*FACTORS AFFECTING CUCURBITA-PEPO CROP
SEED LOSSES AND DAMAGE BY USING A SEED
EXTRACTING MACHINE PROTOTYPE
Tayel. S. A.¹, EL-Nakib A. A.¹, Khairy. M. F. A²,
Kamel, O.M³ and Desouky D. M.⁴

ABSTRACT
Ninety seven percent of seed extracting of cucurbita crops are
accomplished by manual methods. Many Workers are needed for one
feddan which costing to much money. Consequently, increasing the
production cost and reducing the farmer’s profit. Increasing the planted
area of cucurbita crops requires increase of the propelled seed extractors,
with high capacity. The present study is conducted to study the effective
factors on cucurbita pepo crop seeds damage and losses by using seed
extracting prototype. (Common names: cucurbita pepo L, pumpkin,
vegetable marrow, summer pumpkin, autumn pumpkin) In addition the
physical and mechanical properties of cucurbita fruits and seeds were
studied. The results revealed that the seed-extracting machine operated
successfully under field conditions. The combination of 0.116Mg/min
feed rate, 2.48m/s drum speed,15 mm drum-concave clearance and six
days time span after harvesting achieved the minimum values of seed
damage. The feed rate of 0.116Mg/min, drum speed of 3.38 m/s, drum-
concave clearance of 5 mm, the extracting cylinder – curved plate
clearance 5mm, rotational speed of separating sieve 25 rpm and
extracting time after six days achieved the minimum value of seed losses
(4.1%).

INTRODUCTION
Cucurbita crops seeds are important and strategic vegetable
products in Egypt, which can be exported to other countries.
Almost of these seeds considered of the most Egyptians like to
eat. Also, consider valuable source of much needed protein and vegetable
oil. Recently, cucurbita crops have been widely

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cultivated in northern regions of Egypt, such as Kafr- Elsheakh, Dakahlia, El Bohira and the new lands like Nubaria.

*E. M. A.* (2006) reported that the total area of cucurbita crops (squashes) was about 91054 Fed./year, However, the area of summer squashes were about 59595Fed. Cucurbita pepo varieties represent the most of that area, which generally were produced for seeds. Most of crop fruits are varying in shape and volume (wide variation). It is very labor intensive (about 100-man h/Fed.). Extracting seeds are mainly conducted manually and seed extracting machines are not available. However, mechanical extracting is necessary to remove the tedium involved in manual extracting of the fruits. Based on relevant physical properties of the cucurbita pepo fruits, an extracting prototype machine was used to separate seeds from the pulp and placenta. The extracting machine prototype consists of four processes: first is cutting and crushing stage, second is extracting seeds from cut fruits, third is separating seeds from peels, and the fourth is cleaning seeds from placenta and debris.

*Abd-Elmoniem* (1994) classified the seed extraction methods as follows:
1- Methods of separating dry vegetable seeds. These methods are varied based on whether the fruits are dehiscent or indehiscent
2- Methods of extracting seeds from soft fruits, these methods include.
   a) Manual or mechanical separation, by using washing water.
   b) Chemical extraction, by using fermentation or acids and alkaline.

*Buyanov and Voronyuk* (1985) and *Mohsenin* (1986) stated that the differences in the physical and mechanical properties of seeds and fruits are considered the basis for separating and grading. They reported that among these properties the weight and shape, specific gravity, the coefficient of dynamic friction, density, moisture content, the fruit hardness, impact resistance, and surface texture are the basic characters that affecting construction of seed extracting equipment. They also defined that the quantity of seeds is usually 4- 5% of fruit weight. The individual weight of fresh wet seeds is 1.5 to 2 times the weight of dry seeds.

*Baldwin* (1990) mentioned that mechanical damage during harvest is caused largely by fast moving parts of the threshing-drum of the combine.
Vergano et al. (1992) stated that the performance data of the axial-flow vegetable seed-extracting machine about different vegetable fruits and data about manual seed extraction have shown feeding rate of vegetable fruits through seed extracting machine varied from 310 to 1930 kg/h for different vegetables. Such as cucumber, watermelon, tomato, summer squash, brinjal, squash melon and chillies, respectively. The seed loss for all vegetables except squash melon was below 5.86 %.

Kholief et al. (2005) showed the relation between drum speed and seed damage for three various drum shape and three levels of watermelon feed rates. The results showed clearly that the increase of drum speeds tends to increase the seed damage and these may be due to the increase of impact during the separation of seeds.

Fouad (2004) showed that the drum speed had a great effect on the seed losses under studied variables such as feed rate, drum-knives number during and crushing time. The author noticed that increasing drum speed tends to increase visible seed damage at all other variables under study. In addition, the Period between harvesting and separation process affect the visible seed damage.

The present study aims to:
Study the factors that affect seed damage and seed losses of the cucurbita pepo crop by using the extracting machine prototype.

MATERIALS AND METHODS
To estimate cucurbita-pepo visible seed damage and seed losses that occurs by using the extracting machine prototype. In addition, to recognize the main factors that has effect the ratio of seed damage and seed losses.

The following variables were studied:
1- Feeding rate (116, 174 and 232kg / min)
2- Drum speed (2.48, 2.98 and 3.38m/s)
3- Cutting drum and concave clearance (5, 10 and 15mm)
4- Extracting cylinder fingers and plate fingers Clearance (5, 10 and 20mm)
5- Separating sieve speed (25, 30 and 35rpm)
6- Time of extracting after harvesting (1, 3, 6 days)
1. Physical and mechanical properties of cucurbita pepo:
Physical and mechanical properties of cucurbita pepo crop (table:1) such as dimensions of fruits and seeds, volume of fruits, density of fruits, coefficient of friction between cucurbita fruits and steel surface, also rolling angle of fruits were carried out according to the standard methods.

2- Seed extracting prototype machine:
Engineering concepts and developed parts of the machine prototype were carried out at Ganaklies central workshop at the new land district

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Average</th>
<th>C.v.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Dimensions:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Cucurbita-pepo fruit:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mid diameter, cm</td>
<td>15.4</td>
<td>21%</td>
</tr>
<tr>
<td>- Length, cm</td>
<td>25.8</td>
<td>27%</td>
</tr>
<tr>
<td>- Thickness of pulp, cm</td>
<td>2.5</td>
<td>23%</td>
</tr>
<tr>
<td>b) Cucurbita pepo seed:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- length, mm</td>
<td>16.1</td>
<td>26%</td>
</tr>
<tr>
<td>- width, mm</td>
<td>12.14</td>
<td>17%</td>
</tr>
<tr>
<td>- thickness, mm</td>
<td>3</td>
<td>29%</td>
</tr>
<tr>
<td><strong>2. Mass:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- mass of cucurbita pepo fruit, g/fruit</td>
<td>2.6</td>
<td>55%</td>
</tr>
<tr>
<td>- mass of seeds per fruit, g (wet basis)</td>
<td>0.1</td>
<td>50%</td>
</tr>
<tr>
<td>- mass of rind, pulp and placenta per fruit, g</td>
<td>95 :96%</td>
<td></td>
</tr>
<tr>
<td>- mass of total cucurbita pepo fruits ton /fed</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>3. Number of fruits/m² (in the field)</strong></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>4. Volume of fruit, cm³</strong></td>
<td>2700</td>
<td>90%</td>
</tr>
<tr>
<td><strong>5. Density of fruit, kg/m³</strong></td>
<td>670</td>
<td>15%</td>
</tr>
<tr>
<td><strong>6. Density of cut fruit, kg/m³</strong></td>
<td>970</td>
<td></td>
</tr>
<tr>
<td><strong>7. Coefficient of friction</strong></td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td><strong>8. Rolling angle on inclined steel surface</strong></td>
<td>35°</td>
<td></td>
</tr>
</tbody>
</table>

Mechanization sector, Ministry of agriculture. Main parts dimensions of the machine prototype were constructed depending on the measured physical and mechanical properties of fruits. Therefore, the construction was carried out for each part and component of the machine to suit the intended performance of the extracting machine.

Fig.(1): The main parts and units of the extracting seed machine prototype.
The extracting machine operated by a tractor PTO. Cucurbita seed extracting machine is shown in Fig. (1) some technical specifications of extracting machine prototype are listed in table (2)

3. Determination of seeds damage and seed losses:
Visible seed damage was measured but the invisible seeds damage neglected because the maximum production of seeds is eaten as toasted seeds or extracting oil from seeds.

A) Seed damage measurement:
The visible seeds damage, which have any damage due to the using of extracting machine, estimated by the formula:

$$ Damaged\, seeds\, \% = \frac{M_d}{M_u + M_d} \times 100 \quad \text{---------- (1)} $$

$M_d =$mass of damage seeds, g. $M_u =$ mass of undamaged seeds, g

Table (2): The technical specifications of extracting machine prototype:

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacture</td>
<td>Ganaklees, central workshop, Agricultural engineering sector</td>
</tr>
<tr>
<td>Total length, cm</td>
<td>485</td>
</tr>
<tr>
<td>Width, cm</td>
<td>218</td>
</tr>
<tr>
<td>Height, cm</td>
<td>225</td>
</tr>
<tr>
<td>Mass, kg</td>
<td>1750</td>
</tr>
<tr>
<td>Source of power</td>
<td>Tractor PTO.</td>
</tr>
<tr>
<td>Length of the cutting drum, cm</td>
<td>60</td>
</tr>
<tr>
<td>Diameter of the drum, cm</td>
<td>31</td>
</tr>
<tr>
<td>Peripheral diameter of the drum, cm</td>
<td>43</td>
</tr>
<tr>
<td>Total cutting knives on the drum, cm</td>
<td>6 knives (L60cm, W6.5cm and t 0.6cm).</td>
</tr>
<tr>
<td>Hopper Feeding opening of fruits, cm</td>
<td>50 x 60</td>
</tr>
<tr>
<td>Cylindrical separating sieve, cm</td>
<td>Inner diameter 118, total length 170</td>
</tr>
<tr>
<td>Cylindrical sieve opening diameter, cm</td>
<td>1.6</td>
</tr>
<tr>
<td>Cylindrical sieve effective area, m²</td>
<td>5.5</td>
</tr>
<tr>
<td>Primary cleaning sieve</td>
<td>22cm D, 55cm L, effective area 0.34m²</td>
</tr>
<tr>
<td>Extra-cleaning sieve</td>
<td>30cm D, 50cm L, effective area 0.47m²</td>
</tr>
<tr>
<td>Entire cut crop conveying auger</td>
<td>$D_1$, 5cm, $D_2$, 20cm, tread 15cm, L 110cm</td>
</tr>
<tr>
<td>Bottom seed conveying auger</td>
<td>$D_1$, 3cm, $D_2$, 10cm, tread 10cm, L 150cm</td>
</tr>
</tbody>
</table>

B) Seed losses:
The seed losses were determined by rescuing the expelled peels from the cylindrical separating sieve at different feeding rates. Seeds manually collected and weighted.
\[
\text{Seed losses} \% = \frac{M_l}{M_t + M_l} \times 100 \quad \text{(2)}
\]

\(M_l\) = mass of the total seed losses expelled out of the machine, g.
\(M_t\) = mass of collected seeds, g.

The machine productivity was calculated by the following equation:
\[
M \cdot pr. = \frac{60 M_t}{T_E \times 10^3} \quad \text{(3)}
\]

where: \(M \cdot pr.\) = Machine productivity, kg/h;
\(M_t\) = mass of collected seeds, g, and
\(T_E\) = machine running time, min.

RESULTS AND DISCUSSIONS

Obtained results through out several laboratory and field experiments presented and discussed through the following points:

1. Seed damage:

Most of seed damage occurs in the cutting and crushing unit of the machine prototype. That damaged seeds affected many factors such as feeding rate, drum speed, drum-concave clearance and time of extracting after harvesting.

The results during the experiments gave some information on seed damage ratio that affected different variables. As shown in the Figures (2), (3) and (4). Increasing the drum-concave clearance from 5 to 10 to 15mm Fig.(2) tended to decrease the seed damage during the extracting cucurbita pepo seeds. In addition, The presented data in Fig.(3) cleared that increment of spent time between harvesting and extracting process decreases seed damage. The obtained values of seed damage, increased by increasing the feeding rate from 116kg/min to 174kg/min to 232kg/min, due to increasing friction forces on the wet seeds, in addition the obtained values of seed damage increased through increasing the drum speed from 2.48m/s to 2.98m/s to 3.38m/s.

Generally, the feed rate of 116 kg/min., drum speed of 2.48 m/s, drum-concave clearance of 15 mm, and 6 days time of extracting after harvesting represent the minimum values of seeds damage.

2. Seed losses:

The average values of seed losses were affected the feeding rate, drum speed, drum-concave clearance, extracting cylinder-curved plate clearance,
speed of separating sieve and time of extracting after harvesting, are indicated in Figures (5), (6), (7) and (8). It was observed that increasing the drum speed tends to decrease the seed losses at all parameter levels. The data indicated that increasing feed rate from 116 to 174 to 232 kg/min and using drum speed of 3.38 m/s increased the seed losses from 4.1 to 6.5 to 8.5% respectively.

The presented data in Fig. (5) explains that the losses of seeds affected the rotational speed of separating sieve. Increasing separating sieve speeds from 25 to 30 to 35 rpm tend to increase seed losses.

Regarding to the effect of feeding rate, the presented data in Fig. (6) showed that the feeding rate had an implemented effect on the seed losses under studied variables. The 3.38 m/s drum speed gave the minimum percentage of seed losses. The drum speed of 2.48 m/s recorded the highest percentage of losses that trend was because of increasing the kinetic energy and the inertia of the cut fruits, which make them under a smash force, consequently, the sticky seeds inside the placenta moves out from their hidden bed.

The presented data in Fig. (7) explains that the losses of seeds affected the clearance between extracting cylinder rubber fingers and the plate rubber fingers. Increasing the extracting–cylinder clearances from 5.0 to 10 to 20 mm tend to increase seed losses.

Fig. (8) indicates the effect of extracting time on the seed losses at different feeding rates (kg/min), different drum speeds, drum-concave clearance 10 mm, extracting cylinder – curved plate clearance 5 mm and the speed of separating sieve 25 rpm, declared that extracting of cucurbita-pepo seeds after six days from harvesting realized the lowest value of seed losses.

CONCLUSION

The mechanical seed extracting of cucurbita crops is one of the important agricultural operations. This study aims to test and evaluate the field data obtained by the experiments and the observation of the machine prototype. The seed-extracting machine was operated successfully under field conditions. Three feed rates of cucurbita pepo fruits nominated 116, 174 and 232 kg/min, three drum speeds: 2.48, 2.93 and 3.38 m/s, three drum-concave clearances 5, 10 and 15 mm, three clearances of extracting cylinder–plate fingers 5, 10, and 20 mm, three separating sieve speeds 25, 30 and 35 rpm,
Fig.(2): Cucurbita pepo seed damage (%) Vs. drum-concave clearance

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Fig.(3): Cucurbita pepo seed damage (%) Vs. time of extracting after harvesting (Sp.T.)

Fig.(4): Cucurbita pepo seed damage (%) Vs. feeding rates (kg/min)
Drum speed (m/s)

- 2.48
- 2.93
- 3.38

[one day]

Drum speed (m/s)

- 2.48
- 2.93
- 3.38 m/s

[one day]

Seed losses (%)

[three days]

Seed losses (%)

[three days]

Six days

Separating sieve speed (rpm)

Feeding rate (kg/min)

Fig.(5): Cucurbita pepo seed losses (%) Vs. separating sieve speed ( rpm)

Fig.(6): Cucurbita pepo seed losses (%) Vs. feeding rates, (kg/min)
Fig. (7): Cucurbita pepo seed losses (%) vs. extracting cylinder clearance (mm)

Fig. (8): Cucurbita pepo seed losses (%) vs. extracting time after harvesting (days)
three operational times for extracting after harvesting 1, 3 and 6 days. Those variables were used during the operating of the machine prototype. The results summarized as follow:

1. **Seed damage:**
   Seed damage is affected many factors during extracting cucurbita pepo seeds such as feeding rate, drum speed, drum-concave clearance and time of extracting after harvesting.
   * The combination of feed rate 116 kg/min, 2.48 m/s drum speed, 15 mm drum-concave clearance and six days time span after harvesting realized the minimum value of seed damage.

2. **Seed losses:**
   it could be concluded that the feed rate of 116 kg/min., drum speed of 3.38 m/s, drum-concave clearance of 5 mm, the extracting cylinder – curved plate clearance 5mm, rotational speed of separating sieve 25rpm and extracting time after harvesting six days realized the minimum value of losses 4.1% compared with the other levels of variables under study.

**REFERENCES**

**Abd-Elmoniem, H. A. (1994):** Production and physiology of vegetable seeds (Arabic Textbook), Published By Eldar Elarabia - Cairo - Egypt.


**الملخص العربي

العوامل المؤثرة على الفاقد والمتكسر من بذور محصول الكوسة

باستعمال آلة فصل بذور تجريبية

1 - سمير أحمد طايل
2 - عبد القادر على النقيب
3 - محمد فايد عبد الفتاح خيرى
4 - أسامة محمد كامل

م/ دسوقى محمود دسوقى

إنتاج بذور محاصيل الخضر وخاصة بذور القرعيات ذات أهمية إستراتيجية في جمهورية مصر العربية. ويصل محصول القرعيات الصيفي إلى 9595 فدان بمتوسط 8,11 طن/ فدان (نشرة وزارة الزراعة 2002). ويتم استخلاص 97% من هذه البذور بدونه ويجتاز الفدان من أربع إلى 14 عام للإنتهاء منه خلال يوم واحد بنكطة استخلاص 90% جنيه للفدان. ونظراً لزائدة المساحات المنزرعة بمحاصيل القرعيات من أجل الحصول على البذور (اللب) أصبحت الحاجة ملحة إلى الآت استخلاص مقطوعة خلف الجرار.

هذا البحث يهدف إلى دراسة العامل المؤثر الفاقد والمتكسر من بذور محصول الكوسة باستعمال آلة فصل بذور تجريبية محلية الصنع مقطوعة خلف الجرار. والقيام بتجارب حلية للحصول على نتائج فعلية للفاقد والمتكسر من البذور. وتتكون الآلة من أربعة وحدات أساسية:

1 - وحدة تكسير الثمار (الدرفل والصدر).
2 - وحدة استخلاص البذور من الثمار المقطعة (إسطوانة الفرل ذات الأصابع المطاط).
3 - وحدة غزالة لفصل البذور عن القشور (غربال الفصل).

* هذه الدراسة جزء من النتائج المتحصل عليها من رسالة دكتوراه
1 - أستاذ الهندسة الزراعية المنفرج - كلية الزراعة - جامعة الأزهر - القاهرة.
2 - أستاذ ورئيس قسم الهندسة الزراعية - كلية الزراعة - جامعة الأزهر - القاهرة.
3 - رئيس بحوث - معهد بحوث الهندسة الزراعية - الدقي - القاهرة.
4 - مهندس زراعى - قطاع الزراعة الآلية - مركز البحوث الزراعية - وزارة الزراعة.
4- وحدة تنظيف البذور عن المشيمة والأجزاء اللينة (إسطوانات التنظيف الإبدائية والإضافية).

إلى جانب جهاز نقل الحركة من الجرار وإلى أجزاء الآلة من توفير السرعات المناسبة لكل جزء لتحقيق أعلى كفاءة للآلة.

من النتائج التي تم التوصل إليها:

1- حقق معدل تلقيم 116 كجم/ دقيقة وسرعة دريفيل 38 م/ ث، وخلووس بين الدرفل والصدر 5 مم، وخلووس بين إسطوانة الاستخلاص والأصابع المطاط للستارة 5 مم. وسرعة غربال فصل 75 لفة/ دقيقة. و الاستخلاص بعد ستة أيام من حصاد الثمار حقق أقل نسبة للفواقد من البذور 0.1%.

2- حقق معدل تلقيم 116 كجم/ دقيقة وسرعة دريفيل 48 م/ ث، وخلووس بين الدرفل والصدر 15 مم. و الإستخلاص بعد ستة أيام من حصاد الثمار حقق أقل نسبة للفواقد من البذور 0.2%. 

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