

PROPERTIES OF SEED COTTON MECHANICALLY CLEANED BY A LOCAL FABRICATED CLEANER

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Abstract

A new prototype Trash extractor for cleaning mechanical harvested Egyptian cotton (extra-long staple) must be adapted using local materials. The attempt was to develop the Egyptian scutchers to receive mechanically harvested seed cotton. piker through season 2005 at El-Karada Farm – Kafr El-Sheikh Governorate.

It was evaluated under different operational conditions included saw drum speeds, feed rates and cotton fiber moisture contents on physical fiber properties 2.5% span length, 50% span length, fiber length uniformity ratio, color reflectance, color yellowness and seed cotton grade.

The results showed that the new design prototype extractor produced suitable amount of 2.5% and 50% span length; fiber length uniformity ratio; color reflectance (Rd) and seed cotton grade . Also, results showed that color yellowness (+b) was low at all combination experimental levels.

INTRODUCTION

Extra-long staple Egyptian seed cotton is considered as one of the most strategic crop and the major staple field crops in Egypt because its importance for the national economy. But, mechanically harvested seed cotton contains substantial quantities of plant-trash material that must be removed in the early stages of ginning to promote efficient drying, trouble free gin-stand operation and satisfactory lint grades. Cylinder type cleaners are generally employed for removal of leaf material and other fine particulate, while extractor-type machines are employed for the removal of large trash such as burs and sticks (Garner and Baker 1977). Baker *et al.* (1993) found that seed cotton cleaners and extractors reduced the quantity of fine trash and pepper trash in the cotton by about 70%. Columbus and Mangialardi (1996) and Eweida (1997) found that feeding rates of seed cotton to roller gin-stand significantly affected capacity, ginning time and non-lint content. Feeding rate affected insignificantly reflect lint to light (Rd) as well as fiber yellowness (+b). Anon I (1980) said that cotton grade depend essentially on three fundamental factors : percent of tamishes and the strange materials that are mixed with cotton whereas increasing these materials leads to

reduce the grade of cotton. Grade also depends on insect infection and its results such as twisted cloves and decadents colored filaments and also depends on degree of quality of ginning and cleaning. Anthony (1990) found that HVI length was reduced about 0.05 cm when lint cleaner was added to the gin equipment sequence and HVI length was reduced from 2.84 cm to 2.79 cm as moisture decreased from 7.9 to 4.1%. Barker and Baker (1986) found that lint moisture content was an important variable in the equation for length uniformity. Beheary *et al.* (2004) indicated that the highest mean for micronaire values were reached by the highest lint grade of cotton. They indicated too that the highest mean values of color reflectance (Rd%) were recorded by the highest lint grade of cotton. The main objective of the present work is to study the effect of this prototype on the physical fiber quality .

MATERIALS AND METHODS

A pre-cleaning extractor prototype was fabricated and assembled to clean Egyptian cotton varieties (extra-long staple) picked mechanically. It was tested to extract seed cotton from cotton boll heaps and trashes and simultaneously loading the cleared cotton to the bulk carriage facilities, shelling and clearing humid cotton bolls. The main parts of the prototype are shown in Fig. 1 and specification are given in Table (1). The machine consists of machine frame, input opening, mechanical cotton heaps loader, feeder hopper, four impact drums, two saw drums, three doffing drums, reclaimer drum, trash auger, impurity removal concaves and output opening. The extractor is driven by tractor's (PTO) power take off shaft. All drums in this machine were 230 cm diameter and 100 cm length. The tested seed cotton variety Giza 86 was obtained from El-Karada farm, in Kafr El-Sheikh. The experiments were carried out mainly to determine the effects of four saw drum speeds, (7.06, 8.63, 10.20, 12.56 m/s), four feed rates (10, 12.5, 15, 17.5 kg/min) and four levels of fiber moisture content (11.2, 9.8, 8.7, 7.9%) on physical fiber properties. Cotton grade was determined to improve the objectivity and accuracy of measuring quality characteristics of seed cotton.

