Design a Simple Implement for Trimming Okra Pods

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ABSTRACT

Disposal of undesirable parts of vegetables from important processes is that precede different stages of manufacturing, which done in patients form for the consumer quickly and lowest cost. The okra pods trimming must manually process which excess time, effort and money. Thus, the aim of this research is design and evaluation of performance for an implement that trimming the okra pods. To achieve this aim some properties of okra pods measured to determine the specification of cutting design such as share angles and length. The designed implement tested using okra pods of Ismailia variety of number one grading size and it evaluated by identifying okra properties and implement performance. At all tests, the obtained results identified that, the performance of okra trim such as peak diameter, length and okra mass represents values for it prepared mechanically less than that for manually preparing. The implement efficiency were recorded 79.92%; 7.69 % and 15.38 % for best abrade pods, the excessive abrade and the non-abrade respectively. While the implement productivity achieved about 41.04 kg.h^{-1} agonist 10.18 kg.h^{-1} for manually. Then, suggested implement can applied to decrease operating time and workers. Finally, the obtained residues of abrade okra were increased in thickness about 0.1, and .2 mm for trimming manually and mechanically respectively at compare with the theoretical value.

Keywords: Okre pod – trim – abrade - sharpener cone – scratch – implement – manual – efficiency – productivity - sharpness angle – cutting angle - setting angle.

INTRODUCTION

The use of machines, equipments, implements or mechanical tools in preparing or pre-process of fruit or vegetables as clean, trim, peel, cut, … etc, mean the advantages in stay as decent maturity, less microbial load and assured final quality. On another side, collect the residues in one place, which can easy recycle in the direction of transformation into safe manufacturing system no waste. The most common pre-process vegetables in Egypt are still hand-processed.

Okra pods (*Abelmoschus Esculentus*) is one of the common popular eaten in Egypt. Okra; in the world; generally is used as nutritional supplements for vitamin C and A, B complex, iron, etc. It mixed with other ingredients to make soup (Adebooye and Oputa, 1996; Okra food, 2003 and Owolarafe and Shotonde, 2004). It is a traditional vegetable crop commercially cultivated in West Africa, India, Southeast Asia, the southern United States, Brazil, Turkey and northern Australia (Duzyaman, 1997). AOAD (2015) signed that Egypt produced about 5,517,000 Mg from okra pods. The Ministry of Commerce and Industry (2006) pointed that the most important one of processes to protect vegetables is the calyxes of vegetables such as zucchini, eggplant and papaya this operation done manually. He pointed out that the net percentage of the okra for sorting and preparing is about 75%, while the loss is about 25%. In addition, it must pods of homogeneous sizes. Egypt's exports of frozen okra in 2004 amounted to about 2061 Mg for about 12 countries. Okra pods are usually graded to standard sizes > 1.5, 1.5 to 3.0, 3.0 to 4.5, > 4.5 cm. Trade Manager (2017) signed that general description of frozen okra length are super 0.0 to 3 cm, one 3 to 6 cm two 6 to 9 cm. Okra pods are the most complicated and difficult to prepare before process. However, Owolarafe and Shotonde (2004) cleared that the average of an okra pod are 54.6, 28.6 and 26.7 mm for length, width and thickness, respectively. The process of okra pods involves slicing, drying and grinding.

Srivastava *et al.* (2006) and Owolarafe *et al.* (2007) investigate that when okra pod chopped, it takes the elastic behavior by contacted with knife. As the results of this condition, in first, the cutting share will cause a pressure during acting on okra cell and in second, the contact point will subjected to: tensile stress due to bending and great shearing stress applied to the cell wall at the point of contact. After that, the movement of share parallel to the okra edge will applied the compressive force in perpendicular to slicing action.

Owolarafe *et al.* (2007) developed a manually operated okra-slicing device based on its physical parameters. They found that the developed device has an average efficiency of 77.4% and at put about 8.4 kg/h. Ogbobe *et al.* (2007) designed and evaluated performance of a motorized okra pod slicer. They found that the actual capacity of the motorized slicer was 42.8kg/h, which was below the design capacity of 50kg/h. The difference is due to human factor delay in feeding okra in the hopper. The variation in width of the slices was highest for hand compared tool manually and motorized slicers. The highest efficiency was using motorized compared to the other methods. The time required to slice of okra using hands was about 57.75 minutes, 10.14, and 5.5 minutes for manual and motorized slicer respectively.

