DEVELOPMENT AND EVALUATION OF AN ONION PEELING MACHINE

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ABSTRACT

An onion peeling machine was designed, manufactured, developed and evaluated to suit the small and medium processing units. The onion peeling machine consists of seven parts, main frame, peeling drum, inlet and outlet openings, collection basin, water and air supplying systems, and power transmission. The machine was evaluated using different onion bulb sizes (small, medium & large). A mixed sample of different sizes was also tested. The evaluation process was conducted under three different drum rotational speeds (30, 40 and 50 rpm), three different peeling residence times (1, 2 and 3mins) and three different batch loads (18, 24 and 30kg). The optimum peeling efficiency of 74.9, 65.24, 80.08 and 85.45% were obtained at 24kg batch load (0.36 ton/h.), 2min peeling residence time and 40 rpm for small, medium, mixed and large sizes respectively. Water pump and air compressor were added to the peeler to improve the peeling efficiency, and it was tested under the previous conditions. The corresponding values of peeling efficiency for the machine with pump water at water pressure of 400kPa were 76.73, 83.06, 99.20 and 87.49 %, respectively. While they were 76.33, 72.87, 87.530 and 88.37%, respectively for air pumping at pressure of 500kPa. The estimated costs of onions peeling machine were 28.47, 29.56 and33.75 L.E/ton for the machine only, machine with water pump and machine with air compressor respectively. These values of estimated costs using the developed machine are very competitive with the cost of manual peeling process which approached about 75 L.E/ton.

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1. INTRODUCTION

Onions has been a popular food for many centuries. Today they are valued for their flavor, aroma, and taste, being prepared domestically or forming raw materials for a variety of food processes (dehydration, freezing, canning and pickling).

They are probably the most universally used vegetable in most countries. Onion peeling is an essential step in producing many of the onion products such as dehydrated onions, onion powder, onion flavoring, onion salt, onion rings, and pickled and canned onions. Several methods have been used for peeling onions. The common methods used in modern onion processing industry are lye treatment, flame peeling, and mechanical peeling. Lye peeling and flame peeling methods are harsh and are not suitable for many onion products **(Wang, 1993, Srivastava *et al*., 1997 and Naik *et al.*, 2007)**.

Naik *et al.* (2007) designed and tested a batch type multiplier onion peeling machine suitable for farm-level operation. Interaction studies were carried out between the speed of rotation versus peeling efficiency. Damage percentage, unpeeled samples and operational parameters were optimized. The capacity of the peeler is 50-60kg/hr. The peeling efficiency was about 92 % with unpeeled and damaged percentages of 6 and 2 %, respectively. The cost of peeling was worked out to be $27 per tones.

Srivastava *et al*. (1997) designed and tested a medium-size onion peeling machine. The novelty of the machine was four scoring blades assisted by compressed air jets to slit the outer layers of the onion skin. Tests were made to determine peeling performance as affected by onion size, onion shape, compressed-air pressure, and onion feeding rate. The performance of the machine was characterized by peeling efficiency, peeling losses, and throughput rate. Feeding chain speed and air pressure significantly affected the machine's performance. The interactions of onion size with air pressure and onion shape with chain speed significantly affected all performance parameters.

Guldas (2003) found that hand peeling of kiwi fruit has some disadvantages such as difficulty during peeling, increase of loss in weight

and nutritional value. Weight (fruit tissue) loss in hand peeling was higher than alkali peeling.

Adnan (2010) designed and constructed an onion skin peeling machine to meet the standards required by the customer or user. In general machine construction methodology is based on the concept of friction on the surface of the onion and topped with the use of water to helps soften the surface of the onions before peeling process can be done. Meanwhile, the methods and the use of machines is based on the rotation of a soft brush attached to the shaft and fully controlled by a single phase AC motor. This process is expected to make onion skin come out. This machine is build to meet the demand from small-and medium industry in design, function, and price. This machine is also expected to be used for wedding fest preparation in the villages. Efficiency of this machine had been measured and the data are being analyzed using Design Expert software for the ANOVA procedure.

Considering the increasing demand for garlic products in domestic and export market, a low cost garlic clove peeler was developed and its performance was evaluated. The developed garlic clove peeler consisted of a 130 mm diameter, 400 mm long peeling chamber mounted on a mild steel (MS) angle frame. The top portion of the pressure chamber was connected with a 40 mm diameter reducer to separate the thin husk from the peeled material. A 10 mm galvanized iron (GI) pipe was inserted and positioned at a height of 60 mm from the top surface of the garlic bed to flow the air from the compressor. The peeling efficiency of 97.6 percent was observed with peeling time of 70 s for a batch of 500 g (**Mudgal and Champawat**, **2011).**

Abrasive peeling was carried out for different types of vegetables with an abrasive peeler. This is simply a drum with a rough inner surface and a motor. After the vegetables are put inside the drum, the inlet is covered, and the drum is allowed to rotate for a short time. This method is more suitable for root vegetables than fruits, because the latter are usually rather soft. Sweet potato is usually peeled by this method **(Lin, 1995).**

From the previous work, it is clear that the hand peeling process is very tedious, time consuming work and costly as well, therefore, the main aim of this study was to design, fabricate and evaluate an onion peeling

machine from local raw materials to assure high quality, high peeling efficiency and losses reduction with low cost. This machine could be used in small and medium production units, such as restaurants, hotels and small onion dryers.