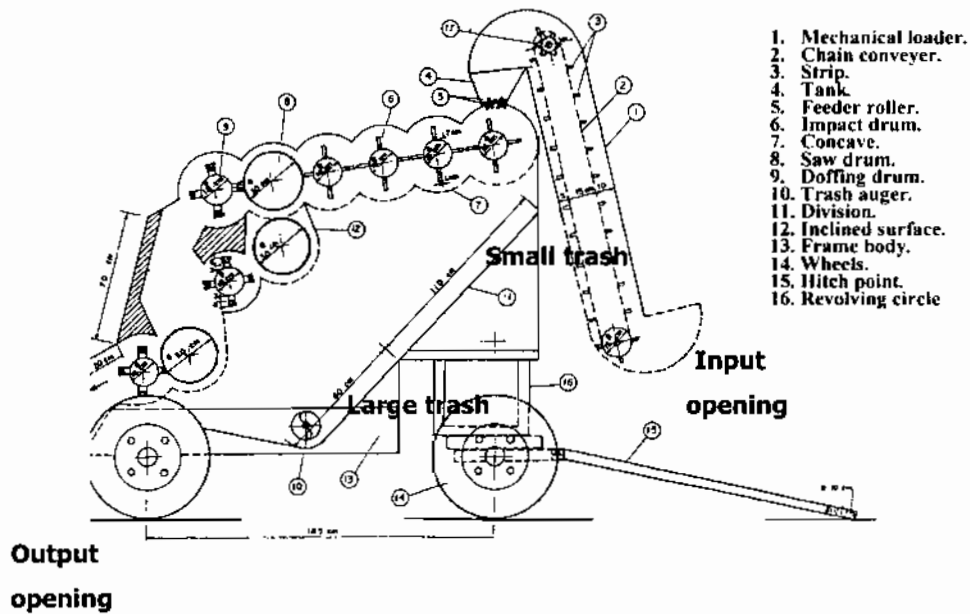


Fig. 1 . General arrangement and principle operation of the new seed cotton extractor.

Table 1. Technical specifications of a new small designed extractor machine.

Item	New designed extractor
Length, Cm	325
Width, Cm	135
Height, Cm	230
Weight, kg	1750
Source of power	Tractor P.T.O.
Input opening for crop, Cm	100 × 30
Output opening for crop, Cm	100 × 30
Number of impact drums	4
Dimension of impact drums (length × diameter), Cms	100 × 30
Hole diameter for curved sieve under impact drum, Cm	1
Number of saw drums	2
Dimension of saw drum (length × diameter), Cm	100 × 30
Hole diameter for curved sieve under saw drums, Cm	2
Diameter of waste auger, Cm	20

Laboratory tests

The cotton technology research laboratories were determined at CRI, ARC, Giza. The fiber properties were measured under standard conditions of $65 \pm 2\%$ relative humidity and $294 \pm 1^\circ\text{k}$ temperature, as follows :

- 1- Seed cotton grade : lint grade was determined by a three export cotton classers belonging to the cotton grades research division, CRI, ARC. The grades were converted to an index (Sallouma, 1970).
- 2- Fiber length : The digital fibrograph model 630 used to measure 2.5% and 50% span fiber length according to May and Bridges (1995).
- 3- Uniformity ratio : Was determined by using the following formula (Anon 2, 1992) :

$$\text{Uniformity ratio} = \frac{50\% \text{ span fiber length}}{2.5\% \text{ span fiber length}} \times 100$$

- 4- Color grade : HVI 9000 according to ASTM (D-1684-96) specifying color grade (reflectance, Rd % and yellowness, +b).

RESULTS AND DISCUSSION**1. Seed cotton grade, unit**

Data of seed cotton grade as affected by different variables are shown in Table 2. The results show that, seed cotton grade was directly proportional with saw drum speed and fiber moisture content and inversely related to feed rate. Cotton grade tend to increase with increasing saw drum speed while it was decreased with increasing feed rate. It was also decreased with decreasing moisture content at all combinations of other variables. The maximum value of seed cotton grade was Fully Good + $\frac{1}{4}$ at saw drum speed of 12.56 m/s, feed rate of 10.00 kg/min and fiber moisture content of 11.20%.

Table 2. Seed cotton grade.

Fiber m.c., %	Feed rate, kg/min Saw drum speed, m/s	Seed cotton grades, unit					Grade Change
		10.0	12.5	15.0	17.5	Control	
11.2	7.06	G+ ¼	G	G. - ¼	F.G.F + ¼	F.G.F.	+
	8.63	G/F.G.	G + ¼	G.	F.G.F./G.	F.G.F.	+
	10.20	F.G. - ¼	F.G. - ¼	G. + ¼	G. - ¼	F.G.F.	+
	12.56	F.G. + ¼	F.G.	G./F.G.	G.	F.G.F.	+
9.8	7.06	G	G. - ¼	F.G.F. + ¼	F.G.F.	F.F./F.G.F.	+
	8.63	G + ¼	G.	F.G.F./G.	F.G.F. + ¼	F.F./F.G.F.	+
	10.20	G/F.G.	G. + ¼	G. - ¼	F.G.F./G.	F.F./F.G.F.	+
	12.56	F.G. - ¼	G/F.G.	G. - ¼	G. - ¼	F.F./F.G.F.	+
8.7	7.06	F.G.F + ¼	F.G.F.	F.G.F. - ¼	F.F. + ¼	F.F. + ¼	+
	8.63	F.G.F/G	F.G.F + ¼	F.G.F.	F.F/F.G.F.	F.F. + ¼	+
	10.20	G - ¼	F.G.F./G	F.G.F. + ¼	F.G.F. - ¼	F.F. + ¼	+
	12.56	G + ¼	G. - ¼	G.	F.G.F.	F.F. + ¼	+
7.9	7.06	F.G.F.	F.G.F. - ¼	F.F. + ¼	F.F.	F.F.	+
	8.63	F.G.F. + ¼	F.G.F.	F.F./F.G.F.	F.F. + ¼	F.F.	+
	10.20	F.G.F./G	F.G.F. + ¼	F.G.F.- ¼	F.F./F.G.F.	F.F.	+
	12.56	G.	G. - ¼	F.G.F.	F.G.F. - ¼	F.F.	+