In a trial to cut plantain pulp slice Obayopo *et al.* (2014) design and performance evaluation of a highly efficient device that simulates the traditional method of cutting plantain pulp transversely. When used the machine to make a 5 mm cut in moderately ripe and unripe matured plantain pulps, it achieves 90.7 % and 92.6 % respectively. Furthermore, efficiency based on the rate of slices production per time was measured to be 90% and 91%, respectively, for moderately ripe and unripe matured plantain pulps. This design apart from increasing the shelf life of plantains will increase the economic benefits for local plantain processors.

Abrade process and shave of okra pods not found all over the world except Egypt. The all countries slice in both domestic and commercial okra processing using sharp knives, manual tools as (Owolarafe *et al.*, 2007) and motorized slicing machines (Ogbobe *et al.*, 2007).

Therefore, the aim of research is design and evaluation of performance for an implement that trimming the okra pods.

Theoretical Approach
Determine the effective factors to remove the okra base

There is no uncertainty that the physical properties of okra are plays the principle factor affecting the cutting share dimensions to forming okra abrading. Fundamentally, there

are three cutting share angles (Ismail- 2012) as shown in Fig. (1). Many factors and parameters affecting removal okra skin such as:-
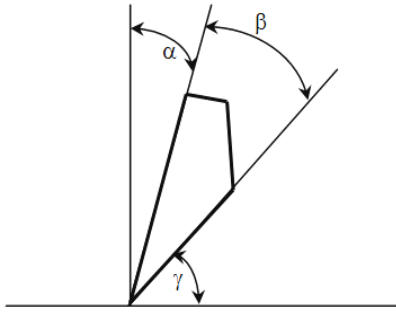

Fig. 1. Angles of share

γ = cutting angle (rake angle) β = sharpness angle α = setting angle

A: The cutting skin thickness

When simulating the method of abrading, the base of okra fruit for the purpose of remove the top layer of crown, the cutting share will be rotate around the center of gravity (GG) penetrates the surface of the okra. Under this condition, the three angles of share performance (α, β and γ) are transferred from the primary situation drawn by continuous lines to the dotted position as shown in Fig (2). Transfers the
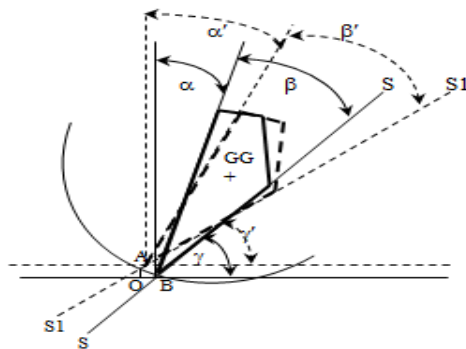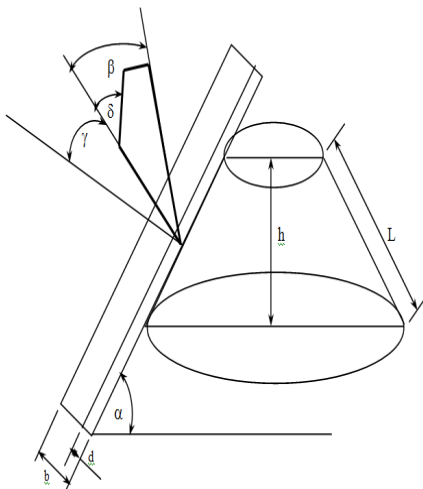
cutting surface of share, that presented by S-S axis which tangent the okra base surface to the position of S1 S1, will creates the triangle ABO (Fig.-3).

