

## CONSTRUCTION AND EVALUATION OF PROTOTYPE SCREW PELLETING MACHINE FOR SUGAR BEET TOPS

ABOU-SHIESHAA. R\* R. KHOLIEF\* H. EL-KHATEEB\*

### ABSTRACT

*The objective of the present study is to construct and evaluate a prototype screw pelleting machine to be used for sugar beet tops. Pelleting machine was fabricated on a private workshop in Dosuq City and tested at Sakha Animal Production Research Station Kafr El-Sheikh Governorate during summer season of 2010. The effect of screw revolving speeds, raw material moisture content and die hole diameters on machine productivity, power requirement, energy consumed and pelleting cost. Also, the effect of tested parameters on pellets quality such as stiffness, durability and pellets bulk density were taken into consideration. Hence the pellets were subjected to heated air at 70 oC, during their treatment in the drying unit.*

*Results indicated that, the optimum operating conditions of the proposed prototype was at screw revolving speed of 180 rpm, raw materials moisture content of 25.74 % (w.b) and die hole diameter of 16 mm. Whereas, it gave machine productivity of 0.098 Mg/h, power requirement of 3.10 kW and energy consumed of about 31.71 kW.h/Mg. Moreover, the optimum operating conditions gave the best pellets quality as well as pellets stiffness of 135.5 N, durability of 95.43 % and pellets bulk density of about 2.136 g/cm<sup>3</sup>. However, the cost calculations proved that, the pelleting cost by using the proposed prototype was reached about 105.20 EGP/Mg.*

### INTRODUCTION

**S**ugar beet is an important crop, not only for sugar production, but also for producing fodder and organic matter for the soil. The cultivated area of sugar beet were 104,525 hectare gave 5,138,190 of sugar beet roots and 1,493,226 tons tops, respectively (ASMOA, 2009). Beet tops consist of about one third crown and two thirds leaves.

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\* Senior researcher in Agric. Eng. Res. Inst., A.R.C., Dokki – Giza.

The green mass of tops ranges from 75 to 80 % of the mass of topped beets.

Feeding shortage is one of the most serious problems facing the animal breeders. However, it can be solved by selecting the proper fodder diet in the acceptable phase. During the period from June to October, most of the Egyptian farmers feed their livestock on very poor quality roughage such as rice and wheat straw. The necessity to dry fodder feed for farm animals in summer period has been increased vigorously in Egypt. Due to lack of fodder crops and concentrates for feeding farm animals, several efforts have been done to improve the nutritive value of crops by-product for feed animals. Sugar beet is one of these crops which, gives large quantities of green tops as a by-product after harvesting the crop.

On the other hand the riddance from crop residues is a great environmental problem because of great quantities from agricultural residues such as rice straw, maize stalks, cotton stalks and sugar beet tops. Burn has had effects on health for population and played a great role in agricultural residues value wasting. This by-products has some disadvantages for using beet tops in feeding animals because of its ferment quickly causing flying breeding nuisance and always present potential air, plant diseases and water pollution problems.

Beet tops are fed mostly to cattle and sheep either ensiled, fresh or pellets from as cured in small in the field. Beet tops are palatable and nutritious for animals. Ruminants are able to utilize large quantities without injury. Beet tops contain about two-thirds of the digestible nutrients found in corn silage (**Martin et al 1976**). So, drying and pelleting sugar beet tops is one of the important method for solving some of the problems of animal feeding and minimize such problems of disposal and pollution. It may offer a significant reduction in feed cost and minimize the requirement of expensive feed stuff.

The advantages of pelleting could be summarized as follows by **Dobie (1959, and 1961)** : a) better keeping quality, b) good bulk handling characteristics, c) more palatability for animals, d) reducing storage space, e) minimum waste, f) optimum feeding results, g) homogeneity from the time of production up to offering to the animal, h) pelleting

for ruminants decreases the ratio of acetate to propionate in the rumen and i) reducing handling costs.

**Susawa (1978)** showed that, the reciprocating machine operates on the same principle as most balers, except that the plunger and compression chamber are so designed as to provide the increased pressure necessary to produce a wafer. The material supplied in front of it into a cylinder. By selecting an adequate length of the cylinder, and the degree and direction of taper of inner surface, the material is pressed in the cylinder and comes out as a wafered product. The machine of this type alone, being not combined with the dryer, is also used for wafering rice straw. He also added that, the factors affecting on compression (wafer ability) in the following points: a) moisture content of materials, b) cut length materials, c) kind of materials, d) temperature of materials, and e) compression pressure of plunger and wafer density. Whereas short cutting causes an increased flow of product, but cut length of 2 to 3 cm is adequate from the viewpoint of performance of machines and feeding animals.

**Ramadan (1980)** mentioned that, the developed design (roller- type) of pelleting machine was used to produce pellets with different mixtures of berseem and molasses mixed by calcium oxide. The most efficient percentage of the mixture was two parts of molasses to one part of calcium oxide in mass. Also, the optimum range of moisture content for the final material under pressure was ranged from 12 to 15%.

**Abd-El-Rahim et al. (1981)** reported that energy requirements for compression cotton stalks increased with increasing applied pressure and with decreasing moisture content of stalks.

Approximately 2.0 kW.h/ton is required to produce a cotton stalk wafer of 15% moisture content for a ratio:  $\frac{L}{D} = 0.6$

Where:

L = Length of stalk, mm and      D = Die diameter, mm.

**Ismael (2001)** developed and tested a pelleting machine (screw type) to produce pellets for poultry from some processing residue (haricot, okra,

and pea wastes) with other components. He showed that the energy consumed in mixing, compressing and cutting of ration containing haricot, okra and pea wastes were 38.11, 28.94 and 24.25kW.h/ton, respectively at pellet diameter 5 mm for the best physical proportion of the pellets.

**Fasina and Sokhansanj (1992)** pointed out that the moisture increase in alfalfa cubes and pellets is exponential to a point of disintegration. The durability of cubes and pellets increased initially with increasing in moisture content up to 4% point of moisture increase and then decrease with further increase in their moisture levels.

**Kholief (1996)** found that sugar beet tops pellets can be stored without any injury below the moisture of about 18% and its palatability for buffaloes was tasted good and they ate pellets readily without leaving residues.

