SEPARATING OF APRICOT PITS KERNEL USING PNEUMATIC SYSTEM

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ABSTRACT

Separation of apricot kernel from shells is important processes to use the kernel and shells. In this study, some physical properties were studied for apricot kernel and shells. pneumatic separator was used and separation module performance was investigated as a function of change in air stream velocity of 9, 10, 11 and 12 m/s, feeding rate of 30, 60, 90 and 120 kg/h, mixture moisture contents of 5.76, 14.46 and 21.67% w. b. and s reen slope of 25 and 35°. The results revealed that, optimum operations conditions were obtained at 11 m/s air velocity, feeding rate of 120 kg/h, mixture moisture content of 14.46 % and screen slope of 25°, the separation effectiveness of 96.18 %, kernel cleanliness of 93.83 %, kernel losses of 0.69 %, kernel productivity of 40 kg/h, specific energy of 4.22 kW.h / Mg and cost of 96 L.E./Mg.

INTRODUCTION

Apricot (*Prunus armeniaca L.*) is one of the major horticultural crops in Egypt due to its export importance and several uses in many food industries. The annual world production for apricot exceeds 3.9 million Mg. Turkey is the biggest apricot producer country in the world with about 676138 Mg/year. Egypt is the eleventh producer country in the world with about 96643 Mg/year (**FAO, 2011**). Cultivation area in Egypt is about 14874 fed., with production is about 6.5 Mg/fed. Approximately 54% of the production comes from Noubaria region (**Agric. Statistics Economic Affairs Sector, 2011**). The apricot fruits comprising of 6-11% of the pits constitute about 22-38% of kernels (**Shah, 1985**). Pits of apricot are used in the production of active carbon. Important applications of activated carbons are related to their use in

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water and industrial wastewater treatment for removal of flavor, color, odor and other undesirable organic impurities **(Dorbrowksi, 2001)**. Apricot pits are also separated into shells and kernels in the regional conglomerates which have washing, sorting, breaking and separating units. The shells are generally used as fuel **(Gezer et al., 2002)**. Crushed shells use to instead of anthracite coal in filters for water treatment **(Aksogan et al., 2003)**. Apricot kernel contains 17.38% protein, 48.70% crude oil, in addition to some elements such as sodium, potassium, calcium, phosphor, iron and zinc **(Ozcan, 2000)**. Kernel is used in production of Benz aldehyde; cosmetics, aroma perfume, and food after remove glycoside amygdaline **(Vursavus and Faruk, 2004)**. Pneumatic separators according to: the direction of air steam in separation duct, which may be divided into (horizontal, inclined and vertical air stream action); the manner of air stream in separation duct (suction or under pressure); circulation manner of air stream (closed or open) and according to number of ducts (one, two or multiple) **(Foronaf and Baflofacke, 1959)**. **Ismail et al. (1994)** studied the effect of vertical airstream velocity, total impurities and specific feed rates on the cleaning efficiency of wheat grain at different moisture contents of mixture. They found that the highest values of cleaning efficiency with minimal losses were in the range of 93.45 - 99.46% at total impurities of 10%, air velocity of 6 - 8 m/s and moisture content of 15%.

The main objectives of the present study are design, manufacture and evaluate the performance of a pneumatic apricot pits kernel separator.

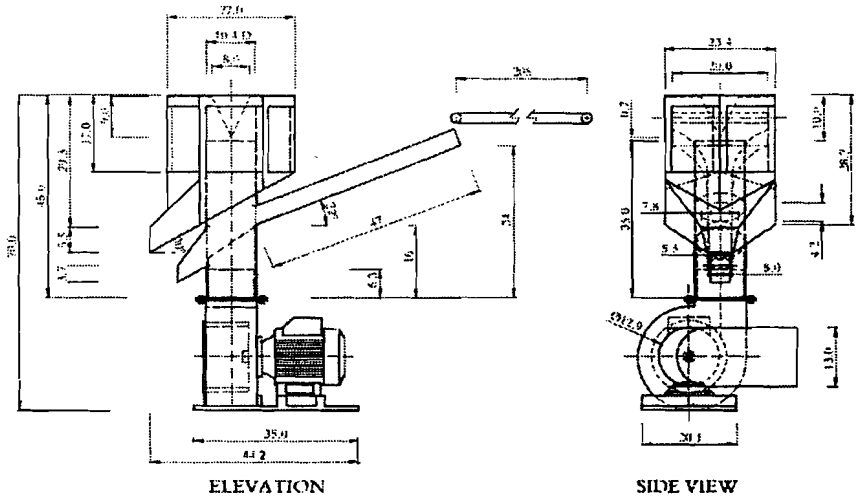## MATERIALS AND METHODS

1. Apricot pits:

Experiments were carried out on local apricot pits, *Al-amar* species was used (Fig.1, a). Pits were cleaned to remove all foreign materials. Samples were broken by apricot pits cracker **(Tayel et al, 2011)** (Fig.1, b).

