Zagazig Journal of Agricultural Engineering 1039-1050

Zagazig J. Agric. Res., Vol. 43 No. (3) 2016

http:/www.zu.edu.eg/ journalDisplay.aspx?Journalld=1&queryType=Master

DEVELOPMENT OF MACHINE FOR EXTRACTING SISAL FIBER

Ahmed I. Imam[1*], M.A. Hassan[2], M.M. Ali[2] and I.S. Youssef[1]

1. Agric. Eng. Inst., Agric, Res. Cent., Dokki, Egypt

2. Agric. Eng. Dept., Faculty of Agric. Zagazig Univ., Egypt

ABSTRACT

Filed experiments were carried out to manufacture an extraction machine from locally available materials suitable for extracting sisal fibers and evaluate its performance under field conditions. The extraction machine (decorticator) performance was conducted under four extracting drum speeds of 7.85, 12.57, 17.28 and 22 m/sec., Three clearances between the knives and the feeding drum of 4, 7and 10 mm, three feeding drum speeds of 0.05, 0.1 and 0.15 m/sec and three different knife number of 2, 3 and 4. Extraction machine (decorticator) performance was evaluated in terms of machine productivity and efficiency, specific energy and operating cost. The experimental results recommended to use the developed machine under the following condition: extracting drum speed of 22 m/sec., clearance of 7 mm, feeding speed of 0.15m/s and 3 knives.

Key words: Sisal extraction machine, decorticator, sisal, drum speeds, knife number, operational costs.

INTRODUCTION

Sisal fiber is one of the most widely used as a natural fiber and is very easily cultivated. It has short renewal times and grows wild in the hedges of field and railway tracks, 4.5 million tons of sisal fibers are produced every year throughout the world. Tanzania and Brazil are the two main producing countries. Sisal fiber is a hard fiber extracted from the leaves of the sisal plant (*Agave sisalana* Perrine). Though native to tropical and sub-tropical North and South America, sisal plant is now widely grown in tropical countries of Africa, the West Indies and the Far East (Murherjee and Satyanarayana, 1984), the sisal plant consists of 4% of fibrous materials only. Sisal fiber is mainly used as ropes in the marine and agricultural industries. Other applications of sisal fibers include twines, cords, upholstery, padding, mat making, fishing nets and fancy articles such as purses, wall hangings, table mats, rugs, sacks for coffee, wagon cover and floor covering. Sentong *et al.* (2002) described the design and construction of a prototype sisal decorticator for small-scale farmers. The prototype provides for improved sisal processing and can be manufactured locally. Productivity of the prototype was 12 kg of dry sisal fiber per hour with a design efficiency of (42.9%) and yield of (3.2%). Test results showed that, after decortications, sisal fibers have to be washed, dried and brushed in order to detach some pulp that may have remained on the fibers. Benjamin *et al.* (2006) constructed and tested an extraction machine decorticator to suit sisal crops fiber consists mainly of steel drum, and four fixed knives. Decorticator was tested at different revolving speeds for drum. He found that increasing the extracting drum speed increased the extraction productivity and machine efficiency. Shipra and Varshney (2012) mentioned that, the juice of the leaves lowers the blood pressure and stimulates their intestinal movements. It possesses ecbolic properties and may be used as an abortifacient as it activates the uterine motility. It is a uterine stimulant, laxative and hypotensive drug .Ashish *et al.* (2015) showed that, the methods used for extraction of sisal fibers from plant leaves are chemical, retting, mechanical similar to the methods that are used for extraction of flax fibers. There are three major fiber extraction

* **Corresponding author: Tel. :** +201000744563
E-mail address: eng_imam82@yahoo.com

methods: mechanical extraction, chemical extraction and retting process. After extraction of fibers by any of these methods, all extracted leaves are washed away before drying. Artificial drying results in higher grade fibers than sun drying. The fibers were dried under a shade to avoid bleaching by direct sunlight. Dry fibers are then combed, sorted into different grades and packed into bales.

So, the objectives of the present work are to:

- Develop and manufacture an extraction machine suitable for extracting sisal fiber.
- Optimize some operating parameters affecting the performance of the developed machine.
- Evaluate the developed machine from the economical point of view.

MATERIALS AND METHODS

The experiments were carried out at Saft El Hena village, Abu Hammad District; Sharkia Governorate during 2014-2015 season to test and evaluate the performance of the manufactured sisal fiber extraction machine (decorticator) under local conditions.

Materials

Sisal

The used sisal crop (*Agave sisalana*) (Photo. 1) was at an average moisture content of 87.25%, leaf length between 1.0 – 1.5 m, leaf width between 0.1–0.3 m, leaf thickness varied from 2mm to 50 mm, and leaf fiber contain 4%.

Extraction machine

The extraction machine was constructed from local materials at a local workshop to extract fiber from sisal leaves crop, which consumed more time, effort and cost. The manufactured machine is of 155 cm length, 123 cm width and 100 cm height. The manufactured decorticator is shown in Photo. 2 and Fig. 1.

Table 1 summarizes the specifications of the manufactured sisal fiber extraction machine.

The extraction machine consists of the following main parts:

Knives

A fixed knife is of rectangular shape made of iron steel with 40 cm length, 5 cm width and 5 cm thickness.

Extracting drum

The extracting drum made of iron steel with 40 cm length, and 30 cm diameter.

Feeding drums

Two feeding drums were made of iron steel with 40 cm length, and 10 cm diameter.

Expulsion drums

Two expulsion drums were made of iron steel with 40 cm length, and 10 cm diameter.

Pulleys

A set of driving pulleys were developed to accommodate for different extraction and feeding speeds ratios. All pulleys were made of aluminum with different diameters (30, 28, 17.5, 15, 12.5 and 10 cm) and 2.5 cm for pulley hole.

Source of power

Two AC Motors three phases ,one of them 3 hp (2.208 kW), rotating speed of 1450 rpm for extracting fiber process and the second AC Motor 0.75 hp (0.552 kW) with gear box reduced (35 rpm) for feeding process.

