Zagazig J. Agric. Res., Vol. 41 No. (3) 2014 609-620

Zagazig Journal of Agricultural Research

http:/www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master

# EFFECT OF SOME ENGINEERING PARAMETERS ON MECHANICAL WATERMELON SEEDS EXTRACTION

**Mohamed A. Abdeen*, M.A. El-Shazly, M.A. Arnaout and M.K. Afify**

Agric. Eng. Dept., Fac. Agric., Zagazig Univ., Egypt

## ABSTRACT

A machine of watermelon seed extraction was evaluated for performance by conducting some experiments at Agricultural Engineering Dep., Faculty of Agriculture, Zagazig University, Sharkia Governorate, during the summer season of 2012-2013. The effect of different operating and engineering parameters was studied to evaluate the machine and choose the proper conditions for seed extracting with least losses and costs under Egyptian conditions. The machine performance was evaluated taking into consideration: machine productivity, extraction efficiency, seed losses, seed damage, energy requirements and cost. Variables of these work are three feeding rates about (20, 30 and 40 kg/min), four different separating unit speeds of 150, 200, 250 and 300 rpm (0.47, 0.63, 0.79 and 0.94 m/sec), three different dimensions ratio of separating unit (0.38, 0.30 and 0.25) and four span time between harvesting and extracting (0, 3, 5 and 7 days). From the obtained data it was concluded that; extracting at the fifth day, 30 kg/min feeding rate, 0.79 m/sec flesh cutting unit speed and 0.30 flesh cutting unit dimensions ratio are considered the proper values for seeds extracting.

**Key words:** Watermelon, seeds extracting, watermelon seeds, cleaning unit.

## INTRODUCTION

Agriculture will remain the major source of income for most third world countries (like Egypt). Consequently, agricultural researchers have to develop the agricultural machines and equipment in order to obtain high efficiency and production. Watermelon (*Citrullus lanatus*) is a vegetable crop which belongs to a Cucurbita family and its seeds are strategic vegetable product in Egypt that can be exported to several Arab countries.

Chen *et al.* (1996) indicated that in order to increase watermelon seed production quantity and quality, the agricultural engineering specialists have realized the need to develop, use, and improve modern watermelon machinery technology. Numerous attempts have been made to transfer appropriate machinery technology for different Egyptian field operations. Those saved the efforts, and time of the farmers, and consequently saving several millions of pounds in Egyptian economy.

* **Corresponding author: Tel.** : +201113738031
**E-mail address:** mohamed.anwer2010@yahcoo.com

Hassan (2000 in Arabic) indicated that a great future is waiting production of watermelon seeds in the developing countries (including Egypt) due to two reasons: high contents of proteins and fats and proper contents of amino and fatty acids. The second may be attributed to availability of plantation in different soils and environmental conditions.

Abo-Haded (2003) reported that the available figures of the annual foreign trade bulletin (CAMPAS, 2000) indicate that moreover, 50% of the vegetables and fruits exports are forwarded to the Arabic countries. In addition, watermelon seeds represent 4% of total Egyptian agricultural exports. Thus watermelon seeds come as an important vegetable crop with a good exportation potentiality. This is especially true since Egypt enjoys a comparative advantage in both its production and exportation.

Amir (2004) manufactured and evaluated a locally prototype for extracting watermelon seeds, using the developed equipment saved extraction cost and time by 50 and 62% compare to manual method. To obtain maximum watermelon extracting and cleaning efficiency, the machine adjusting the following conditions: 60 kg/min feed rate, 4.71 m/sec drum speed, 4 knifes on the drum, 40 mm clearance between drum and concave, 8 cleaning brushes with 4.71 m/sec speed, and extraction operation must be done after 7 days after harvesting.

Fouad (2004) designed a machine for seed extraction by a combination of impact and rubbing actions. He mentioned that the date of processing, brush speed and brushes number have positive relationship with cleaning efficiency. He added that the maximum values of 94.47% of cleaning efficiency were achieved with the 60 kg/min feed rate, 4.71 m/sec drum speed, 4.71 brush speed, 8 brushed number and time of extraction after seven days from the watermelon harvesting. He added that the feed rates, drum speed and knives number have positive relationship with consumed power. He added that the minimum and maximum values of 8.57 and 16.83 kW power consumed at 60 and 90 kg/min feed rate, 4.71 and 11.79 m/sec drum speed with 2 and 8 knives number respectively.

El-Gaddi *et al.* (2011) designed, fabricated and evaluated for performance a low cost summer squash seed extraction machine. He found that the extraction cost by the developed machine was calculated at 20.83$/t compared to 192$/t for manual extracting. Therefore, a saving of more than 89% in extraction cost can be achieved utilizing the developed machine.

Eliwa and El-Fatih (2012) developed and evaluate a machine for watermelon seeds extraction and cutting peel to maximize it as a green food for animals. The result indicated that minimum percentage of seed losses and damage valued 1.2% and 0.13% respectively and maximum value of seed extraction efficiency 98.7% was obtained at 250 rpm flesh cutting unit speed, circular concave hole and two days span time after harvesting. Also, they found that the extraction cost by the developed machine was 219.38 L.E/fad., which the manual cost 1200 L.E/fad. Hence, a saving of above 81.72% can be achieved as well as about 6.7 ton/fad., green fodder for animals.

Therefore, the objectives of this work are to:

1. Select the proper operating and engineering parameters affecting the mechanical watermelon seed extraction performance.
2. Evaluate the mechanical seed extracting machine from the economical point of view.

## MATERIALS AND METHODS

A watermelon seeds extracting machine was evaluated for performance by conducting some experiments at Agricultural Engineering Dep., Faculty of Agriculture, Zagazig University, Sharkia Governorate, during the season of 2012-2013. The effect of different operating and engineering parameters such as (feed rate, flesh cutting unit speed, flesh cutting unit dimensions ratio and span time after harvesting before extracting) on watermelon seed extracting machine was studied to choose the proper conditions for seed extracting with least losses and costs under Egyptian conditions.

Watermelon (*citrullus lanatus.*) was sown on April and harvested during July, some physical properties of watermelon fruits and seeds were measured, preliminary experiments were carried out. After ending the required experiments, modifications and adjustments, the machine became ready for the fieldwork.

### Materials

#### Watermelon fruits

Watermelon fruits (*citrullus lanatus.*) were cultivated to obtain seeds, most of fruits are varying in shape and volume.

#### Extracting machine

Main machine parts dimensions were chosen depending on the measured physical and mechanical properties of fruits and seeds.