This triangle represents the projected dimension area of cutting part that may be recommended by shear. It is presented as changing in cutting skin layer (t, mm) of removal okra skin and the sharpness share wide (R, mm). Then, it may be recognized that the rotation of cutting surface around the GG point happen a displacement of "γ" angle consequently the change in "γ" may be presented as "Δγ = γ- γ′ and by zooming the cutting skin as shown in Fig. (3), then:

$$\Delta\gamma = Sin^{-1} \frac{\Delta t}{R} \tag{1}$$

$$\Delta\gamma = Sin\,(\gamma_1 - \gamma_2) = \frac{\Delta t}{R} \tag{2}$$

Where:

Δγ is the change rate of cutting share angle during rotated around the GG point, degree

Δt is the changing in cutting skin layer, mm

B: The cutting skin length

The cutting share will be set, under condition that, to tangent the inclination surface of okra base. Regarding to Fig. (4) and Fig. (5), the share length (L_1) may be conformed from the following relation;
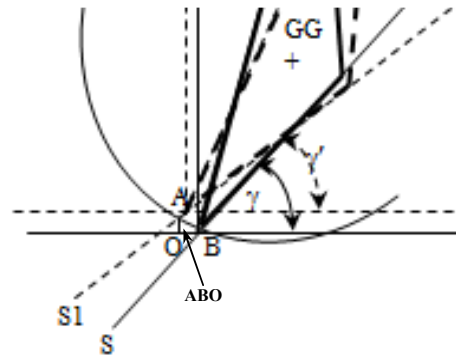

Fig. 2. Abrading simulation

Fig. 3. Zooming the cutting skin

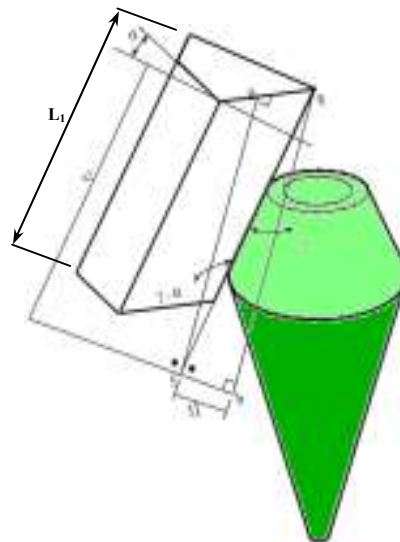**Fig. 4. Share with the base action**

Fig. 5. Interaction share with okra pods

$$L = h \sin \alpha \qquad (3)$$

Where:

L is the length of cutting okra base, mm

h   is the height okra base, it definite as the distance between the height point from base to the lowest deformed surface (Fig- 3), mm

α is   the slopping surface of okra base, degree at the same time is equal to the share setting angle.

The share length "L_1" must be largest that the "L" dimension to recognize the best cutting. Then,

$$L_1 = L + \Delta S \qquad (4)$$

Where; ΔS is the independent dimension relative to physical properties of okra

MATERIALS AND METHODS

Trimming of okra pod mean, abrade the okra base that take a conical shape, cut the top and scratch its sides. For this reason the trimming implement for okra pods were designed and evaluated during 2014 to 2016 seasons. The implement consists of main two parts; cover and body as shown in Fig. (6).


1- Body 2- Cover 3- Drive shaft 4- Rotating hand 5- Raise hand

Fig. 6. Components of okra trimming implement

The cover (Fig 7-a) is disc which made from steel with 320 and 5 mm diameter and thickness respectively. On the side of cover supported main gear and the sharpener cone. The main gear with 180 mm diameter, 15 mm thickness and with 125 teeth used to drive the 13 gears with 55 mm diameter, 32 mm thickness and 37 teeth for each one. The abrade unit shaped a special sharpener screwed in center of each driven gear. The sharpener cone dimensions of 19.4 mm diameter of cone base and 5.8 mm diameter of the top. It with 20.16 mm total length and 56º setting angle (Fig. 8) with screwed base of 23.33 mm diameter and 11.09 mm length to connect with the gear. At another side of cover disc, the rotated hand is supported in the cover center, which connected on the center of the main gear. The rotated hand was made from steel bar 2 × 35 mm diameter and length respectively in horizontal part and 25 × 175 mm diameter and length respectively from wood in vertical part. In addition, the cover can raised by two metal hand with 40 × 15 × 77 mm length, width and height respectively.