Measuring instrument

The following instrumentations with desirable accuracy were used for different measurements during the execution of experiments: stop watch, electronic balance, caliper, digital tachometer, a wattmeter and clamp meter.

Methods

The extracting fiber experiments were conducted to optimize some operational parameters affecting the performance of sisal fiber extraction machine. These parameters are:

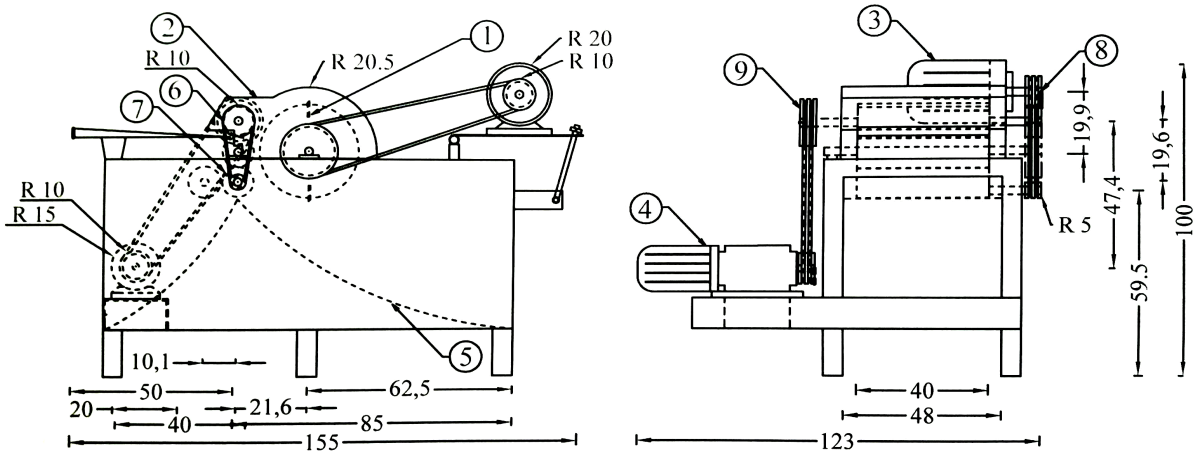
1. Four extracting drum linear speeds of 7.85 (500), 12.57 (800), 17.28 (1100) and 22 (1400) m/sec (rpm).
2. Three clearances between the knives and the feeding drum of (4, 7and 10 mm).
3. Three feeding drum linear speeds of 0.05 (10), 0.1 (20) and 0.15 (30) m/sec (rpm).
4. Three different knife numbers of (2, 3 and 4).

Photo. 1. View of the sisal plant

Photo. 2. Extraction machine

Table 1. Specifications of sisal fiber extraction machine

Item	Specifications of device
Model	Local made
Overall length	1.55 m
Overall width	1.23 m
Overall high	100 cm
Extracting drum diameter	30 cm
Extracting drum width	40 cm
Feeding and Expulsion drums diameter	10 cm
Feeding and Expulsion drums width	40 cm
Source of power	Two electrical motors(2.21,0.55 kW)for extracting process and feeding process
Knife shape	Rectangular
Knife number	From 2 to 4
Clearances	From 4 to10 mm



S. view **Elevation**

No.	Part name	No. of part	No.	Part name	No. of part	No.	Part name	No. of part
1	Extraction drum	1	4	AC motor+ gear box	1	7	Expulsion drums	2
2	Cover	1	5	Concave	1	8	Pulleys of extracting drum	4
3	AC motor	1	6	Feeding drums	2	9	Pulleys of feeding drum	3

Fig. 1. Schematic view of the sisal fiber extraction machine

Procedures

A given quantity of 5 kg mass of sisal leaves was extracted in the decorticator machine after adapting extracting drum speed, clearances, feeding drum speeds and the knife number. The elapsed time to complete the sample processing is measured and recorded and total consumed (kW) under working load was determined by using a wattmeter (700–k type). The processed sample was received in a special container to measure its fiber mass and pulp it to different parameters. The process is repeated 3 times for each combination of different study parameters.

Measurements

Evaluation of the sisal fiber extraction machine performance was carried out taking into consideration the following indicators:

Machine productivity and efficiency

Productivity of the sisal fiber extraction machine

It is the rate of machine productivity in the time unit (Mg/hr).

Efficiency of the sisal fiber extraction machine

$$\text{Machine efficiency} = \frac{\text{Wout}}{\text{Win}} \times 100$$

Where:

Wout = output (yield mass, Mg).

Win = input (sample mass, Mg).

Sisal fiber productivity and extracting fiber efficiency

Sisal fiber productivity

It is the rate of fiber productivity in the time unit (Mg/hr).

Extracting fiber efficiency

$$\text{Extracting fiber efficiency} = \frac{\text{Wf out}}{\text{Wf in}} \times 100$$

Where:

Wf out = mass of dried extracted fiber output (fiber mass, Mg)

Wf in = mass of potential fiber content (fiber sample mass, Mg)

Wf in =Win x (4%), 4 %= fiber percentage in a leaves (Murherjee and Satyanarayana, 1984).

Extracting power and specific energy

The required extracting power was estimated by using the following equation (Kurt, l979)

$$\text{Total consumed power} = \frac{\sqrt{3}\,\text{I.V}\;\;\eta.\text{V}\eta\text{c}}{1000}\,(\text{kW})$$

Where:

I = line current strength in Amperes, V = Potential strength (voltage) equal to 380 V, $\cos\Theta$ = power factor (equal to 0.84) and η = Mechanical efficiency.

The specific energy (kW.hr./Mg) was calculated by using the following equation:

Specific energy = the consumed power (kW) / extraction machine productivity (Mg/hr).