2. EXPERIMENTAL PROCEDURES

2.1 Description of the onion peeling machine.

The onion peeling machine consists of seven parts, included main frame, peeling drum, inlet and outlet openings, collection basin, water and air supply systems, and power transmission, as shown in Fig. (1). The peeling drum is considered the most important part in the machine; it has a length of 1000 mm and diameter of 480 mm as shown in Fig. (2).

Elevation
Dim.mm

Side view
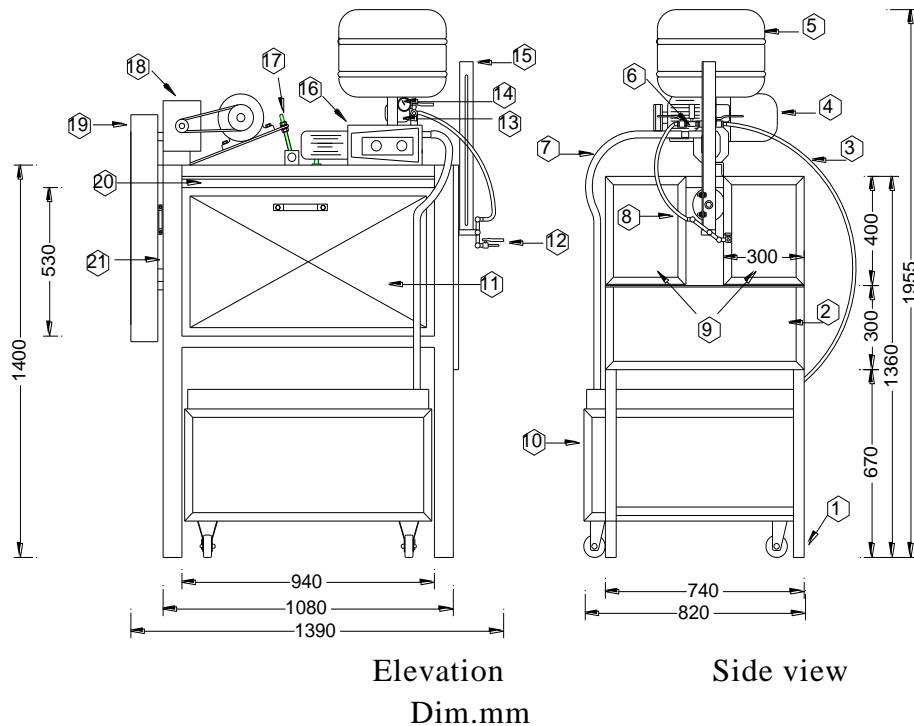
1. Peeler chassis	8. Water pressure hose	15. An iron arm
2. Outlet opening	9. Two inlet openings	16. Water pump
3. Water by pass hose	10. Collection basin	17. V- belt adjust screw
4. Electric motor	11. Side cover	18. Gear box
5. Water tank pressure	12. A joint link	19. Sprocket and chain cover
6. metal couples	13. Water pressure control	20. Top cover
7. Water suction hose	14. Water pressure gage	21. Back cover

Fig. 1: Schematic diagram of the prototype onion peeling machine.

The peeling drum consists of two circular frames of galvanized metal sheets with 4 mm thickness, 100 mm length and 480 mm diameter. Twenty four peeling beams of galvanized sheet U-shaped with dimensions of 25 x 35 x 2mm for height, width and thickness, respectively, were fixed on the internal surface of the circular frame. Each beam was filled with a wooden slice to fix the steel plate saw with a sharp edge tooth on it using bolts to hold the plate saw inside the beam, and to reduce the impact of onion falling during rotation. The depth of abrasive edge can be adjusted by raising or lowering the plate saw by external bolts. The upper distance from edge to edge of the saw teeth is 8 mm, and the number of saw teeth of 1 meter length is 125 teeth. A 250mm blank space was left between each beam to facilitate the delivery of the peels. The drum was fixed on a horizontal shaft supported by one ball bearing (30 mm ID) from the closed side of drum and mounted on two wheels from the other opened sides.