F.G. = Fully Good G. = Good F.G.F.= Fully Good Fair
 F.F. = Fully Fair G.F.= Good Fair F. = Fair

2. Seed cotton fiber length, mm

Fiber length which related to the average length of fiber in a sample and considered very important factor that determine cotton price in the markets. Fiber length classified as follows: a) 2.5% span fiber length, mm; b) 50% span fiber length, mm. Table 3 and Figs. 2, 3 illustrate the effects of saw drum speeds, feed rates and fiber moisture content on each of 2.5% and 50% span fiber length. It is clear that, 2.5% and 50% span fiber length have a decreasing trend with increasing saw drum speed and with decreasing moisture content. Meanwhile it was increased with increasing feed rate at all test combinations of other variables. The maximum 2.5% span fiber length of 32.5 mm and the maximum 50% span fiber length of 16.1 mm were recorded at cleaning seed cotton mechanically with saw drum speed of 7.06 m/s, feed rate level of 17.5 kg/min and fiber moisture content of 11.2%.

Table 3. Average physical fiber properties.

Fiber moisture content, %	Feed Rate, kg/min	2.5% span fiber length, mm				50% span fiber length, mm				Uniformity ratio, %				Color reflectance, unit				Color yellowness, unit			
		Saw drum speed, m/s	10.0	12.5	15.0	17.5	10.0	12.5	15.0	17.5	10.0	12.5	15.0	17.5	10.0	12.5	15.0	17.5	10.0	12.5	15.0
11.2	7.06	31.5	31.7	32.3	32.5	15.3	15.5	15.9	16.1	48.6	48.9	49.2	49.5	70.3	69.8	69.1	68.9	7.2	7.1	6.6	6.2
	8.63	31.0	31.5	31.9	32.2	14.2	15.2	15.5	15.7	47.7	48.3	48.6	48.8	70.6	70.2	69.6	69.1	7.9	7.5	7.0	6.6
	10.20	30.6	31.1	31.4	31.7	14.5	14.9	15.1	15.4	47.4	47.9	48.1	48.6	71.8	70.7	70.2	69.5	8.1	7.9	7.6	7.0
	12.56	30.2	30.6	30.9	31.4	14.3	14.6	14.8	15.2	47.0	47.7	47.9	48.4	71.5	71.0	70.6	70.0	8.3	8.2	8.0	7.3
9.8	7.06	31.0	31.5	31.9	32.3	14.9	15.2	15.5	15.8	48.1	48.3	48.6	48.9	70.9	70.4	70.2	69.3	7.9	7.4	7.0	6.5
	8.63	30.6	31.0	31.6	31.9	14.4	14.7	15.1	15.4	47.1	47.7	47.8	48.3	71.4	70.8	70.5	69.8	8.3	7.9	7.6	7.1
	10.20	30.2	30.7	31.1	31.5	14.1	14.4	14.8	15.1	46.7	46.9	47.6	47.9	71.8	71.2	70.8	70.3	8.5	8.1	7.9	7.5
	12.56	29.6	30.0	30.4	31.0	13.7	14.0	14.4	14.8	46.3	46.6	47.3	47.7	72.3	71.8	71.2	70.8	8.7	8.4	8.1	7.9
8.7	7.06	30.2	30.8	31.2	31.8	14.4	14.8	15.1	15.5	47.7	48.0	48.4	48.7	71.6	71.0	70.4	69.9	8.3	8.0	7.7	7.1
	8.63	29.7	30.3	30.9	31.3	13.9	14.3	14.7	15.0	46.8	47.2	47.6	47.9	72.0	71.3	70.8	70.3	8.4	8.2	8.0	7.5
	10.20	29.2	29.8	30.4	30.9	13.6	14.0	14.4	14.7	46.6	46.9	47.4	47.6	72.5	71.9	71.2	70.9	8.6	8.4	8.2	7.9
	12.56	28.8	29.3	29.9	30.5	13.3	13.6	14.0	14.4	46.2	46.4	46.8	47.2	73.1	72.6	71.9	71.3	8.8	8.6	8.4	8.1
7.9	7.06	29.5	30.0	30.5	31.1	14.0	14.3	14.7	15.1	47.5	47.7	48.2	48.6	72.1	71.7	71.1	70.6	8.5	8.3	7.9	7.5
	8.63	29.0	29.6	30.2	30.8	13.5	13.9	14.3	14.7	46.6	47.0	47.4	47.7	72.2	72.0	71.8	71.3	8.6	8.5	8.3	8.2
	10.20	28.6	29.2	29.6	30.2	13.2	13.6	13.9	14.3	46.2	46.6	47.0	47.3	73.1	72.7	72.2	71.8	8.9	8.7	8.4	8.3
	12.56	28.1	28.8	29.4	29.6	12.9	13.3	13.7	14.0	45.9	46.2	46.6	46.9	74.1	73.7	72.8	72.3	9.2	8.9	8.6	8.4

3. Fiber length uniformity ratio, %

Uniformity considered as the important fiber adjectives after length and grade where effect on industrialization efficiency and properties of threads. Fiber length uniformity ratio as affected by different variables shown in Table 3 and Fig. 4. Uniformity ratio decreased by increasing saw drum speed and with decreasing moisture content. Meanwhile it increased by increasing feed rate levels at all combinations of other variables. The maximum uniformity ratio of 49.5% was recorded at cleaning seed cotton mechanically at saw drum speed of 7.06 m/s, feed rate of 17.5 kg/min and fiber moisture content of 11.2%.

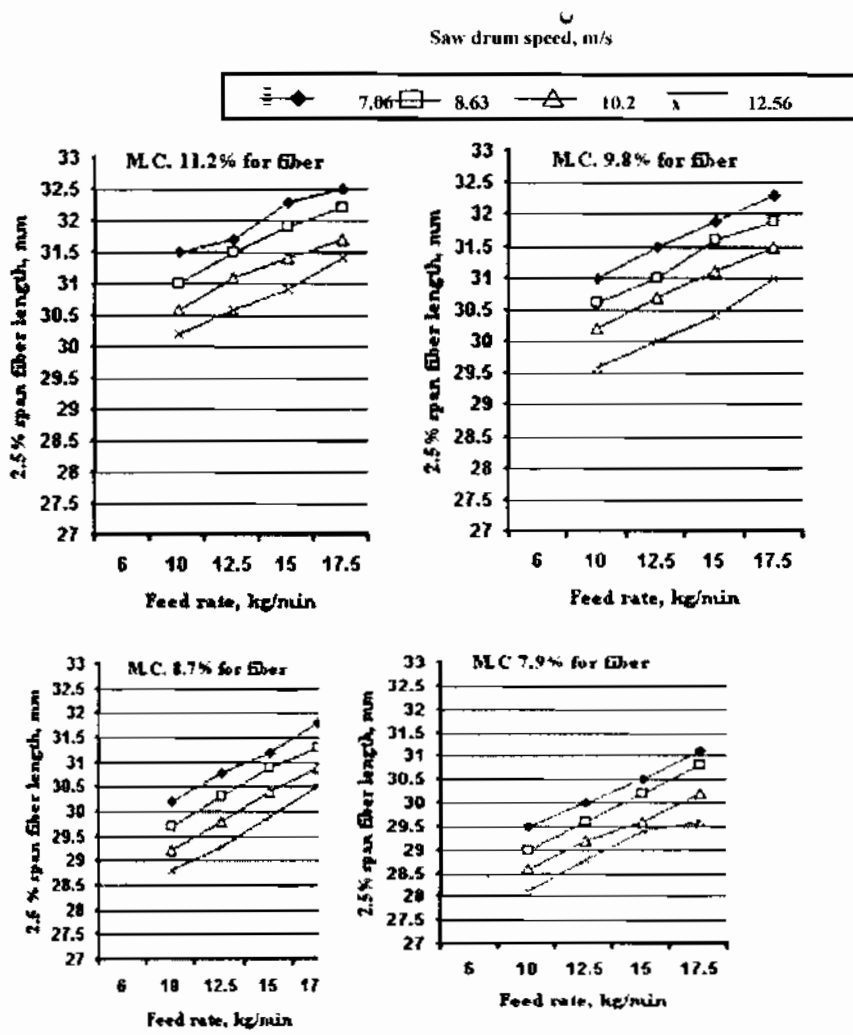


Fig.2. Main effect of saw drum speed on 2.5% span fiber length in mm at different feed rates and fiber moisture contents for new locally extractor machine.