Machine unit operating cost

$$\text{Machine unit operating cost (LE /Mg)} = \frac{\text{Machine cost (LE /hr.)}}{\text{Machine productivity (Mg/hr.)}}$$

The machine cost was determined by using the following formula (Awady, 1978):

$$C = (p / h)(1 / a + i / 2 + t + r) + (W * e) + m/288$$

Where:

C: Machine hourly cost, LE./h; P: Price of machine, 7000 LE; h: Yearly working hours, 3500 hr; a: Life expectancy of the machine, 10 year; i: Interest rate, 10%; t: Taxes and over heads ratio, 10%; r: Repairs and maintenance ratio, 10%; W: Power of motor in, kW; e: electricity cost, 0.34 LE /kW.hr.; m: The monthly average wage, 1500 LE; and 288: The monthly average working hours (12 hr. × 6 days × 4 weeks).

RESULTS AND DISCUSSION

Machine Productivity and Efficiency

Effect of extracting drum speed on machine productivity and efficiency

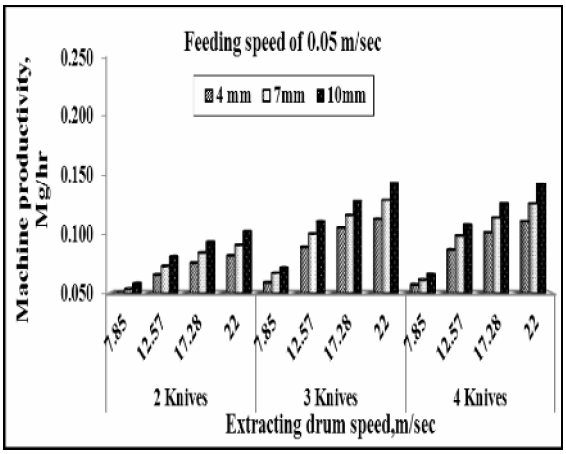
Results in Figs. 2 and 3 show relationship between extracting drum speed and machine productivity. It's noticed that increasing extracting drum speed from 7.85 to 22 m/sec., caused increase in productivity from 0.072 to 0.144 and from 0.108 to 0.180 and from 0.128 to 0.235 Mg/hr., for feeding speeds of 0.05, 0.10 and 0.15 m/sec., respectively under constant clearance between the knives and the feeding drum of 10 mm and knife numbers of 3. On the other hand, increasing extracting drum speed from 7.85 to 22 m/s lead to increase the machine efficiency from 71.81 to 86.32, from 78.21 to 90.02, and from 74.22 to 88.05 %, under the same previous conditions. Increasing extracting drum speed causes more extracting action at the leaves, which led to more separating of the fiber and more machine efficiency. While increasing the extracting drum speed more than 17.28 m/sec decreased the machine efficiency. Hence, the machine efficiency takes the opposite trend of the machine capacity with high extracting drum speeds.

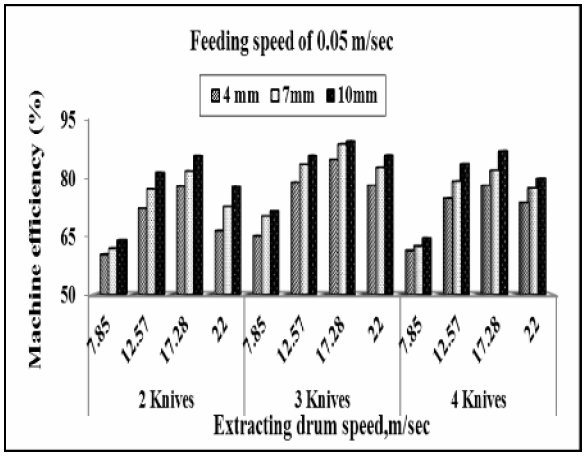
Effect of clearance on machine productivity and efficiency

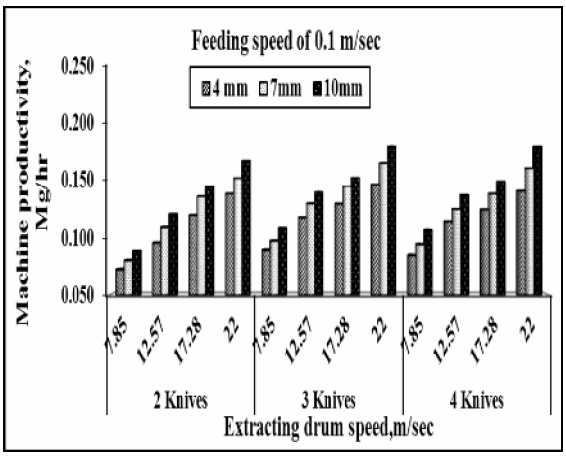
Figs. 2 and 3 display the relation between clearances between the knives and the feeding drum and machine productivity and efficiency. Hence, it appears that, increasing the clearance between the knives and the feeding drum from 4 to 10 mm, the values of productivity increased from 0.113 to 0.144, from 0.147 to 0.180 and from 0.180 to 0.235 Mg/hr., for feeding speeds of 0.05, 0, 10 and 0.15 m/s, respectively under extracting drum speed of 22 m/sec and knife number of 3. On the other hand, changing clearances between the knives and the feeding drum from, 4 to 10 mm, the values of machine efficiency changed from 85.25 to 89.92, from 88.12 to 93.21 and from 85.12 to 90.34% for feeding speed of 0.05, 0.10 and 0.15 m/sec, respectively, under extracting drum speed of 17.28 m/sec. and knife number of 3. The increase in machine efficiency by increasing the clearance between the knives and the feeding drum from 4 to 10 mm may be due to ease passage product from inside the machine that means decreasing in the treatment consumed time and reduce the losses.

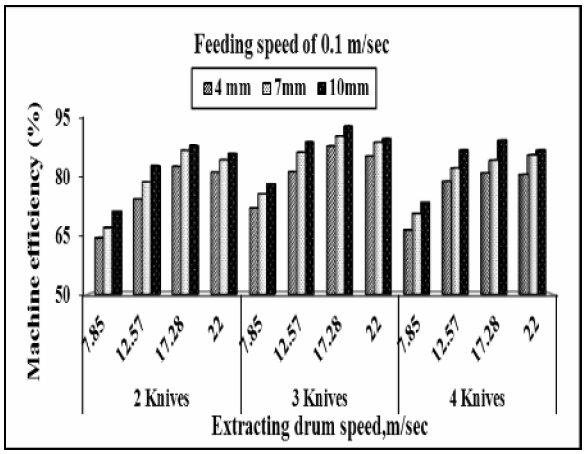
Effect of feeding speed on machine productivity and efficiency

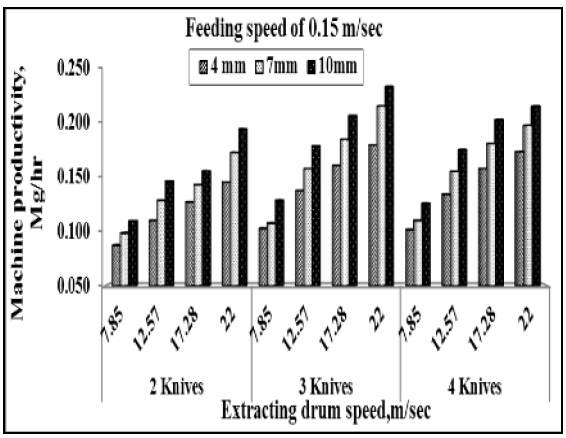
Results in Figs. 2 and 3 show that, increasing feeding speed from 0.05 to 0.15 m/sec leads to increase the machine productivity from 0.072 to 0.128, from 0.111to 0.179, from 0.128 to 0.207 and from 0.144 to 0.235 Mg/hr at extracting drum speeds of 7.85,12.57,17.28 and 22 m/sec, respectively. Under clearance between the knives and the feeding drum of 7mm and knife number of 3 . Also, increasing feeding speed











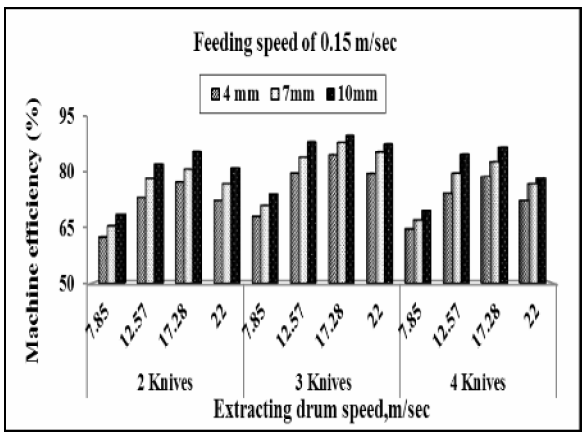


Fig. 2. Effect of extracting drum speed on machine productivity under different clearances, and knife number using feeding speeds of 0.05, 0.1 and 0.15 m/sec.

Fig. 3. Effect of extracting drum speed on machine efficiency under different clearances, and knife number using feeding speeds of 0.05, 0.1 and 0.15 m/sec.

leads to increase machine efficiency from 71.81 to 74.22, from 86.23 to 88.63, from 89.92 to 90.34, and from 86.32 to 88.05%, under the same previous conditions, at clearances between the knives and the feeding drum of 10mm and knife number of 3.

Effect of knife number on machine productivity and efficiency

Results in Figs. 2 and 3 show that increasing number of knives from 2 to 4, the production rate increased from 0.103 to 0.143, from 0.168 to 0.180 and from 0.195 to 0.216 Mg/hr for feeding speed of 0.05,0,10 and 0.15, respectively, using extracting drum speed of 22 m/s and clearance between the knives and the feeding drum of 10 mm Also, increasing number of knives from 2 to 4 lead to increase the machine efficiency from 86.21 to 89.92, from 88.29 to 93.21 and from 85.98 to 90.34% for feeding speeds of 0.05, 0.10 and 0.15 m/sec, respectively, using extracting drum speed of 17.28 m/sec and clearance between the knives and the feeding drum of 10 mm. Increasing the knife number to 4 decreased the machine efficiency under all clearances, extracting drum speeds, and feeding speed. The increase in machine efficiency by increasing the number of knives from 2 to 3 could be due to increase the number of cutting edges which facilitated the extraction process. Meanwhile, the machine efficiency decreased by increasing the knife numbers to 4. This phenomenon is attributed to the cutting and pressing leaves caused by the reduced spacing between knives and the increase of knives knocking number in time unit on the leaves due to increasing the cutting fiber and moisture losses.

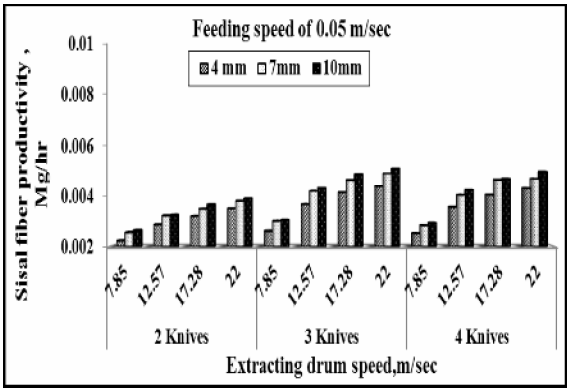
Sisal Fiber Productivity and Extracting Fiber Efficiency

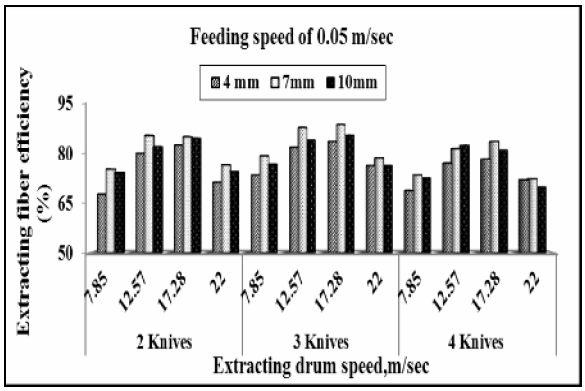
Effect of extracting drum speed on sisal fiber productivity and extracting fiber efficiency

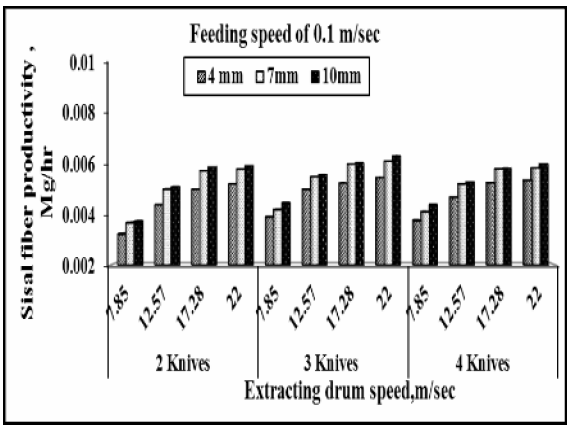
Results in Figs. 4 and 5 show a remarkable drop in the extracting fiber efficiency with a consequent sharp rise in fiber productivity as the extracting drum speed increased. Results show that, increasing extracting drum speed from 7.85 to 22 m/sec caused increase in fiber productivity from 0.0031 to 0.051 , from 0.0045 to 0.0063 and from 0.0049 to 0.0081 Mg/hr., for feeding speeds of 0.05, 0.10 and 0.15 m/sec., respectively under clearance between the knives and the feeding drum of 7 mm and knife number of 3 .On the other hand, increasing extracting drum speed from 7.85 to 22 m/sec lead to increase the extracting fiber efficiency from 79.63 to 79.03, from 81.65 to 82.49 and from 76.87 to 87.18%, under the same previous conditions. Increasing extracting drum speed from 7.85 to 17.28 m/sec. causes more extracting action at the leaves, which leads to more separating of the fiber and increased machine efficiency for extracting fiber. While increasing the extracting drum speed more than 17.28 m/sec. caused the machine efficiency for extracting fiber to decline. Hence, decreased extracting fiber efficiency takes the opposite trend of the productivity machine of fiber with high extracting drum speeds.

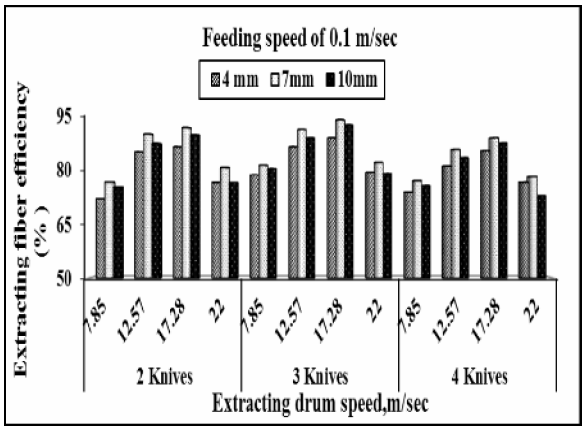
Effect of clearance on sisal fiber productivity and extracting fiber efficiency

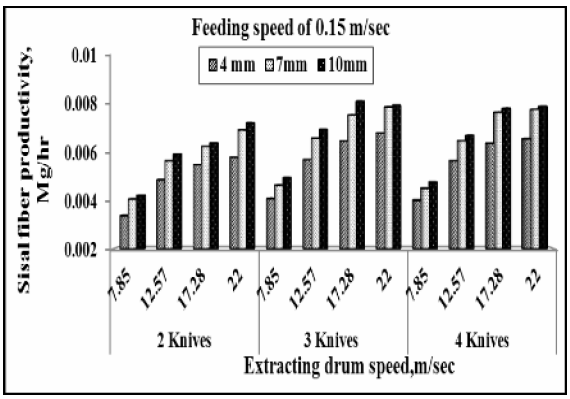
Figs. 4 and 5 display the relation between clearances between the knives and the feeding drum and sisal fiber productivity and extracting fiber efficiency. Hence, it appears that, the fiber productivity increased by changing the clearance between the knives and the feeding drum from, 4 to 10 mm, the values of fiber productivity increased from 0.0044 to 0.0051, from 0.0055 to 0.0063 and 0.0068 to 0.0081 Mg/hr., for feeding speeds of 0.05, 0.10 and 0.15 m/sec., respectively under extracting drum speed of 22 m/sec., and knife number of 3. The values of extracting fiber efficiency changed by increasing clearance between the knives and the feeding drum from 4 to10 mm they increased from 83.93 to 85.71, from 89.29 to 92.86 and from 85.71 to 88.57% for feeding speeds of 0.05, 0.10 and 0.15 m/sec., respectively, under extracting drum speed of 17.28 m/sec. and knife numbers of 3. The increase in extracting fiber efficiency by increasing the clearance between the knives and the feeding drum from 4 to7 mm may be due to ease passage product from inside the machine that means decreasing in the treatment consumed time and reduce the losses. While increasing the clearance from more than 7 mm decreased the extracting fiber efficiency. This could be attributed to the increase sisal pulp that stuck with fiber which leads to increasing losses.











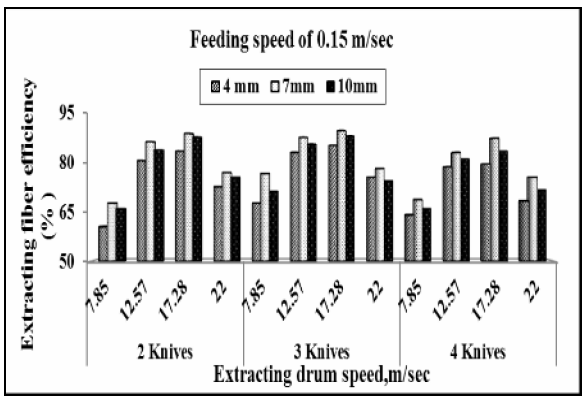


Fig. 4. Effect of extracting drum speed on sisal fiber productivity under different clearances, and knife number using feeding speeds of 0.05, 0.1 and 0.15 m/sec.

Fig. 5. Effect of extracting drum speed on extracting fiber efficiency under different clearances, and knife number using feeding speeds of 0.05, 0.1 and 0.15 m/sec.

Effect of feeding speed on sisal fiber productivity and extracting fiber efficiency

Results in Figs. 4 and 5 show that, increasing feeding speed from 0.05 to 0.15 m/sec., leads to increase the fiber productivity from 0.0031 to 0.0049 Mg/hr, from 0.0043 to 0.007, from 0.0049 to 0.0081 and from 0.0051 to 0.0081 Mg/hr at extracting drum speeds of 7.85, 12.57, 17.28 and 22 m/sec., respectively. Also, increasing feeding speed leads to increase the extracting fiber efficiency from 79.63 to 76.87, from 88.12 to 88.1, from 89 to 90.18, and from 79.03 to 78.38% under the same previous conditions, at clearance between the knives and the feeding drum and the number of knives of 7 mm and 3knives, respectively.

Effect of knife number on sisal fiber productivity and extracting fiber efficiency

Figs. 4 and 5 illustrate the fiber productivity as it affected by knives number. Results show that, increasing number of knives from 2 to 4 leads to increase fiber productivity from 0.0039 to 0.005, from 0.006 to 0.006 and from 0.0072 to 0.0079Mg/hr for feeding speeds of 0.05, 0.10 and 0.15 m/s, respectively, using extracting drum speed of 22 m/sec and clearance between the knives and the feeding drum of 10 mm. Also, increasing number of knives from 2 to 4 leads to increase the extracting fiber efficiency from 85.36 to 89, from 92.14 to 94.31 and from 89.29 to 90.18 % for feeding speeds of 0.05, 0.10 and 0.15 m/sec, respectively, using extracting drum speed of 17.28 m/sec and clearance between the knives and the feeding drum of 7 mm. Increasing the knife number to 4 decreased the extracting fiber efficiency due to increase the number of cutting edges which facilitated the extracting process.

Specific Energy

Effect of extracting drum speed on specific energy

Results in Fig. 6 show that, increasing extracting drum speed leads to decrease specific energy to process the unit mass of sisal leaves. The specific energy of 59.98, 44.53, 41.87 and 40.52 kW.hr/Mg, and specific energy of 41.71, 36.89, 36.5 and 33.55 kW.hr/Mg were measured at feeding speeds of 0.05 and 0.1 m/sec., respectively using knife number of 3 and clearance between the knives and the feeding drum of 10 mm, also the specific energy of 36.39, 29.59, 27.64 and 26.4 kW.hr/ Mg was found under the same condition but at feeding speed of 0.15m/s, under extracting drum speeds of 7.85, 12.57, 17.28 and 22 m/sec respectively. Therefore, it appears that lower specific energy was obtained at the higher extracting drum speed. This attributed to increasing machine productivity at higher speeds.

Effect of clearance on specific energy:

Results in Fig. 6 show that, increasing clearance between the knives and the feeding drum leads to decrease specific energy. The specific energy at clearances of 4, 7 and 10 mm was found to be 51.56, 45.19 and 40.52 kW.hr./Mg at extracting drum speed of 22 m/sec, feeding speed of 0.05m/sec and knife numbers of 3. Also, the specific energy of 41.20, 36.47 and 33.55 kW.hr/Mg was recorded at the same conditions but at feeding speed of 0.1m/s. On the other hand, the specific energy of 34.42 , 28.69 and 26.4 kW.hr./Mg were recorded at the same conditions but feeding speed of 0.15m/sec, all under clearance between the knives and the feeding drum of 4, 7 and 10 mm ,respectively. Therefore, it appears that lower specific energy was obtained at widest clearance between the knives and the feeding drum of 10 mm. This attributed to increasing of machine productivity is higher than increasing in power required rate.

Effect of feeding speed on specific energy

The obtained data in Fig. 6 indicate that, increasing the feeding speed of sisal leaves from 0.05to 0.15 m/sec decreased the specific energy from 59.98 to36.29, from 44.53 to 29.59, from 41.87 to 27.64 kW.hr./Mg and from 40.52 to 26.4 at extracting drum speed of 7.85 and 22 m/sec., respectively under clearance between knives and feeding drum of 10 mm and knife number of 3. Therefore, it appears that, lower specific energy was obtained at the higher feeding speed. This attributed to increasing of machine productivity at higher feeding speeds.

Effect of knife number on specific energy

Results in Fig. 6 show that, increasing knife number from 2 to 3 leads to decrease specific energy while increasing it to 4 tends to increase the specific energy. The specific energy of

56.82, 40.52 and 40.83 kW.hr/Mg were recorded at extracting drum speed of 22 m/sec., clearance between the knives and the feeding drum of 10 mm and feeding speeds 0.05m/sec, also the specific energy of 36.05, 33.55 and 33.56 kW.hr/Mg were recorded at the same conditions but at feeding speed of 0.1m/sec. On the other hand, the specific energy of 31.76, 26.4 and 28.69 kW.hr/Mg were recorded at the same conditions but at feeding speed of 0.15 m/sec., all under knives numbers of 2, 3 and 4 respectively. Therefore, it appears that, lower specific energy was obtained at knife number of 3 knives. This attributed to increasing of machine productivity.

Operational Cost

Effect of extracting drum speed on operational cost

Results in Fig. 7 show that, increasing extracting drum speed leads to decrease operational cost. The operational costs were 99.88, 66.63, 58.85 and 53.46 LE/Mg using clearance between the knives and the feeding drum of 10 mm, feeding speed of 0.05 m/sec, and knife number of 3, also the operational costs were 66.90, 53.45, 49.84 and 43.11 LE /Mg at the same conditions but at feeding speed of 0.1 m/sec., while the operational costs were 56.81, 41.91, 36.95 and 33.29 LE /Mg at feeding speed of 0.15m/sec, using clearance between the knives and the feeding drum of 10 mm and number of knives 3, for extracting drum speed of 7.85, 12.57, 17.28 to 22 m/sec., respectively. Same trend of this relationship was found at other operational parameters. Therefore, it appears that lower operational cost was obtained at the higher extracting drum speeds. This attributed to increasing in productivity.

Effect of clearance on operational cost

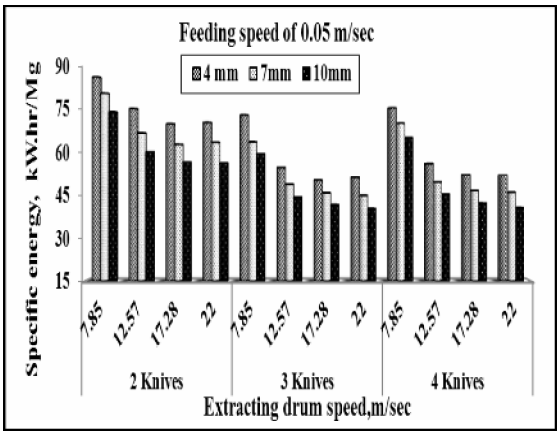
Results in Fig. 7 show that increasing clearance between the knives and the feeding drum leads to decrease operational cost. The operational costs of 68.02, 59.62 and 53.46 LE /Mg, were calculated at feeding speed of 0.05 m/sec., using extracting drum speed of 22 m/sec, and knife number of 3 knives, also the operational costs of 52.94, 46.87 and 43.11 LE /Mg were found at feeding speed of 0.1 m/sec., using extracting drum speed of 22 m/sec. and knife numbers of 3 knives. On the other hand, the operational cost of 43.41, 36.18 and 33.29 LE/Mg were noticed at feeding speed of 0.15 m/sec., using extracting drum speed of 22 m/sec. and knife numbers of 3 knives, where clearance between the knives ,the feeding drum were 4, 7and 10, respectively. Therefore, it appears that lower operational cost was obtained at the widest clearance of 10 mm. This attributed to increasing in machine productivity.

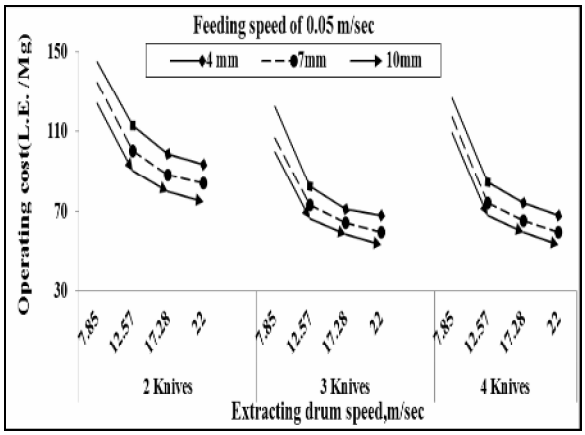
Effect of feeding speed on operational cost

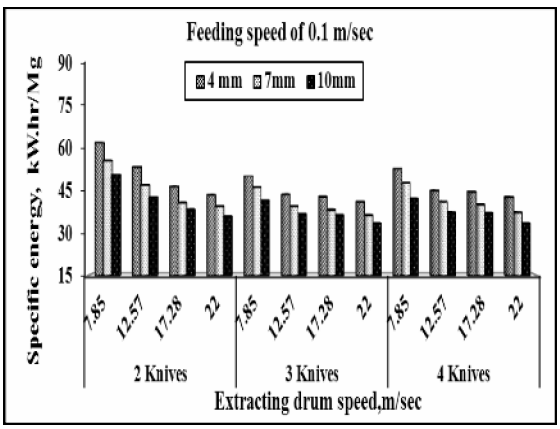
Results in Fig. 7 show that, using feeding speed of 0.15 m/sec., leads to decrease operational costs compared to all feeding speeds. Increasing feeding speed from 0.05 to 0.15 m/sec., decreased the operational costs from 99.88 to 56.81, from 66.63 to 41.91, from 58.85 to 36.95 and from 53.46 to 33.29 LE /Mg at extracting drum speeds of 7.85, 12.57, 17.28 and 22 m/sec., respectively under clearance between the knives and the feeding drum of 10 mm and knife number of 3. The same trends of this relationship were found at other different combination of clearance between the knives and the feeding drum, and number of knives. Therefore, it appears that lower operational cost was obtained at feeding speed of 0.15 m/sec. This attributed to increasing in machine productivity.

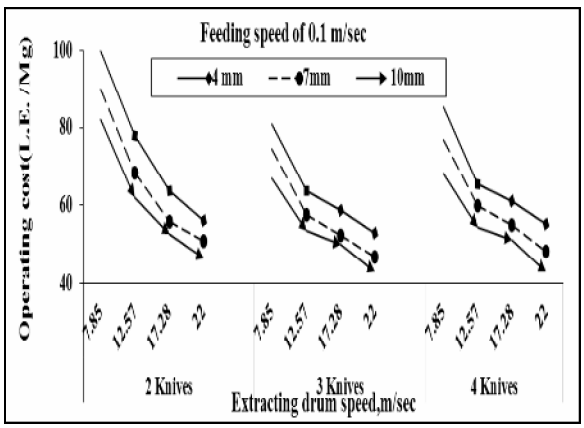
Effect of knife number on operational cost

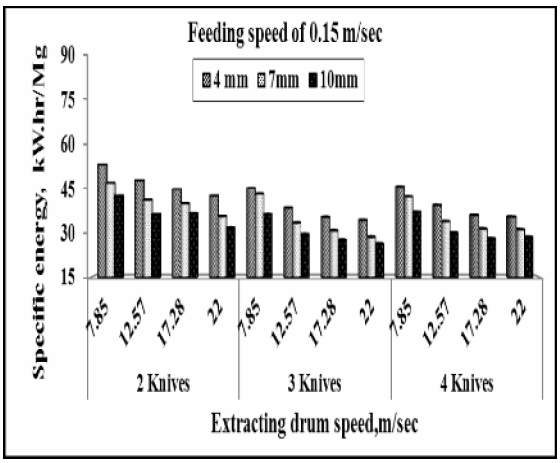
Results in Fig. 7 show that, increasing knife number from 2 to 3 leads to decrease operational cost, while increasing it to 4 caused a slight increase of operational cost. The incurred operational costs of 74.96, 53.46 and 53.86 LE/ Mg were found at feeding speed of 0.05 m/sec., using extracting drum speed of 22 m/sec., and clearance between the knives and the feeding drum of 10 mm, also operational costs of 46.32, 43.11 and 43.12 LE/Mg were found at feeding speed of 0.1 m/sec., using extracting drum speed of 22 m/sec., and clearance between the knives and the feeding drum of 10 mm, while operational cost of 40.09, 33.29 and 36.18 LE / Mg at feeding speed of 0.15 m/sec., using extracting drum speed of 22 m/sec. and clearance between the knives and the feeding drum of 10 mm, where knives numbers were 2, 3 and 4, respectively. Therefore, it appears that lower operational cost was obtained at the knife number of 3 knives. This attributed to increasing in machine productivity.