The extracting machine dimensions are (95, 80 and 110 cm) for length, width and height, respectively. It consisted mainly of separating unit (Flesh cutting unit), cleaning unit, concave, electric motor, transmission system and frame, as shown in Fig. 1.

| No. | Part name |
|---|---|
| 1 | Separating unit |
| 2 | Drum |
| 3 | motor |
| 4 | Seed outlet |
| 5 | frame |

**All dimensions in mm.**

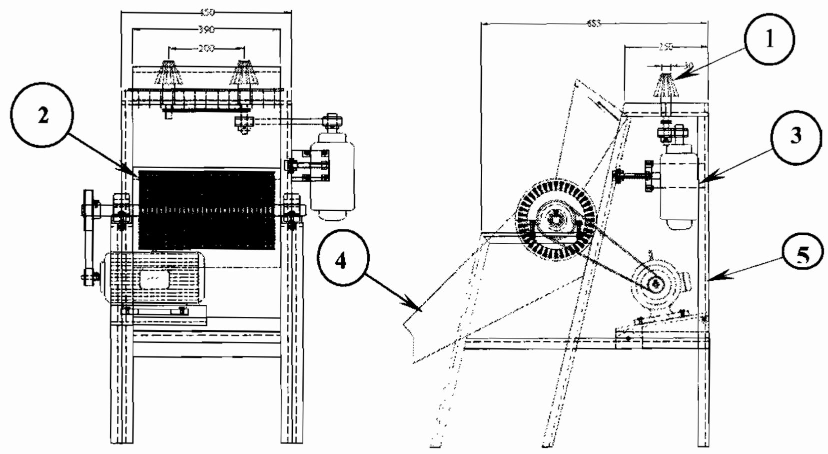



**Fig. 1. The views of seed extraction machine**

## Frame

All machine units and their parts were fixed on the frame which fabricated from steel.

## Separating Unit (Flesh Cutting Unit)

It was at the top of frame and consisted of two rotary conical shaped units(90 mm height) made from aluminum alloys used to separate flesh and seeds from fruit peel after cutting it manually into two parts.

## Cleaning Unit

The cleaning unit was consisted of a rotating drum 180 mm diameter and 450 mm length as shown in Fig. 2. A plastic brushes (40 mm length) was fixed to the circumference of drum, there were screw bolts (30 mm length) distributed in a volute shape on four rows to support and help the plastic brushes to break flesh easily.

## Concave

The concave was constructed from sheet steel of 3 mm thickness, 450 mm length and 190 mm diameter. The concave was perforated with circular holes of 15 mm diameter as shown in Fig. 2.

## Transmission System

Pulley and belts were used as a transmission system to transmit the motion from motor to the movable parts

## Power Source

Two electric motors were used for operating this machine, the first is 1hp to operate flesh cutting unit (separating unit) and the other is 0.25hp to operate the drum (cleaning unit).

## Methods

The germination of seeds inside the fruit almost starts after ten days from harvesting.

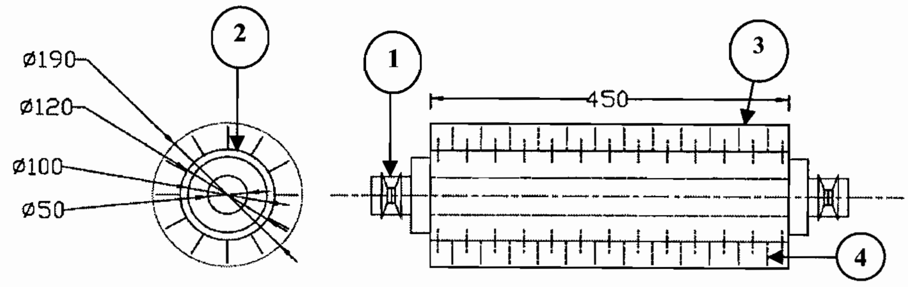
The experiments were done before that time as watermelon fruits were harvested and then, the seeds were extracted by the extraction machine.

The extraction of watermelon seeds from fruits included the following steps:

1. Cutting the fruits manually into two halves by using a knife.
2. Feeding the two halves manually on the two rotary conical units to separate the flesh and seeds from its peel.
3. Separating seeds from flesh using the cleaning drum with plastic brush and screw bolts by supporting of washing water.

A schematic diagram was explained the path of the seeds beginning with put the watermelon fruit on the separation unit to obtain the seeds as shown in Fig. 3.

| No. | Part name |
|---|---|
| 1 | Shaft |
| 2 | Drum |
| 3 | Concave |
| 4 | Plastic brushes |




**Side view** **Elevation**

**All dimensions in mm.**

**Fig. 2. The views of cleaning unit of the seed extraction machine**

1- Watermelon fruit
2- Separating unit
3- Galvanized transfer slope
4- Feeding opening
5- Cleaning drum
6- Concave
7- Seed outlet
8- Sieves
9- Clean seeds
10- Electric motor
11- Main frame
12- Water washing pipe

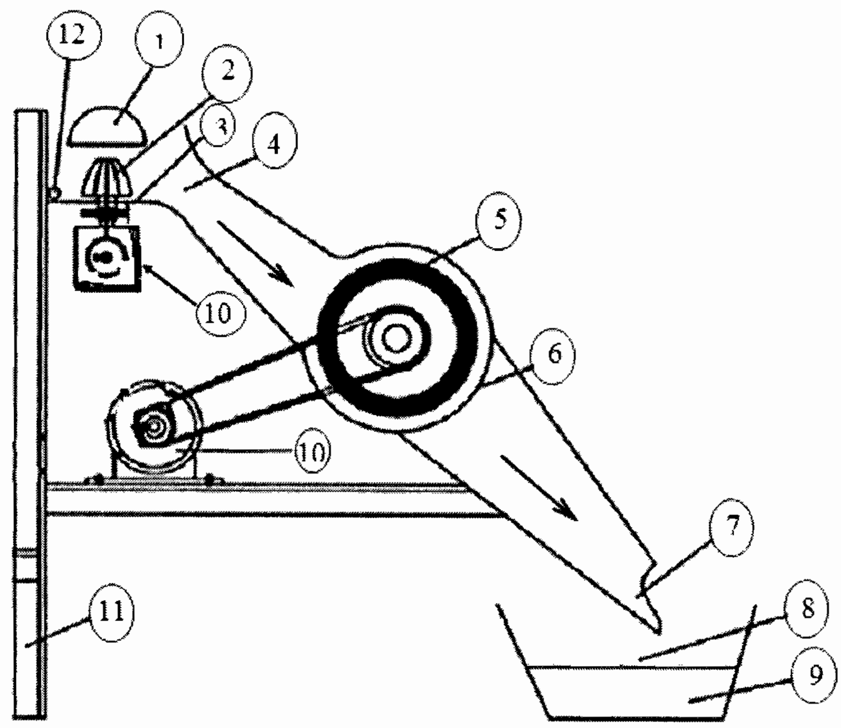



**Fig. 3. A schematic diagram of the extracted seeds path through extracting machine**

## Experimental Conditions

The experiments were conducted under the following variables:

- Four different separating unit speeds of 150, 200, 250 and 300 rpm (0.47, 0.63, 0.79 and 0.94 m/sec).
- Three different ratios between separating unit small and large diameter (0.38, 0.30 and 0.25).
- Three feeding rates about (20, 30 and 40 kg/ min).
- Four different span time from harvesting to extracting operation (0, 3, 5 and 7 days).

Evaluation of the previous variables was carried out taking into consideration the following indicators:

- Machine productivity
- Machine extraction efficiency
- Seed losses
- Seed damage
- Specific Energy
- Criterion cost

## Measurements

### Some physical properties of watermelon fruits

Main parts dimensions of the machine are depending on the measured physical properties of fruits. A random sample of 100 fruits was taken to measure their properties and replicated four times.

### Dimensions of watermelon fruits

The dimensions of watermelon fruits were measured as length and width.

### Mass of watermelon fruits

Mass of watermelon fruits was determined by using balance with an accuracy of 0. 1 g.

### Fruit volume

The volume of watermelon fruits was measured by water displacement method. The displacement volume of water which equal to the sample volume was calculated by the following equation:

$$V = V_1 - V_0$$

Where:

V: Actual fruit volume, $cm^3$

$V_1$: Volume of water, $cm^3$

$V_0$: The recorded volume of water after each sample placing, $cm^3$

### Seed damage

The percentage of seed damage was calculated based on the original weight of sample according to Desta and Mishra (1990).

$$\text{Damage (\%)} = (M_b/M_t)\times 100$$

Where:

$M_b$: Mass of broken seeds in the sample, g.

$M_t$: Total mass of seeds in the sample, g.

### Seed losses

$$\text{Seed losses (\%)} = \frac{M_1}{M_1+M_2}\times 100$$

Where:

$M_1$: Mass of seeds mixed with the expelled peels, g

$M_2$: Mass of cleaned seeds from output opening, g

### Machine extracting efficiency

$$\text{Extracting efficiency (\%)} = (M_c / M_t) \text{ x } 100$$

Where:

$M_c$: Mass of seeds from the output opening, g

$M_t$: Mass of total extracted seeds, g

### Specific energy

The specific energy for operating seed extracting machine was calculated as follow:

$$\text{Specific energy, kW.hr/Mg} = \frac{\text{Required power, kW}}{\text{Machine productivity, Mg/hr}}$$

### Required power

The consumed power (kW) was estimated by the equation of John (1988).

$$P = (I \times V \times \eta) / 1000$$

Where:

P: Required power, kW

I: Current Intensity, Ampere (double phase)

V: The potential difference, voltage (being equal to be 220 V)

$\eta$: Mechanical efficiency (%) (assumed to be 75%)

### Criterion costs

The required criterion costs for seed extraction were estimated according to Kumar and Goss (1980) as following:

Criterion cost, L.E./Mg = Operating cost + Losses cost + Seed damage cost

$$\text{Operating cost, L.E./Mg} = \frac{\text{Machine cost, L.E./hr}}{\text{Machine productivity, Mg/hr}}$$

## RESULTS AND DISCUSSION

The discussion will cover the effect of different operating and engineering parameters on machine performance under the following headings:

### Machine Productivity

By increasing flesh cutting unit speed from 0.47 to 0.79 m/sec, the productivity increased from 103.10 to 106.37 kg/hr. any further, more increase from 0.79 up to 0.94 m/sec the productivity decreased from 106.37 to 103.93 kg/hr, as shown in Fig. 4 that is due to labor less control on holding the fruit within increasing the speed which leads to low machine separating.

From Fig. 4, it noticed that The productivity increased from 102.04 to 106.37 kg/hr by decreasing flesh cutting unit dimensions ratio from 0.38 to 0.30 then productivity decreased from 106.37 to 104.43 kg/hr by decreasing flesh cutting unit dimension from 0.30to 0.25, that is due to increase in separating unit volume that leads to more separation, but any more increase in the volume leads to break fruits and less control from the labor which leads to less separation.

As shown in Fig. 4, the machine productivity increased from 89.54 to 106.37 kg/hr by increasing feeding rate from 20 to 30 kg/min, whereas it decreased from 106.37 to 95.86 kg/hr by increasing feeding rate from 30 to 40 kg/min.

Fig. 4 remarked that increasing span time from 0 to 5 days leads to an increase on machine productivity from 78.50 to 106.37 kg/hr, then there is a decrease from 106.37 to 90.72 kg/hr by any more increase on span time from 5 to 7 days.

The combination of 0.79 m/sec flesh cutting unit speed, 0.30 mm flesh cutting unit dimensions ratio, 30kg/min feed rate and five days span time after harvesting achieved the maximum value of productivity 106.37 kg/hr.

### Extracting Efficiency

By increasing flesh cutting unit speed from 0.47 to 0.79 m/sec, extracting efficiency increased from 97.95 to 99.15%, then the efficiency decreased from 99.15 to 98.86% by increasing flesh cutting unit speed from 0.79 to 0.94 m/sec, as shown in Fig. 5.

The obtained values of extracting efficiency increased from 98.72 to 99.15% by decreasing flesh cutting unit dimensions ratio from 0.38 to 0.30 and the efficiency decreased from 99.15 to 98.53% within more decrease on flesh cutting unit dimensions ratio from 0.30to 0.25.

Results in Fig. 5 illustrated that, extracting efficiency decreased from 99.15 to 98.97% by increasing feeding rate from 20 to 40 kg/min, because the labor don't have enough time to separate all seeds as the feed rate increased .

Increasing the span time from 0 to 5 days tends to increase the extracting efficiency from 98.60 to 99.15%, then the efficiency decreased from 99.15 to 98.95% by increasing span time from 5 to 7 days as shown on Fig. 5.