(a)   (b)

Fig. (1): (a) Apricot pits of *Alamar*, (b) kernel and shells mixture.

2. Separation unit:

The separation unit was made from local materials. It was manufactured installed and tested at workshop of Faculty of Agricultural Engineering, AL-Azhar University. Figs. (2), (3) show an elevation and side view of separation unit, and assembling of separation unit respectively.

ELEVATION   SIDE VIEW

(Dimensions in cm.)

Fig. (2): Elevation and side view of separation unit.

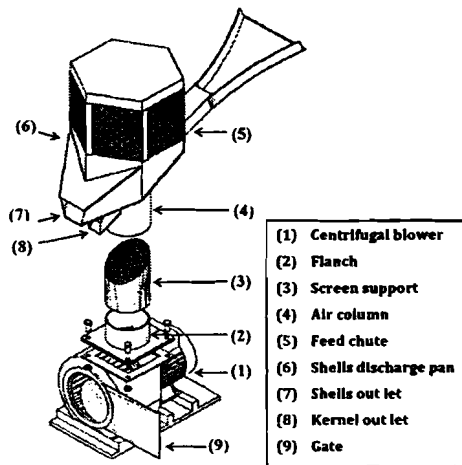|	
(1)	Centrifugal blower
(2)	Flanch
(3)	Screen support
(4)	Air column
(5)	Feed chute
(6)	Shells discharge pan
(7)	Shells out let
(8)	Kernel out let
(9)	Gate

Fig. (3): Assembling of separation unit.

The separation unit consists of *Centrifugal blower* (with outlet dimensions of 10x10 cm), used to push the air throw the air column. The power source is an electric motor of 0.37 kW, single phase and rotation speed of 2850 rpm. Air flow is controlled by gate in blower inlet, a *Flange* that was fixed directly in the blower and designed to join the blower with the air column across the *screen support*, it is galvanized iron cylinder with 9.8 cm internal diameter and 16 cm high, upper face of this support on ellipse shape to easing kernel out of, wire screen used has openings of 4 mm^2, *air column* (it is cylindrical shape with 10.4 cm internal diameter, 3mm thick and 35 cm high). It made of UPVC material, air column has two openings; one of them to entry the mixture in middle column with dimensions 5x4 cm and the other opening to exit the kernel at 7.8 cm horizontal distance from column base; with dimensions of 6x8 cm. *Feed shut*, it used to feeding mixture from hopper to air column. It made of fiberglass sheet with 2 mm thick and fixed in separation unit with 22 degree slope depending on the average coefficient friction of fiberglass. *Shells discharge pan*, it made of fiberglass, this pan consists of deflector cone, plastic net and surface discharge pan has slope depending on coefficient of friction with shells. The shells discharge pan was fixed on air column by using chloroform. *Kernel outlet*, kernel out let made from fiberglass, it has slope depending on coefficient of friction with kernel, it was fixed on air column using chloroform.

3. Measurement instruments:

1) Electric balance: Sartorius type, made in Japan, with accuracy of 0.0001 g was used for measuring weight of samples.

2) Electrical oven: with forced hot air circulation, *VENTICELL55* type, and maximum temperature of 250°c to evaluate the moisture content.

3) An apparatus of friction angle measurement: The friction angle was measured by an instrument fabricated in the workshop of Agricultural Engineering Faculty, Al-Azhar University, various materials galvanized sheet and fiber glass were installed on the changeable plane to study the effect of these materials on the friction angle.

4) Anemometer: with Accuracy of 0.1m/s, range measurement of 0 - 30 m/s.

5) Feeding rate measurement apparatus: Feeding rate measurement apparatus consists of flat flexible belt has length of 2.05 m, 0.20 m width and 0.5 mm thickness to lade 1 kg mixture, belt was fixed in wooden frame by 4 bearing pulleys and was rotated by electric motor (0.37 kW, 1400 rpm), it was connected with a speed controller (inverter) of model No. SV004IC5-1, (Fig. 5).
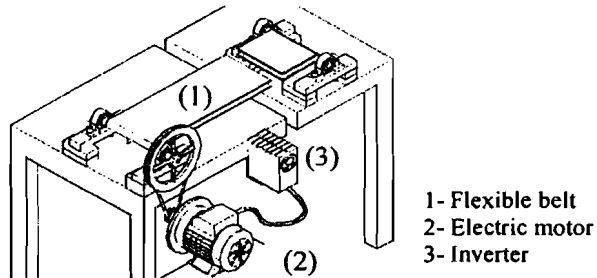

1- Flexible belt
2- Electric motor
3- Inverter

Fig. (5): Feeding rate measurement apparatus.