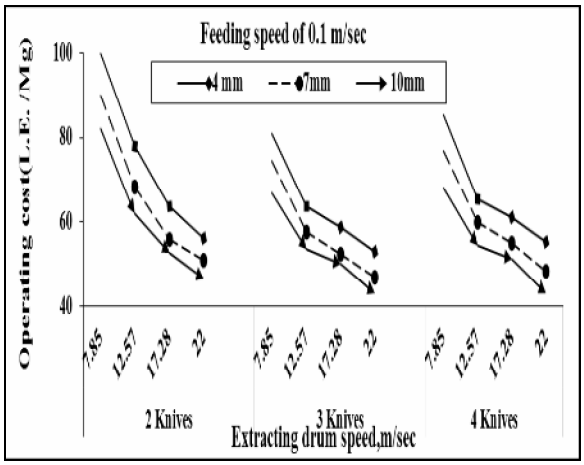


Fig. 6. Effect of extracting drum speed on specific energy under different clearances, and knife number using feeding speeds of 0.05, 0.1 and 0.15 m/sec.

Fig. 7. Effect of extracting drum speed on operational cost under different clearances, and knife number using feeding speeds of 0.05, 0.1 and 0.15 m/sec.

REFERENCES

Ashish, H., K. Pradyumkumar and K. Pooja (2015). Agave Americana leaf fibers. fiber open access J., 1(3): 64-75.

Awady, M.N., I. Yehia, M.T. Ebaid and E.M. Arif (1978). Development and theory of rice cleaner for reducing impurities and losses. Misr J.of Agric. Eng., Oct., v. (n): 53-68.

Benjamin, J., S. Joe, B.J. Dolak and T. Weiser (2006). A portable sisal decorticator for Kenyan farmers. Int. J. for Service Learning in Eng., 2 (1): 92-116.

Kurt, G. (l979). Engineering Formulas. 3rd Ed. Mc Graw- Hill book Co.

Murherjee, P.S. and K.G. Satyanarayana (1984). Structure and properties of some vegetable fibers, part 1. Sisal fiber. J. Materials Sci., 19: 3925-3934.

Sentong, J., J.B. Kawongolo and L. Bro and J.B. Kawongolo (2002). Design of a decorticator for small scale sisal processing in Uganda. Am. Soc. Agric. Engin. J., 10 (026202) : 590-598.

Shipra, S. and V. K. Varshney (2012). Chemical analysis of *agave sisalana* juice for its possible utilization. Acta Chim. Pharm. Indica: 2(1): 60-66.

تطـــويـــر آلـــة لإســـتخـــلاص أليـــاف السيـــســـال

أحمـــد إبراهيـــم إمام [١] - محمـــود عبدالعزيز حســـن [٢]
محمود مصطفى علي على [٢] -إبراهيم صلاح الدين يوسف [١]

١- معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – الدقى – مصر

٢- قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق – مصر

أجريت الدراسة على محصول أوراق السيسال خلال موسم ٢٠١٤-٢٠١٥م بقرية صفط الحنا- مركز أبو حماد- بمحافظة الشرقية- جمهورية مصر العربية.كان الهدف الرئيسي للدراسة هو تصنيع وتطوير وتقييم آلة لاستخلاص ألياف السيسال تناسب المزارع الصغير بغرض الإستفادة من محصول أوراق السيسال فى إنتاج الألياف وتقديرالإنتاجية والكفاءة وأستهلاك الطاقة وتكلفة التشغيل للآلة، وقد تم اختبار الآلة من خلال دراسة تأثير المتغيرات الآتية: أربع سرعات خطية لدرفيل الإستخلاص ٧,٨٥ م/ث ، ١٢,٥٧ م/ث ، ١٧,٢٨ م/ث ، و٢٢م/ث وثلاث قيم للخلوص بين حافة السكينة المثبتة على درفيل الأستخلاص ودرفيل التغذية السفلي (٤مم ، ٧مم ، و١٠مم) وثلاث سرعات للتغذية ٠,٠٥ م/ث ، ٠,١ م/ث، و٠,١٥م/ث وثلاث أعداد مختلفة من السكاكين (٢ ، ٣ ، و ٤) سكينة، وقد تم تقييم أداء الآلة من حيث: إنتاجية الآلة وكفاءة الآلة وإنتاجية الألياف وكفاءة استخلاص الألياف و القدرة والطاقة المستهلكة وتكاليف التشغيل، ومن خلال النتائج تم التوصل إلى التوصيات الآتية:لاستخدام الآلة لاستخلاص الألياف والحصول على أعلى إنتاجية ٠,٢١٦ ميجا جرام/ساعة وأقل تكاليف ٣٦,١٨ جنية /للطن وأقل استهلاك للطاقة ٢٨,٦٩كيلووات.ساعة/ ميجا جرام يوصى باستخدامها تحت العوامل الآتية: سرعة درفيل الإستخلاص ٢٢م/ث والخلوص بين السكينة ودرفيل التغذية (٧ مم) وسرعة درفيل التغذية ٠,١٥ م/ث وعدد السكاكين المستخدم (٣ سكينة).

المحكمـــون:

١- أ.د. ســـمير أحمـــد علـــى أستاذ الهندسة الزراعية – كلية الزراعة – جامعة بنها.

٢- أ.د. محمد محمد مراد حسن أستاذ الهندسة الزراعية المتفرغ – كلية الزراعة – جامعة الزقازيق.