Finally, it could be noticed from the above mentioned discussion that the operating conditions of 0.79 m/sec flesh cutting unit speed, 0.30 mm flesh cutting unit dimensions ratio, 20kg/min feed rate and five days span time after harvesting achieved the maximum value of extraction efficiency 99.15%.

### Seed Losses

Fig. 6, illustrated that increasing flesh cutting unit speed from 0.47 to 0.79 m/sec, decreased seed damage from 2.05 to 0.85% , then the seed damage increased from 0.85 to 1.14% as the flesh cutting unit speed increased from 0.79 to 0.94 m/sec, due to increasing vibration and instability of the fruit over flesh cutting unit.

The obtained values of seed losses decreased from 1.28 to 0.85% by decreasing flesh cutting unit dimensions ratio from 0.38 to 0.30, then it increased from 0.85 to 1.47% while decreasing flesh cutting unit dimensions ratio from 0.30 to 0.25, as shown in Fig. 6.

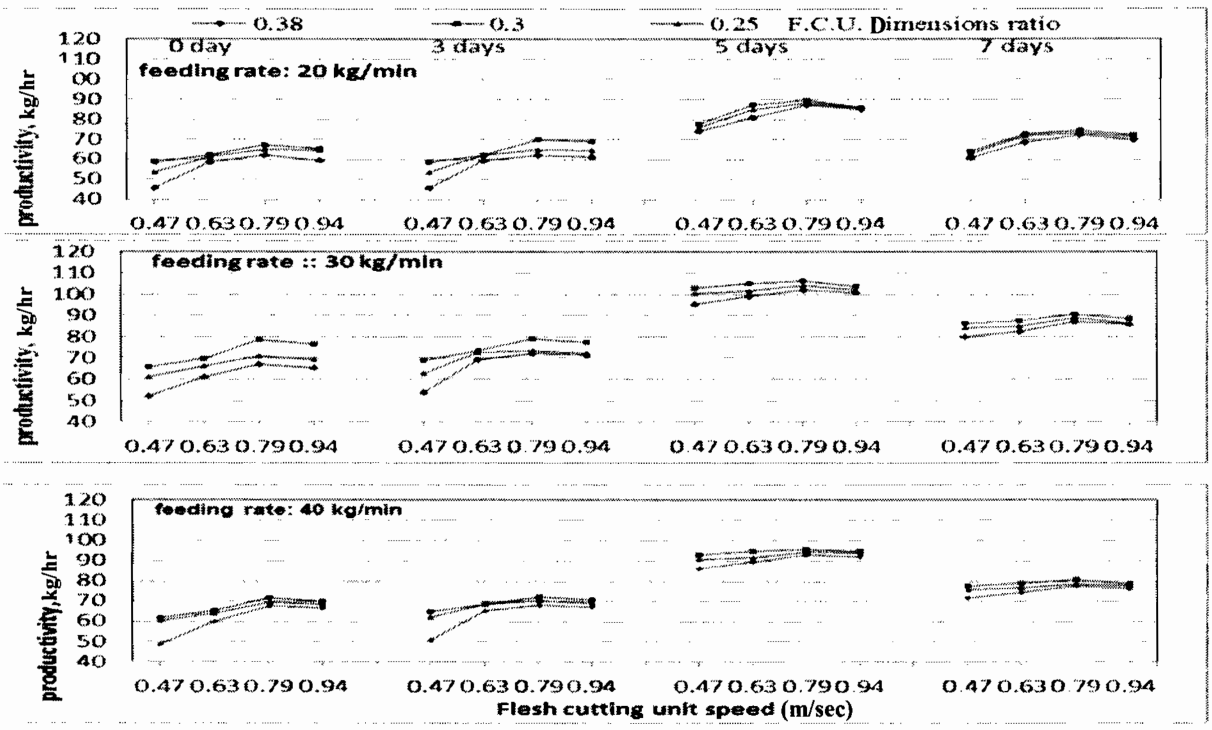



**Fig. 4. Effect of flesh cutting unit speed, flesh cutting unit dimensions ratio, span time and feeding rates on machine productivity**

**F.C.U.** : Flesh cutting unit

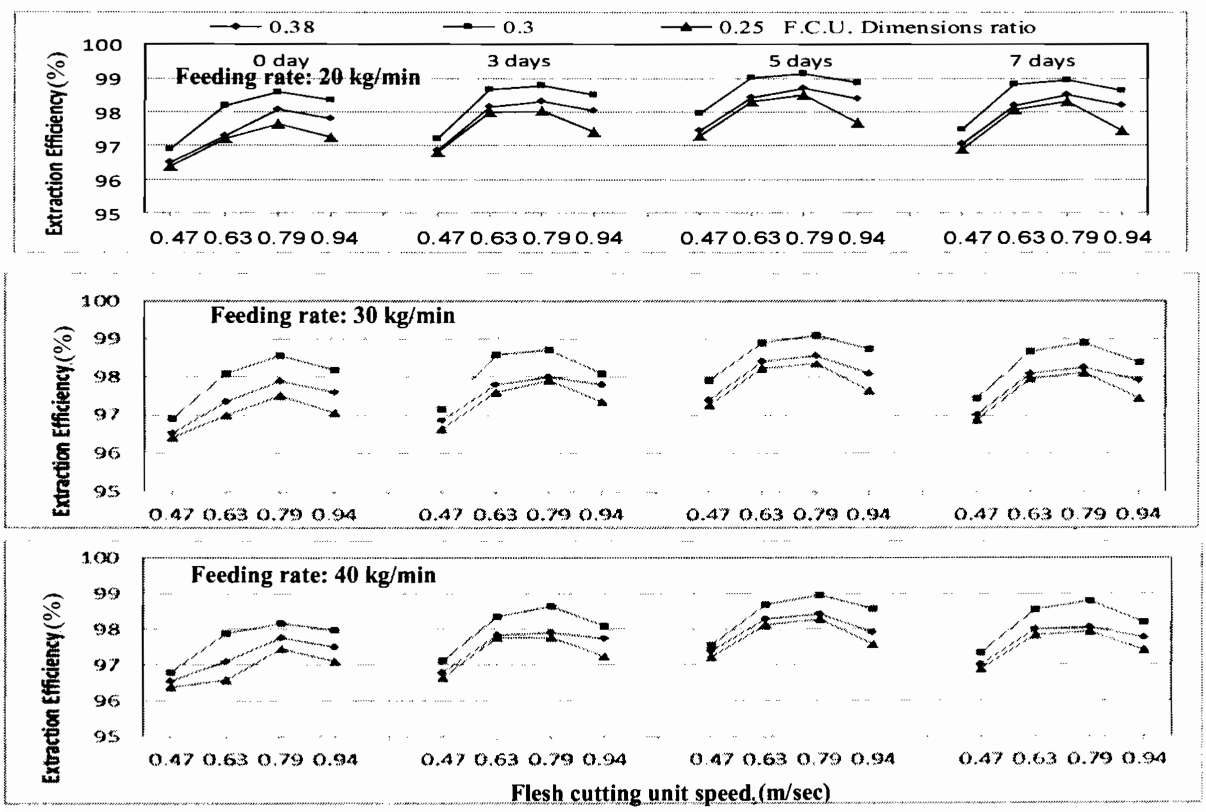



**Fig. 5. Effect of flesh cutting unit speed flesh cutting unit dimensions ratio, span time and feeding rate on extraction efficiency**