Detailes A

1. Steel plate saw   3. peeling beam   5. Beam bolt
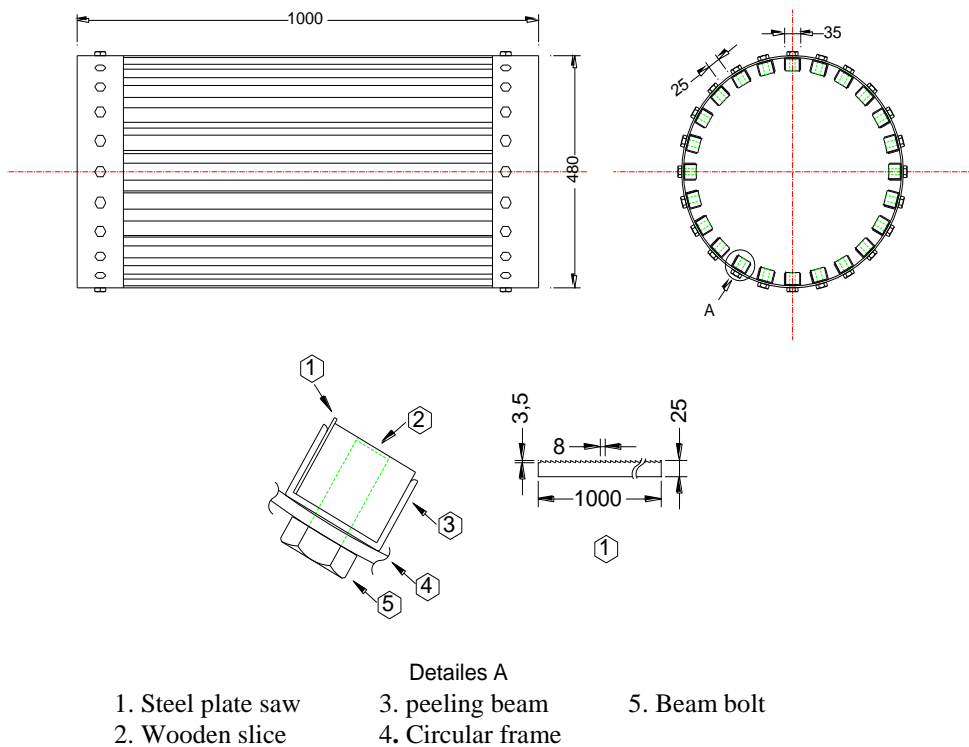2. Wooden slice   4. Circular frame

Fig. 2: Schematic diagram of the peeling drum

The inlet and outlet openings were made of galvanized sheet metal of 1.5 mm thickness; one for feeding and the other for unloading. The inlet opening consists of two upper doors (400 x 300 mm dimensions), with an empty vertical distance between them (140mm.) to be easy in raising or lowering the nozzles pipe. During onion feeding, the outlet opening is closed and these two doors are opened. The outlet opening is placed under the inlet opening; the size of outlet opening is 400 x 300 mm.

The collection basin consists of four parts (the basin chassis, the water and peel collection basin, the strainer stand and the strainer). The basin chassis which is mounted on four wheels to carry the basin has 10mm thickness, and dimensions of 920 x820 x390 mm for length, width and height, respectively. The basin was made of galvanized steel sheet, of 1.5mm thickness and the dimensions of basin are 900 x 800 x 460 mm for length, width and height, respectively. The basin bottom is opened with a hole of 25 mm diameter attached with on/off valve to drain the water.

2.2. Power transmission system:

The peeling drum is driven by a 1.5 kW, single phase electric motor. The motor is connected to gear box to reduce the speed from 1450 to 29 rpm (50/1) and convert the horizontal rotational motion to vertical .The power was transmitted to the gear box by using different sizes of pulleys and V-shape belts. Two sprockets with the same diameter (140mm, 34teeth) and chain were used to transmit the available power from the gear box to the peeling drum shaft without slippage.

2.3. Water and air supply systems:

A water pump of 0.75 kW and 400 kPa maximum pressure and an air compressor of 300 liter capacity with 1200 kPa maximum pressure were used to test the effect of compressed water or air in improving the performance of peeling process as shown in Fig. (3). The water was recycled at 1-2 h, interval due to the blocked of screen filter mesh every 1-2 h.

2.3. Physical properties of the onions used for the experimental work:

The mass and thickness of all onion components of Giza 20 onion cultivar were measured and statistically analyzed. 30 onion bulbs were taken randomly and divided into 10 samples for 3-size categories (small size: < 40 mm; medium size: from 40-70 mm& large size: >70mm **(Bahnasawy et al., 2002)**), to get the mean values (Av.). All layers of onion leaves sample were carefully separated, as well as the onion tip and the onion root to determine the mass and thickness percentages. The average moisture content of the onion used in the experiments was 87.34±0.33%.

Elevation   Side view   Dim.mm

1. Screen filter   6. Water pump   11 Air pressure hose
2. None-return valve   7. Water tank pressure   12. Flange
3. Water excess hose   8. an iron arm   13. Water pressure control
4. Water and air nozzles 9.a joint link   14. Metal links group
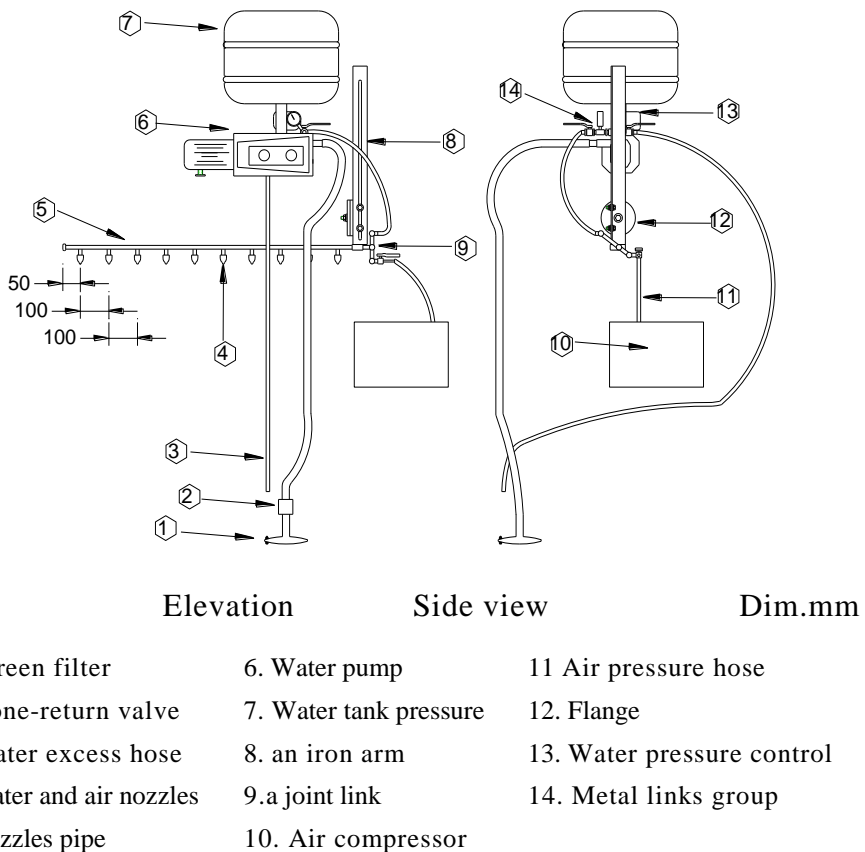5. Nozzles pipe   10. Air compressor

