 430 mm length. Each cylinder have spout in the end to collect the fruits. First cylinder has 111 holes with 35 mm diameter, second cylinder has 104 holes with 40 mm diameter and third cylinder has 77 holes with 45 mm diameter. Iron metal-sheet of 35 mm length, 32 mm width and 1.5 mm thickness was assembled upper grading-drums spacing and bolted on two sides of fruit bin. Each roll is suspended on the frame by two bearings. It is driven by pulley and belts attached with an electrical motor, as one pulley is fixed on each drum.

Fruit cutoff and chute: Made PVC sheet with length of 450 mm and width of 160 mm. Three fruit cutoffs were passed inside the three grading drums and were hinged with left side of frame by cantilevers. The fruits roll on the concaved part of cutoff (chute) and drop into funnels. The curved part prevents the jamming of fruits. The total inclined-angle of cutoff and chute is 11.5^0.

Power transmission: An electrical motor with power of 0.225 kW (0.3 hp) is used to operate grading machine. Chains and sprockets were used to transmit the available power from the motor driven shaft to each cylinder in grading units.



Dims. in mm.

Fig. 1: Views of grading-machine for fruits.

<u>A-3) Modification recommendation:</u>

Such development had been introduced to overcome the problems noticed during grading apricot fruits using the ordinary grading machine. The grading machine is not suitable for grading fruits like apricot successfully. The problem here is the difficult to grading apricot fruits and this is because the apricot fruits sensitive fruits for bruising and so easy to have damage in high speed of machine. Therefore, the three grading perforated-rolls were coated by rubber (fig. 2b) to decrease the impact force between cylinder and fruits. Also, the grading speed was decreased by change the pulley diameters to decrease the fruit damage.

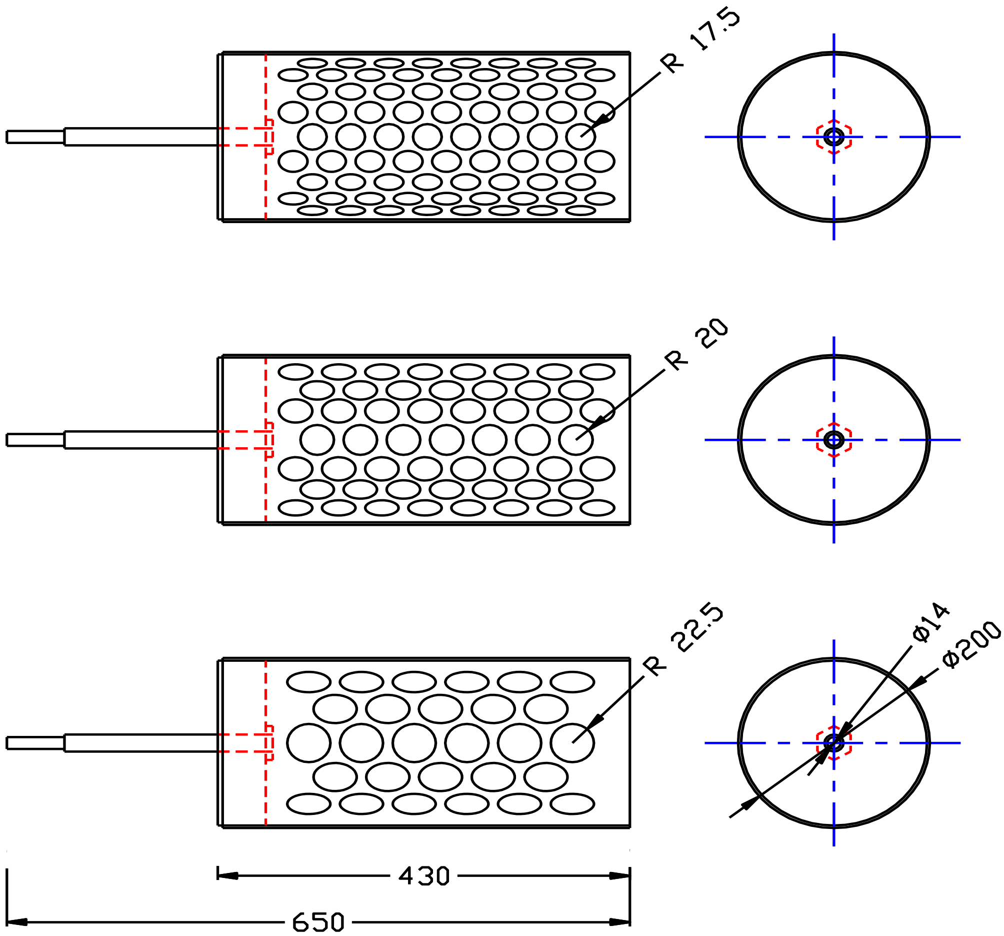


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Fig. 2a: Grading revolving drums before modification