**Khalil (2001)** compared three different types of complete pelleted rations, whereas the control ration (A) contained 50% berseem hay, ration (B) contained 25% berseem hay and 25% dried sugar beet tops (DSBT) and ration (C) contained 50% (DSBT). Berseem hay and (DSBT) were grounded by mill grinding after that mixed with other concentrates ingredients and manufactured as the complete pelleted in pelleting machine. He also added that, the density of pellets were 1.392, 1.841 and 2.359 g/cm<sup>3</sup> and its hardness were about 13.62, 15.43 and 18.97 kg, while its mass loss were 9.73, 4.13 and 2.56% for complete pelleted rations A, B and C, respectively. Generally increasing the level of DSBT in the complete pelleted rations increased the density and hardness of pellets and decreased its mass loss.

According to the Egyptian standard specification for prepared animal feeds and feedstuffs (**EOS, 1987**), compressed feeds are sized into four categories as follows: a) sizes < 2mm in diameter ranked: powder or mash, which was used for all types of poultry and birds. b) sizes 2-5mm in diameter, which was used for rabbits, goats and fishes. c) sizes 5-10mm in diameter for small animals (< 6 months). and d) sizes 10-22mm in diameter for large animals (>6 months).

**Gupta (2001)** reported that, the feed pelleting machine can be operate by 5 hp electric motor used for making feed pellets of forage crops, with or without concentrate at a capacity of 60 to 80 kg/h. The diameter of feed pellets can be varied from 5 mm to 40 mm with length of 2.5 to 12 cm.

The objective of the present study is to construct and evaluate a prototype screw pelleting machine for sugar beet tops.

## **MATERIALS AND METHODS**

### **Materials:**

The present study was carried out to construct screw pelleting machine. It was fabricated at private workshop in Dosuq city and experiments were carried out at Sakha Animal Production Research Station Kafr El-Sheikh Governorate during summer season of 2010. The machine consists of two main parts (screw pelleting and drying units) joined together on the main frame by means of ball bearing and fixed by bolts as shown in Fig. 1. The specifications of pelleting machine are indicated in Table 1.

#### **a) Frame:**

The frame was reinforced with four corners. It was manufactured from angle bars 5 x 5 x 0.5 cm. The frame includes elements to fix hitching systems, screw pelleting unit drying unit and two electrical motors.

#### **b) Screw pelleting unit:**

The screw pelleting unit consists of compressing screw, housing provide with hopper. The compressing screw has dimensions of 45 cm long, 20.75 cm diameter, and pitch of 8.5 cm. Hence the screw was tapered from the back to the die and it was made of cast iron. The die is very important part for forming pellets with the desired diameter as shown in Fig. 2. So, it was used for blocking the housing from the end. It was made from hard steel with dimensions of 23 cm diameter and 3 cm thick. It has 12 holes with 8, 12, and 16 mm diameter with a wider conical shape from the entry side.

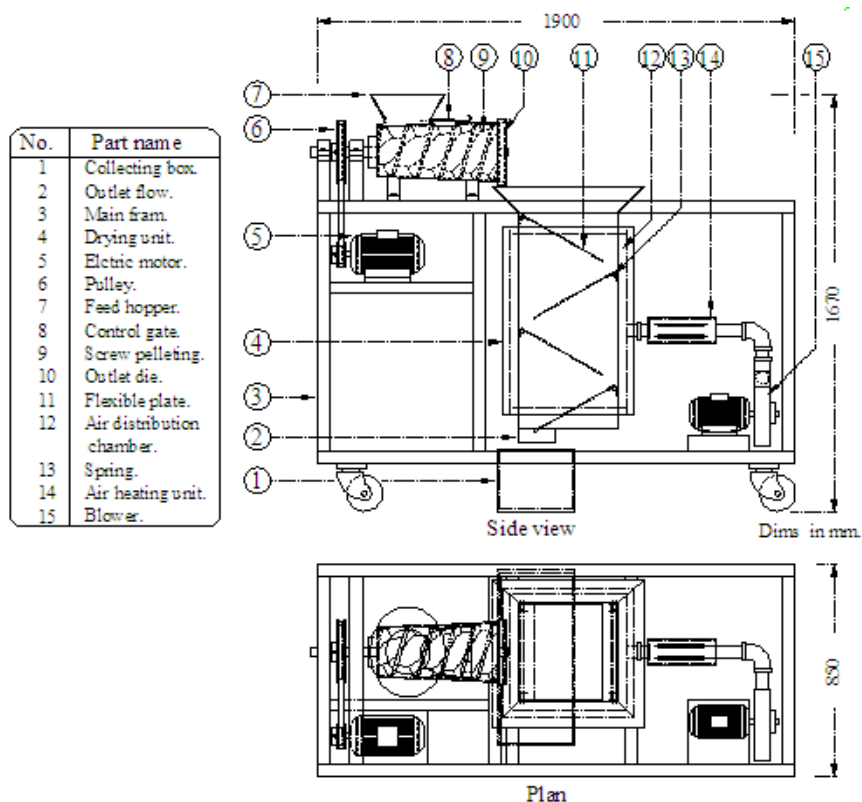


Fig. 1: A schematic digram of the constructed screw pelleting machine

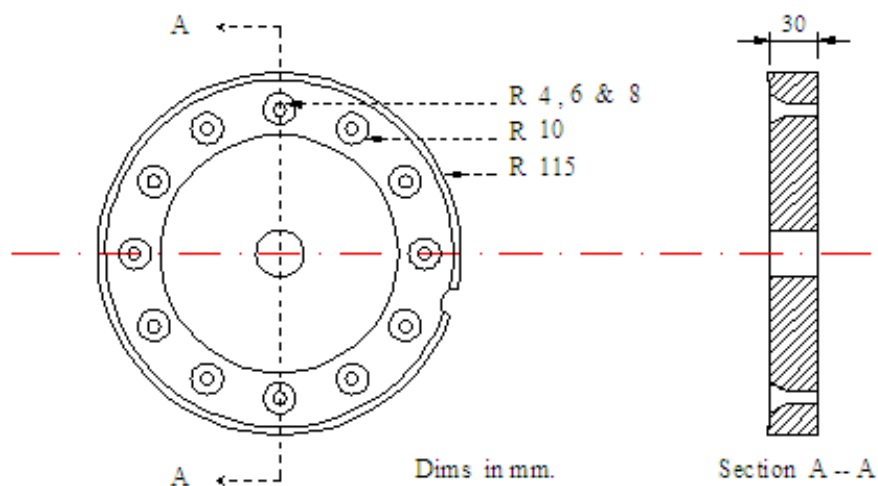


Fig. 2: The outlet die.

Table 1: Technical Specifications of the screw pelleting machine.