**F.C.U.** : Flesh cutting unit

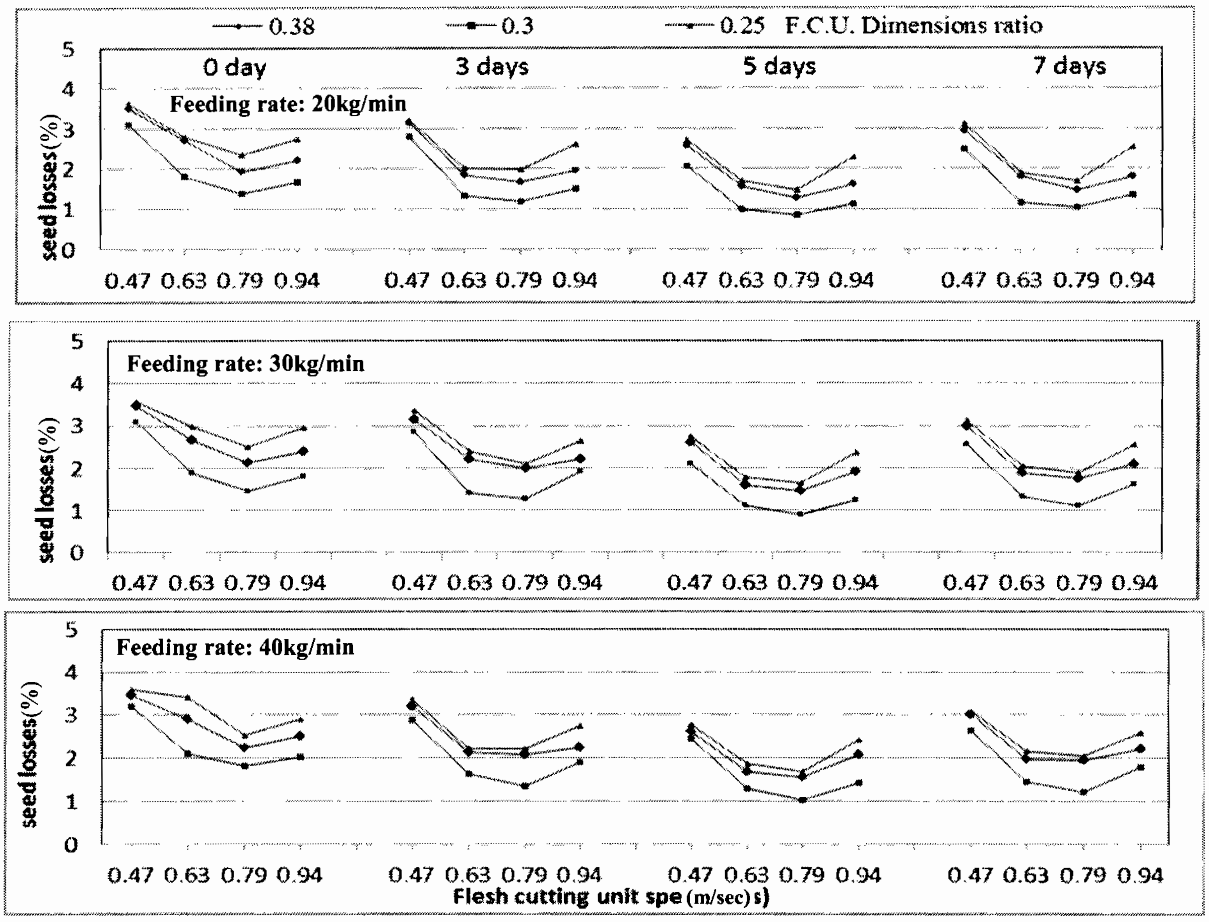



**Fig. 6. Effect of flesh cutting unit speed, flesh cutting unit dimensions ratio, span time and feeding rate on seed losses**

**F.C.U.** : Flesh cutting unit

As shown in Fig. 6, the seed losses percentage increased from 0.85 to 1.03 % by increasing feeding rate from 20 to 40 kg/min, due to the increase of non-separated seeds on the peel.

Fig. 6 showed that, increasing span time from 0 to 5 days leads seed losses to decrease from 1.40 to 0.85% ,then the seed losses increased from 0.85 to 1.05% by increasing span time from 5 to 7 days because of decomposition of the internal components of fruits and peel weakness, so the labor cannot hold catching the fruit for extraction.

The minimum value of seed losses 0.85% was recorded at 0.79 m/sec flesh cutting unit speed, 0.30 mm flesh cutting unit dimensions ratio, 20kg/min feed rate and five days span time after harvesting.

## Seed Damage

From Fig. 7, it noticed that increasing flesh cutting unit speed from 0.47 to 0.79 m/sec led to a decrease on seed damage from 0.87 to 0.36%, any further more increase in flesh cutting unit speed from 0.79 to 0.94 m/sec, the seed damage increased from 0.36 to 0.48%, due to increasing impact force between fruits and separating unit.

Referring to data in Fig. 7, the seed damage decreased from 0.54 to 0.36 % by decreasing flesh cutting unit dimension ratio from 0.38 to 0.30, then increased to 0.63% by decreasing the ratio between unit dimensions to 0.25.

Damaged seed percentage increased from 0.36 to 0.58% by increasing feeding rate from 20 to 40 kg/min as shown in Fig. 7 because of increasing impact and friction force between the fruit and flesh cutting unit.