6) Terminal velocity apparatus: The apparatus (Fig. 4), (used by **Awady and El- Sayed, 1994**) was used to measure the terminal velocity for suspension of kernel and shells samples, it consists of a rectangular tube constructed from transparent (plexi-glass) and connected with the outlet of the electric blower, two wire screens were fitted at the bottom and top of the transparent tube, an air-flow straightener was attached with the lower screen to improve flow uniformity throw the rectangular tube, a choke valve is built as the inlet of blower to control the air flow rate manually by control lever.
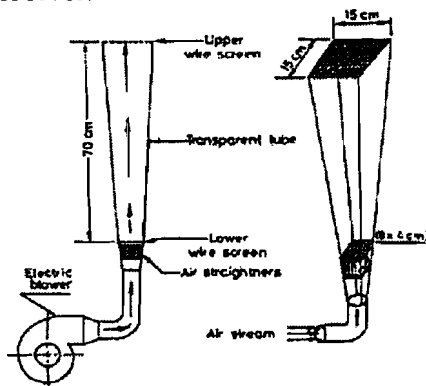

Fig. (4): Terminal velocity apparatus (Awady and El-sayed, 1994).

7) Digital AVO meter: with accuracy of device 0.01, range the measurement (0 - 40 A).

8) Stop watch: with accuracy of 0.01 s to measure the separation time.

4. Theoretical approach:

According to physical proprieties of apricot kernel and shells can be definition the following:

4.1. Air stream velocity: suitable air stream velocity must be ranged between both of kernel terminal velocity and shells terminal velocity as following:

$$V_{t\,(sh)} < V_a < V_{t\,(k)}$$

4.2. Kernel motion on separation screen with slope: as shown in Fig. (6,a) to move kernel on screen must be:

$$M_k\,g\,sin\,\alpha \geq \mu\,M_k\,g\,cos\,\alpha$$

Also, kernel motion velocity (Vm) can be calculated as following:

$$V^2 = V_0^2 + 2as$$

$$V_m = \sqrt{\sqrt{2gh}\,sin^2\alpha + 2s\left(\frac{M_k g sin\alpha - \mu M_k g cos\alpha}{M_k}\right)}$$

4.3. Shells motion that pushing with air force: as shown in Fig. (6,b)

$$F_a = M_{sh}\,g + M_{sh}\,a \quad (where\ F_a > M_{sh}\,g)$$

$$\tfrac{1}{2}\,C_d\,\rho_a\,A_p\,V_a^2 = M_{sh}\,g + M_{sh}\,a\ _{(acceleration)}$$

$$a\,_{(acceleration)} = (\tfrac{1}{2}\,C_d\,\rho_a\,A_p\,V_a^2 - M_{sh}\,g)\,/\,M_{sh}$$

4.4. Height of air column (duct): as shown in Fig. (6,b), the maximum rise for shell (*l*) can be calculated as following – at this height, the velocity of shell (V_e) is nihilistic –:

$$V_{actual} = V_a - V_y$$

$$V_y = V_i\,sin\,\alpha$$

$$\therefore V_{actual} = V_a - sin\,\alpha\,\sqrt{\sqrt{2gh}\,sin^2\alpha + 2s\left(\frac{M_{sh}g\,sin\alpha - \mu M_{sh}g\,cos\alpha}{M_{sh}}\right)}$$

$$Also,\quad V_e^2 = V_{actual}^2 - 2\,a\,l$$

$$\therefore l = \frac{V_{actual}^2}{2\,a}$$

This equation calculates the maximum of shell rise that pushed by air force, consequently, the high of air column (duct) must be less than value of the equation to let the shells out.
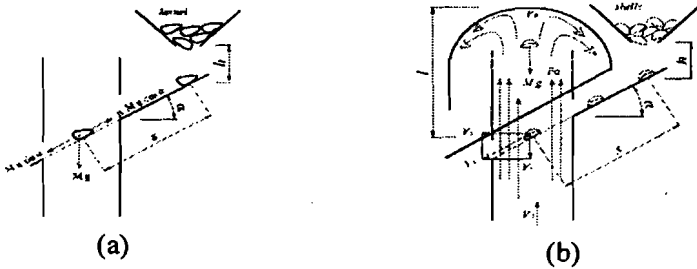
(a)   (b)

Fig. (6): Kernel and shells motions analysis.

Physical properties:

For study some physical properties for apricot kernel and shells, a random sample of 50 apricot pits were cracked mechanically (**Tayel et al., 2011**), 50 kernels and 304 pieces of shell were produced from cracking process. Some physical, mechanical and aerodynamic properties were evaluated in minimum mixture moisture contents of 5.76% w.b. (4.50% and 12.08% w.b. for shells and kernels, respectively). At this level of moisture content, the percent's of components in mixture were 69% and 31% for shells and kernel, respectively, properties were shown in Table (1).