Items	Specifications
<b>Main dimension:</b>	
Overall length, cm	190
Overall width, cm	85
Overall height, cm	167
Total machine mass, kg	240
<b>Screw:</b>	
Average length, cm	45
Average diameter, cm	20.75
Average pitch (trough width), cm	8.5
Average peak height (trough depth), cm	3.75
Flights No.	12
Electric motor, hP ( kW)	4 (3)
<b>Drying unit:</b>	
- Outer length, cm	52
Outer width, cm	52
Overall height, cm	100
No. of flexible plate	4
Total unit mass, kg	70
Electric motor, hP ( kW)	0.53 (0.4)
<b>Hopper:</b>	
Average length, cm	36
Average diameter, cm	30

### c) Drying unit:

The moisture contents of pellets seems to be higher for packing or handling so, pellets should be dried. After compressing, the pellets was directly passed through the drying unit. It consists mainly from silo with dimensions of 100 x 52 x 52 cm and it was made from metal sheet 3 mm thick. However, the silo was isolated by wood and it was provided with four flexible plates hinged by tension spring fixed with rotating axes to delay the dropping of pellets and to subject them to the blowed heated air. Hence the blowed air was heated by the assistment of electric heater to obtain the desired temperature. The air flow was forced through the holes distributed all over the silo wall to ensure its effect on the pellets during their passing from the pelleting units into the flexible plates to be collected outside the drying unit on collecting box with dimensions of 70 x 30 x 25 cm.

**d) Power transmission system:**

Two different size of electric motors were used to operate both the pelleting and the blower in the drying units. The main one has power of 3.0 kW and an auxiliary motor with 0.4 kW. The main motor drives the screw pelleting unit by using different sizes of pulley and "V" belt. However, the auxiliary motor drives the blower in the drying unit.

**Experimental procedures:**

The proposed prototype was used for pelleting grinding sugar beet tops mixed with other ingredients. Beet tops were collected after harvesting and spread on the ground. They were turned up side down every other day at 9 a.m. after complete drying, sugar beet tops were collected and then grinded by using roller mill grinding machine. Then it was mixed by hand with other concentrates ingredients and manufactured as the complete pelleted rations as shown in Table 2.

The chemical composition of dried sugar beet tops on dry matter basis were 77.62 % for dry matter (12.77% for crude protein, 14.44% for crude fiber, 2.22% for ether extract and 48.19% for nitrogen free extract) and 22.28% for ash, respectively. It can be noticed that, the crude protein and fiber were lowest, but the nitrogen free extract and ash content were highest (Khalil, 2001).

Tests were carried out by using four screw revolving speeds: 60, 100, 140, and 180 rpm, three different levels of ration materials moisture content: 25.74, 30.62 and 36.59 % (w.b.) and three die hole diameters of 8, 12 and 16 mm. Hence drying temperature was kept constant at 70 °C during pelleting process.

**Table 2: Pellets components of ingredients.**

<b>Ingredients</b>	<b>Weight basis,%</b>
Dried sugar beet tops	50.00
Yellow corn	14.00
Wheat bran	30.00
Molasses	3.00
Limestone	1.50
Common salt	1.00
Minerals	0.50



**Measurements:**

**a) Estimation of power and energy consumption:**

Ammeter and Voltmeter were used for measuring current strength and potential difference, respectively before and during experiments. Reading of Ammeter (I) and Voltmeter (V) were taken before and during each treatment. The power consumption (kW) was calculated from the values of Ampere (I) and Volt (V) . The power consumption (P) was calculated by using the following formula (**Lockwood and Dunstan,1971**).

$$Power\ requirement = \frac{\sqrt{3I.V.\cos\Theta}}{1000}, kW \dots\dots\dots (1)$$

**Where:**

- I = Line current strength in Amperes;
- V = Potential difference (Voltage) being equal to 380 Volts;
- Cos Θ = Coefficient of utilized power (being equal 0.71 ) and
- η = Mechanical efficiency of motor assumed 95 %.

The energy requirements was calculated by using the following equation:

$$Energy\ requirement = \frac{P}{C}, kW \dots\dots\dots (2)$$

**Where:**

- P = Power requirement in, kW ;
- C = Machine productivity in, Mg/h.

**b) Moisture content determination:**

The desired moisture content of pellets component ingredients was adjusted by drying or rewetting. However the moisture content was determined according to **AOAC, (1994)**. The standard air oven method using 25 gm samples placed in air oven at 130C<sup>0</sup> for 16 hours.

**c) determination of pellets stiffness:**

A portable stiffness tester (174866) Kiyō Seisakusho, L.T.D. was used to determine the rupture force in Newton.

**d) Durability test:**

Durability of pellets is determined by subjecting them to treatments similar to those which they might experience in normal farm handling operations. The ASAE-S269.3 device was used for testing purpose under 50 rpm for one minute and the durability index was calculated by using the following equation:

$$Durability\ index = \frac{M_a}{M_b} \times 100, \% \dots\dots\dots (3)$$

Where:

Ma = Mass of pellets after shaking, g and

Mb = Mass of tested pellets before shaking, g.

**e) Pellets bulk density:**

It was calculated by using the following equation:

$$Density\ after\ forming = \frac{M_d}{V_d}, (g/cm^3) \dots\dots\dots (4)$$

Where:

Md = Pellets sample mass, g and

Vd = Pellets sample volume, cm<sup>3</sup>.

**f) Machine operation costs:**

The machine operation costs were calculated according to the following assumption:

**Fixed costs:**

- Depreciation = (List price – Salvage value)/Machine life, EGP/year

Salvage value is 10 % of original cost.

- Interest = Interest rate (List price – Salvage value) /2, EGP/ year

- Shelter, taxes insurance = 2% x List price.

Total fixed cost =

$$\left[ \frac{Depreciation + Shelter, taxes and insurance}{Hours\ of\ use\ per\ year} \right], EGP/h \dots\dots\dots 5)$$

**Variable costs:**

- Repairs and maintenance = 5.77% of List price / Hours of use Per year, EGP / h as mentioned by **(Bowers, 1987)**

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

- Greasing = 2.0 x .025/No. of hours per day, EGP/h

- Labor cost = 4.0 EGP/h

Total Variable costs = (Repair and maintenance cost+ Electricity + Greasing + Labor), EGP./h..... (6)

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

CP = Total cost / Machine productivity, EGP/Mg ..... (7)

## RESULTS AND DISCUSSION

### **a) Machine productivity:**

Figure 3 illustrates the effect of screw revolving speed, die hole diameter and pellets ration moisture contents on machine productivity. It was found that, machine productivity increased by increasing the screw revolving speeds, die hole diameter and pellets ration moisture contents. Data presented in the same Figure showed that the increase of screw revolving speeds from 60 to 180 rpm increases the machine productivity by 23.44, 30.77 and 33.84% for die diameter of 8 mm and pellets ration moisture contents of 25.74, 30.62 and 36.59 %, respectively.