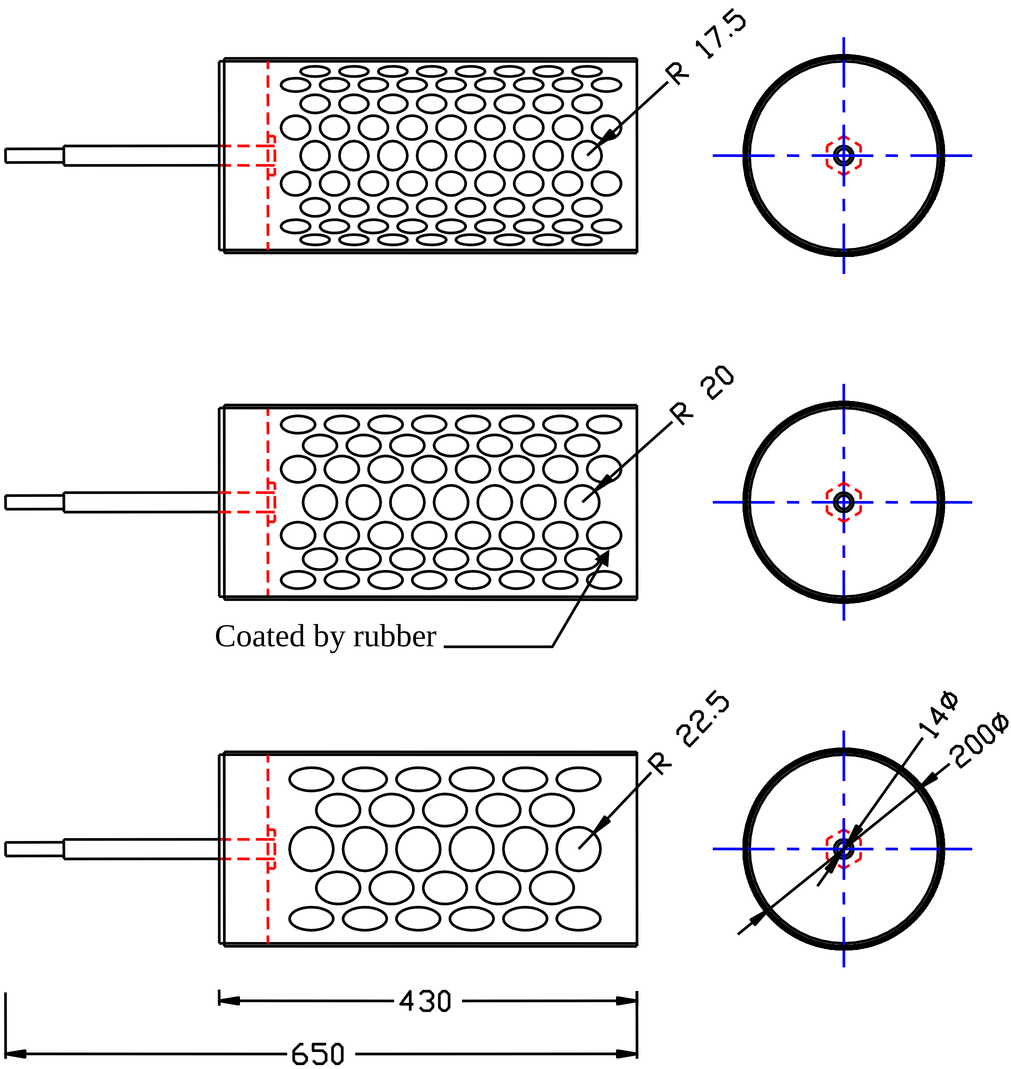

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Fig. 2b: Grading revolving drums after modification

A-4) Instruments:

-Digital balance: With accuracy of 0.2 g, to measure mass of fruit.

Speedometer: With accuracy of 1 %, to measure the rotational shaft-speed (range: 40-5000 rpm direct reading).

-Digital caliper with venire: With accuracy of 0.01 mm, to measure different dimensions of fruits.

-Graduated cylinder: Of 1000 ml with accuracy of 25 ml, to determine the real density and volume of fruit by immersion in water.

-Friction and rolling-angle measuring device: Used to measure friction and rolling angle, with accuracy of 0.1 degree.

B) Methods:

B-1) The studied variables:

The following variables were tested to show their effect on grading efficiency, fruit damage and productivity:-

1- **Grading speed:** Four different grading speeds 5, 8, 11 and 14 rpm (0.05, 0.08, 0.12 and 0.15 m/s).
2- **Fruit batch:** Four different feed batch of 5, 10, 15 and 20 kg.
3- **Type of grading cylinder:** Two different types of PVC and rubber coated.

B-2) Physical properties of the apricot fruits:

A random sample of one hundred fruits was taken from apricot (Canino variety) to measure physical properties.