Table (1): Properties of apricot pit kernel and its shells.

Properties		Range		Mean	S.D.	C.V. (%)
		Min.	Max.			
Mass (M), g	Kernel (k)	0.32	0.61	0.47	0.07	14
	Shells (sh)	0.02	0.62	0.19	0.11	57
True Density(ρ_t), kg/m³	Kernel	913	1300	1100	82.9	8
	shells	625	1750	1286	247.2	19
Projected area (A_p), mm²	Kernel	102	158	124	12.94	10
	shells	25	193	91	34.95	39
Coefficient of friction (μ)	Galvanized iron	Kernel	0.471	0.583	0.520	0.03	6
		Shells	0.456	0.577	0.526	0.03	6
	Fiberglass	Kernel	0.321	0.494	0.402	0.04	11
		Shells	0.372	0.515	0.426	0.04	8
Terminal velocity (V_t), m/s	Kernel	10.58	16.40	14.21	1.21	3
	shells	4.64	16.20	9.00	1.76	20
Drag coefficient (C_d).	Kernel	0.24	0.41	0.29	0.03	12
	shells	0.10	1.25	0.38	0.08	21

Experimental procedure:

The experiments were designed and carried out to study the effect of the following variables: 9, 10, 11, and 12 m/s air velocities; 30, 60, 90 and

120 kg/h feeding rates; 5.76, 14.46 and 21.67±0.5% w.b. moisture contents; 25 and 35° slopes of wire screen.

Measurements:

- **Density**: True volumes of the individual samples were determined using the liquid displacement method. Toluene (C_7H_8) liquid was used because it's absorbed by samples to a lesser extent. Also, its surface tension is low **(Mohsenin, 1970)** and density was measured by divided true volume on mass of sample.

- **Projected area**: Projected area of kernels and shells samples was plotted to measure by using a scanner and the sample pictures were exported to Auto CAD 2007 program to calculate the area **(Dosoky, 2011)**.

- **The moisture content:** Moisture content was determined using a digital electrical oven with forced hot air circulation. The moisture content for samples is evaluated according to **ASAE standards (1994)**, by oven drying at 105°c for 24 hours. Moisture content was calculated on wet bases as follows:

$$M.C.(\%) = \frac{Mw - Md}{Mw} \times 100$$

Where:

Mw: Mass of wet samples, kg; and

Md: Mass of dry samples, kg.

The samples desired moisture content levels were achieved by incubated in water for 1 and 2 hours before the experiment **(Inan, 2001)**, and samples were kept in fridge temperature for 48 h to complete absorption of humidity.

- **Coefficient of Static Friction:** Coefficient of static friction of a sample on two surfaces including galvanized iron and fiberglass were determined, a sample was put on the surface with adjustable slope. When a sample started to move, the tangent of the slope angle calculate as follows:

$$\mu = \tan \theta = y / x$$

Where, θ: Friction angle, degree.

- *Terminal velocity and drag coefficient:* The terminal air velocity was measured using a terminal velocity apparatus according to **Awady and El- sayed (1994)**. The sample was placed on the lower screen. Terminal velocity can be obtained by measuring the air velocity required to suspend the particles in the vertical air stream. Air velocity was measured at the bottom of the tube by an anemometer. The air velocity changes according to changes in the cross-section of the tube. The value of the terminal velocity (Vt) was calculated using the following expression:

$$Vt(ms^{-1}) = \frac{Air\ flow\ rate\ of\ subsiding\ the\ material,\ (m^3 s^{-1})}{cross\ section\ area\ of\ the\ tube,\ (m^2)}$$

When a particle is suspended into a turbulent stream of air, equilibrium is achieved between its weight (Mg) and the drag force, and can calculated drag coefficient as follows:

$$Cd = \left(\frac{2Mg}{V^2 \times \rho a \times Ap} \right)$$

Where:

Cd: The coefficient of drag;

ρ_u: air density, (1.25 kg/m^3);

Ap: particle area projected to air stream, m^2; and

V_t: air terminal velocity, m/s.

Parameters of technical evaluation:

Parameters of technical evaluation were calculated as the following equations **(Kashayap and Pandya, 1965)**:

$$KR\ .(\%) = \frac{Ka}{Ka + Kb} \times 100 \quad , \qquad KC\ .(\%) = \frac{Ka}{Ka + SHa} \times 100 \quad ,$$

$$KC\ .(\%) = \frac{Ka}{Ka + SHa} \times 100 \quad , \qquad \eta.(\%) = KR \times SHR \times 100$$

Where:

KR: Kernel recovery;   Ka: separated kernel, g;

KC: kernel cleanliness;   Kb: kernel loss in shells outlet, g;

SHR: shells rejected;   SHa: separated shells, g;

η: separation effectiveness; and   SHb: shells outlet in separated kernel, g.

- **Productivity (Pr):** Time of separating was measured by stopwatch to determine the kernel production using the following equation:

$$Pr = \frac{Mass\ of\ separated\ kernel\ (kg)}{Time\ of\ separation\ (h)}$$

- **Specific energy requirement (SER):** The specific energy requirement was calculated using the following equation:

$$SER = \frac{Power,\ (kW)}{Pr.\ (kg/h)}$$

- **Cost analysis:**

The pneumatic separator economical and financial analyses were carried out calculation the following parameters, the methodology of estimating costs (L.E./h) was as follow **(Hunt, 1983):**

Total cost (L.E./h) = Fixed cost (L.E./h) + Variable cost (L.E./h)

A. Fixed costs:

1) Depreciation of machine (D): depreciation of machine (L.E./year) was calculated from the following equation:

$$D = \frac{(P - S)}{L}$$

Where:

P: Purchase price, L.E. (350 L.E.);

S: Salvage or Selling price, L.E. (Salvage = 10% of cost now); and

L: Time between buying and selling, Year. (10 years).

2) Interest rate: interest rate was considered as a percentage of the machine purchase per year. (In Egypt, Interest rate was conceded 9%).

3) Taxes, insurance and shelter: taxes, insurance and shelter were considered 2% of the machine purchase price per year.

B. Variable costs:

1) Repairs and maintenance: repairs and maintenance is about 5.77% of purchase price.

2) Electric cost (KW): Total power consumed was calculated according to **(lockwood and dunstan, 1971)** as following equation:

$$KW = \frac{(I.V.u.\cos\theta)}{1000}$$

Where:

I: Current strength, amperes (Current strength was 1 ampere);

V: Potential difference voltage (to 220v);

µ: Mechanical efficiency of motor (0.95); and

cosθ: Power factor (being equal to 0.8).

Price kW of electric is 0.3 *L.E. / kW.h.*

3) Lubricant cost: lubricant cost was taken as (15%) of electric cost.

4) Labor cost: labor wage was considered 900 L.E./month work so that the labor wage was 9000 L.E./year. Yearly working hours is assumed in the present work to be: (300 days/year × 8 h/day = 2400 h/year).

C. Operating cost:

$$Cost\ of\ (L.E./kg) = \frac{Unit\ hourly\ cost,\ (L.E./h)}{Pr,\ (kg/h)}$$

RESULTS AND DISCUSSIONS

Effect of studied variables on separation effectiveness and percent of cleanliness:

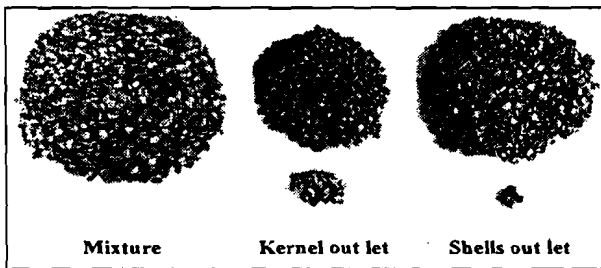The output of the apricot pits kernel and shell separation was classified as shown in Fig. (7)

| Mixture | Kernel out let | Shells out let |

Fig. (7): Result of separation process.

1. Effect of air velocity:

Fig. (8) shows that the air stream velocity had a great effect on the performance of the separation unit, separation effectiveness was increased with increasing air velocity from 9 to 11 m/s, especially at upmost moisture content (21.67%), while in case decreasing level

moisture contents from (5.76 to 14.46%), separation effectiveness decrease with increased of air velocity to 12 m/s under all experimental conditions. The minimum mean effectiveness obtained was 45.53% when the air stream velocity, feeding rate, mixture moisture content and screen slope were 9m/s, 30 kg/h, 21.67% and 35° respectively. While the maximum value which was 96.18% when the air stream velocity, feeding rate, mixture moisture content and screen slope were 11m/s, 120 kg/h, 14.46% and 25°, respectively.

Fig. (9) shows the relationship between the air stream velocity and mean kernel cleanliness at different values of feeding rate, mixture moisture content and screen slope. The results showed that, by increasing air velocity from 9 to 12 m/s, kernel cleanliness increased under all experimental conditions .The minimum mean kernel cleanliness obtained was 49.82% when the air stream velocity, feeding rate, sample moisture content and screen slope were 9m/s, 30 kg/h, 21.67% and 35°, respectively. While the maximum value which was 98.76% when the air stream velocity, feeding rate, sample moisture content and screen slope were 12m/s, 120 kg/h, 5.76% and 25°, respectively.

This effect was due to the fact that, increase of air stream velocity gives the air stream opportunity to carry out most of shells because terminal velocity for shell less than kernel terminal velocity, while kernel losses increased more at air stream velocity of 12 m/s especially at low levels of moisture content because the kernels were light, this leading to easy driftage kernel by air stream leading to reduced effectiveness in the end. These results are in agreement with **Ismail et al. (1994) and Eissa (2009).**

2. Effect of moisture content:

The results showed that, by increasing moisture content from 5.76 to 14.46 % separation effectiveness and cleanliness increased slightly in all experimental treatments and then decreased at moisture content of 21.67%. It was observed that, the increase of mixture moisture content from 5.76 to 21.67% caused decreased in percent of effectiveness, kernel cleanliness and kernel losses at all air stream velocities, feeding rates and screen slopes. This effect was due to the fact that, increase of mixture moisture content gives the mixture opportunity to resistance of air stream

velocities. When moistening mixture to increase moisture content, notes that kernel absorption to water was higher than shells, that leads to decreased of kernel losses at moisture content of 14.46%, while weight of shells un increased a lot at this moisture content, there explain the slightly increase in effectiveness and cleanliness at moisture content of 14.46%. These results are in agreement with **Ismail et al. (1994).**
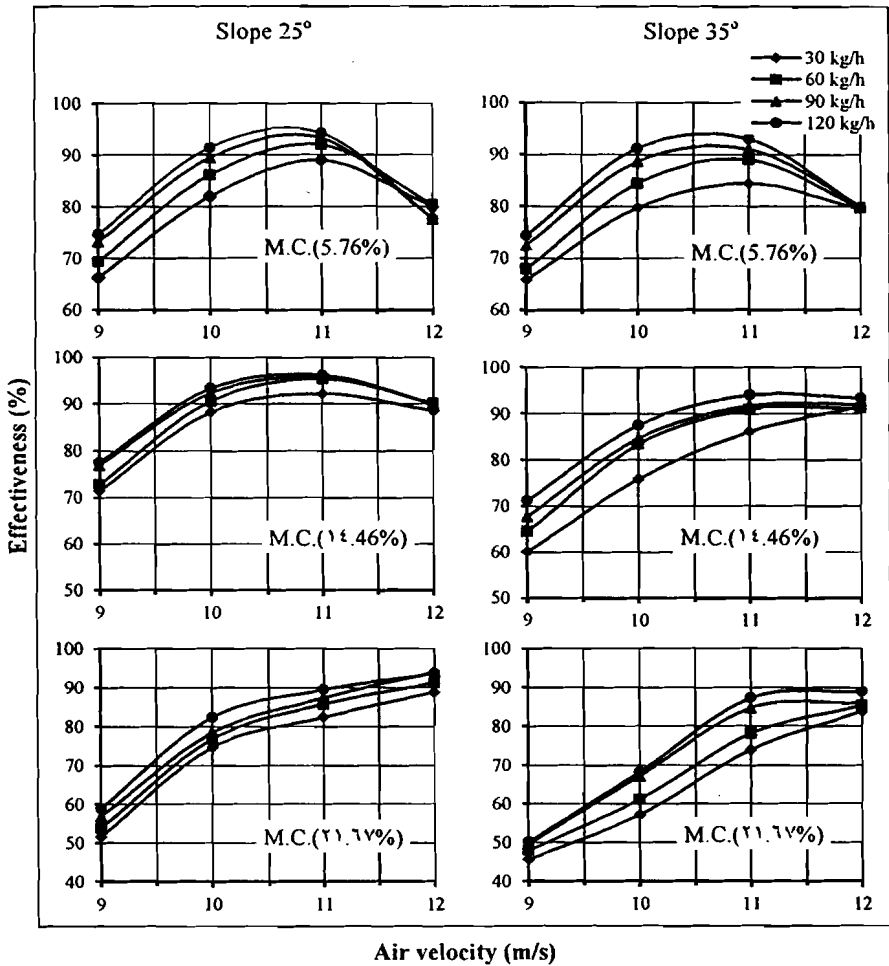

Fig. (8): Effect of studied variables on separation effectiveness.
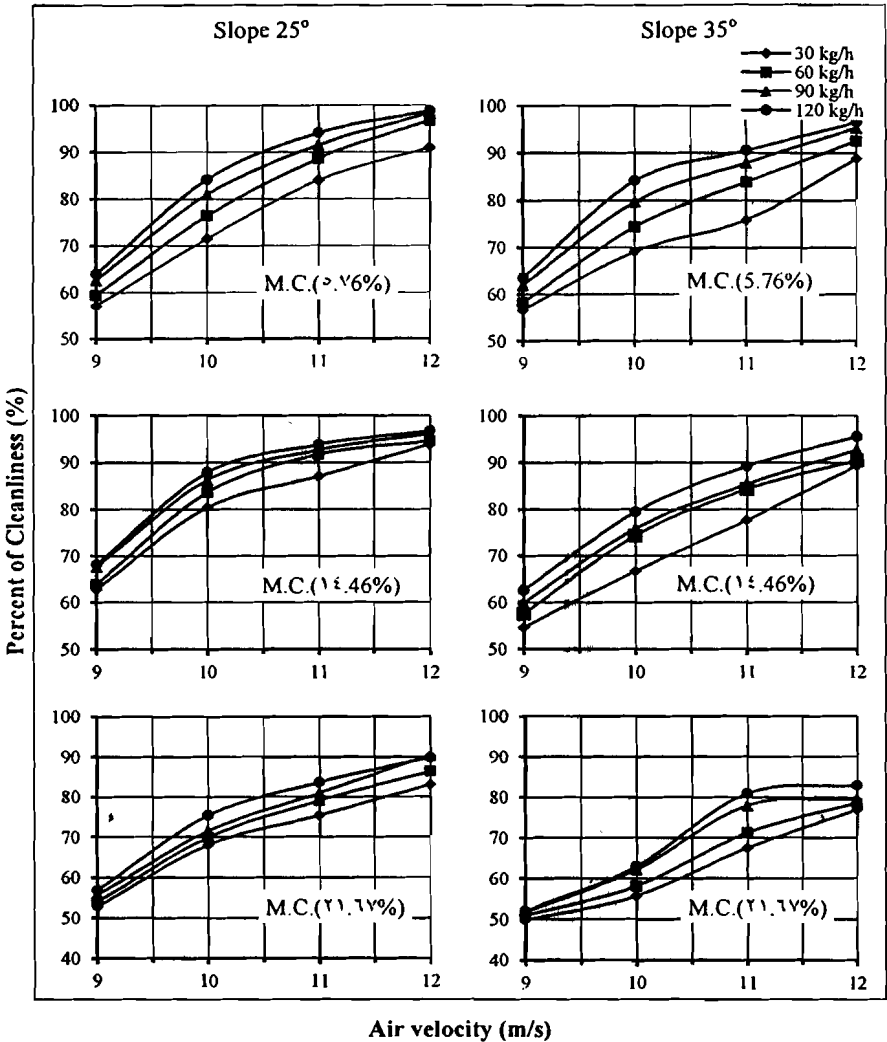
Fig. (9): Effect of studied variables on kernel cleanliness.

3. Effect of feeding rate:

The results showed that, by increasing feeding rate from 30 to 120 kg/h separation effectiveness, kernel cleanliness and losses increased in all experimental treatments exclusive feeding rate of 120 kg/h this was a little increase in separation effectiveness, this gave marked about outside for separation unit. These results are disagree old results. According to

Ismael et al. (1994) and **Eissa (2009)**; the effect of the specific feeding rate is related to the increase of the thickness of mixture layer throw the separation duct. Consequently, the separation condition got worse because that affects the air resistance per unit length. While, in this search this action not done because density for mixture are high. Also, design of feeding rate unit and its height from feed chute related to the decrease of the thickness of mixture layer and slowed moving throw the separation duct that not allow to overlap between layers of feeding.

4. Effect of screen slope:

Notes from figures that, increase of separation effectiveness, kernel cleanliness and losses at screen slope of 25°, while these factors of evaluations were less at screen slope of 35°. This result due to speed of bypassing of mixture through air column stream; while, this is not happen when used screen slope of 25° because it is friction angle with material of screen.

- *Kernel productivity,*

Unit separation productivity was 40 kg/h.

- *Specific energy requirement:*

Specific energy requirement was 4.22 kW.h/Mg.

- *Separation unit costs:*

Total separation unit costs were 3.85 L.E./h and 0.10 L.E./kg (96 L.E./Mg).

CONCLUSION

This research aimed to study the feasibility of separation of mixture of apricot kernel and shells. Some physical, mechanical and aerodynamic properties were studied for kernel and shells, and the type of separator (pneumatic separator) was selected according to different in terminal velocity between kernel and shells. The separation unit was performed by using a range of air stream velocities, mixture feeding rates, and screen slopes at different mixture moisture contents.

The optimum operating condition of separation was found at air stream velocity of 11 m/s, mixture feeding rate of 120 kg/h, screen slope of 25° and average mixture moisture content of 14.46% where gave the best result of separation effectiveness of 96.18%, kernel cleanliness of

93.15%, kernel losses of 0.69%, kernel productivity was 40 kg/h, specific energy requirement was 4.22 kW.h /Mg and cost was 0.10 L.E./kg.

The research recommends feasibility of using pneumatic system to separate similar mixture products, such as shells and kernels of peach and plum pits, after studying the physical properties of these products.

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<u>الملخص العربى</u>

فصل لب نوى المشمش باستخدام نظام دفع الهواء

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تعتبر عملية فصل وتنظيف لب نوى المشمش من القشر واحدة من أهم العمليات بغرض الزراعة وتعظيم الإستفادة منه فى صناعة الزيوت والروائح العطرية ومستحضرات التجميل وانتاج بعض العقاقير وتسويقه طبقا للمعايير الدولية، كما تسهل استخدام القشر فى انتاج الكربون النشط عالى الكفاءة فى ازالة الملوثات الناتجه عن العمليات الصناعية والغذائية ومياه الشرب،حيث أن عملية الفصل اليدوى مجهدة ومكلفة اقتصاديا،وحيث أنه تم سابقا تكسير نوى المشمش بوحدة تكسير، لذا يهدف هذا البحث إلى إختيار أنسب طريقة تلائم عملية فصل خليط اللب والقشر، ودراسة العوامل المؤثرة على أداء وحدة الفصل والتنظيف، وإجراء تقيم فنى وإقتصادى. تم دراسة بعض الخواص الطبيعية مثل الكتلة والكثافة ومساحة الاسقاط الضوئى ومعامل الاحتكاك

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والسرعة الحرجة ومعامل الجرف لكل من لب وقشر نواة المشمش (صنف العمار) عند متوسط محتوى رطوبى للخليط (٥.٧٦% على أساس رطب)، وأختيرت طريقة الفصل بناء على الإختلاف فى الوزن والسرعة الحرجة بين القشر واللب، وصممت الوحدة تعتمد على نظرية الفصل بتيار الهواء الرأسى، بورشة كلية الهندسة الزراعية جامعة الأزهر ـ القاهرة، حيث تتكون من سير للتغذية ووحدة الفصل، وتم إختبار الوحدة مع أربع سرعات لتيار الهواء (٩ – ١٠ – ١١ – ١٢ م/ث)، وأربعة معدلات تغذية للخليط (٣٠ – ٦٠ – ٩٠ – ١٢٠ كجم/س)، وثلاثة محتويات رطوبة للخليط (٥.٧٦ – ١٤.٤٦ – ٢١.٦٧±٠.٥ % على أساس رطب)، وزاويتان لميل الغربال (٢٥ – ٣٥ درجة)؛ تم تقييم النتائج من حيث الكفاءة الكلية للنموذج، ودرجة التنظيف ، وكانت النتائج كالتالى:

أولا: الخواص الطبيعية والميكانيكية والأيروديناميكية:

كان متوسط الوزن (٠.٤٧ و ٠.١٩ جم) ، الكثافة (١١٠٠ و ١٢٨٦ كجم/م³)، مساحة الاسقاط الضوئى (١٢٤ و ٩١ مم²)، معامل الاحتكاك (٠.٤٠٢ و ٠.٤٢٦)، السرعة الحرجة (١٤.٢١ و ٩ م/ث)، ومعامل الجرف (٠.٢٩ و ٠.٣٨) لكل من اللب والقشر على التوالى.

ثانيا: تأثير عوامل الدراسة على وحدة الفصل والتنظيف:

١ـ بزيادة سرعة الهواء زادت درجة التنظيف لأقصى قيمة لها، وكذلك زادت الكفاءة الكلية للوحدة حتى حد معين تم بدأت تتناقص.

٢ـ بزيادة معدل التغذية زادت قيم كل من درجة التنظيف والكفاءة الكلية للوحدة.

٣ـ بزيادة المحتوى الرطوبى زادت قيم كل من كفاءة الوحدة الكلية ودرجة التنظيف زيادة نسبية عند حد معين ثم تناقصت بمعدل كبير عند أقصى محتوى رطوبى.

٤ـ بزيادة زاوية ميل الغربال قلت جميع قيم درجة التنظيف والكفاءة الكلية للوحدة.

وجدت أفضل كفاءة كلية للوحدة (٩٦.١٨ %) وأفضل درجة تنظيف (٩٣.٨٣ %) بنسبة فاقد ٠.٦٩ %) وذلك عند محتوى رطوبى للخليط (١٤.٤٦ ±٠.٥ % على أساس رطب) وسرعة تيار الهواء (١١ م/ث) ومعدل تغذية للخليط (١٢٠ كجم/س) وزاوية ميل للغربال (٢٥ درجة)، وتم إجراء تقييم إقتصادى حيث وجدت تكاليف تشغيل الوحدة (٣.٨٥ جنيه/ساعة) و(٩٦جنيه/طن)، وإنتاجية اللب (٤٠ كجم/ساعة)، وكانت الطاقة النوعية (٤.٢٢ كيلووات.ساعة/ طن) عند ظروف التشغيل المثلى.

يوصى البحث بإمكانية إستخدام نظام دفع الهواء لفصل مخاليط مشابهه مثل قشر ولب نوى الخوخ والبرقوق وذلك بعد دراسة الخواص الطبيعية لتلك المنتجات.