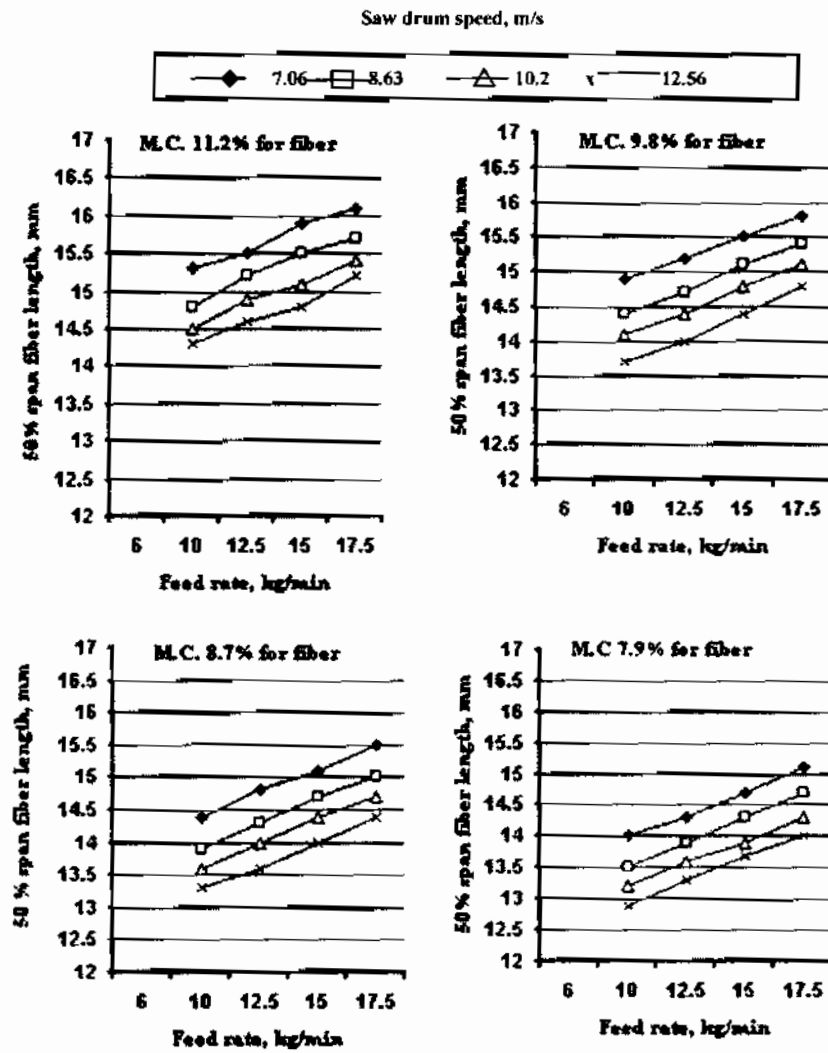


Fig. 3. Main effect of saw drum speed on 50% span fiber length, mm at different feed rates and fiber moisture contents for new locally extractor machine.