The shape of apricot (Canino variery) was studied in terms of fruit height (H) and diameter (D) in mm. The digital caliper was used to measure different principal dimensions of fruit. Fruit shape index was taken as mentioned by **Buyanov and Voronyuk, (1985).** The following equations were used to calculate sphericity, projected area and real density according to **Mohsenin, (1986)** as follows:

$$\text{Sphericity ratio} = H / D \qquad \text{-------------------(1)}$$

$$\text{Projected area} = \pi /4 (H*D),\ cm^2 \qquad \text{-------------------(2)}$$

$$\text{Real density} = \text{mass / real volume},\ g/cm^3 \qquad \text{-------------------(3)}$$

B-3) Mechanical properties of the apricot fruits:

Rolling-angle measurement:

The fruits are placed on a horizontal surface one by one then the angle of inclination is gradually increased until the fruits begin to roll. For each fruit of an average sample (50), the angle was determined for the maximum stable.

Friction-angle measurement:

The fruits are placed as a group bounded together on a horizontal surface then the angle of inclination is gradually increased until the fruits begin sliding without rolling. For each fruits group of an average sample (10), the friction angles were determined.

B-4) Machine performances:

Grading productivity: Was calculated by using the following formula according to **Amin (1994)**:

$$P = \frac{3600 * M}{T} \quad \text{------------------------------------(4)}$$

Where: P = Grading productivity, kg/h. M = Mass of sample, kg and
T = Time in seconds.

Grading efficiency: The grading efficiency (μ) of each outlet has been calculated according to **Amin (1994)** as follows:

$\mu_1 = M_{o1}/M_{i1}$, $\mu_2 = M_{o1}/M_{i1}$, $\mu_3 = M_{o1}/M_{i1}$, **and** $\mu_4 = M_{o1}/M_{i1}$ **-----(5)**

Where: μ_1, μ_2, μ_3 **and** μ_4: Grading efficiency of fruits for each outlet in the machine, %.

M_{i1}, M_{i2}, M_{i3} **and** M_{i4}: Mass of each class inside fruit hopper, kg and M_{o1}, M_{o2}, M_{o3} **and** M_{o4}: Mass of the fruit for each outlet in the machine, kg .

Machine grading efficiency (Total grading efficiency): The total grading efficiency machine (μ) has been calculated using the following equation:

$$\mu = (\mu_1 + \mu_2 + \mu_3 + \mu_4) / 4 \quad \text{---(6)}$$

Mechanical damage: Percentage of mechanical damage was calculated by using the following formula:

$$Df = \frac{Nd}{Nt} x\,100 \quad \text{---(7)}$$

Where: N_d = Number of damaged fruits and N_t = Total number of fruits.

Estimating the costs of using the machine: The operation cost of grading machine was calculated according to the following equation given by **Awady, 1978 (updating 1998)** modified for electrical motor drive:

$$C=P/h(1/a+I/2+t+r)+(w.e)+m/144 \quad \text{-----------------------------(8)}$$

Where: C = hourly cost, P = price of machine, h = yearly working-hours, a = life expected of machine, I = interest rate/year, t = taxes and overhead ratio, w = power of motor in kW,e= hourly cost/kW.h, and m/144 = monthly wage ratio.

Notice that all units have to be consistent to result in " C = LE/h".

Operating cost (L.E./Mg) = machine cost (LE/h) / machine productivity (Mg/h) ---(9)

RESULTS AND DISCUSSION

1) Physical properties of Canino apricot fruits:

Table 1 shows dimensions, sphericity, mass, volume and bulk density of Canino apricot variety fruits. These data were measured of 100 fruit sample, according to the standard set in **(Mohsenin 1986).**

Table 1: physical properties of canino apricot variety.

Physical properties	Max.	Min.	Average
Diameter, mm	47	35	40
Height, mm	44	33	38
Sphericity	1.3	1.0	1.15
Mass, g	41	32	36
Volume, cm^3	50	32	40
Bulk density, g/ cm^3	0.9	0.81	0.95

Dimensions of fruit:

Table 1 shows that the fruit diameter (D) and height (H) ranges of sample were 35 - 47 mm (average 40 mm) and 33-44 mm (average 38 mm) respectively. Fig. 3 indicates the percentage of frequency is 55 % for apricot fruits at mean fruits diameter of about 37 mm and mean fruits height of about 40 mm with the percentage of frequency 45 %.

Shape and size:

If sphericiety is less than 0.9, the fruit belongs to oblate group, if it is greater than 1.1 it belongs to oblong group, the remaining fruits with intermediate index values are considered to be round **(Buyanov and Voronyuk, 1985).** Table 1 indicates that the fruit sphericity ranged in sample between 1-1.3 % (average 1.15 %) of canino apricot variety.

Mass, volume and bulk density:

Table 1 indicates that the canino apricot mass and volume ranges of sample were 32-41 g, (average 36 g) and 32-50 cm^3 (average 40 cm^3), respectively. Also, from Table 1, the fruit bulk density of sample were 0.81-0.9 g/cm^3 (average 0.95 g/cm^3).