However the body consists of residues box and disc (Fig. 7-B). The disc used to carry thirteen cases of pod near the brim abuts of 20 mm. The constant distance occurred between each case of pod is 30 mm. The case of pod is a cylinder in shape with 24.72 × 31.7 mm outer diameter and height respectively. It has a conical inside shape with 16.85 to 11.34 mm from the upper to the lower diameters respectively. The inside wall was divided with 5 to 8 notches for longitudinal of it to scratch the high and dark edges of okra sides (Fig. 8). The disc supported by three triangular angles with nail rivets on the upper part of residues box. At the center of disc the main hollow shaft shaped like a net was fitted the disc with length of 30 mm and outer and inner diameters of 25 and 20 respectively.

The upper and lower cutting knives, made from stainless steel with 1.0 mm thickness, 135 mm length and 40 mm width. The upper knife can connect and rise on the center main shaft. While the lower knife (Fig. 7-C) connected with the lower end of main shaft, which rotate with, abrade part. The residues box made from tin with 4 mm thickness. The residues box is cylindrical in shape with 320 × 375 mm diameter and height respectively. It has a filmy plastic with 120 × 255 mm width and height as a door to empty the trimming okra residues.
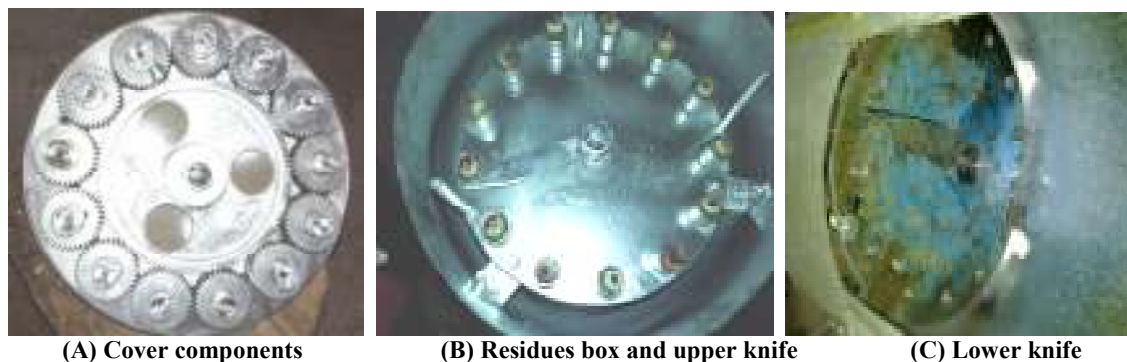
(A) Cover components   **(B) Residues box and upper knife**   **(C) Lower knife**

Fig. 7. The implement parts for trimming okra pod.

Fig. 8. The sharpener cone   **Fig. 9. The case of pod**

The experiments were done in special workshop in seasons 2014 to 2016. The pre experiments are include the selected and grading okra pods with high maturity and dimensions which ranging from 30 to 60 mm long as a recommended grade size of one. The all selected samples were weighted and measured its dimensions, such as; peak and neck diameters, total length, fruit length and base cone angle. One sample trimming manually as a traditional method. However the other samples trimming by the designed implement.

The mechanical experimental tests done by put thirteen okra pods in case of pod then the upper knife connecter and rotated to top the okra nick as the same high. The implement cover's was support on the body to connect each pod carefully in the sharpener. The hand was rotated about three times to abrade a conical thin layer. Each pod weighted, measure the above dimensions except nick diameter for both okra trimming manual and mechanical.

To evaluate the trimming process, the comparative of trim pod quality related to pods properties as mass, peak diameter and pod length produced from trimming mechanical and manual. Also, to evaluate the implement performance, the trimming efficiency of okra pods, excess "Oe" and non-abrade (ou) were determined using the following formulas:

$$Oe = \frac{Excess\ abrade\ pod}{All\ pods} \times 100$$

$$Ou = \frac{Un\text{-}abrade\ pod}{All\ pods} \times 100$$

$$Trimming\ Eff = \frac{Abrade\ pod}{All\ pods} \times 100$$

The implement productivity, "kg/h" was determined and compared with the productivity at manual trim okra pods. The mass determined using electrical balance with an accuracy of 0.01 g. The pod dimensions measured using digital venire caliper with an accuracy of 0.05 mm. However, the sample size 39 pods. The experimental was design in randomized complete plot design in three replicates. Statistical analyses were used to evaluate the standard deviation.