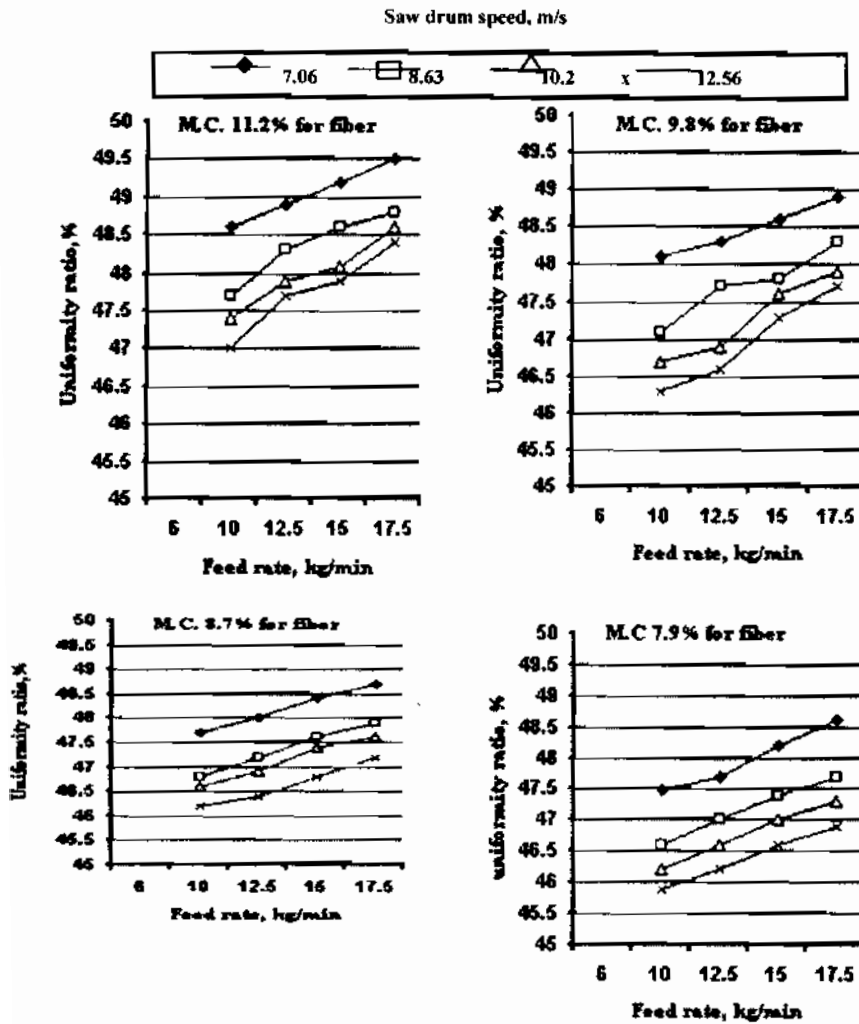


Fig.4 . Main effect of saw drum speed on Uniformity ratio, % at different feed rates and fiber moisture contents for new fabricated extractor machine.

4. Color grade

Seed cotton color grade is divided into two components: a) seed cotton color reflectance (Rd), %; b) seed cotton color yellowness, unit. Table 3 and Figs 5 and 6 indicate that, values of color reflectance (Rd) and color yellowness (+b) has an increasing trend with increasing saw drum speed and with decreasing moisture content. Also, it has a decreasing trend with increasing feed rate at all combination of other variables. The maximum color reflectance values of 74.1% was recorded at cleaning seed cotton mechanically harvested with saw drum speed of 12.56 m/s, feed rate of 10 kg/min and fiber moisture content of 7.9%. Minimum color yellowness of 6.2 unit was recorded at saw drum speed 7.06 m/s, feed rate of 17.5 kg/min. and fiber moisture content of 11.2%.

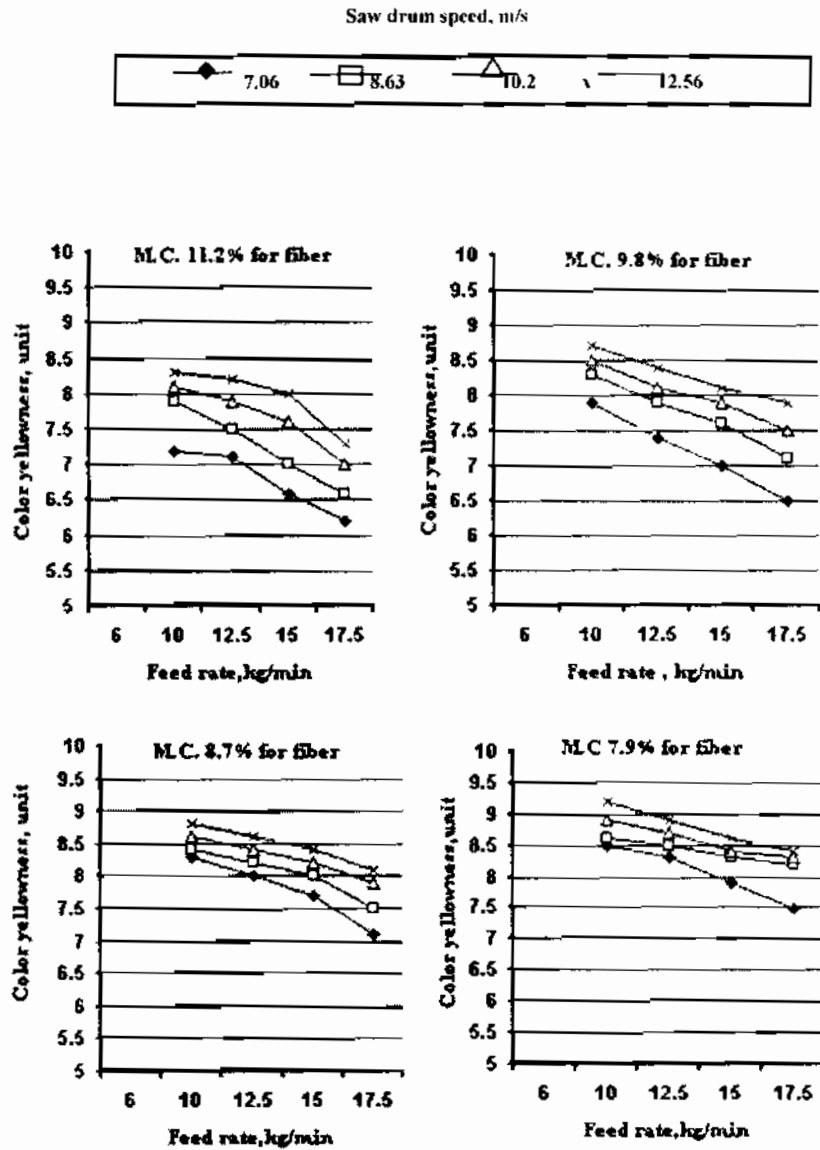


Fig.5 . Main effect of saw drum speed on Color yellowness, unit at different feed rates and moisture contents for new locally fabricated extractor machine.