Fig. 3: Schematic diagram of water and air supply systems.

2.3.1. Calculations of the peels mass and thickness percentage:

The calculated peels mass percentage was defined as the ratio of the peels mass to be removed to the total onion mass which could be determined as follows:

$$M_{c.p} = \frac{(M_{f.s.l} + M_{s.s.l} + M_{t.s.l} + M_{s.f.l})}{M_{total}} \times 100 \quad \dots\dots\dots\dots\dots\dots (1)$$

Where:

$M_{c.p}$ = the calculated peels mass (%), to be removed;
$M_{f.s.l}$ = the first squamous leaf mass; g;
$M_{s.s.l}$ = the second squamous leaf mass, g;
$M_{t.s.l}$ = the third squamous leaf mass, g;
$M_{s.f.l}$ = the squamous fleshy leaf mass, g and
M_{total} = the total onion mass, g.

The same equation was used to calculate the thickness components percentage.

2.4. Evaluation of the onion peeling machine:

Machine peeling capacity, peeling efficiency and the percentage of removed peels were the main items of the peeling machine performance evaluation. These parameters were evaluated at different onion bulb sizes (small, medium, large and mixed), different drum rotational speeds (30, 40 and 50 rpm), different peeling residence times (1, 2 and 3min) and different batch loads (18, 24 and 30kg). Three replicates were used for each experiment; a sample of six onions was used for each replicate. Each sample was marked for identification. For marking, different color dyes were placed on the onion root. The sample was weighed before feeding to the machine to determine the M_i (initial mass). The onion sample was weighed again after peeling process to determine M_m (mass after leaving the machine).

2.4.1. Machine peeling capacity:

Machine peeling capacity (t/h) was defined as the batch load of the onions divided by the total peeling time (loading time+ peeling residence

time+ unloading time) in an hour, and could be calculated using the following equation:

$$C_p = \frac{L_b}{(T_l + T_r + T_u)} \times \frac{60}{1000}$$ .... (2)

Where:

C_p = machine peeling capacity, ton/h;

L_b = batch load, kg;

T_l = loading time, min;

T_r = peeling residence time, min and

T_u = unloading time, min.

2.4.2. Percentage of the removed peels:

Peels removed percentage was defined as the ratio of the mass of peels removed by the machine to the initial mass of the sample expressed as percentage as follows:

$$R_p = \frac{M_i - M_m}{M_i} \times 100$$ .... (3)
(Srivastava *et al*. 1997)

Where:

R_p = the removed peels by the machine, %;

M_i = initial sample mass, g and

M_m = sample mass after leaving the machine, g.

2.4.3. Peeling Efficiency.

Peeling efficiency was defined as the ratio of the peels removed by the machine (%) to the calculated peels mass (%),to be removed. It could be computed as follows:

$$\eta_p = \frac{R_p}{M_{c.p}} \times 100$$ .... (4)

Where:

η_p = peeling efficiency, % and

$M_{c.p}$= the calculated peels mass (%), to be removed.

The closer the value of η_p% to $100 \pm$ S.D, the higher the peeling efficiency, η_p% less than $100 \pm$ S.D refers to an incomplete peeling onions, while η_p% greater than $100 \pm$ S.D denotes some loss of useful onion flesh for the sized samples.

2.5. Modifications for improvement of the onion peeling machine:

After determining the most effective factors for the performance of the proposed machine as a result of the previous evaluation tests, the water pump and air compressor were used individually to improve the peeling efficiency. Pressurized air or water is used to blow the peel down to the collection basin. The same previous equation of the peeler evaluation were used to determine the performance of the onion peeling machine, as affected by (experimental factors) water and air pressures. Three levels of water and air pressures were used in the experiment (200, 300 and 400kPa) and (400, 500 and 600kPa) respectively, with four sizes of onions.

3. RESULTS AND DISCUSSION

3.1. Some physical properties of the onions used in the study:

3.1.1. The mass and thickness of the onions:

Table (1) shows the mass and percentage of the peels to be removed which represent the sum of the first, second and third squamous leaves and the squamous fleshy leaf mass and thickness.