RESULTS AND DISCUSSION

Interpretation of okra trimming

Fig. (10) illustrates some properties of okra pods which used under different tests. From figure (10-A), it clear that the peak diameter of okra pods was 15.38 ± 1.47 mm before trimming then after manual and mechanical trimming, it decreased about 3.38 and 7.41 %. Meanwhile figure (10-B) shows the differences of okra pod length which recorded 54.93 ± 0.96 mm before trimming then after trimming decreased about 17.40 and 21.39 % respectively at trim manual and using the designed implement. However figure (10- C) explain that the average of okra pod mass before trimming was 5.85 ± 0.48 g but it decreased about 14.02 and 17.09 % respectively at trim manual and using the designed implement. The results conducted that the trimming okra properties using the implement decreased from the manual trimming. These results may due to the fact okra pods with different shape and size then the implement un-controlled for each pod simultaneously.
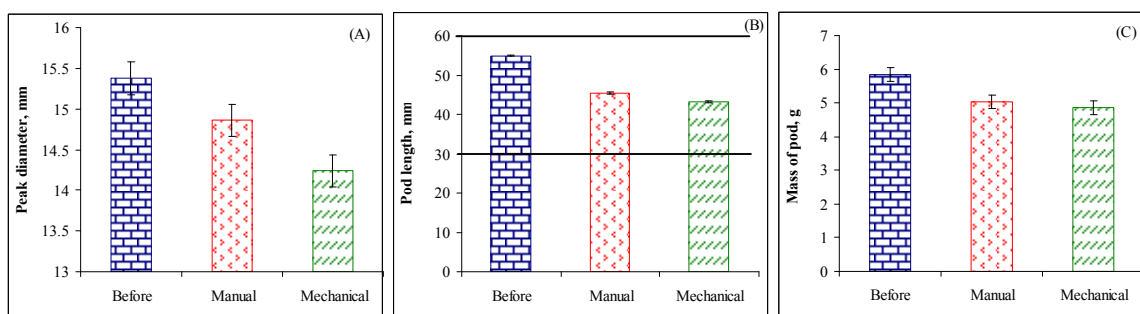

Fig. 10. Some properties of okra pods.

Trim efficiency

The trimming efficiency of okra pods include well abrade pods, excessive and un- abrade pods as shown in Fig (11). From the figure it can clear that the abrade pods recorded 79.92 %, the excessive abrade found about 7.69 % and the un-abrade establish about 15.38 %. Furthermore, the implement productivity achieved about 41.04 kg.h^{-1} but the manually productivity gave about 10.18 kg.h^{-1}.

On the other sides, the compare of theoretical, which calculated using Eq. (2), and actual thickness of shaved for okra pods, as shown in Fig. (13), clear that the lowest thickness was 0.96 mm found at theoretical but the manual and mechanical shaved thickness from okra pods were 1.06 and 1.16 mm respectively. This may due to okra pods variation in shape.
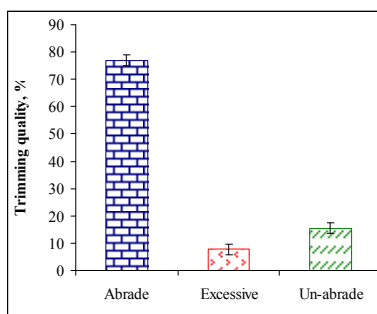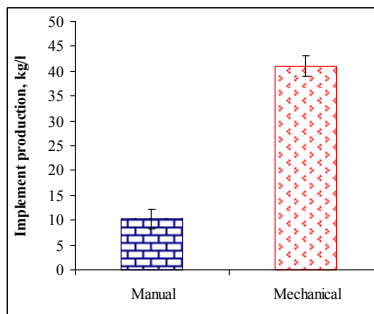
Fig. 11. Okra trimming efficiency.