However, the data also showed that the increase of die hole diameter from 8 to 16 mm tends to increase the machine productivity by 12.5, 16.92 and 20.90% with screw revolving speed of 60 rpm at the same above mentioned pellets ration moisture contents.

Meanwhile, the increase in pellets ration moisture content from 25.74 to 36.59 % leads to increase the machine productivity by 4.69% with die hole diameter of 8 mm and screw revolving speed of 60 rpm. This increase in machine productivity may be attributed to the decrease in the time required for pelleting process. However, the increase in machine productivity as pellets ration moisture content increase may be due to the increase in flow rate into the extrusion during the

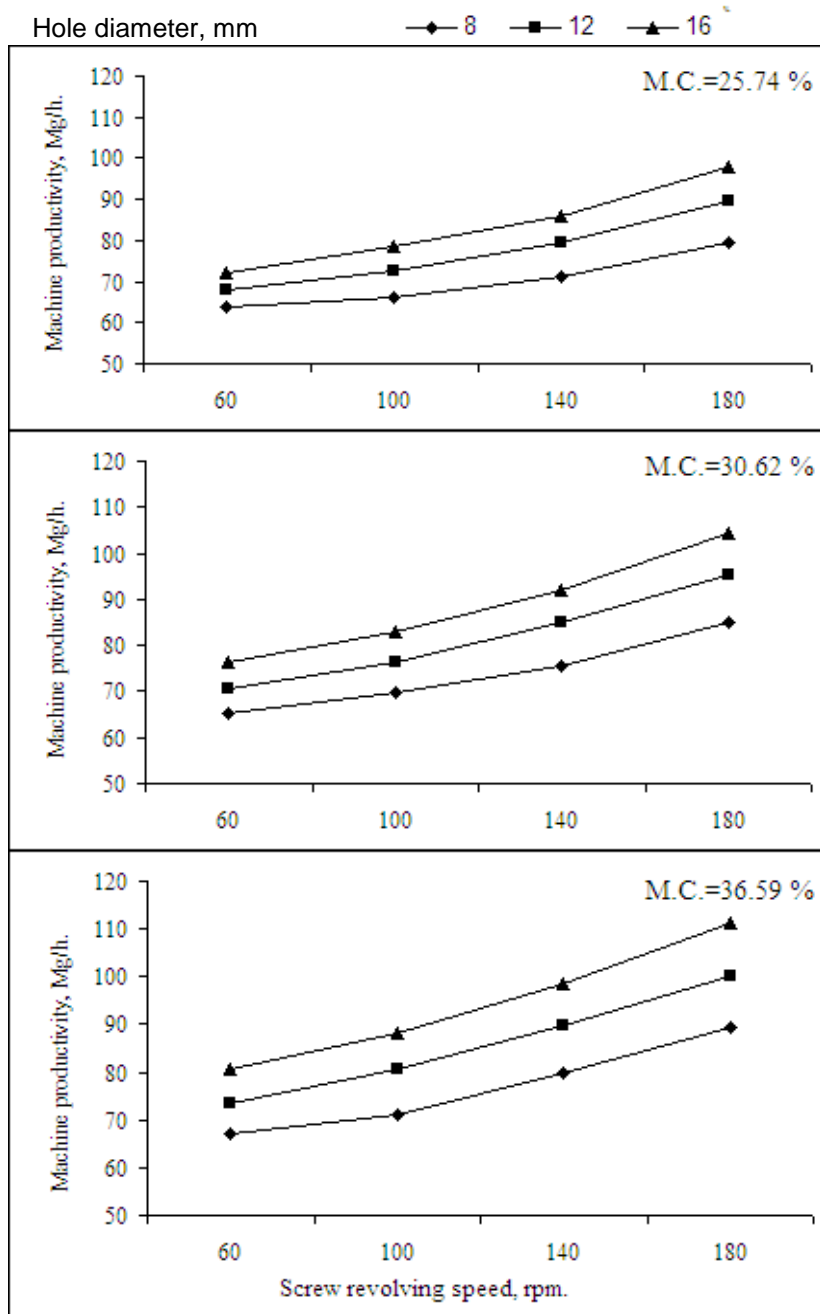


Fig.3: Effect of screw revolving speed, die hole diameter and ration moisture content on machine productivity.

pelleting process by increasing both die hole diameter and screw revolving speeds.

### **b) Power and energy consumption:**

Referring to the effect of screw revolving speeds, die hole diameters and pellets ration moisture contents on power and energy consumption as shown in Fig.4. It is conceivable that, the increase of screw revolving speeds from 60 to 180 rpm tends to increase the power requirement from 2.88 to 3.41 kW with die hole diameter of 8 mm and pellets ration moisture content of 25.74 %. Meanwhile, the same increase in screw revolving speed decreases the energy consumption from 45.18 to 42.93 kW.h/Mg at the same above mentioned conditions. The same results were obtained with other die hole diameters and screw revolving speeds.

From the previous data it is evident that, the increase in die hole diameter from 8 to 16 mm tends to decrease the power requirement from 2.88 to 2.51 kW at screw revolving speed of 60 rpm and pellets ration moisture content of 25.74 %. However, the same increase in die hole diameter decreases the energy consumption from 45.81 to 34.74 kW.h/Mg, at the same above mentioned conditions. The same trend were obtained with the other screw revolving speeds and pellets ration moisture contents.

Moreover, the increase in pellets ration moisture contents from 25.74 to 36.59 % decreases the power requirement by 17.36, 15.46, 14.38 and 14.37 % with die hole diameter of 8 mm and screw revolving speeds of 60, 100, 140 and 180 rpm, respectively. The same results were obtained with other die hole diameters. In the same manner, the same increase in pellets ration moisture contents reduce the energy consumed by 21.55, 21.56, 23.41 and 23.97 % at the same above mentioned conditions.

### **c) Pellets stiffness:**

Stiffness of pellets were taken into consideration to investigate the effect of mechanical action during pelleting process under different operation conditions. Hence the stiffness of pellets were measured just after drying to find out its ability for breaking-up. Data presented in

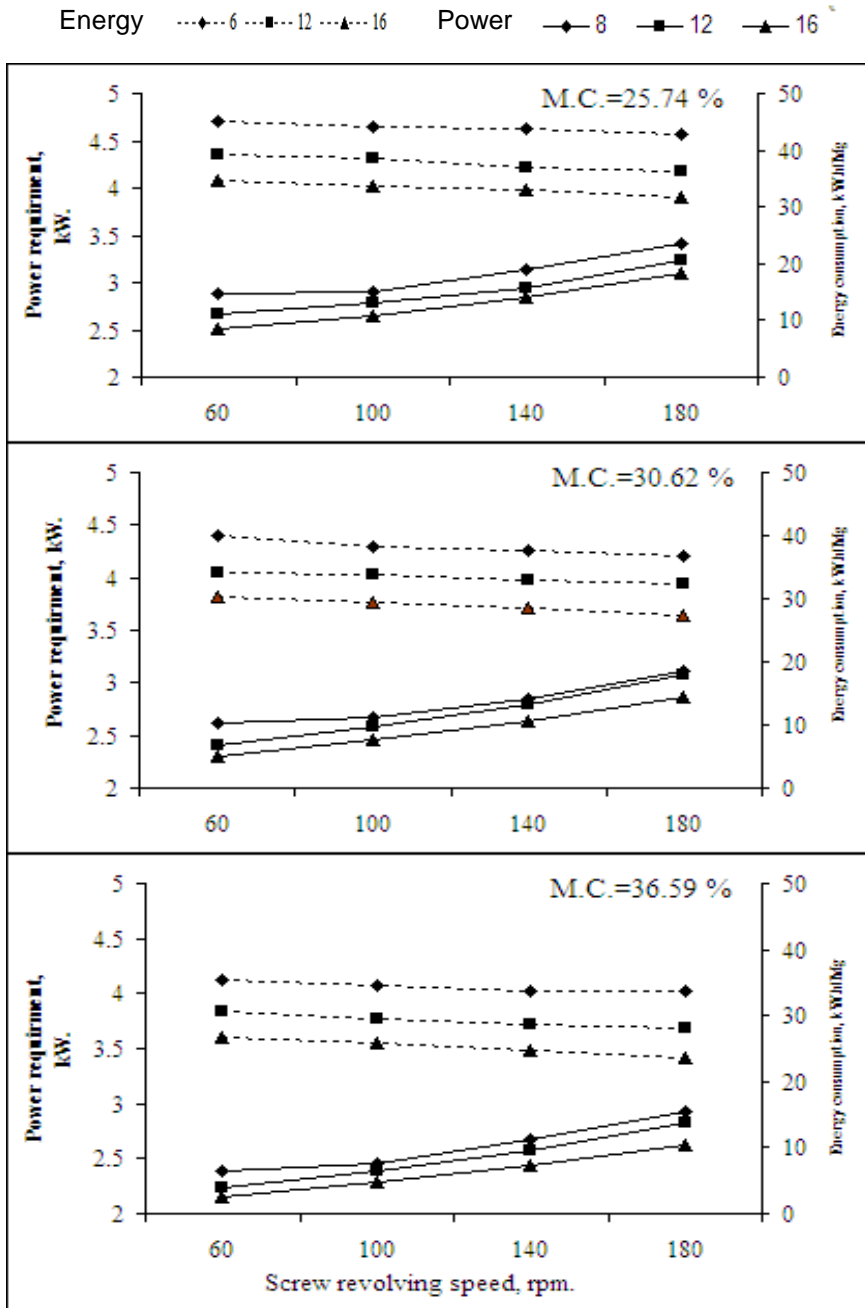


Fig.4: Effect of screw revolving speed, die hole diameter and ration moisture content on power requirement and energy consumption.

Fig. 5 shows the effect of screw revolving speeds, die hole diameter and pellets ration moisture contents. It can be stated that, the stiffness of pellets were increased by the increase of screw revolving speeds, meanwhile they were decreased by increasing both die hole diameters and pellets ration moisture contents. Whereas, the increase of screw revolving speeds from 60 to 180 rpm leads to increase the pellets hardness by 11.61,12.72, and 12.45 % with pellets ration moisture content of 25.74 % and die hole diameters of 8, 12,and 16 mm, respectively. However, the same results were obtained with other pellets ration moisture contents .

In the same manner, the increase of die hole diameter from 8 to 16 mm the pellets stiffness decreased from 139.5 to 120.5, from 124.3 to 99.0 and from 104.5 to 81.0 N for screw revolving speed of 60 rpm and pellets ration moisture content of 25.74, 30.62 and 36.59 %, respectively. Hence, the same results were obtained with other die hole diameters.

On the other hand, the increase of pellets ration moisture contents from 25.74 to 36.59 % the pellets stiffness decreased by 25.09 % with die hole diameter of 8 mm and screw revolving speed of 60 rpm. However, the same trend was obtained with other die hole diameters.

#### **d) Durability of pellets:**

The most critical factor in the performance of pelleting machine is pellets durability. Regarding to the effect of screw revolving speeds, pellets ration moisture contents and die hole diameters in Fig. 6. It can be observed that, the increase of screw revolving speeds from 60 to 180 rpm increases the durability from 96.62 to 97.60, from 94.63 to 95.55 and from 92.57 to 93.50% with die hole diameter of 8 mm and pellets ration moisture contents of 25.74, 30.62 and 36.59 5, respectively. This trend may be due to the increase in the pressure and compaction occurred during pelleting process this results agree with **Kaddor et al (2005)**. Also, the same trend were obtained with other die hole diameters.

Meanwhile, the increase in both die hole diameter and pellets ration moisture contents decreases the pelleting efficiency which, otherwise

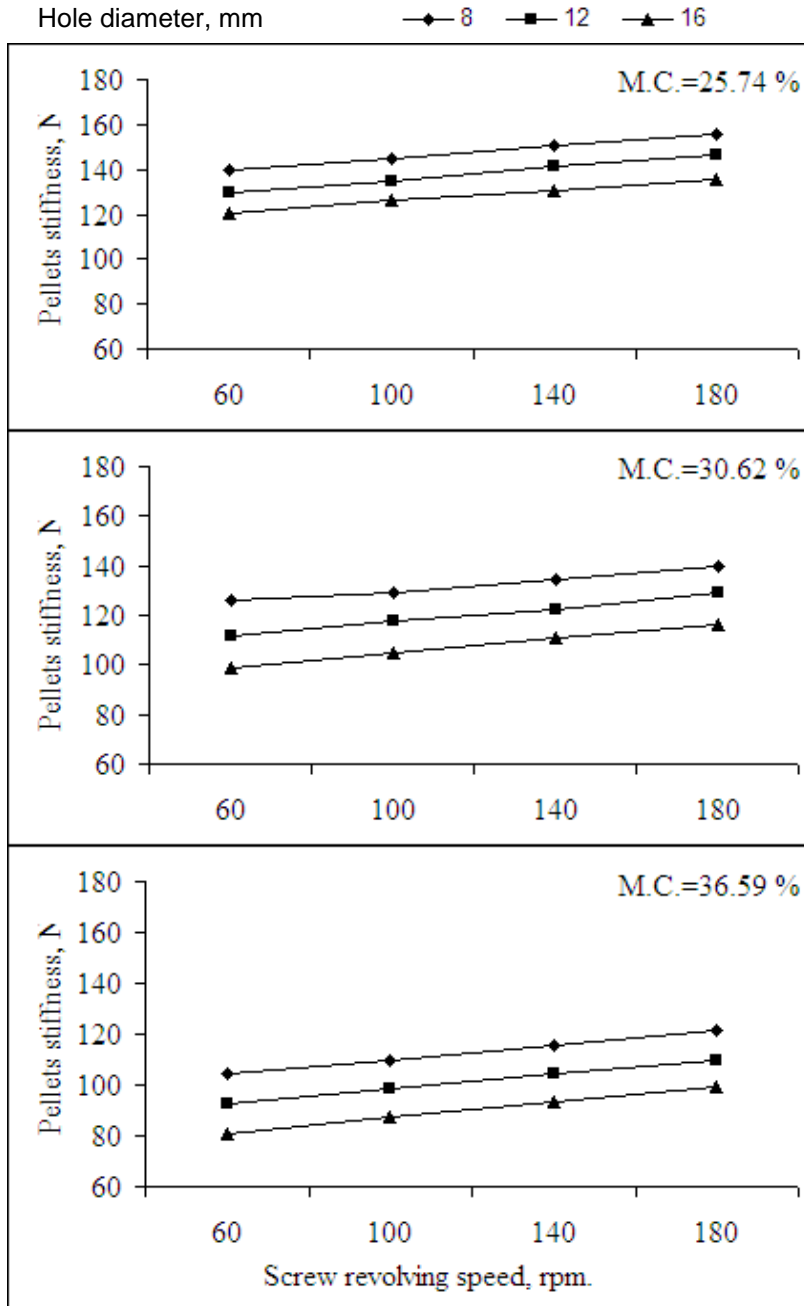


Fig. 5: Effect of screw revolving speed, die hole diameter and ration moisture content on pellets stiffness.



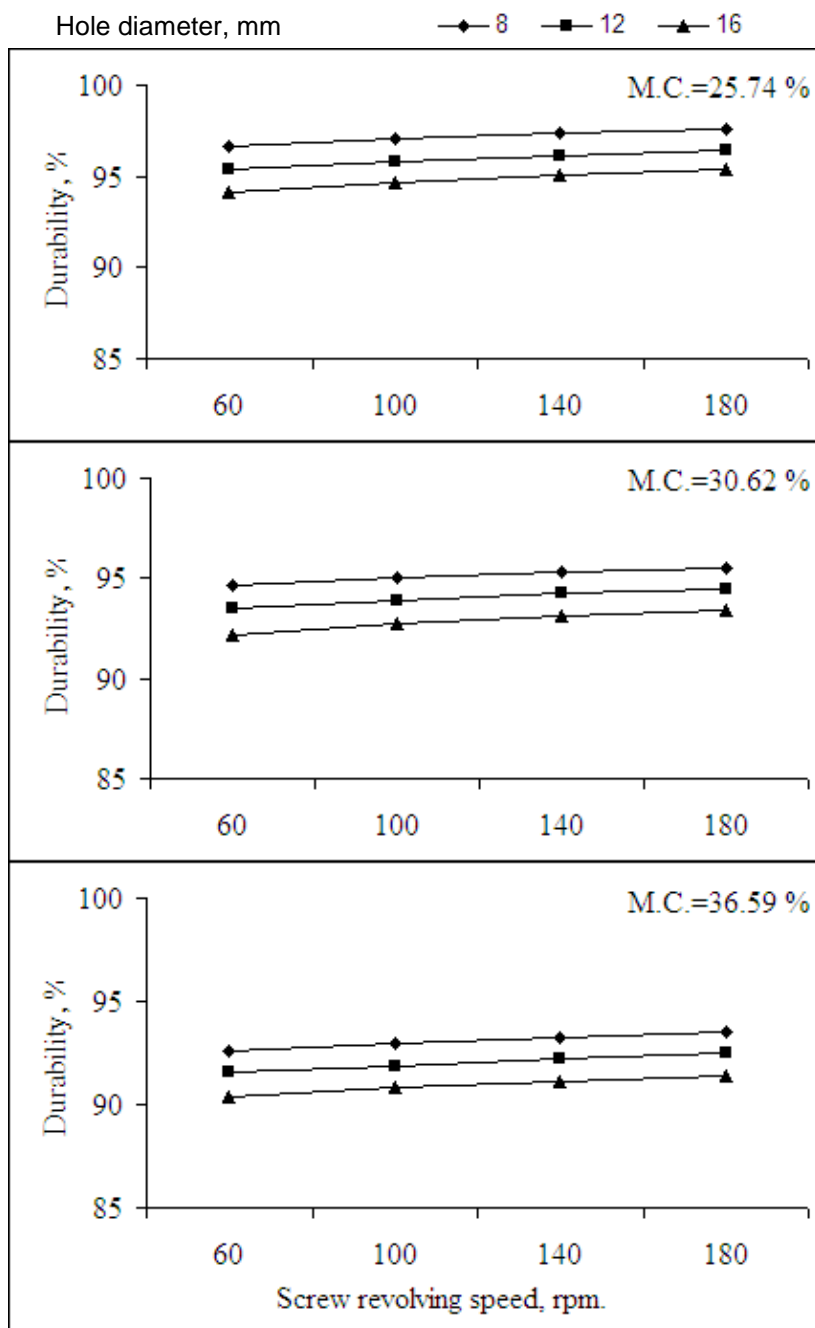


Fig. 6: Effect of screw revolving speed, die hole diameter and ration moisture content on durability of pellets.

decreases the durability. The increase of pellets ration moisture content from 25.74 to 36.59 % tends to decrease the durability from 96.62 to 92.57, from 95.42 to 91.55 and from 94.15 to 90.35% with revolving speed of 60 rpm and die hole diameter of 8, 12 and 16 mm, respectively. The same results were obtained with other revolving speeds.

#### **e) Pellets bulk density:**

The obtained results in Fig.7 shows the effect of screw revolving speeds, pellets ration moisture contents and die hole diameters on pellets bulk density. It can be evident that, the increase in screw revolving speeds from 60 to 180 rpm tends to reduce the pellets bulk density by 4.82, 5.99 and 7.34 % with die hole diameter of 8 mm and pellets ration moisture contents of 25.74, 30.62 and 36.59 %, respectively. This may be due to the compaction exposed to the ration. The same trend was obtained with other die hole diameters.

On the other hand, the increase in pellets ration moisture content from 25.74 to 36.59 % tends to reduce the bulk density from 2.133 to 1.691, from 2.175 to 1.742, from 2.210 to 1.788 and from 2.241 to 1.825 g/cm<sup>3</sup> with die hole diameter of 8 mm and screw revolving speeds of 60, 100, 140 and 180 rpm, respectively. The same results were obtained with other die hole diameters.

Also, the increase in die hole diameter from 8 to 16 mm leads to decrease the bulk density by 5.63, 6.80 and 8.57 % with screw revolving speed of 60 rpm and pellets ration moisture contents of 25.74, 30.62 and 36.59 %, respectively. The same trend was obtained with other die hole diameters.

#### **f) Pelleting cost:**

Table 3 summarizes the effect of screw revolving speed, die hole diameter and pellets ration moisture contents on machine productivity, energy consumption and pelleting cost. Results observed that, the increase in screw revolving speed from 60 to 180 rpm tends to increase the machine productivity from 0.072 to 0.098 Mg/h. Also, energy consumed reduces from 39.36 to 36.17 kW.h/Mg at the same

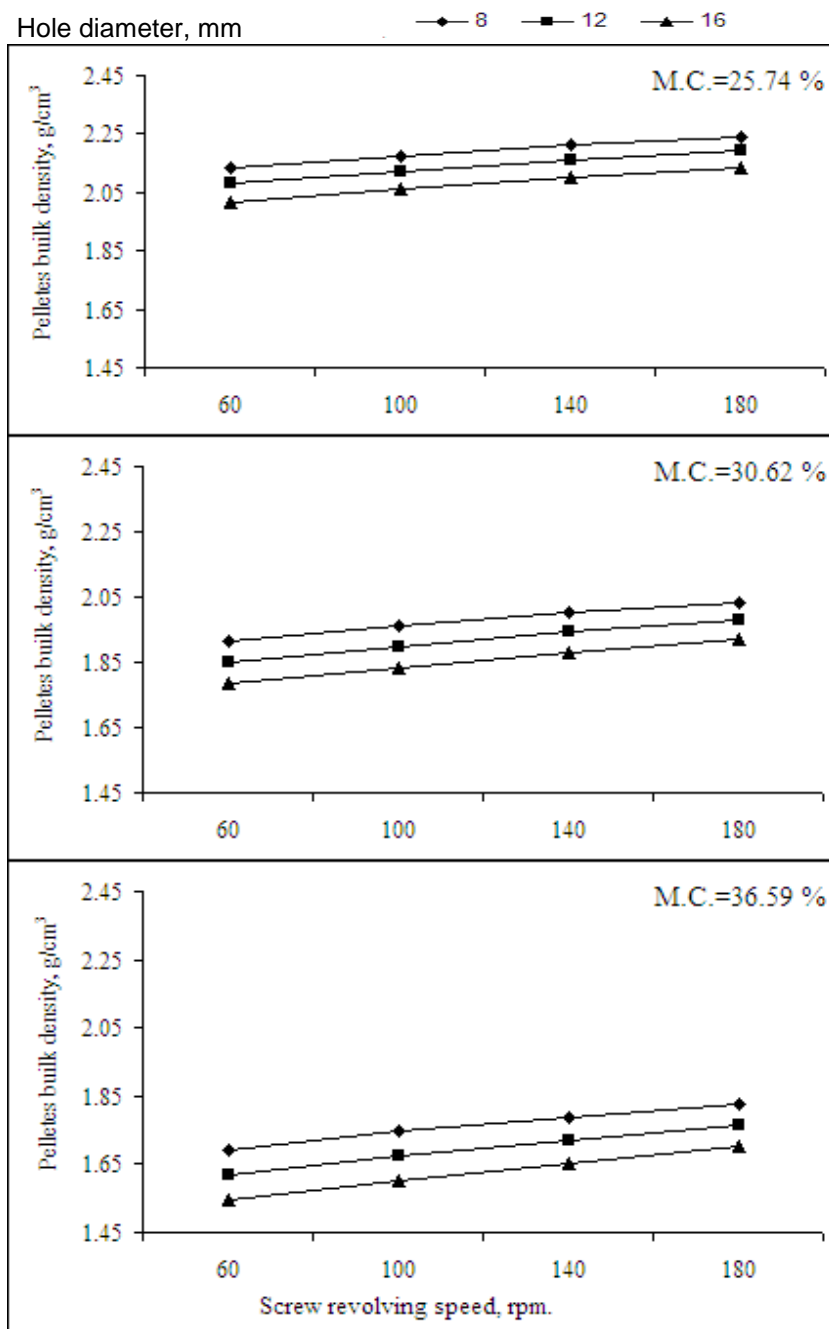


Fig.7: Effect of screw revolving speed, die hole diameter and ration moisture content on pellets bulk density.

mentioned conditions. However, pelleting cost was reached 105.20 EGP/Mg.

**Table 3:** Effect of screw revolving speeds, die hole diameter and pellets ration moisture content on machine productivity, energy consumption and pelleting cost.

Pellets ration moisture content, %	Die hole diameter, mm	Screw revolving speed, rpm	Machine productivity, Mg/h	Energy consumption, kW.h/Mg	Pelleting cost, EGP/Mg
25.74	16	60	0.072	34.74	143.19
		100	0.078	33.81	132.18
		140	0.086	32.99	119.88
		180	0.098	31.71	105.20

### CONCLUSION

The main results in this study can be summarized as follows:

- 1- The minimum value of energy consumed reached 23.63 kW.h/Mg at screw revolving speed of 180 rpm die hole diameter of 16 mm and pellets ration moisture content of 36.59 %.
- 2- Machine productivity of 0.098 Mg/h seems to be acceptable under the optimum operating conditions.
- 3- The optimum operating conditions gave the best pellets qualities in terms of stiffness 135.5 N, durability of 95.43 % and pellets bulk density of about 2.136 g/cm<sup>3</sup>.
- 4- Pelleting cost by using the proposed pelleting machine was reached about 105.20 EGP/Mg.
- 5- The optimum operating conditions of screw pelleting machine was at pellets ration moisture content of 25.74 %, die hole diameter of 16 mm and screw revolving speed of 180 rpm.

### REFERENCES

- Association of Official Analytical Chemists (1994).** Official Methods of analysis 20<sup>th</sup> ed. Artington, VA.
- Abd El-Rahim, Y.M.; A.S.Huzayyin and I.S.Taha (1981).** Dimensional analysis and wafering cotton stalks. Trans. of the ASAE, 24 (4): 829-832.