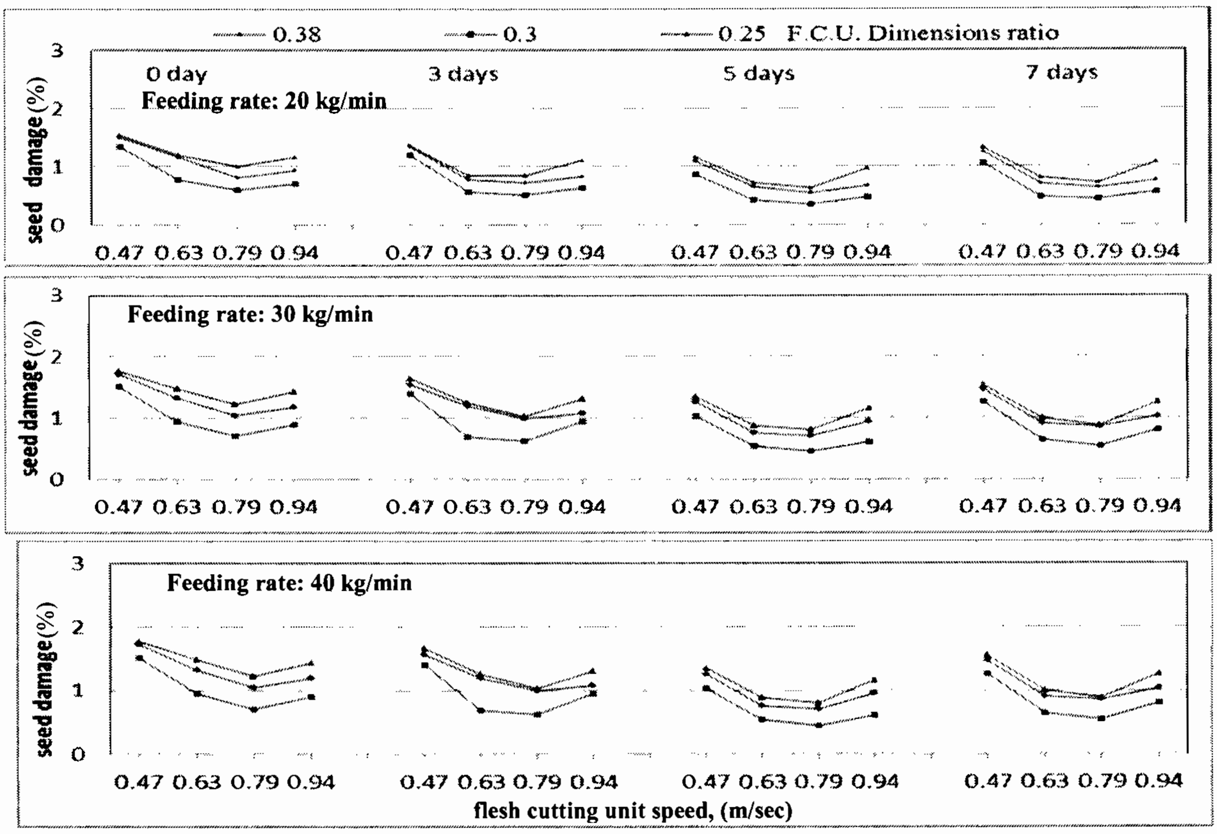



**Fig. 7. Effect of flesh cutting unit speed, flesh cutting unit dimensions ratio, span time and feeding rate on seed damage**

**F.C.U.** : Flesh cutting unit

Data in Fig. 7, viewed that increasing span time from 0 to 5 days leads to a decrease on seed damage percentage from 0.60 to 0.36%, then there is an increase on seed damage from 0.36 to 0.57 % by increasing span time from 5 to 7 days, due to decomposition of fruit flesh which expose seeds to more friction and impact.

The extracting conditions of 0.79 m/sec flesh cutting unit speed, 0.30 mm flesh cutting unit dimensions ratio, 20kg/min feed rate and five days span time after harvesting achieved the minimum value of seed damage 0.36%.

## Specific Energy

By increasing flesh cutting unit speed from 0.47 to 0.79 m/sec, the specific energy decreased from 9.12 to 8.84 kW.hr/Mg, then the energy increased from 8.84 to 9.05 kW.hr/Mg by increasing flesh cutting unit speed from 0.79 to 0.94 m/sec, as shown in Fig. 8.

Fig. 8 showed that the specific energy decreased from 9.22 to 8.84 kW.hr/Mg while decreasing flesh cutting unit dimensions ratio from 0.38 to 0.30, then energy increased from 8.84 to 9.01 kW.hr/Mg by increasing flesh cutting unit dimensions ratio from 0.30 to 0.25.

As shown in Fig. 8, specific energy decreased from 10.14 to 8.84 kW.hr/Mg by increasing feed rate from 20 to 30 kg/min and increased from 8.84 to 9.98 kW.hr/Mg by increasing feed rate from 30 to 40 kg/min.

Data in Fig. 8 cleared that, increasing span time from 0 to 5 days, decreased specific energy from 13.03 to 8.84 kW.hr/Mg, then specific energy increased from 8.84 to 10.55 kW.hr/Mg by increasing span time from 5 to 7 days.

Flesh cutting unit speed of 0.79 m/sec, 0.30 mm flesh cutting unit dimensions ratio, 30kg/min feed rate and five days span time after harvesting achieved the minimum value of Specific energy 8.84 kW.hr/Mg.