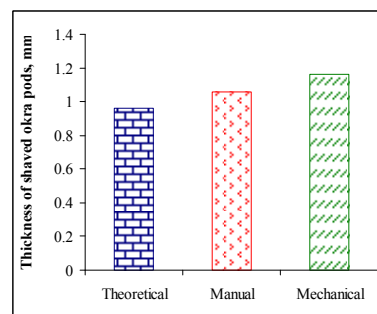**Fig. 12. Productivity of okra trimming implements.**

Fig. 13. Thickness of shaved okra pods.

CONCLUSION

At all tests, the obtained results identified that, the performance of okra trim such as peak diameter, length and okra mass represents values for it prepared mechanically less than that for manually preparing. The implement efficiency were recorded 79.92%; 7.69 % and 15.38 % for well abrade pods, the excessive abrade and the un-abrade respectively. While the implement productivity achieved about 41.04 kg.h^{-1} agonist 10.18 kg.h^{-1} for manually. Also, the thickness of shaved okra pods increased about 0.1 and 0.2 mm from the theoretical thickness respectively for abrade manually and by implement. Then, suggested implement can applied to decrease operating time and workers effort.

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تصميم آلة لتهذيب قرون الباميا
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عمليات التخلص من الأجزاء الغير مرغوبه فى الخضر من العمليات الهامة التى تسبق مراحل التصنيع المختلفة والتى يجب أن تتم بالشكل المرضى للمستهلك بسرعة وبأقل تكلفة. وحيث أن عملية التخلص من الأجزاء الغير مرغوبة فى ثمار الباميا مازالت تتم يدوياً حتى الآن مما يستهلك الوقت والجهد والمال ويصل المنتج إلى المستهلك بشكل غير جيد لعدم إنتظام العملية وأحياناً عدم أدائها على الشكل المرضى لذوق المستهلك. مما يجعل الحاجة ملحة لإنتاج آلة تقوم بعملية تهذيب قرون الباميا، والذى يشمل تقميع القاعدة فى شكل مخروط قطع الجزء الطرفى للقرن وخربشة الجوانب المرتفعة، على أن يتم ضبطها لتجهيز ثمار الباميا بالشكل المرغوب لدى المستهلك وبالتالى تزيد جودة المنتج التسويقية. لذا يهدف هذا البحث إلى تصميم وتقييم أداء معدة تقوم بتهذيب قرون الباميا. ولهذا تم دراسة بعض خواص قرون الباميا (أكبر قطر – الطول – الكتلة) بعد تدريجها وإختيار أكثر الأحجام تداولاً (رقم ١) والتى يتراوح طول القرون بها بين ٣٠ – ٦٠ مم وذلك لتحديد زوايا مخروط التقميع والطول المناسب لحافة التقميع نظرياً ثم تصنيع المخروط بالمواصفات المحددة نظرياً. وتم تصنيع آلة يتم إدارتها وتغذيتها يدوياً وتم إضافة سكين علوية وأخرى سفلية لتقوم بتهذيب ١٣ قرن باميا فى نفس الوقت حيث تم إجراء التجارب فى ثلاث مكررات كل مكررة تضم ٣٩ قرن. ولتقييم الآلة تم حساب كفاءة التهذيب – نسبة التقميع الزئد – نسبة التقميع المنخفض – إنتاجية الآلة مقارنة بالتهذيب اليدوى. ونتج من التجارب إنخفاض كل من أكبر قطر، طول وكتلة الباميا التى تم تهذيبها آلياً مقارنة بما تم تهذيبها يدوياً. بينما لوحظ أن كفاءة الآلة وصلت إلى ٧٩.٩٢% ونسبة التقميع الزئد والمنخفض ٧.٦٩، ١٥.٣٨ % على التوالى فى حين زادت الإنتاجية بإستخدام الآلة بحوالى أربع أمثال التهذيب اليدوى. كما وجد أن سمك الجزء المزال من القاعدة المخروطية زاد بحوالى ٠.١، ٠.٢ مم عند التقميع اليدوى والآلى على التوالى مقارنة بما هو محسوب نظرأ. وعليه فإن الآلة المقترحة يمكن تطبيقها لخفض زمن التشغيل وإجهاد العمالة اليدوية.

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