- Bowers, W. (1987).** Fundamentals of machine operation Machinery management. Text Book. Deere and Company Moline: 91.
- Dobie, J. B. (1959).** Engineering appraisal of hay pelleting. Ag. Eng., 40: 76-93.
- Dobie, J.B. (1961).** Materials handling systems for hay wafers. Ag. Eng., 42 (12) : 692-667.
- Fasina, O.O and S. Sokhansanj (1992).** Hygroscopic moisture absorption by alfalfa cubes and pellets. Trans. of the ASAE, 35 (5): 1615-1619.
- Gupta, P.D. (2001).** Mechanization of harvesting pelleting and densifying operations in forages. ASAE, Annual International Meeting.
- Ismael, N. K. (2001).** Engineering studies on the processing of some agricultural wastes. Ph.D. Thesis, Fac. of Ag., Mans. Univ., Egypt.
- Kaddour, U. A; T. R. Owies and H. A. El-Gendy (2005).** A study on the effect of using steam-lock in extruder pelleting machine to produce floating fish feed pellets.
- Kholief, R. M. (1996).** Manufacturing of pellets production machine for livestock. Ph.D Thesis, Fac. of Ag., Kafrelsheikh, Tanta Univ., Egypt.
- Khalil, A. A. (2001).** Productivity performance of growing lambs fed complete pelleted rations containing different levels of dried sugar beet tops. M.Sc. Thesis, Fac. of Ag., Kafrelsheikh, Tanta Univ., Egypt.
- Lockwood, F. B. and R. Dunstan (1971).** Electrical engineering principles. Meinemann Educational Books, Ltd. London.
- Martin, J. H.; W. H. Leonard and D. L .Stamp (1976).** Principles of field crop production. 3<sup>rd</sup> ed., Macmillan Pubi Co., Inc. New York: 877-897.
- Agricultural Statistics Ministry of Agriculture. (2009).** Ministry of Agriculture and Land Reclamation, Economic Affair Sector.
- Ramadan, M. H. (1980).** Studies on manufacturing livestock pellets. M.Sc. Thesis, Fac. of Ag., Mansoura Univ., Egypt.

**Susawa, K. (1978).** Roughage wavering techniques in Japan. JARQ, 12(1): 17-21, Tropical Agriculture Research Center, Japan.

المراجع العربية:

- الهيئة المصرية العامة للتوحيد القياسي (١٩٨٧) • المواصفات القياسية المصرية ٩٨٧/٣ الأعلاف المصنعة ومواد العلف الخام.

### الملخص العربي

## تصنيع وتقييم نموذج أولى لإنتاج مصبغات العلف من عرش بنجر السكر

د/ رفاعى ابوشعشع\* د/ رزق خليف\* د/ حماده الخطيب\*

تزداد حدة الفجوة العلفية عاما بعد آخر لتسبب العجز الهائل في الموازنة العلفية ، حيث تشير إلى حقيقة هامة وهى أن الحيوانات المزرعية لا تحصل إلا على ٧٠% من احتياجاتها الغذائية اللازمة لإظهار كفاءتها الإنتاجية • الأمر الذي أدى إلى تدهور انتاجيتها • وبالرغم من توفر هذا الكم الهائل من المخلفات الزراعية فان ٣٠% منها يستخدم في تغذية الحيوان والباقي لا يستفاد به أو يحرق ويعتبر جرم كبير وسوء تخطيط تدفع البلاد ثمنه إذا تعود الأفراد أو أتيح لهم حرق المواد العضوية التي يمكن استخدامها في تغذية الحيوان والتي تدخل في العلائق بنسب متفاوتة من ١٠ إلى أكثر من ٥٠% حسب طبيعة مكونات العليقة ونوع الحيوان •

ويعتبر عرش بنجر السكر من المخلفات الزراعية الهامة حيث التركيب الكيماوي على أساس المادة الجافة ٧٧.٦٢% مادة جافة (١٢.٧٧% بروتين خام، ١٤.٤٤% ألياف خام ، ٢.٢٢% مستخلص اثيرى ، ٤٨.١٩% مستخلص خالي من الازوت)، ٢٢.٢٨% رماد. ويلاحظ ارتفاع محتواة من الكربوهيدرات الذائبة ، الرماد الأمر الذي يعظم من استخدامه كعلف حيواني ضروري وهام • Khalil, 2001

ولقد تم إدخال عرش بنجر السكر بعد تجفيفه وطحنه كمكون رئيسي في العليقة لعمل مصبغات باستخدام الآله موضوع الدراسة بعد تعديلها لتناسب عمل المصبغات كعلف حيواني وتجفيفها فى وقت واحد من خلال دراسة كل من :

- سرعة بريمة الكبس (٦٠ - ١٠٠ - ١٤٠ - ١٨٠ لفة / دقيقة) •
- أقطار فتحات قرص التشكيل (٨ - ١٢ - ١٦ مم) •
- مستويات رطوبة للعليقة ( ٢٥.٧٤ - ٣٠.٦٢ - ٣٦.٥٩% على أساس رطب) •

• باحث أول بمعهد بحوث الهندسة الزراعية - مركز البحوث الزراعية - الدقى - جيزة •

وتأثيرها على كل من الطاقة المطلوبة لإنتاج مصبغات العلف ، إنتاجية الآلة ، صلابة العلف المصنع ، نسبة العلف المفقود أثناء التداول (متانة العلف المصنع) وكثافة العلف المصنع .

ويمكن تلخيص النتائج المتحصل عليها كما يلي:

- ١- أوضحت النتائج أن الطاقة المستهلكة للآلة في عملية الكبس والتجفيف كانت ٣١.٧١ كيلوات. ساعة/ طن عند سرعة دورا نية لعمود الكبس ١٨٠ لفة/ دقيقة وقطر قرص التشكيل ١٦ مم ومحتوى رطوبى للعليقة ٢٥.٧٤% على أساس رطب .
- ٢- بلغت إنتاجية الآلة عند ظروف التشغيل المثلى ٠.٠٩٨ طن/ ساعة عند صلابة العلف المصنع ١٣٥.٥ نيوتن، ومتانة أصابع العلف أثناء التداول ٩٥.٤٣% وكثافة أصابع العلف ٢.١٣٦ جم/سم<sup>٣</sup>.
- ٣- تكاليف التشغيل للآلة ١٠٥.٢ جنية/ طن عند ظروف التشغيل المثلى لرطوبة عليقه ٢٥.٧٤% وقطر قرص التشكيل ١٦ مم وسرعة دورا نية لعمود الكبس ١٨٠ لفة/ دقيقة.