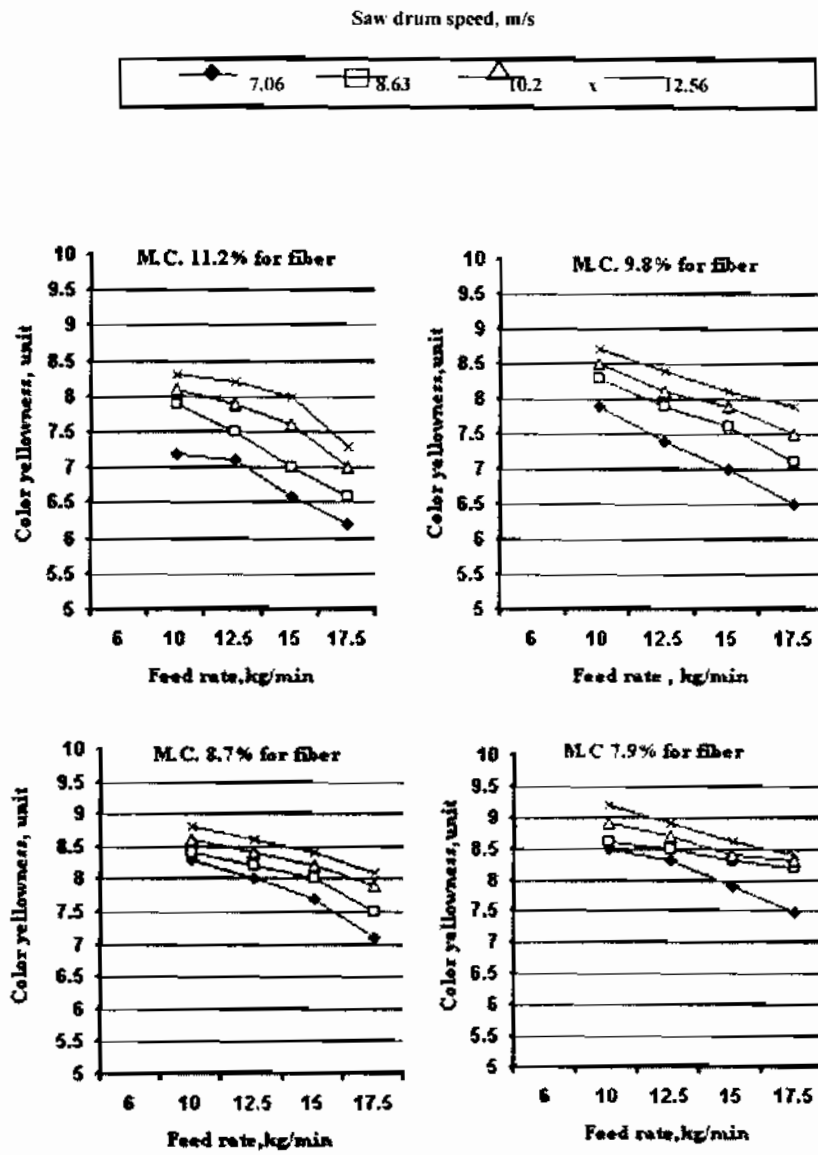


Fig. 6 . Main effect of saw drum speed on Color yellowness, unit at different feed rates and moisture contents for new locally fabricated extractor machine.

CONCLUSION

The main objective of this study was to test a locally fabricated extractor for cleaning seed cotton as well as estimating the effect of some operating parameters that affect the performance of seed cotton fiber physical quality.

The effects of four saw drum speeds 7.06, 8.03, 10.20 and 12.56 m/s, four feed rates 10, 12.5, 15 and 17.5 kg/min and four levels of fiber moisture content 11.2, 9.8, 8.7 and 7.9% was tested. The evaluated fiber quality was: seed cotton grade, unit; 2.5% span fiber length, mm; 50% span fiber length, mm; fiber length uniformity ratio, %; color reflectance, % and color yellowness, unit. The results of the present study led to the following conclusion :

1. The maximum amount of seed cotton grade was Fully Good + $\frac{1}{4}$ recorded at saw drum speed of 12.56 m/s, feed rate of 10.0 kg/min and fiber moisture content of 11.2%.
2. The maximum amount of 2.5%; 50%, span fiber length and uniformity ratio, were 32.5 mm; 16.1 mm and 49.5% respectively, recorded at saw drum speed of 7.06 m/s, feed rate of 17.5 kg/min and fiber moisture content 11.2%. and
3. The maximum amount of color reflectance (Rd) was 74.1% recorded at saw drum speed of 12.56 m/s, feed rate of 10 kg/min and fiber moisture content of 7.9% while, the minimum amount of color yellowness was 6.2 unit recorded at saw drum speed of 7.06 m/s and feed rate of 17.5 kg/min and fiber moisture content of 11.2%.