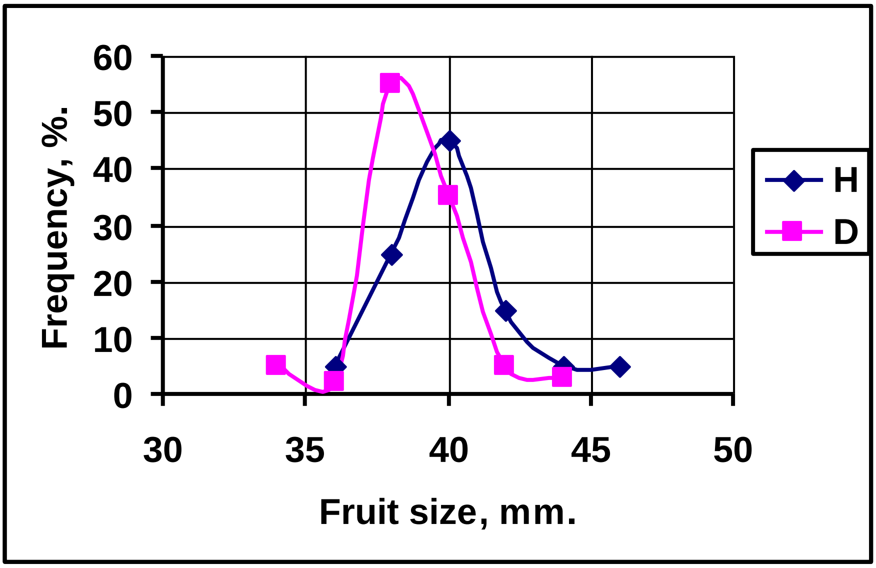

Fig. 3: Frequency curves distribution of fruit dimensions of apricot.

2) Mechanical properties of the fruits:

Table 2 shows friction and rolling angles of Canino apricot variety. The maximum friction angle 36 - 39 degree (average 37.5) and rolling angle 20-30 degree (average 25 degree) were obtained with wood surface. Whereas, the minimum range of friction angle 12-14 degree (average 13 degree) and rolling angles 12-18 degree (average 15 degree) were obtained metal and stainless steal surface.

Table 2: Mechanical properties of Canino apricot variety.

Surface type	Friction angle, degree			Rolling angle, degree		
	Max.	Min	Av.	Max.	Min	Av.
Wood	39	36	37.5	30	20	25
Metal	14	12	13	18	12	15
Stainless steal	14	12	13	18	12	15
PVC	15	12	13.5	21	19	20

3) Effect of grading speed and fruit batch on grading efficiency of four fruit-classes (sizes):

Fig. 4 shows the effect of grading speed and fruit batch on grading efficiency of four fruit-sizes using rubber coated cylinder.

By increasing grading-speed and fruit batch the grading efficiency decreased in general for apricot fruits at different fruit size**.**

There was a negative effect by increasing grading speed from 5 to 14 rpm. And fruit batch from 5 to 20kg.

The maximum grading efficiencies of 98.9, 98.9, 98.9 and 100 % for fruit sizes 35, 40, 45 and > 45 mm respectively were obtained with grading speed of 5 and 8 rpm (0.05 and 0.08 m/s) and fruit batch of 5 kg. Meanwhile, the minimum grading efficiencies of 79.43, 84.15, 75 and 100 % for fruit sizes 35, 40, 40 and > 45 mm respectively were obtained with grading speed of 14 rpm (0.15 m/s) and fruit batch of 20 kg.

The grading machine efficiency decreased by increasing grading speed is due do quick fruits passing over the grading revolving drums so decreasing the grading time of grading fruits. Meanwhile, the decreasing grading machine efficiency by increasing fruit batch is due to the fruits accumulated on the surface of drums.

4) Effect of grading speed and fruit batch on machine grading efficiency (total grading efficiency):

Fig. 5 shows the effect of grading speed and fruit batch on machine grading efficiency by rubber coated cylinder.

By increasing grading-speed and fruit batch the grading efficiency decreased in general. There was a negative effect by increasing grading speed from 5 to 14 rpm., and increasing fruit batch from 5 to 2o kg.

By increasing grading speed from 5 to 14 rpm the machine grading efficiency decreased from 98.41 to 93.26 % at fruit batch of 10 kg and rubber coated cylinder. The grading machine efficiency decreased by increasing grading speed is due do quick fruits passing over the grading revolving drums so decreasing the grading time of grading fruits. Meanwhile, the decreasing grading machine efficiency by increasing fruit batch is due to the fruits accumulated on the surface of drums.

The maximum grading efficiency values of 98.41 % were obtained with grading speed of 8 rpm. and fruit batch of 10 kg.