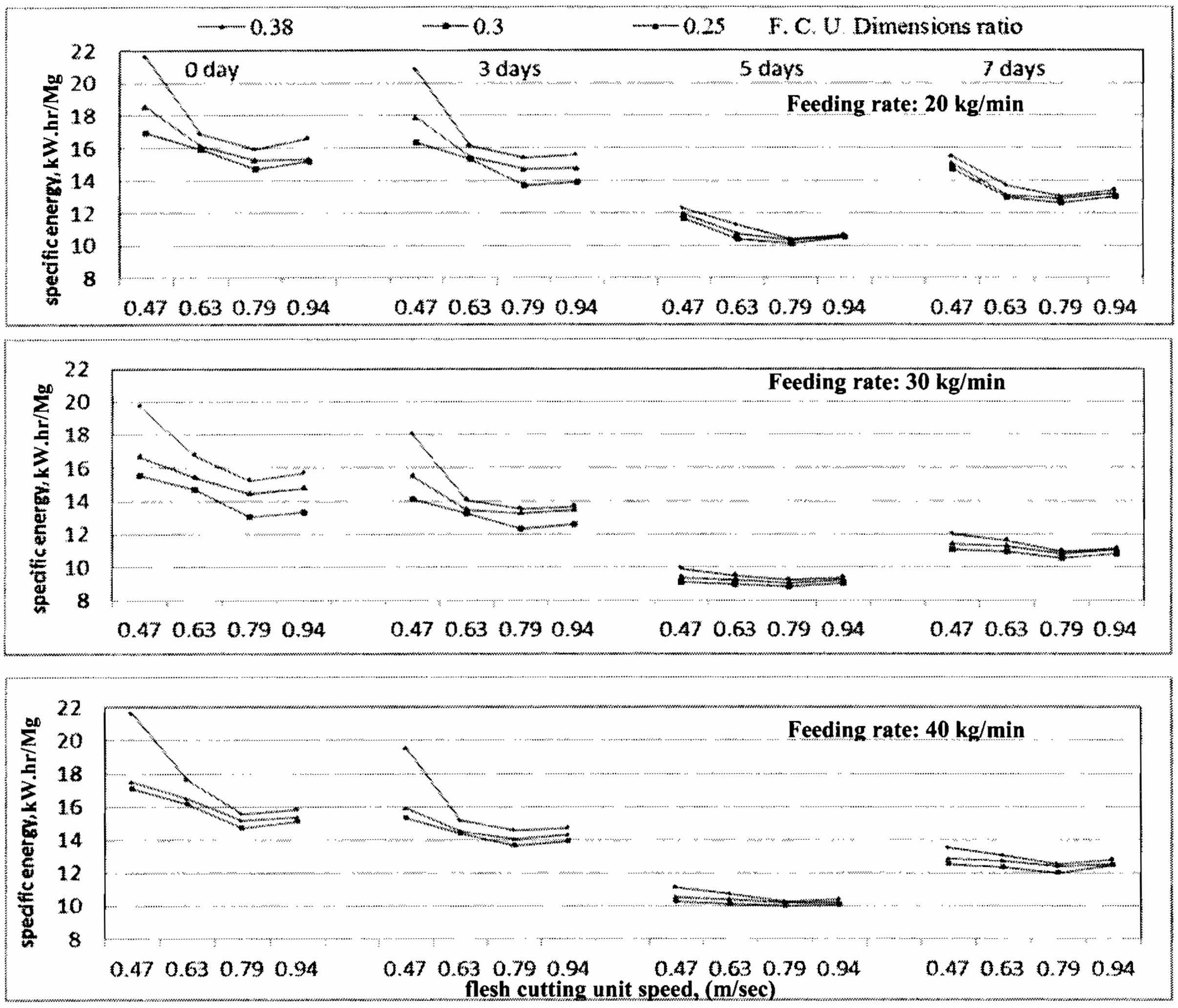



**Fig. 8. Effect of flesh cutting unit speed, flesh cutting unit dimensions ratio, span time and feeding rate on specific energy**

**F.C.U. :** Flesh cutting unit

## Criterion Cost

From Fig. 9, it cleared that increasing flesh cutting unit speed from 0.47 to 0.79 m/sec tends to decrease criterion cost from 202.11 to 195.75 L.E./Mg , then cost increased from 195.75 to 200.39 L.E./Mg, while increasing flesh cutting unit speed from 0.79 to 0.94 m/sec.

The criterion cost decreased from 204.13 to 195.75 L.E./Mg by decreasing flesh cutting unit dimensions ratio from 0.38 to 0.30. On the other side, the cost increased from 195.75 to 199.48 L.E./Mg while decreasing flesh cutting unit dimensions ratio from 0.30 to 0.25.

Specific energy decreased from 232.49 to 195.75 L.E./Mg by increasing feeding rate from 20 to 30 kg/min and increased from 195.75 to 217.28 L.E./Mg by increasing feeding rate from 30 to 40 kg/min, as shown in Fig. 9.

Fig. 9 remarked that increasing span time from 0 to 5 days decreased criterion cost from 265.27 to 195.75 L.E./Mg. Whereas, the cost increased from 195.75 to 229.53 L.E./Mg by increasing span time from 5 to 7 days

The minimum value of criterion cost 195.75 L.E./Mg was achieved at operating conditions of 0.79 m/sec flesh cutting unit speed, 0.30 mm flesh cutting unit dimensions ratio, 30kg/min feed rate and five days span time after harvesting.