From the previous conclusion, the new fabricated extractor was considered as an economical machine suitable for Egyptian cotton varieties.

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وحدة صغيرة لتنظيف القطن الزهر المجني أليا

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محصول القطن من أهم المحاصيل الاقتصادية في مصر وقد ارتبط لفترة طويلة بالإقتصاد القومى للبلاد ومازال. ولكن في السنوات الأخيرة لوحظ تناقص المساحات المزروعة بالقطن بدرجة كبيرة حتى أصبحت المساحة المزروعة سنوياً تتراوح في حدود (٧٥٠) ألف فدان. وهذا النقص في المساحات راجع إلى ارتفاع تكاليف إنتاج المحصول ومناقسة محاصيل أخرى أقل في التكلفة من محصول القطن. لذلك أصبح ضرورياً الاتجاه إلى الجني الآلي لتقليل هذه التكاليف. ولكن المزارع المصري مازال يخشى أسلوب الجني الآلي خوفاً من عدم نظافة القطن الناتج من الجني الآلي وتدنى رتبته وجودته وبالتالي انخفاض سعر تداوله ولذلك فقد كان الهدف الرئيسى من هذا البحث هو تصنيع آلة محلية صغيرة لتنظيف القطن الزهر المجني ألياً مع مراعاة البساطة في أداؤها وتعطى كفاءة تنظيف عالية مع المحافظة على صفات الجودة الرئيسية للقطن الزهر. ويمكن لهذه الآلة أيضاً أن تستخدم داخل المحالج المصرية لتنظيف أقطان الأراضي والديق والأقطان الملوثة بالشوائب كمرحلة تنظيف ابتدائية حتى يتم قبول هذه الأقطان لدى المحالج المصرية. وقد تم دراسة تأثير العوامل الآتية:

- ١- سرعة الدرفيل المنشاري وقد استخدم أربع سرعات كان ٧,٠٦، ٨,٦٣، ١٠,٢٠، ١٢,٥٦ م/ث.
- ٢- معدلات التقييم للآلة وقد استخدم أربعة معدلات لتقييم كانت ١٠، ١٢,٥، ١٥,٠، ١٧,٥ كج/د.
- ٣- المحتوى الرطوبى لألياف القطن الزهر حيث تم إجراء التجارب عند أربعة محتويات رطوبة كانت ٧,٩، ٨,٧، ٩,٨، ١١,٢ %.

وقد تم التوصل للنتائج الآتية :

- ١- الآلة المصنعة محلياً كانت ذات كفاءة على فصل نسبة كبيرة من الشوائب وبالتالي فإنها كانت تعطى درجات رتب عالية مقارنة بالرتب قبل التنظيف وكانت أعلى رتبة تم الحصول عليها هي فولى جود + ١/٤ وذلك باستخدام الآلة عند سرعة درفيل منشارى ١٢,٥٦ م/ث ومعدل تقييم ١٠ كج/د ومحتوى رطوبى ١١,٢ %.
- ٢- الآلة المصنعة محلياً كانت تحافظ على أطوال الألياف وذلك عند نسب توزيع ٢,٥ %، ٥٠ % وكانت أكبر قيمة لأطوال الألياف عند نسبة توزيع ٢,٥ % هي ٣٢,٥م وأيضاً أكبر قيمة لأطوال الألياف عند نسبة توزيع ٥٠ % هي ١٦,١م وذلك عند استخدام سرعة درفيل منشاري ٧,٠٦ م/ث ومعدل تقييم ١٧,٥ كج/د ومحتوى رطوبى للألياف ١١,٢ %.
- ٣- أعلى قيمة تماثل لأطوال الألياف كانت ٤٩,٥ % وذلك عند استخدام الآلة مع سرعة درفيل منشارى ٧,٠٦ م/ث ومعدل تقييم ١٧,٥ كج/د ومحتوى رطوبى للألياف ١١,٢ %.

- ٤- أعطت الآلة قيم مرتفعة من درجة إنعكاس اللون للقطن الزهر وكانت أعلى قيمة ٧٤,١% عند استخدام الآلة عند سرعة درفيل منشاري ١٢,٥٦ م/ث ومعدل تقييم ١٠ كج/د ومحتوى رطوبى للألياف ٧,٩%.
- ٥- أعطت الآلة أيضاً قيم منخفضة من درجة الإصفرار للألياف وكانت أقل قيمة هي ٦,٢ وحدة عند استخدام الآلة عند سرعة درفيل منشاري ٧,٠٦ م/ث ومعدل تقييم ١٧,٥ كج/د ومحتوى رطوبى للألياف ١١,٢%.