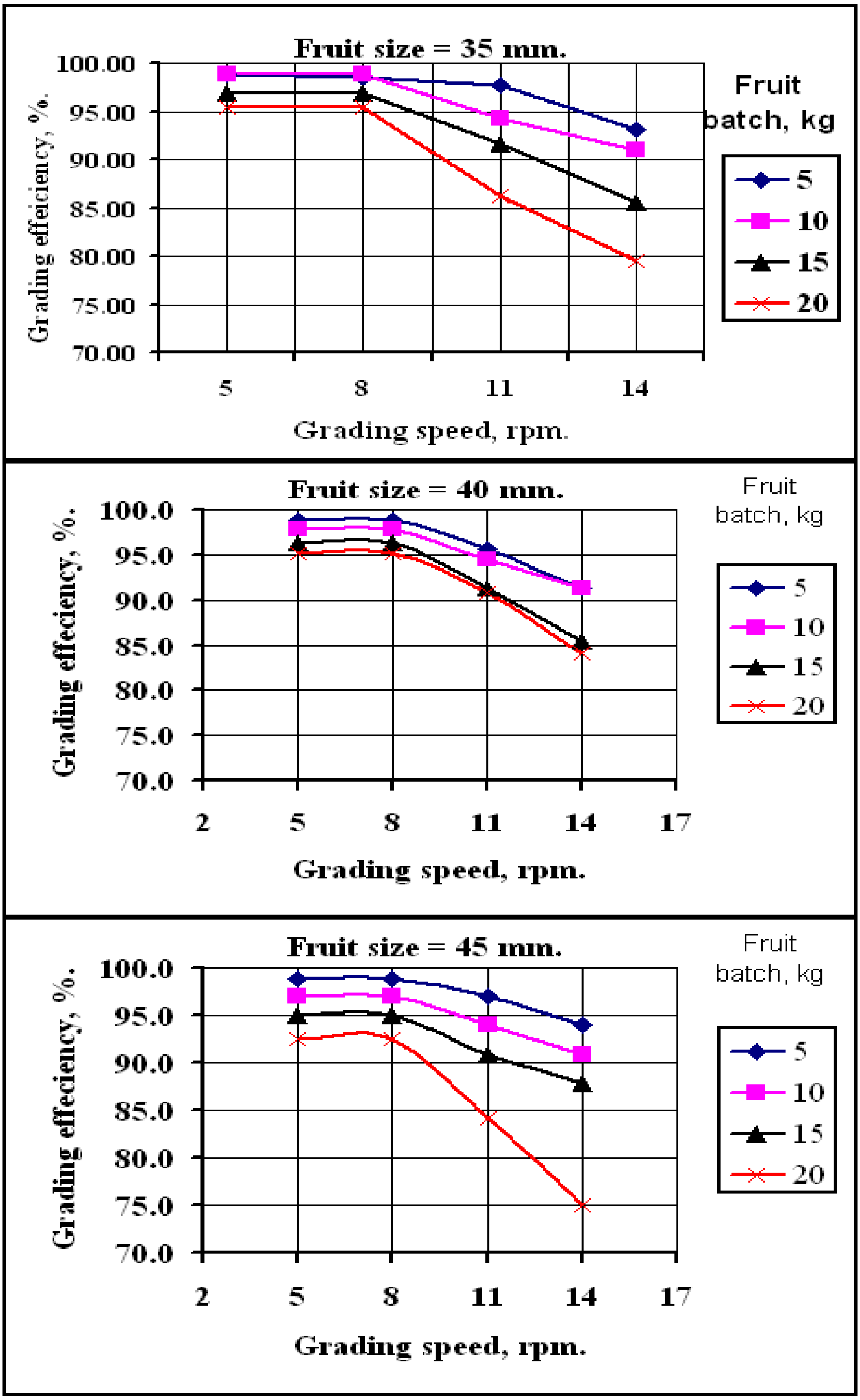

Fig. 4: Effect of grading speed, hole diameter of grading drums and fruit batch on grading efficiency.

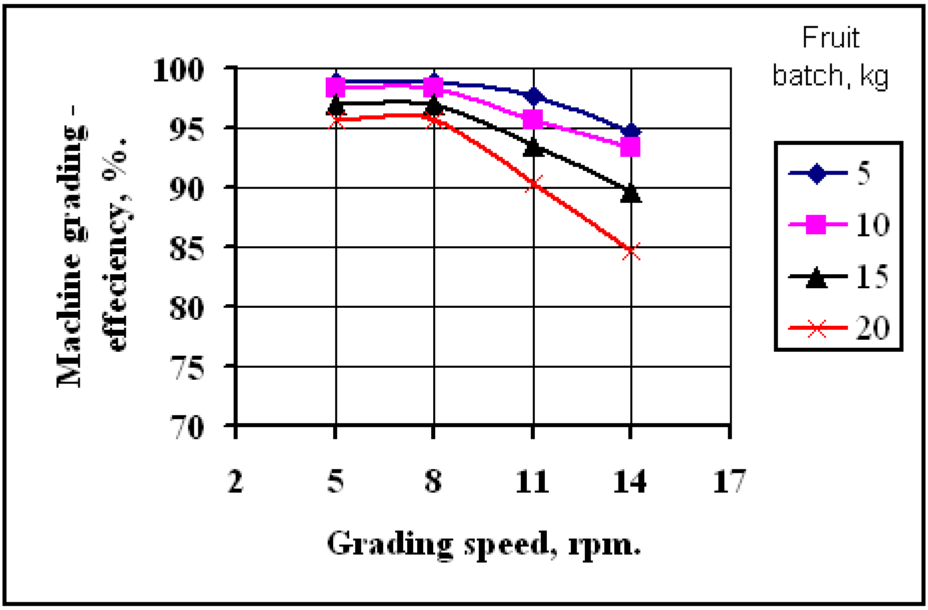

Fig. 5: Effect of grading speed and fruit batch on machine grading efficiency.

5) Effect of grading speed, fruit batch and type of grading cylinder on fruit damage:

Fig. 6 shows the effect of grading speed, fruit batch and type of grading cylinder (P.V.C. cylinder and rubber coated cylinder method) on fruit damage.

The fruit damage increased by increasing grading speed and decreased by increasing fruit batch in general for methods of P.V.C. cylinder and rubber coated cylinder.

The methods of rubber coated cylinder give lowest fruit damage comber with P.V.C. cylinder.

The maximum fruit damage of 9.22 % was obtained with grading speed of 14 rpm (0.14 m/s) fruit batch of 5 kg. and P.V.C. cylinder method. Meanwhile, the minimum fruit-damage of zero % was obtained with grading speed of 5 and 8 rpm (0.05 and 0.08 m/s), fruit batch of 5 kg and coated cylinder method.

The percentage of fruit damage increased from 0.0 to 1.42 % as the grading speed increased from 5 to 14 rpm at fruit batch of 5 kg respectively for the method of rubber coated cylinder, while it was increased from 2.84 to 9.22 % for the method of P.V.C. cylinder at the same conditions.

The increasing of fruit damage by increasing grading speed is due to increasing impact force among fruits surface and grading drums. Meanwhile, the increasing of fruit damage of p.v.c. cylinder is due to increasing friction among fruits surface comparing with rubber coated cylinder.

The fruit damage values was zero % were obtained with grading speed of 8 rpm, fruit batch of 10 kg. and rubber coated cylinder

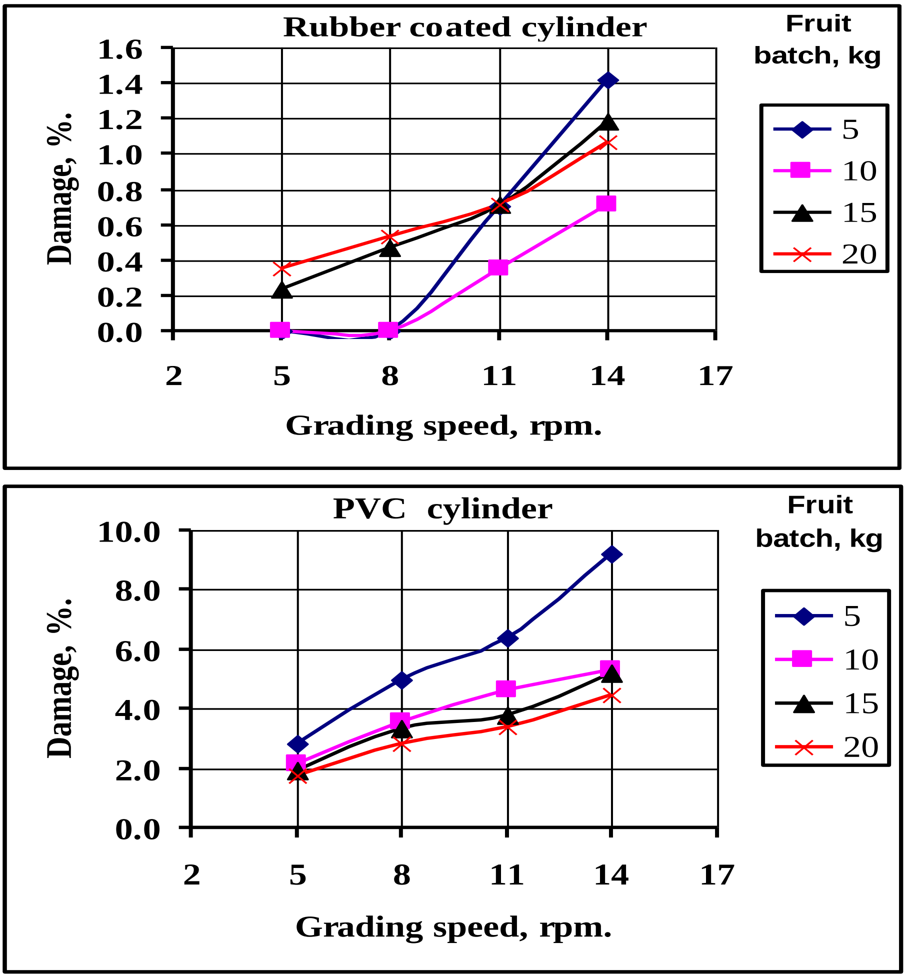

Fig.6: Effect of grading speed, fruit batch and type of grading cylinder (P.V.C. cylinder and rubber coated cylinder method) on fruit damage.

6) Effect of grading speed and fruit batch on grading productivity:

Data in Fig.7 shows the effect of grading-speed and fruit batch on grading productivity by using rubber coated cylinder

By increasing grading-speed and fruit batch the grading productivity increased in general for apricot fruits.

The highest productivity value was 1180.33 kg/h. these values were obtained by using high operating speed of 14 rpm and high fruit batch of 20 kg. Meanwhile, the lowest productivity was 327.27 kg/h. obtained by using low operating speed of 5 rpm and low fruit batch of 5 kg. (fig. 7).

The productivity of 610.17 kg/h was achieved with grading speed of 8 rpm., fruit batch of 10 kg. and rubber coated cylinder**.**

The increasing of grading-machine productivity by increasing grading speed and fruit batch is due to decreasing the time of grading and fruit mass respectively.

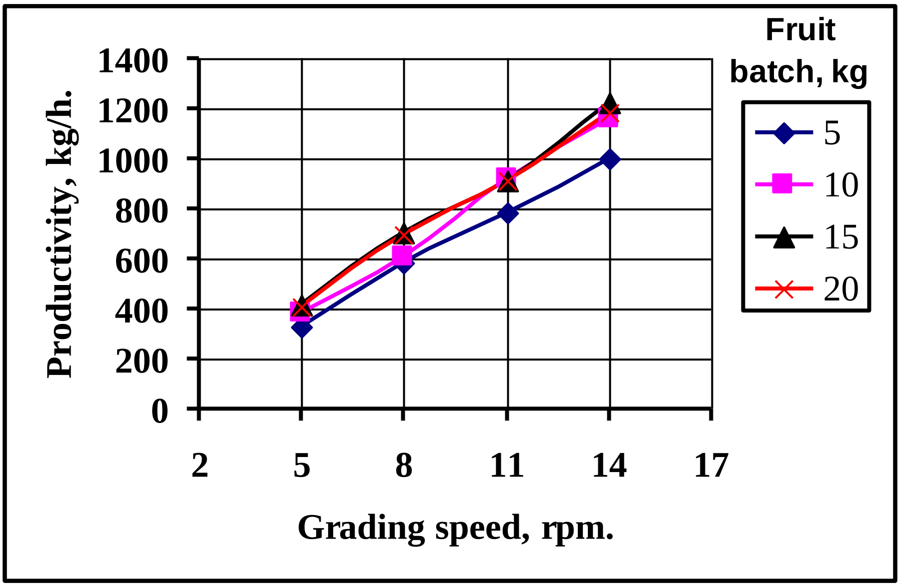

Fig.7: Effect of grading speed and fruit batch on grading productivity.

It was found that the acceptable values for grading efficiency of 98.41 %, fruit damage of zero % and productivity of 610.17 kg/h. These values were obtained at grading speed of 8 rpm, fruit batch of 10 kg. and rubber coated cylinder**.**

7) Estimating the cost:

It was found that the operation costs of the grading machine were 7.37 L.E./h and 12.1 L.E./Mg.

COUNCLUSION

Physical and mechanical properties of apricot fruits (Canino variety) under study, grading efficiency, fruit damage and productivity using constant grading tilt angle of 7^o on grading efficiency, fruit damage and productivity, were studied to evaluate the performance of developed grading machine.

The optimum conditions of grading machine to be operated at the maximum efficiency are: Grading speed of. 8 rpm., fruit batch of 10 kg and rubber coated cylinder. Achieved grading efficiency of 98.41 %, fruit damage of zero %, and productivity of 610.17 kg/h. Operation costs was 7.37 L.E./h and 12.1 L.E./Mg.

REFERENCES

Abd-Alla, H., 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.

Agric. Statistics Economic Affairs Sector, (2006). Data on citrus statistices, Oral com Prof. Dr. Latif, Sen, Res., Citrus Div., Hort.Res. Inst., A.R.C.

Amin, E. E. A. A. (1994). Development of a grading machine for some horticulture farm crops. J.Agric. Sci. Mansoura Univ. 19(7) :3139-3149.

Awady, M. N. (1978) (updating 1998). Engineering of tractors and Agricultural machinery. TextBook., col. Ag., Ain-shams Univ., 5 th. Ed.,: 164-167. (In Arabic).

Buyanov, A. I. and B. A. Voronyuk (1985). Physical and mechanical properties of plant, Fertilizers and soils. Amerind Pub. Co., PVT., LTD., New Delhi, India. 753 P.

El-Raie, A. E., A. F. El-Sahrigi and M. M. Mousa (1998). Engineering factors affecting the development of grading machine for fruits. 6th Conference of Misr Society of Ag. Eng., 21-22 Oct.: 79-90.

EL-Raie, A., I. Yehia, M. Attallah, and K. S. Khalil (2012). Factors affecting the design a grading machine for lemon fruits, Misr J. Ag. Eng., 37(2): in Press.

Genidy, S. K. A. (2003). Manufacturing and performance evaluation of a locally machine grading of some vegetables and fruits. Ph. D. thesis Agric. Eng, Dept., Fac. Of Agric., Kafr-El Sheikh, Tanta Univ.

Haydar H., I. Gezer, M. M. Ozcan And B. MuratAsma (2007). Post harvest chemical and physical–mechanical properties of some apricot varieties cultivated in Turkey. Journal of Food Engineering 79 : 364–373.

Hojat A., H. Fathollahzadeh and H. Mobli (2008). Some Physical and Mechanical Properties of Apricot Fruits, Pits and Kernels (C.V Tabarzeh) American-Eurasian J. Agric. and Environ. Sci., 3 (5): 703-707.

Matouk, A. M., A. M. El-Gengy, Y. M. El-Hadidi, E. A. Amin, and M. M. Abd El-Rahman (1999). Evaluation the effect of some mechanical parameters on handling characteristics of sphere-like crops. Misr J. Agric. Eng., 16(4):701-719.

Mohsenin, N. N. (1986). Physical properties of plant and animal materials. Gorden and Breach Sc. Pub., N. Y.

Mostafa, H. M. S. (2003). Development an appropriate system for onion grading. Unpublished M. Sc. Thesis. Fac. Of Agric. Moshtohor. Zagazig Univ. Benha Braanch.

Mousa, M. M. (1998). Engineering factors affecting the development of grading machine for citrus, Ph. D., Fac. of Ag., Cairo U.: 126-255.

Patrick, C. (2002). Systems for pre-sprouting potatoes, crops technologist, green mount agricultural college, N. I., National Potatoes Conference, February, Burdens Distribution Ltd:1-2.

Xiaoyang, G, P. H. Heinemann and J. lrudayaraj (2003). Non-destructive apple bruise on line test and classification with Raman spectroscopy. Paper No:033025 an ASAE meeting presentation July 27-30.

Yıldız, F. (1994). New technologies in apricot processing. Journal of Standard, Apricot Special Issue, Ankara, pp. 67–69.

الملخص العربى

تطوير الة لتدريج ثمار المشمش

د.محمد طة عبيد (١)، د.مرفت عطاالله (٣) ، د. خليل سيد خليل(٢)

يعتبر محصول المشمش من أهم المحاصيل الزراعية فى مصر لما لها من أهمية تصديرية وكذلك استخدمات عديدة فى كثير من الصناعات الغذائية. حيث تبلغ المساحة المنزرعة من محصول المشمش حوالى ١٧.٧٨٦ فدان بإنتاجية ٥.٣ ميجا جرام /فدان ، بإنتاجية ٦٢.٦١٣ ميجا جرام /سنة. يعتبر المشمش من محاصيل الفاكهة ذات النواة الحجرية.

تعد عملية تدريج ثمار المشمش ومداولتها وخاصة الطرية منها في غاية الاهمية وذلك للمحافظة على نوعيتها الجيدة وتقليل التلف واطالة عمر التخزين فالتداول غير السليم للثمار يؤثر مباشرة على الصفات التسويقية للثمار فالرضوض والاضرار الاخرى تظهر على الثمار بشكل بقع بنيه او سوداء مما يقلل من جاذبيتها اثناء التسويق كما ان الجروح والخدوش تعمل على سهولة دخول الكائنات الحية الدقيقة والمسببة لتعفن الثمار. يتبين من الامور اعلاه ان عدم التدريج الصحيح يسبب خسائر كبيرة في كمية المحصول ونوعية وعمر خزنه واسعار البيع والارباح الممكن تحقيقها منها ويجب ان تدرج ثمار المشمش وخاصة الطرية منها لغرض الاستهلاك الطازج او بغرض التخرين.

يتناول هذا البحث دراسة العوامل المؤثرة فى كفاءة عملية التدريج وحساب تكاليف التشغيل وتقدير نسبة التلف الميكانيكى والإنتاجية، وذلك للحصول على عوامل تطوير الجهاز والخروج بتصميم مناسب واقتصادي للظروف المحلية مع التوصيات لأفضل عوامل التشغيل باستخدام نوع من المحاصيل التصديرية الهامة فى مصر وهو المشمش (صنف الكانينو).

وقد تم تغيير سرعة التشغيل في المدى ٥-١٤ لفة/دقيقة ،ودفعة التغذية فى المدى ٥-٢٠ كج ونوعين من الدرافيل الدوارة PVC والمطاط، وكذلك دراسة الخواص الطبيعية والميكانيكية لمحصول المشمش.

خرجت النتائج بالتوصيات التالية: للحصول على أعلى كفاءة تدريج وأقل تلف ميكانيكي للثمار (في ظروف هذا البحث): سرعة التشغيل ٨ لفة/دقيقة ، ودفعة تغذية ١٠ كج. والدرفيل المغطى بالمطاط.

وفى هذه الظروف بلغت كفاءة التدريج ٩٨.٤١ ٪، ونسبة التلف الميكانيكي صفر ٪ والانتاجية ٦١٠.١٧ كجم/ساعة وتكلفة التشغيل ٧.٣٧ جنية/ساعة (١٢.١ جنيها/ميجاجرام).

(١)، (٢) باحث اول، وباحث على الترتيب، معهد بحوث الهندسة الزراعية.