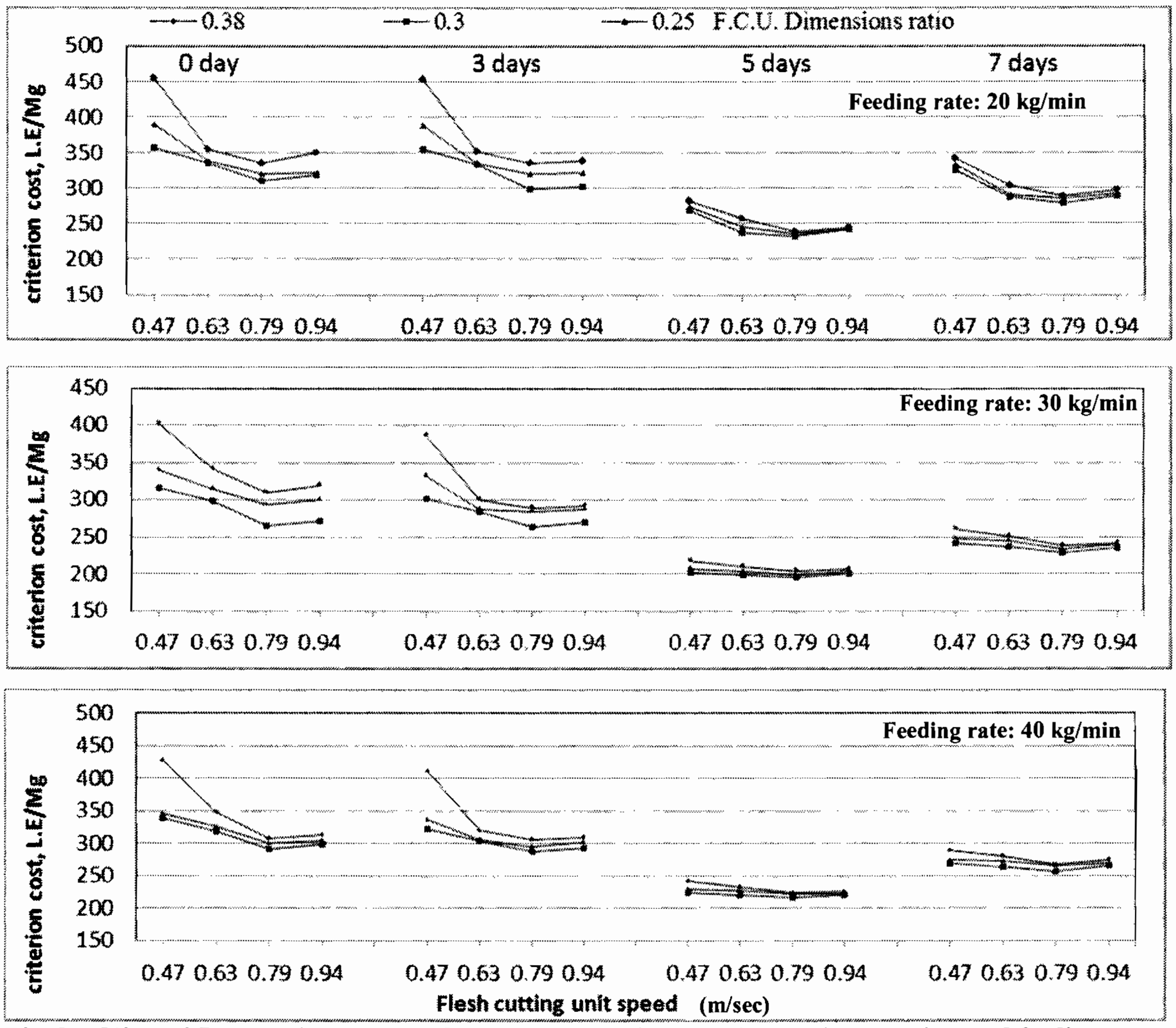



**Fig. 9. Effect of flesh cutting unit speed, flesh cutting unit dimensions ratio, span time and feeding rate on criterion cost**

**F.C.U.** : Flesh cutting unit

## Conclusion

From the obtained data, it can be concluded that: The optimum watermelon extracting performance was achieved under the following operating conditions:

- Extracting operation was conducted at the 5th day after harvesting.
- Flesh cutting unit speed of 0.79 m/sec
- Flesh cutting unit dimensions ratio of 0.30.
- Feeding rate about 30 kg/min.

## REFERENCES

Abo-Haded, A. (2003). The Egyptian agricultural exports, annual foreign trade bulletin (CAMPAS) bulletin of commodity consumption in Egypt, separate issues, Cairo.

Amir, I.F.S. (2004). Construction and performance of machine for separating Watermelon seeds. Ph.D. Thesis, Fac. Agric. Mansoura, Univ., Egypt.

Chen, H., J. de Baerdemaeker and V. Bellon (1996). Finite element study of the melon for nondestructive sensing of firmness. Trans. of the ASAE, 39 (3): 1057-1065.

Desta, K.D. and T.W. Mishra (1990). Development and performance evaluation of sorghum thresher. AMA, 21 (3): 33-37.

El-Gaddi, K.A., S.A. Marey and I.F. Sayed-Ahmed (2011). Development and performance evaluation of a summer squash seed extracting machine. Middle-East J. Scientific Res., 7(3): 352-361.

Eliwa, A.A. and A. El-Fatih (2012). Developing a local extraction watermelon seeds machine. J. of Applied Sci. Res., 8 (1): P 481.

Fouad, I.S.A.A.A. (2004). Construction and performance of a machine for separating watermelon seeds Ph.D. Thesis El-Mansoura Univ., 45-80.

John, G.A. (1988). Power hydraulics. PAVIC publications.

Kumar, R. and J. R. Goss (1980). Total combine harvester cost optimization in Alfalfa seed harvesting. Trans. Of the ASAE, 23 (1): 39-42.

حسن، أحمد عبد المنعم (٢٠٠٠). تكنولوجيا الإنتاج والممارسات الزراعية المتطورة– سلسلة محاصيل الخضر– القرعيات (البطيخ). الدار العربية للنشر والتوزيع، القاهرة، مصر، ٦٩.

## تأثير بعض العوامل الهندسية على الاستخلاص الميكانيكى لبذور بطيخ اللب

**محمد أنور محمود عابدين – محمود عبد الرحمن الشاذلى**

**مـــراد علـى ابراهيم ارناؤوط – محمـــود خطـــاب عفيفـى**

قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق - مصر

تم تقييم أداء آلة لاستخلاص بذور بطيخ اللب عن طريق إجراء بعض التجارب فى قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق بمحافظة الشرقية خلال صيف (٢٠١٢-٢٠١٣)، وتم دراسة تأثير مختلف العوامل التشغيلية والهندسية على عملية الاستخلاص الميكانيكى بهدف تقييم الآلة وتحديد أنسب الظروف لاستخلاص البذور بأقل فاقد وأقل تكاليف تحت الظروف المصرية، وتم تقييم أداء الآلة من خلال الإنتاجية، كفاء الفصل، فواقد وتلف البذور، الطاقة النوعية المستهلكة بالإضافة إلى تكاليف الاستخلاص، وتمثلت متغيرات التجربة فى ثلاث معدلات تلقيم مختلفة (٢٠، ٣٠، ٤٠ كجم /دقيقة)، أربعة سرعات لوحدة فصل اللب من القشر(٠,٤٧ ، ٠,٦٣، ٠,٧٩، ٠,٩٤ م/ث)، ثلاثة نسب مختلفة بين أبعاد وحدة الفصل (٠,٣٨، ٠,٣٠، ٠,٢٥) وأربعة فترات مختلفة بين الحصاد والاستخلاص (صفر، ٣، ٥، ٧ أيام)، ومن خلال النتائج تم التوصل إلى الآتى: تعتبر فترة ٥ أيام للاستخلاص بعد الحصاد ، معدل التلقيم ٣٠ كجم/ دقيقة ، وسرعة ٠,٧٩ م/ث لوحدة الفصل ، ونسبة ٠,٣٠ بين إبعاد وحدة الفصل هى أنسب ظروف لتشغيل آلة الاستخلاص الميكانيكى ، حيث أنها أعطت أعلى إنتاجية ١٠٦,٣٧ كجم / ساعة و اقل طاقة نوعية ٨,٨٤ كيلووات.ساعة/ طن وأعطت أيضاً اقل تكلفة ١٩٥,٧٥ جنيه/فدان.

المحكمـــــون:

١- أ.د. طـــارق زكـــــي فـوده أستاذ الهندسة الزراعية ووكيل كلية الزراعة لشئون خدمة المجتمع وتنمية البيئة – جامعة طنطا.

٢- أ.د. محمد محمد مراد حسن أستاذ ورئيس قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق.