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ENERGY REQUIREMENTS OF CHOPPING OPERATION FOR FODDER BEET

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ABSTRACT

The objective of the present study was to evaluate the performance of two different types of fodder beet chopper and to select the most proper machine to suit the Egyptian farms. The performance of both two machines was tested using three different drum speeds, four feed rates at two different levels of tuber moisture content. These parameters were tested to estimate power and energy requirements, final quality as particle size and cost evaluation. Experiments were conducted at Rice Mech. Center, Meet El-Dyba, Kafr El-Sheikh, Governorate during the winter season of 1999/2000 using fodder beet crop (Rota variety).

The results showed that chopping machine S-1801 is strongly recommended for its good performance. Whereas, it gives the best final quality as particle mesh size < 20 mm of about 62% that preferable for animal nutrition

Moreover, the unit energy of 3.91 kW.h/ Mg was obtained by using the same machine at drum speed of 22.31 m/s, feed rate of 102 kg/h and tuber moisture content of 85.13%. However, the unit cost reached its minimum value of 19.30 L.E/Mg.

Generally, the volumetric capacity of chopped fodder beet in comparison with the whole tubers was 44.44%.

Key words: Fodder beet, chopping size, voluntary consumption, volumetric capacity and energy requirements.

INTRODUCTION

Fodder beet is a new forage crop in Egypt, the roots are used for animal feeding. The great shortage in animal foodstuff and their distribution around the year are the main problems facing animal production in Egypt. Many attempts have been made to introduce unconventional new forages, especially for the summer season when animals are under-fed. Fodder beet has several advantages and its cultivation may help in overcoming the problem of animal feeding. It could be sown in the new reclaimed sandy soils and its roots and leaves are acceptable for animal feeding beside of green forages in Egypt.

Using chopping machines of fodder beet roots with suitable size for feed animals, was trial to hoped to participate in solving our serious problems of feed shortage during summer season.

Several studies were carried out in Egypt to evaluate and use fodder beet roots in animal feeding (**Gabra et al., 1987; Darwish et al., 1989; Nowar et**

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al.,1989; **Shalaby et al., 1989 and Gabra et al.,1992 and 1993)**. Fooder beet roots could be successfully used for feeding sheep **(Gruber et al., 1987 and Gabra et al.,1993)**, lactating dairy cows **(Gabra et al.,1992., Muller et al., 1994; De Brabander et al., 1995; Phipps et al., 1995 and Deininger et al., 1996)** and fattening bulls **(Fiems et al., 1992)**.

Chopping fodder beet roots is a main point for feeding small ruminants. In this connection, **(Gabra et al., 1987)** reported that biting roots by sheep was slow and hard and negatively affected daily intake. They concluded that chopping roots at small pieces are suitable for the pointed mouth of sheep and may increase feed intake and feeding values. The chopping size significantly affected daily feed intake of fodder beet roots. Animals fed the smallest size (2 cm) consumed significantly more feed than those fed the larger sizes. Feed intake decreased with increasing chopping size of roots. Animals fed the smallest size consumed 7.8 kg fresh/day (0.715 kg dry matter). From the above mentioned results encourage sowing fodder beet especially in new reclaimed lands to participate in solving the problem of green forage shortage in summer. On the other hand, the mechanical an physical means aimed to minimizing the size of molecules by cutting or normal grinding which helps the animals to eat all the residues without leaving any parts of it. So, the process of cutting and crushing of the residue as corn stalks and rice residues become necessary to increase the rate of eating by the animal **(Abou- Rhya, 1967)**.

Chopping energy requirements of forage crops is mainly affected by two factors, namely; physical and mechanical properties of plant stem and the cutterhead parameters. At low cutting speeds, cutting energy is a linear function of stalk diameter, however, the effect of stalks moisture content has very little effect on shear energy for sharp blades **(Yurnnam and Pratap, 1991)**. Meanwhile, **Hennen (1971) and Kepner et al., (1982)** reported that chopping energy was related to size of cut . Chopping energy was inversely proportional to size of cut for small cuts, while the relationship become inaccurate as the size of cut increased beyond 1.0 to 1.5 inches. Approximately 40 percent of the total input energy is utilized in the cutterhead **(Blevins and Hansen, 1966; Kepner et al., 1982)**. Total energy requirements per Mg a forage decrease somewhat as the feed rate is increased, because the power requirements are relatively independent of feed rate **(Kepner et al., 1982)**.

The increment in corn moisture content, culterhead speed and the decrement in feed mechanism speed gave small pieces of chopped corn that, make a suitable media of fermentation which produces a good quality silage. Cutting corn stalks at moisture content of 40.22%, cutterhead speed of 27.65 m/s and feeding mechanism speed of 0.41 m/min produced the maximum value of unit energy 2.08 kW.h/Mg. Meanwhile, the minimum value of cutting length 12.24 mm was obtained with same treatments at corn moisture content of 62.82% **(Kholief et al., 1998)**. A Korean chopping machine that had a cutting device consisting of a knife that moves in a vertical rotary movement in the front of a fixed knife with a clearance of 2mm. They found that the rate of machine production of forage increased to 34.04 and 46.7% by increasing the rpm to 600 and 950, respectively **(Shehata and EL-Shall, 1987)**. Cutting at 38-mm theoretical length required 15% less power than cutting at 6-mm length to meet peak power demand **(Savoie et al., 1989)**.

The chief objective in chopping fodder beet roots is to reducing storage space **an** handling costs in addition to transform the increasing amount of green fodder during winter season in order to use it in summer season. A suitable chopping machine must be designed for chopping fodder beet roots at small size. Chopping fodder beet roots at suitable size may share in solving the problem of limited consumption of such feed by small ruminants **(Gabra and Gad, 1999)**.