The results show that the average onion peels mass were 2.84 ±0.72, 9.06±2.49 and 18.94±3.44 g for the variety Giza 20 at three sizes (small, medium & large). The highest and the lowest peels mass recorded values were 18.94±3.44 and 2.84 ±0.72g for the large and small bulb sizes respectively. The calculated peels mass percentages were 6.37±1.7, 7.18±1.83 and 7.89±0.97 % for the previous three sizes. The calculated peels mass percentage ($M_{c.p}$) was used to calculate the peeling efficiency.

Table 1: Mass of all onion components of Giza 20 onion cultivar.

Onion layer	Mass, g						Mass, %					
	Small		Medium		Large		Small		Medium		Large	
	Av.	SD	Av.	SD	Av.	SD	Av.	SD	Av.	SD	Av.	SD
$M_{c.p}$	2.84	0.72	9.06	2.49	18.94	3.44	6.37	1.70	7.18	1.83	7.89	0.97
$M_{f.l.w.b}$	33.80	7.37	100.20	22.38	193.35	21.96	73.53	3.06	77.79	4.49	80.83	3.38
$M_{f.l.o.b}$	6.20	1.10	13.90	3.69	20.99	10.86	13.66	1.24	11.10	3.04	8.38	3.12
M_{tip}	1.62	0.43	2.82	0.70	3.81	0.88	3.64	1.10	2.27	0.73	1.60	0.38
M_{root}	1.30	0.48	2.07	0.67	3.04	0.82	2.81	0.78	1.66	0.62	1.31	0.43
M_{total}	45.75	8.83	128.05	24.72	240.12	34.22						

$M_{c.p}$ The calculated peels mass to be removed (g) and (%)

$M_{f.l.w.b}$ The fleshy leaves with blades mass (g) and (%)

$M_{f.l.o.b}$ The fleshy leaves without blades mass (g) and (%)

M_{top} The top onion mass (g) and (%)

M_{root} The root onion mass (g) and (%)

M_{total} The total onion mass (g)

Table (2) shows the average thickness of all components of leaves onions. As shown in the table the onion peels thicknesses were 1.11±0.31, 1.75±0.44 and 2.4±0.34 for the previous three sizes. The maximum and the minimum peels thickness recorded values were 2.4±0.34 and 1.11±0.31 for the large and small size, respectively. The calculated peels thicknesses percentages were 6.63±1.25, 5.81±1.43 and 5.69±0.77 % for the previous three sizes.

Table 2: Thickness of all onion components of Giza 20 onion cultivar.

Onion layers	Thickness, mm						Thickness , %					
	Small		Medium		Large		Small		Medium		Large	
	Av.	SD	Av.	SD	Av.	SD	Av.	SD	Av.	SD	Av.	SD
$T_{c.p}$	1.11	0.31	1.75	0.44	2.40	0.34	6.63	1.25	5.81	1.43	5.69	0.77
$T_{f.l.w.b}$	10.33	1.68	22.50	3.06	33.81	2.49	62.51	3.79	74.53	4.69	80.17	3.09
$T_{f.l.o.b}$	5.10	0.99	5.90	1.49	6.02	1.66	30.86	3.69	19.66	4.79	14.14	3.12
T_{total}	16.54	2.53	30.15	3.21	42.23	3.61						

$T_{c.p}$ The calculated peels thickness that to be removed (mm) and (%)

$T_{f.l.w.b}$ The fleshy leaves with blades as thickness (mm) and (%)

$T_{f.l.o.b}$ The fleshy leaves without blades as thickness (mm) and (%)

T_{total} The total onion thickness (mm)

Based on the obtained results of peels thicknesses, the height of saw teeth could be designed, as well as the strength of peels adhesion with bulb, The smaller bulb size, the greater the strength of adhesion between the peels with bulb and vice versa. So that for teeth height design, leaves thickness were considered. For small onion size category, 1.1 mm thickness was taken, mean while, 1.75 mm was taken for the large size category. In general, the height teeth were designed and adjusted at 1.5 mm, which achieves the best previous conditions

3.2. Evaluation of the onion peeling machine.

3.2.1. Machine capacity:

The productivity of the onion peeling machine was mainly affected by the batch load and the peeling residence time. Figs. (4) and (5) show the peeling machine capacity at different batch loads and peeling residence times.
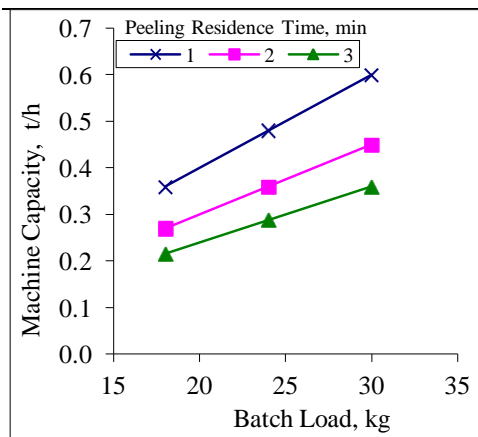

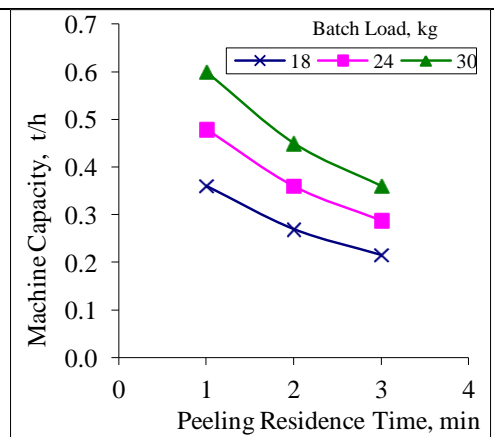Fig. (4) Machine capacity vs. batch load at different residence times.

Fig. (5) Machine capacity vs. residence times at different batch loads.

It can be noticed that the increase of the batch load from 18 to 30 kg, tends to increase the capacity of the onion peeler from 0.36 to 0.6 ton/h at
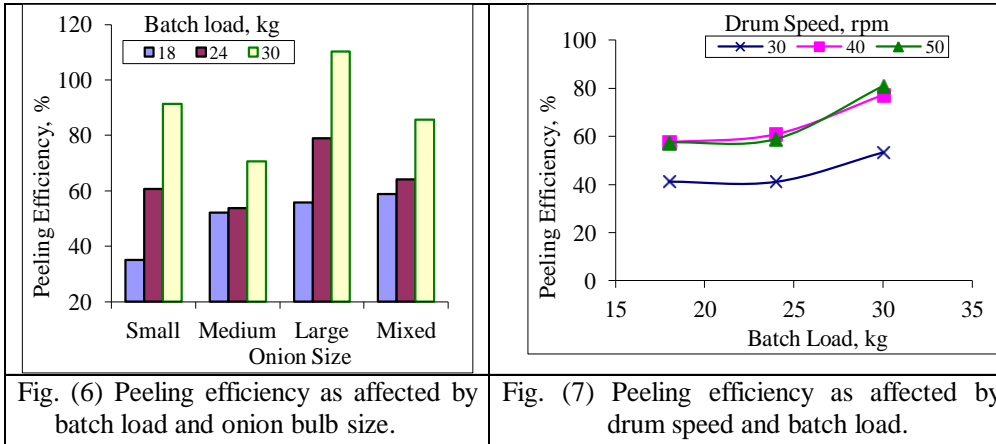
1min residence time, from 0.27 to 0.45 ton/h at 2min and from 0.216 to 0.36 ton/h at 3min peeling residence time. Increasing the peeling residence time from 1 to 3 min, tends to decrease the capacity of the onion peeler from 0.36 to 0.216 ton/ h at 18 kg batch load, from 0.48 to 0.288 ton/h at 24 kg and from 0.6 to 0.36 ton/h at 30 kg batch load.

3.2.2. Machine peeling efficiency.

Table (3) and Figs. (6) and (7) show the peeling efficiency as affected by rotation speed, batch load, peeling residence time and onion bulb size. The results show that the machine efficiency increased by increasing the pervious factors, where it reached the highest value at large size, 30kg batch load, 3min peeling residence time and 40 rpm drum rotational speed and the lowest value was obtained at small size, 18kg batch load, one min peeling residence time and 30 rpm drum speed.

Table 3: Machine peeling efficiency (%), of the tested onion peeler.

Drum speed, rpm	Peeling residence time, min	Size, mm											
		Small			Medium			Large			Mixed		
		Batch load, kg			Batch load, kg			Batch load, kg			Batch load, kg		
		18	24	30	18	24	30	18	24	30	18	24	30
30	1	21.03	43.57	47.99	31.71	31.80	39.66	39.16	60.75	83.81	50.73	41.39	52.78
	2	23.74	46.73	57.12	44.59	42.56	58.82	45.44	65.92	95.37	56.26	49.76	62.71
	3	26.23	53.13	74.35	47.45	49.17	61.75	48.16	69.85	106.25	60.89	57.05	72.18
40	1	35.48	51.91	94.81	50.10	50.16	66.14	52.80	78.36	114.50	52.27	61.53	88.95
	2	41.87	74.90	113.74	55.88	65.24	78.06	59.22	85.45	129.85	65.50	80.08	96.56
	3	43.51	82.07	128.27	67.11	67.66	87.83	62.91	88.68	133.79	70.67	88.30	112.31
50	1	36.88	52.20	88.87	44.80	54.51	68.74	57.95	77.27	96.90	54.27	58.56	89.05
	2	42.47	68.39	105.77	58.78	60.57	83.33	65.60	88.02	113.19	58.66	69.27	96.31
	3	44.28	72.96	111.80	68.80	61.56	91.27	70.72	96.20	118.67	59.89	71.98	100.33

Fig. (6) Peeling efficiency as affected by batch load and onion bulb size.	Fig. (7) Peeling efficiency as affected by drum speed and batch load.

It is worthwhile to notice that the peeling efficiency values at both 40 and 50 rpm were almost similar, which means, working at rotation speed of 40 rpm will gave the same results as 50 rpm.

Also, increasing the batch load to 30 kg caused a serious damage in the onion which gave very wrong indication on the peeling efficiency, the same was happened when the residence time increased from 2 to 3 min.

The optimum peeling efficiency of 74.9, 65.24, 85.45 and 80.08 % were obtained at 24kg batch load, 2min peeling residence time and 40 rpm for small, medium, large and mixed sizes respectively. It should be said that, the above mentioned values of peeling efficiency was not selected based on the highest values shown in tables (3), but the interaction of both efficiency and the final quality of peeled bulbs, which included the impacted and cracked bulbs.