The main objectives of this study is to evaluate the performance of two various chopping machines in fodder beet to be used in Egyptian animal production farm. The performance of both two machines is to test the influencing cylinder peripheral speeds, feed rates and tubers moisture contents on the following:

a) Power and energy requirements;
b) Final quality of product as particle size (fineness degree) and
c) Cost evaluation was also studied.

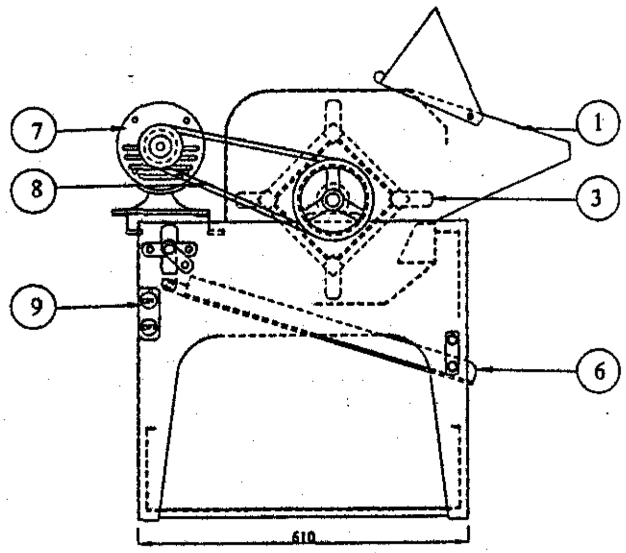
MATERAIALS AND METHODS

Field experiments were carried out at forage crops section, Sakha Agricultural Research Center, Kafr El-Sheikh Governorate, during winter season of 1999 / 2000 by using fodder bet (Beta vulgaris L.) Rota variety.

Factors affecting fodder beet chopping were examined by using two different chopping machines. Small chopping machine the Suzutec type, model S-1801, Japan make which is denoted as S-1801 for experimental tests. This machine has spike- tooth cylinder. However, another chopping machine Suzutec type, model S-2000, which has rub bar cylinder type, Japan make which is donated as S-2000. Table 1 summarizes the technical specifications of both two tested machines. Both two machines are driven by a 1500 W electric motor they having a potential difference (Voltage) of about 220 V. Figs. 1 and 2 show the machine parts. All experimental tests were run at Rice Mechanization Center, Meet El-Dyba, Kafr El-Sheikh Governorate. Table 2 summarizes the physical properties of Rota fodder beet variety used in all examined experimental tests.

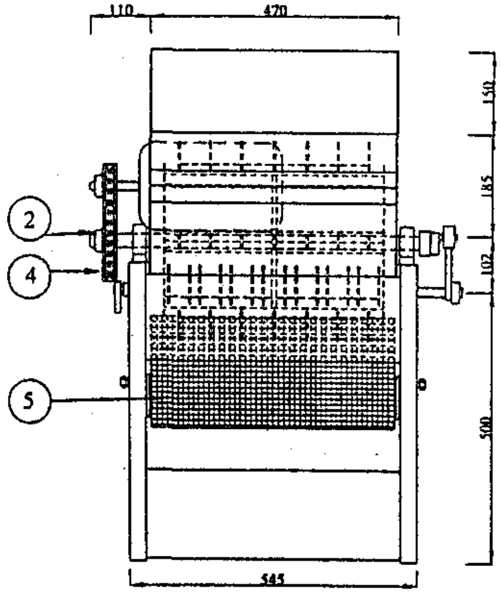
Table 1: Some technical specifications of fodder beet chopper.

Items	Specification	
	S- 1801	S- 2000
Model	Suzutec S- 1801	Suzutec S- 2000
Overall length, cm	84	67
Overall width, cm	70	51
Overall height, cm	94	93
Net mass, kg	60	75
Type of cylinder, cm	Spike – tooth	Rub bar
Length of cylinder, cm	42	23
Diameter of cylinder, cm	36	14.5
Working capacity, kg/h.	100.2-199.8	31.2-102.6
Power requirement, W	1500	1500



Elevation

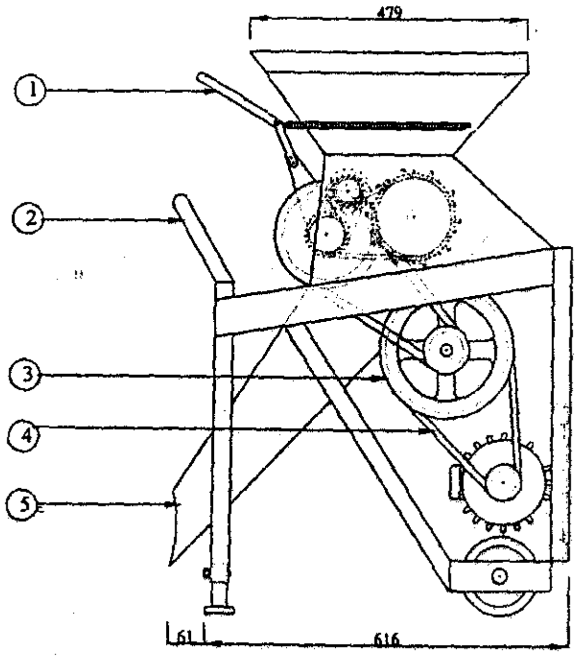
P. No.	Description
1	Feed opening.
2	Chopping drum.
3	Cutterhead.
4	Drum pulley.
5	Agitator.
6	Outlet opening.
7	Electric motor.
8	V-Belt.
9	Main switch.



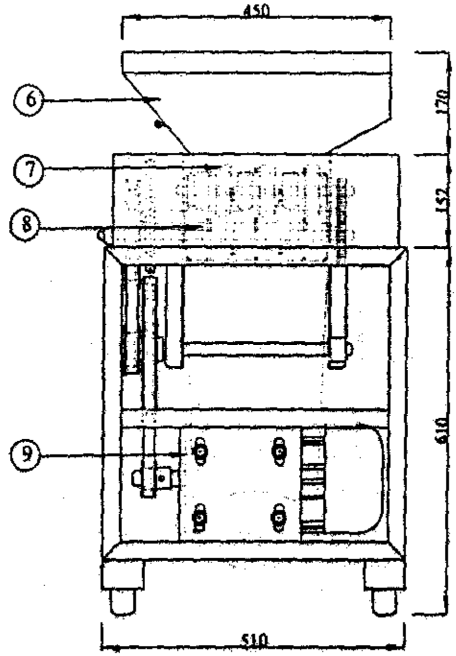
Side view

Dim.in mm

Fig. 1 : An elevation and side view for chopping machine(S-1801).



P. No.	Description
1	Spring-loaded lever
2	Stand.
3	Pulley.
4	V-Belt.
5	Outlet opening.
6	Feed opening.
7	Main drum.
8	Auxiliary drum.
9	Electric motor.



Dim. in mm.

Fig. 2 : An elevation and side view for chopping machine (S-2000).

Table 2: Some physical properties of variety (Rota) of fodder beet roots.

No. of sample	Physical properties			
	Mass, kg	Length, cm	Diameter, cm	Volume, cm^3
1	3.56	25.60	20.53	3357.4
2	3.15	26.11	18.92	2970.7
3	2.92	27.71	18.75	2753.8
4	3.10	28.42	20.91	2923.6
5	3.24	25.00	21.40	3055.6
Total	15.97	132.84	100.51	15061.1
Mean	3.19	26.57	20.10	3012.2

The machine S- 1801 was tested three drum speeds of 14.52, 18.59 and 22.31 m/s and four feed rates of 100.2, 130.2, 169.8 and 199.8 kg/h. On the other hand, the machine S- 2000 was tested at three drum speeds of 0.35, 0.52 and 0.69 m/s and four feed rates of 31.2, 41.4, 81.0 and 102.6 kg/h. Both two machines were tested under two levels of tubers moisture content of about 72.34 and 85.13% (w.b.) Mean of three replications of each variable was taken to represent the effect of this variable. The cylinder speeds before and after loading were measured using a digital tachometer, which was engaged into the cylinder shaft. Each tuber was cut into four parts by hand using a knife and then massed of about 10 kg of samples and dropped into the chopping opening feed. The chopped materials were collected in a box below for each treatment of both two machines.

Miscellaneous equipment:

a) Digital vernier, (with an accuracy of about 0.01 millimeter);
b) Mettler balance (Accuracy of 0.01 g);
c) Massing balance with a maximum reading of 10 kg and accuracy of 10 g;
d) Electric oven and
e) Stopwatch.
f) Sieves: Three standard sieves were used to determine the fineness degree of product.
g)Tachometer: The rotational speed of axes were measured by using digital tachometer, HT- 5100, Ono Sokki Co, LTD. Japan make.

Methods:

(a) Estimation of moisture content of fodder:

To estimate the moisture content in fodder beet chopped, the samples were dried in oven till (105 ^{0}C) until having a constant mass to calculate the moisture content. It was calculated on wet basis according to the following equation;

$$Moisture\ content = \frac{Mass\ of\ wet\ sample - Mass\ of\ dry\ sample}{Mass\ of\ wet\ sample} x100,\ \% \quad \ldots\ldots\ldots\ldots 1$$

(b) Chopping size:

Copping size of fodder beet tubers were measured by using crumb structure measuring device. It consisted of three sieves having different mesh sizes. The sieve diameter was 20cm and the mesh sizes are 60, 40 and 20 mm. Chopped fodder samples were randomly taken from product with three replicates. The sieve apparatus containing the chopped fodder samples is put into motion in a semicirculating fashion for one minute. After sieving the entire individual fraction, were massed and converted as a percentage of total sample mass.

(c) Estimation of power and energy requirements:

The consumed power was estimated using clamp meter by measuring the line current strength (I) and voltage potential difference values (V). Total and useful powers were then estimated according to **(Lockwood and Dunstan, 1971)** as follows:

$$Total\ consumed\ power\ (load) = \frac{IV.Cos\theta.\eta}{1000},\ kW \quad \text{.......... 2}$$

$$Usefil\ power = Power\ at\ load - Power\ at\ no.\ load,\ kW \quad \text{.......... 3}$$

Where:

I = line current strength in Amperes;

V = potential difference (Voltage) being equal to 220 V ;

$Cos\theta$ = mechanical efficiency assumed (90 %) and

η = power factor (was taken as 0.71).

The energy requirements was calculated by using the following equation:

$$Energy\ requirements = \frac{P}{C},\ kW.h/Mg \quad \text{.......... 4}$$

Where:

P = the consumed power to chopping fodder in, kW ;

C = chopping capacity of the machine in, Mg/h

(d) Feeding animals:

Daily ration of chopped fodder was offered to two mature Rahmay rams twice daily for one week and water was available at all time. This experiment was carried out at Mehalt Mousa animal production research station. It was repeated using stored chopped fodder beet to study the effect of storage on voluntary consumption of rams and the ability to eat it.

(e) Storage of chopped fodder beet:

The chopped fodder beet roots were stored on a natural ventilated storage three months in order to study the effect of moldgrowth and volumetric capacity on storage of fodder.

(f) Machine operation costs:

The machine operation costs were calculated according to **(Younis, 1997)** as follow:

Fixed costs:

- Depreciation = (original cost- salvage value)/ mechanical life, L.E/year
  Salvage value is 10% of original cost.
- Interest = Interest rate x (original + salvage value)/2, L.E/year.

- Shelter, taxes insurance = 4% x original cost.

$$Total\ fixed\ cost = \left[\frac{Depreciation + Interest + Shelte.\ taxes\ and\ insurance}{Hours\ of\ use\ per\ year}\right].\ L.E./h \ldots\ldots\ldots\ 5$$

Variable costs:

-Repairs and maintenance = 5.77% X original cost / hours of use per year, L.E/h **(Bowers,** 1987)

-Electricity cost =Maximum power consumed, (kW/h) x electricity price, L.E. /h.

-Greasing = 1.5 x .25 / No. of hours per day, L.E./h.

-Labor cost = 1.5 L.E. /h

-Total Variable costs =(Repair + Electricity +Lubrication + Labor), L.E./h.

The cost of production (CP) was calculated by using the following formula:

$$CP = Total\ costs / Total\ chopped\ materials.\ L.E./kg. \ldots\ldots\ldots\ 6$$

RESULTS AND DISCUSSION

1-Energy and unit cost:

Concerning with the results obtained from the experimental work. It can be stated that there was a direct proportion between the unit energy consumption and drum speed. These due to several of the energy components are proportional to the square or cube of drum speed **(Kepner et al., 1982)**. Figs. 3 and 4 show the relationships between drum speeds and unit energy at four levels of feed rates and two different levels of fodder beet moisture content.

It may be pointed out that the increase of drum speed from 14.52 to 22.31 m/s leads to increase the unit energy consumption by 16.36, 12.74, 11.05 and 10.97% at feed rates of 100.2, 130.2, 169.8 and 199.8 kg/h, respectively, using fodder beet moisture content of 72.34% (w.b.) for machine S-1801.

Hence the same increase drum speed increase the percentage of unit energy consumption by 25.83, 29.41, 26.06 and 23.17% at the same above mentioned feed rates and beet moisture content by using the same machine.

On the other hand, the increase of drum speed from 0.35 to 0.69 m/s tends to increase the percentage of unit energy consumption by 15.16, 11.65, 9.94 and 10.03% at feed rates of 31.20, 41.4, 81.0 and 102.6 kg/h, respectively, using fodder beet moisture content of 72.34% (w.b.) for machine S-2000.

However, the same increase of drum speed increase the percentage of unit energy consumption by 13.68, 12.09, 13.60 and 12.64% at the same above mentioned feed rates and beet moisture content by using the same machine.

Table 3 summarizes the cost calculations for two various chopping machines. The unit cost was deduced to determine the best machine. So, it can be stated that, chopper machine S-1801 resulted a drastic reduction of 62.38% in comparison with chopping machine S-2000.

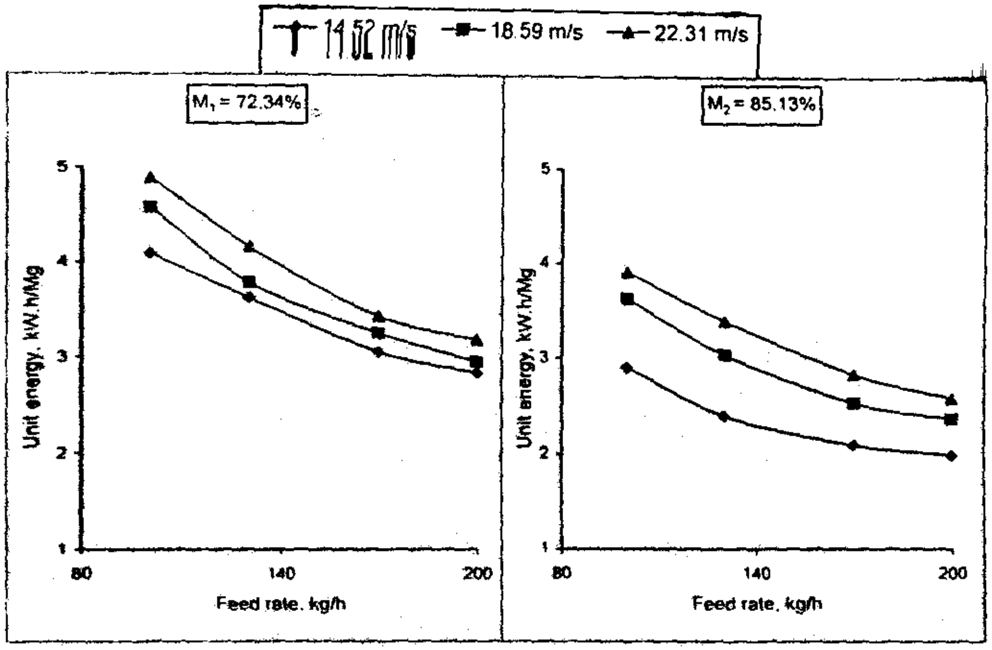


Fig.3 : Effect of drum speed, feed rate and fodder beet moisture content on unit energy requirments for machine S-1801.

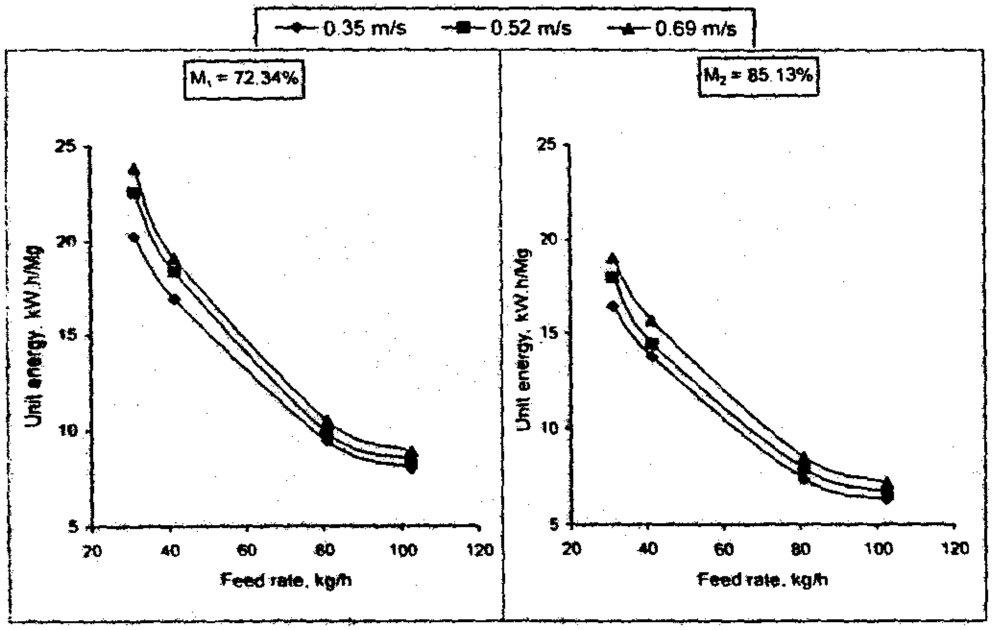


Fig.4 : Effect of drum speed, feed rate and fodder beet moisture content on unit energy requirments for machine S-2000.

Table 3: Cost calculations for two different types of chopping machines.

Chopping machine	Cost items L.E/h							Total cost, LE/h	Produ-ctivity, Mg/h	Unit cost, LE/t
	Fixed cost			Variable cost						
	Dep.	Int.	She.	R&M	Energy	Grease	Wages			
S-1801	0.90	0.55	0.4	0.58	0.13	0.05	1.25	3.86	0.20	19.30
S-2000	1.35	0.83	0.6	0.87	0.18	0.05	1.25	5.13	0.10	51.30

Equation 7: Illustrates the effect of tuber moisture content, drum speed and feed rate on the unit energy as in the form:

$$U_e = a + b(M_c) + c(D_s) + d(F_r) \qquad (7)$$

Where:

U_e = unit energy, kW.h/Mg;

a, b, c and d =coefficient constants ;

M_c = tuber moisture content, % (w.b.);

D_s = drum speed, m/s; and

F_r = feed rate, kg/h.

2- Chopping sizes:

a) Effect of drum speed, feed rates and fodder beet moisture on chopping size of < 20 mm.

Chopping machine (S-1801):

Dealing with the results showed in Figs. 5 and 6. It can be mentioned that, there was a positive effect of drum speed on the chopping sizes. Increasing the drum speed from 14.52 to 22.31 m/s increases the percentage of chopping from 48 to 55, 45 to 53, 43 to 50 and 40 to 47% at feed rates of about 100.2, 130.2, 169.8 and 199.8 kg/h, respectively for fodder beet moisture content of 72.34% (w.b.).

Whilst, the same increase in drum speed tends to increase the percentage of sizes from 54 to 62, 50 to 60, 48 to 58 and 45 to 55% at the same above mentioned feed rates and fodder beet moisture content of 85.13%, respectively.

Chopping machine S-2000:

Figs. 7 and 8 show the effects of drum speed, feed rate and moisture content on chopping sizes. The drum speed increase from 0.35 to 0.69 m/s raised the percentage chopping sizes from 27 to 36, to 33, 23 to 31 and 21 to 29% at feed rates of 31.2, 41.4, 81 and 102.6 kg/h and moisture content of 72.35 (w.b.), respectively,

Moreover, the same increase in drum speed increases the percentage of chopping sizes from 36 to 43, 35 to 40, 33 to 38 and 30 to 35% at the same four levels of feed rates and moisture content of 85.13%, respectively.

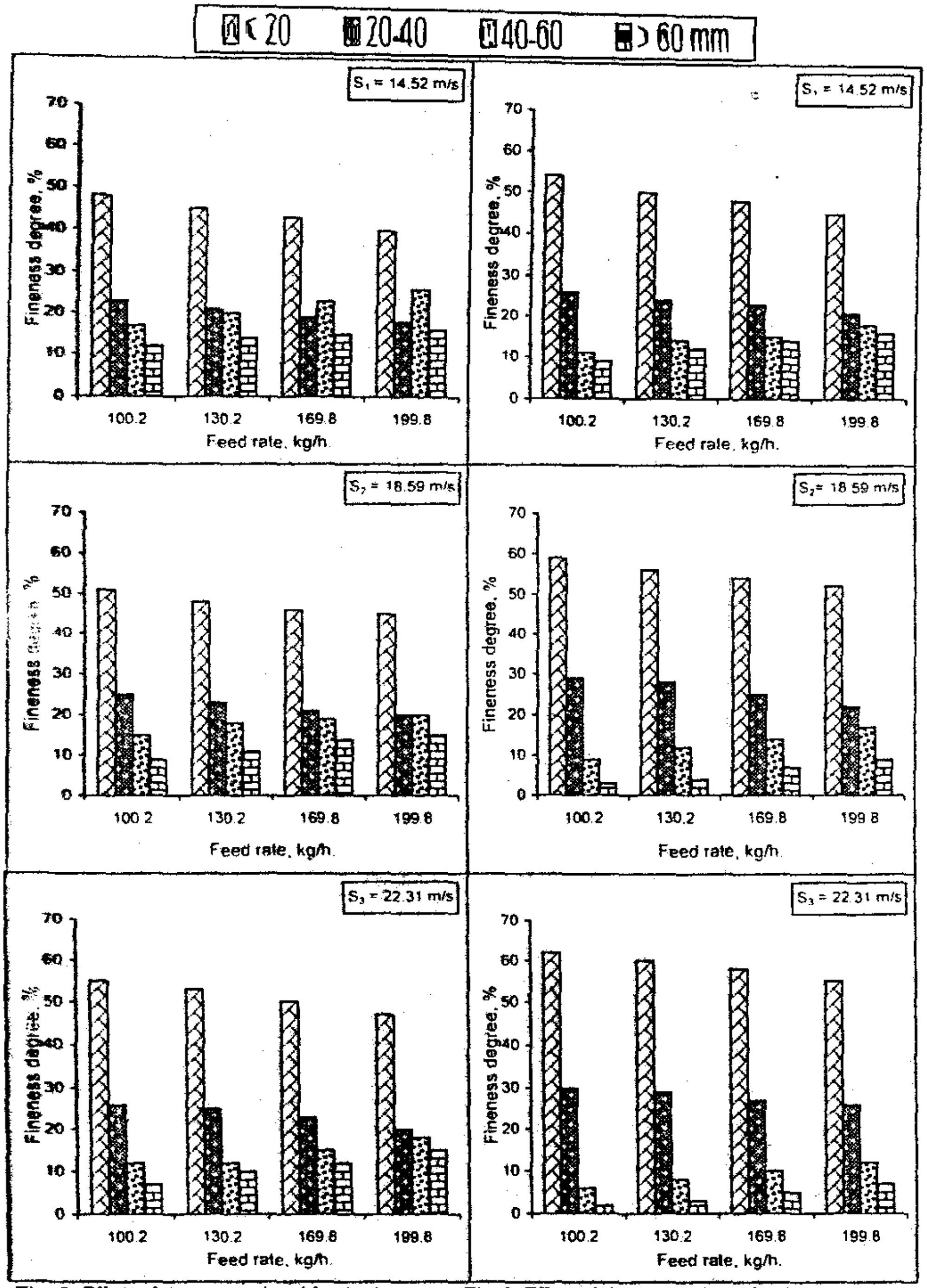


Fig. 5: Effect of drum speed and feed rate on fineness levels at fodder beet moisture content 72.34% for S-1801.

Fig. 6: Effect of drum speed and feed rate on fineness levels at fodder beet moisture content 85.13% for S-1801.

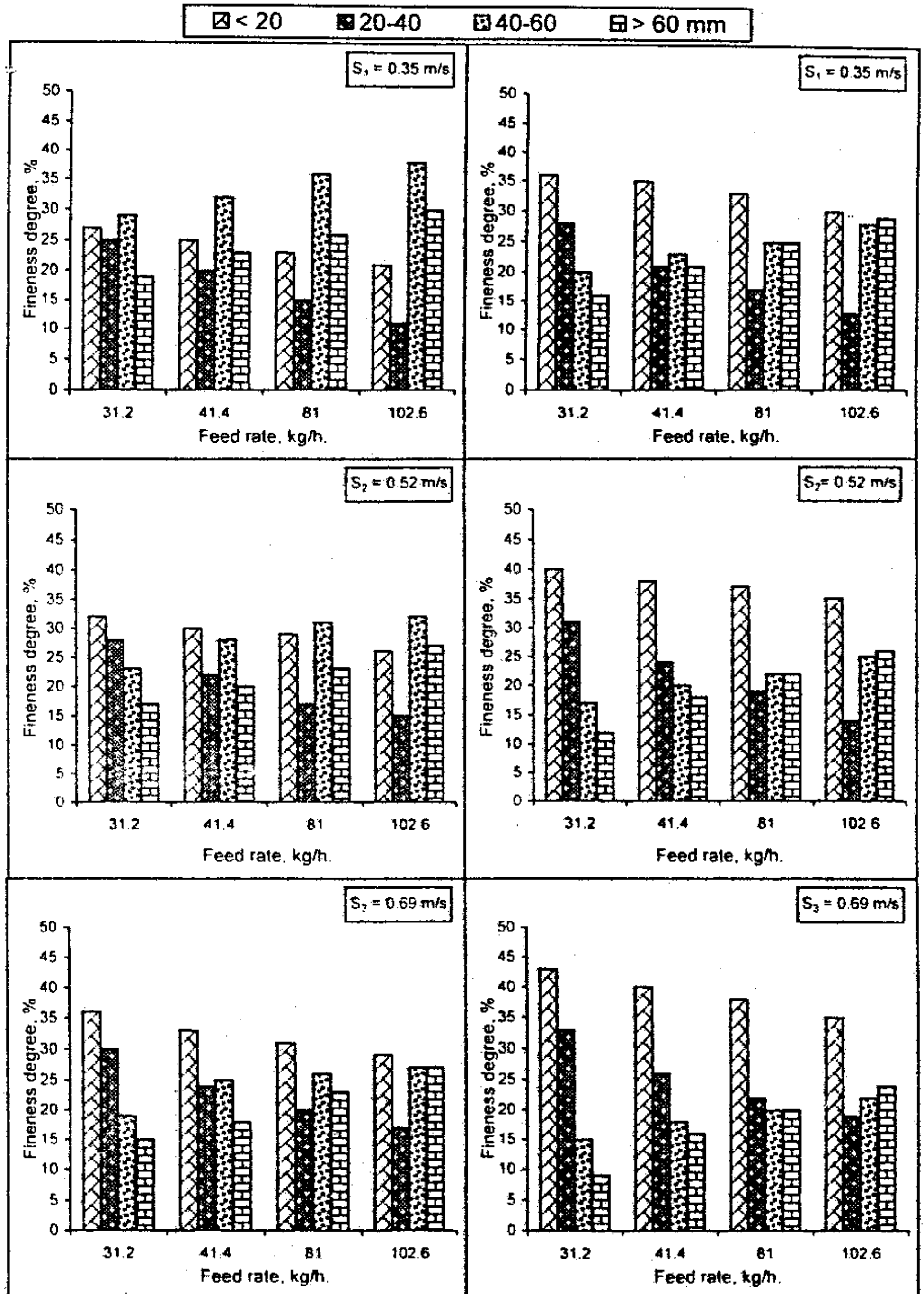


Fig. 7: Effect of drum speed and feed rate on fineness levels at fodder beet moisture content 72.34% for S-2000.

Fig. 8: Effect of drum speed and feed rate on fineness levels at fodder beet moisture content 85.13% for S-2000.

b) Effect of drum speed, feed rates and beet moisture content on chopping size of > 60 mm:

Chopping machine S-1801:

There was a reverse proportion between drum speed and chopping size of > 60 mm. Whereas, the increase in drum speed from 14.52 to 22.31 m/s decreases the percentage of chopping size from 12 to 7, 14 to 10, 15 to 12 and 16 to 15% at feed rates of 100.2, 130.2, 169.8 and 199.8 kg/h. and fodder moisture content of 72.34% (w.b.), respectively as shown in Figs 5 and 6.

In the same manner, the increase in drum speed decreases the percentage of chopping size from 9 to 2, 12 to 3, 14 to 5 and 16 to 7% at the same above mentioned feed rates and moisture content of about 85.13%, respectively.

Chopping machine S-2000:

Results presented in Figs. 7 and 8 illustrated the effects of different chopping parameters on chopping sizes. Drum speed increase from 0.35 to 0.69 m/s reduced percentage of chopping sizes from 19 to 15, 23 to 18, 26 to 23 and 30 to 27% at the four different levels of feed rates (31.2, 41.4, 81 and 102.6 kg/h) and moisture content of 72.34% (w.b.), respectively.

However, it decreases from 16 to 9, 21 to 16, 25 to 20 and 29 to 24% at the same above mentioned operating conditions, respectively, and moisture content of about 85.13% (w.b.).

On the other hand, it can be found that the other chopping size level of > 20-60 mm were fluctuated from 6 to 30 and 11 to 38% for chopping machines S-1801 and S-2000, respectively, as shown in Figs. 7 and 8.

Equation 8: Indicates the effect of tuber moisture content, drum speed and feed rate on the finnes degree at cutting level of < 20 mm

$$F_d = a + b(M_c) + c(D_s) + d(F_r) \qquad \text{.......8}$$

Where:

F_d = fineness degree, %.

The regression and correlation coefficient for the unit energy and finnes degree <20 mm are presented in Table 4.

Table 4: The regression and correlation coefficients for the unit energy and fineness degree for two various chopping machines.

Parameters	S-1801					S-2000					d.f
	Con-stant a	Regression coefficient			Corre-lation coeffic-ient (r)	Const-ant a	Regression coefficient			Corre-lation coeffic-ient (r)	
		b	c	d			b	c	d		
Unit energy, kW h/Mg	8.86	-0.07	0.09	-0.01	0.98	39.07	-0.22	4.97	-0.17	0.97	71
Fineness degree, mm	-0.08	0.53	1.08	-0.07	0.99	-23.26	0.64	20.22	0.08	0.98	71

3-Feeding animals:

The chopped fodder beet roots were offered to two mature Rahmay rams were chosen to be of almost the same body mass (45 kg) to observe their voluntary consumption. It has been noticed that, the palatability of rams was very good and they ate all of meal readily without leaving residues. The nutrition of rams was continued for 7 days, the meal was suitable for feeding and the rate of rams intake was 7.30 kg fresh/day (0.669 kg dry matter). This experiment was repeated after natural drying and stored of chopped fodder beet to study the effect of drying and storage on the voluntary consumption of rams and palatability to eat them. The same observation was also noticed. These results evidenced clearly that, storage did not leave any harmful effect on both chopped fodder and palatability of rams. These encourage the transformation of the amounts of feedstuffs during winter season to use them in a summer ration.

4-Chopped fodder beet storage:

The chopped fodder beet was stored for three months to observe the effect of moldgrowth in them. It has been noticed that there was an absence of mold-growth in feedstuffs at moisture content 19.45% of forage materials. Therefore, the safe moisture content of chopped fodder beet storage was 19.45%.

Theses results are in agreement with those obtained by **(Susawa, 1978)** the safe moisture content for chopped fodder beet storage was obtained without mold-growth after subjecting them to natural drying a period of time of about 24 to 48 h after chopping operation by using solar energy before storage.

The volumetric capacity of chopped fodder beet in comparison with whole tubers has been studied. It has been noticed that a mass of 100 kg of a chopped fodder beet occupies a volume of about 0.05 m^3. Whereas, the same mass of whole tubers occupies a volume have about 0.09 m^3 These results indicated that, the volumetric capacity of chopped fodder beet was about 44.44%. More than the volumetric capacity of whole tubers. This encourages using them as a summer ration.

CONCLUSION

From the previous results the following conclusions are drived:

1. In general the increase in both drum speed and tuber moisture content increases the percentage of particle mesh size of < 20 mm. However, increasing the feed rate decreased it.
2. It was evident that, the chopping machine S-1801 gave the highest percentage of particle mesh size of <20 mm it was reached 62 % at drum speed of 22.31 m/s, feed rate of 100.2 kg/h and tuber moisture content of 85.13 %. Whilst, it reached 43 % at drum speed of 0.69 m/s, feed rate 31.2 kg/h and the same above mentioned tuber moisture content for S-2000.
3. Regarding to the unit energy consumption for chopping machine S-1801 gives the lowest values of unit energy in all cases comparing with the other machine. However it was reached 3.91 and 19.01 kW.h/Mg for chopping machine S-1801 and S-2000, respectively.
4. The cost analysis indicated that, chopping machine S-1801 costs a drastic reduction of unit cost of 62.38 % in comparison with chopping machine S-2000.

5. **Chopping** machine S-1801 was considered the superior machine in reducing the **unit** energy, unit cost and increasing the percentage of particle mesh size of <20 **mm** which, preferable by animal nutrition.
6. **The** volumetric capacity of chopped fodder beet in comparison with the whole **tubers** was 44.44 %.

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الملخص العربى

الطـاقة اللازمة لعمــلية تقطيـع بنجــر العلف

د. رزق محمد خليف*

يعتبر نقص الأعلاف هى أساس الفجوة الغذائية فى مصر ، وان الحيوان يستهلك ما يوازى ٦,٣ مليار جنية من الدخل القومى السنوى ويعتدى على ما هو مخصص للإنسان ومع ذلك هناك عجز فى الثروة الحيوانية لمجابهة الاكتفاء الذاتى فى مجال البروتين الحيوانى. واثراء لخلق موارد علفيه غير تقليدية تزيد من حيث النوع والكم فى هذا الاتجاه الجديد للأعلاف الغير تقليدية كان زراعة محصول بنجر العلف أحد أهم الحلول الفعالة للتغلب على مشكلة نقص العلف الصيفى. وحيث أن متوسط المادة الجافة للفدان لمحصول بنجر العلف والتى تمثل الغذاء الأساسى للحيوان تمثل ما يوازى إنتاج ٥ أفدنه من الذرة من المواد الكربوهيدراتية بالإضافة الى ارتفاع نسبة البروتين فيه أكثر من الذرة ومذاقه الحلو ونضجه يتم فى يونيو حيث قمة الاحتياج الى المواد النشوية اللازمة للأعلاف.

ولقد تناول البحث دراسة تأثير كل من نوع الآلة وسرعة الدرفيل (من ١٤,٥٢ الى ٢٢,٣١متر/ثانية) ومعدل التغذية (من ١٠٠,٢ الى ١٩٩,٨ كج/ساعة) ومستويات رطوبة بنجر العلف (من ٧٢,٣٤ الى ٨٥,١٣٥ على أساس رطب) للآلة **S-1801**، وكذا تأثير كل من سرعة الدرفيل (من ٠,٣٥ الى ٠,٦٩ متر/ثانية) ومعدل التغذية (من ٣١,٢ الى ١٠٢,٦ كج/ساعة) ومستويات رطوبة بنجر العلف (من ٧٢,٣٤ الى ٨٥,١٣٥ على أساس رطب) للآلة **S-2000**،وذلك على وحدة الطاقة المستهلكة، وأحجام القطع، وتكاليف عملية التقطيع لمحصول بنجر العلف صنف روتا.

ويمكن تلخيص النتائج المتحصل عليها كما يلى:-

١- وجد أن الآلة **S-1801** أعطت أعلى نسبة تقطيع ٦٢ % لأحجام قطع اقل من ٢٠مم حيث أنها مرغوب فيها لتغذية الحيوان، وأقل طاقة لازمة لعملية التقطيع كانت ٣,٩١ كيلو وات. ساعة/ ميجا جرام ، وأقل تكاليف ١٩,٣٠ جم /طن عند معدل تغذية ١٠٠,٢ كج/ ساعة، وسرعة الدرفيل ٢٢,٣١ متر/ ثانية، ومحتوى رطوبى للبنجر ٨٥,١٣ %.

٢- وعلى الجانب الأخر بالنسبة للآلة **S-2000** كانت نسبة التقطيع لأحجام قطع أقل من ٢٠مم ٤٣ %، ووحدة الطاقة المستهلكة ١٩,٠١ كيلو وات .ساعة/ ميجا جرام، وتكاليف تشغيل ٥١,٣٠ جم /ميجا جرام عند معدل تغذية ٣١,٢ كج/ ساعة، وسرعة درفيل ٠,٦٩ متر/ ثانية، ومحتوى رطوبى للبنجر ٨٥,١٣ %.

٣- انخفضت السعة الحجميه لتخزين بنجر العلف المقطع إلى ٤٤,٤٤ % بالمقارنة بمثيلتها قبل عملية التقطيع مما يساعد على إمكانية تخزين وتداول بنجر العلف المقطع.

٤- بصفة عامة يمكن القول بأن استخدام الآلة **S-1801** فى عملية تقطيع بنجر العلف كان مرضيا للغاية.

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