3.3 Effect of the modification systems for improvement of the onion peeling process:

To improve the peeling efficiency, a water pump and air compressor were used to remove the peels out from the peeling drum and to increase the peels separation process, which increases the peeling efficiency. Water was pumped at pressure ranged from 200 to 400 kPa at flow rate ranged from 1.42 to 2.2 m^3/h. The air compressor presses the air at pressure ranged from 400 to 600 kPa at flow rate ranged from 0.44 to 0.57 m^3/h.

Table 4: Peeling efficiency (%), of the modified peeler at different water pressures.

Water pressures, kPa	Size, mm			
	Small	Medium	Large	Mixed
200	70.10	69.82	87.11	78.67
300	73.33	75.17	91.43	82.39
400	76.73	83.06	99.20	87.49

Table 5: Peeling efficiency, (%) of the modified peeler at different air pressures.

Air pressures, kPa	Size, mm			
	Small	Medium	Large	Mixed
400	72.21	63.11	83.85	81.340
500	76.33	72.87	88.37	87.530
600	75.03	74.65	87.98	84.133

The results indicated the highest peeling efficiency were 76.73, 83.06, 99.20 and 87.49 % at 400kPa for water pump improvement, while they were 76.33, 72.87, 88.37 and 87.530 % at 500kPa for air pumping system for the small, medium, large and mixed sizes respectively.

From the results it could be seen that the proposed improvement systems of peeling efficiency were worthy for medium, large and mixed sizes of bulbs, while with it has not given any improvement with the small size bulbs compared to the previous results of evaluation. This may be due to the high adhesion force of the leaves in the small size bulbs.

4.3. Power requirements:

The relationship between the power requirements for the peeler with, without load and useful power are show in Figs. (8) and (9). Increasing the water pressure from 200 to 400 kPa caused an increasing of the power loaded and useful power from 1.464 to 1.521 kW and from 0.746 to 0.803 kW for the power under load condition and useful power respectively. And the increasing of the air pressure from 400 to 600 kPa

caused an increase of power under load condition and the useful power from 1.619 to 1.69 kW and from 0.901 to 0.972 kW, respectively. It could be noticed that the air compressor consumed more power than the water pump.
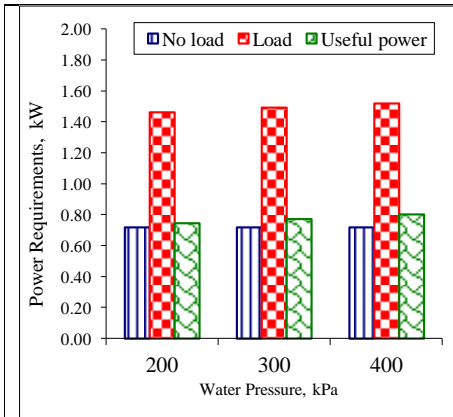

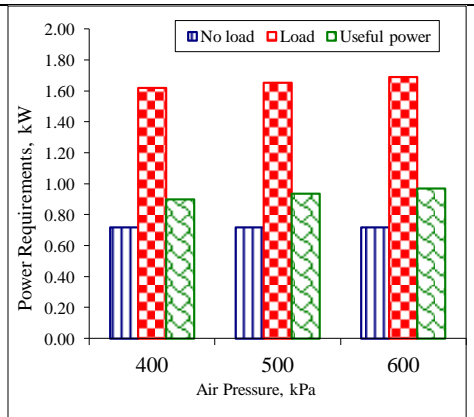| Fig. (8) Power requirements as affected by water pressure	Fig. (9) Power requirements as affected by air pressure

4.3 Cost of onion peeling:

The initial price of the onion peeling machine including the fabrications costs and the raw materials, was L.E. 4500 while it was reached, L.E. 5000 and 10050 for the machine with water pump and air compressor, respectively.

The estimated costs of onions peeling machine were 28.47, 29.56 and 33.75 L.E/ton for the machine only, machine with using water pump and machine with using air compressor, respectively. This is in comparison with 75 L.E/ton for hand peeling. Or in other words was about 2.2 times higher than that of the onion peeling machine.

Meanwhile, the machine is simple, maintainable and can be operated using small power (about 0.887 kW) and consumes limited amount of water about (0.18 m^3/h) using water pump with water recycling and constructed of standard locally manufactured components. This machine can be considered as a labor saver and may solve the problem of labor scarcity especially in onions peeling process.

4. CONCLUSION

A sample onion peeling machine was designed, manufactured and evaluated successively for different bulb sizes and different operational parameters such as rotational speed, feeding rate and peeling residence time. The most important results could be summarized as follows:

♦ The machine capacity increased from 0.282 to 0.47 ton/h, with increasing of batch load from 18 to 30 kg, while it was decreased from 0.48 to 0.288 ton/h, with increasing the peeling residence time from 1 to 3 mins.

♦ Peeling efficiency increased with all parameter under study. The optimum peeling efficiency of 74.9, 65.24, 85.45% and 80.08 were obtained at 24kg batch load, 2min peeling residence time and 40 rpm for small, medium, large and mixed sizes, respectively. With consideration of the final quality and soundness of the peeled bulbs.

♦ Water pump and air compressor were added to peeler to improve the peeling efficiency. The highest peeling efficiency were 76.73, 83.06, 99.20 and 87.49% at 400kPa with water pump, and were 76.33, 72.87, 88.37 and 87.530 % at 500kPa for air compressor for the small, medium, large and mixed sizes, respectively.

♦ Power requirements under the conditions of loaded machine and the useful power ranged from 1.464 to 1.521 kW and from 0.746 to 0.803 kW for the machine with water pressure and ranged from 1.619 to 1.69 kW and from 0.901 to 0.972 kW for the machine with air pressure, respectively**.**

♦ The estimated costs of onions peeling machine were 28.47, 29.56 and 33.75 L.E/ton for the machine before modification, machine with water pump and machine with air compressor, respectively, compared with 75 L.E/ton for hand peeling.

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الملخص العربى

تطوير وتقييم آلة لتقشير البصل

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يهدف هذا البحث إلى تطوير وتقييم آلة لتقشير البصل تناسب الأحجام المختلفة، مع دراسة العوامل المؤثرة على أدائها. وتتكون الآلة من إطارمعدنى، اسطوانة التقشير، صندوق تروس، محرك، مجموعة نقل حركة، حوض تجميع القشر والمياه، نظام أمداد المياه والهواء. ولانجاز ذلك تم اختيار صنف جيزة ٢٠بثلاثة فئات تدريج (<٤٠)(صغير)، ٤٠-٧٠ (متوسط)،>٧٠(كبير) مم) وتم دراسة بعض الخواص الطبيعية للبصل المتعلقة بموضوع الدراسة، وتم استخدام هذه الخصائص في تصميم الآلة. تم تقييم الآلة من خلال اختيار انسب مستويات للعوامل المؤثرة على أدائها. تم أيضا تحسين أداء الآلة باستخدام طلمبة مياه وضاغط هواء كلا على حده وذلك لرفع كفاءتها وتم حساب تكاليف التشغيل الاقتصادية للآلة و مقارنتها بالطريقة اليدوية.

وكانت أهم النتائج المتحصل عليها كما يلي:

١- تراوح متوسط نسبة كتلة القشر المراد ازالتة لصنف جيزة ٢٠ ما بين٦.٣٧±١.٧و٧.٨٩± ٠.٩٧ % واستخدمت هذه النسبة لحساب كفاءة عملية التقشير.

٢- تراوح متوسط سمك القشر المراد ازالتة ما بين١.١١±٠.٣١ و٢.٤ ٠.٣٤± مم واستخدمت هذه القيم لتحديد الارتفاع التصميمي لسلاح التقشير.

٣- الكفاءة المثلى لآلة التقشير إثناء تقييمها هي ٧٤.٩ ،٦٥.٥٤، ٨٥.٤٥ و ٨٠.٠٨% للفئة الصغيرة والمتوسطة والكبيرة والمختلطة على التوالي عند ٢٤ كجم حمل الدفعة، ٢دقيقة زمن البقاء داخل الآلة ،٤٠٠ لفة/دقيقة سرعة دوران آلة التقشير حيث اختيرت تلك القيم مع الأخذ في الاعتبار جودة عملية التقشير.

٤- إنتاجية الآلة عند انسب كفاءة كانت ٠.٣٦ طن/ساعة.

١ باحث مساعد ــ معهد بحوث الهندسة الزراعية ــ مركز البحوث الزراعية ــ دقى ــ جيزة.

٢ استاذ الهندسة الزراعية ــ رئيس قسم الهندسة الزراعية ــ كلية الزراعة بمشتهرــ جامعة بنها.

٢ استاذ الهندسة الزراعية المساعد ــ قسم الهندسة الزراعية ــ كلية الزراعة بمشتهرــ جامعة بنها.

٤ مدرس الهندسة الزراعية ــ قسم الهندسة الزراعية ــ كلية الزراعة بمشتهرــ جامعة بنها.

٥- رئيس بحوث ــ معهد بحوث الهندسة الزراعية ــ مركز البحوث الزراعية ــ دقى ــ جيزة.

٥- زادت كفاءة آلة التقشير باستخدام ضغط الماء الى٧٦.٧٢، ٨٣.٠٦، ٩٩.٢و٨٧.٤٩%عند ضغط ٤٠٠ كيلو باسكال وباستخدام ضغط الهواء إلى ٧٦.٣٣، ٧٢.٨٧، ٨٨.٣٧ و٨٧.٥٣ % عند ضغط ٥٠٠ كيلو باسكال للفئة الصغيرة والمتوسطة والكبيرة والمختلطة على التوالي.

٦- تكاليف الخامات والتصنيع لآلة التقشير كان ٤٥٠٠، ٥٠٠٠و ١٠٠٥٠ جنية لآلة التقشير فقط ، لآلة التقشير مع استخدام طلمبة المياه و لآلة التقشير مع استخدام ضاغط الهواء على التوالي. وكانت تكاليف تشغيل آلة التقشير هي ٢٨.٤٧ ، ٢٩.٥٦ و ٣٣.٧٥ جنية / طن فى حين كانت تكاليف التقشير اليدوي هى٧٥ جنية/ طن.

٧- مما سبق نستخلص أن هذه الآلة بسيطة التركيب وسهلة الصيانة واقتصادية وتشغل حيز صغير ويمكن تعديلها لتلائم الخطوط الكبيرة في مصانع تجفيف البصل.