

## **DEVELOPMENT AND PERFORMANCE EVALUATION OF A RAMMING MACHINE FOR PELLETS PRODUCTION**

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### **ABSTRACT**

This study was carried out to develop and evaluate a pelleting machine to overcome the separation of the fodder components during the pelleting process and to increase the machine productivity. The machine modification was accomplished at private workshop in Kafrelsheikh governorate. The experiments was carried out during the year of 2011 in Rice Mechanization Center, Meet El-Deeba village, Kafrelsheikh governorate, Egypt. The effect of fodder types (Berseem hay and Cottonseed), raw materials moisture content (22.83, 27.61 and 32.58% w.b.), crank arm speeds (45, 70, 90 and 120rpm) and die hole diameters (3, 6, 9 and 12mm) on machine productivity, energy consumed and pelleting cost. Also, the effect of tested parameters on pellet quality such as durability, stiffness and pellet bulk density were taken into consideration. The results showed that, the optimum operating conditions of the developed pelleting machine was at raw materials moisture content of 22.83%(w.b.), crank arm speed of 120rpm and die hole diameter of 12mm. Where, it gave machine productivity of 0.248 and 0.255Mg/h, energy consumed of 4.90 and 5.13kW.h/Mg and operating cost of 46.42 and 45.23LE/Mg for Berseem hay and Cottonseed fodders, respectively. Moreover, the optimum operating conditions gave the best pellets quality as well as pellets durability of 95.64 and 93.66%, bulk density of about 2.22 and 2.18g/cm<sup>3</sup>, and stiffness of 175.6 and 172.7N for Berseem hay and Cottonseed fodders, respectively.

### **INTRODUCTION**

Pelleting has been, and continues to be, a popular processing technique in feed manufacturing. In basic terms, pelleting converts a finely ground blend of ingredients into dense, free flowing agglomerates (pellets). There are many reasons used to justify the process, but it may be appropriate to list just a few: improved animal performance, decreased feed wastage, reduced selective feeding, improved bulk density, better material handling characteristics, destruction of deleterious organisms and customer expectations (*Suppadit et al., 2002 and Behnke, 2006*). Die thickness and hole size varies with the type of product to be pelleted. Relieved dies have an enlarged diameter on the discharge side of the hole. Relief length is the distance of the die hole which has a greater diameter than the rest of the hole (*Aarseth and Prestliikken, 2003*). *Behnke (1990)* studied the effect of effective die thickness, on length, pellet durability in this experiments reported earlier in this paper. His results indicate, clearly, that durabilities were significantly enhanced with the use of the thicker die; however, production rates were as significantly reduced. *Kholief (1996)* designed, fabricated and evaluated a pelleting machine to study the effect of some operating parameters on forming pellets from sugarbeet tops, Berseem hay and Cottonseed with other components. He concluded that, the machine productivity was 0.0923, 0.095

and 0.086Mg/h for sugarbeet tops, Berseem hay and Cottonseed fodders, respectively at about 17.76% moisture content when the crank arm speed and the die hole diameter were 0.84m/s and 20mm. The pelleting cost (operating and raw materials cost) of 528.87, 655.68 and 662.57LE/Mg was obtained at the same fodders and operating conditions, respectively. *Gupta (2001)* reported that, the feed pelleting machine can be operate by 5hp 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 to 40mm with length of 2.5 to 12cm. *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 grinded 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 2.359g/cm<sup>3</sup> and its stiffness were about 13.62, 15.43 and 18.97kg, 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 stiffness of pellets and decreased its mass loss. According to the Egyptian standard specification for prepared animal feeds and feedstuffs, in Arabic, 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 2-6mm in diameter, which was used for rabbits, goats and fishes. c) sizes 5-10mm in diameter for small animals (<6months). And d) sizes 10-22mm in diameter for large animals (>6months). *Moritz et al., (2001)* found that moisture is important for gelatinization of starch and denaturizing of proteins, important for adhering particles into a pellet. *Fasina et al., (2004)* showed that bulk density decreased and particle of pelleted litter increased by increasing the moisture content. The force required to rupture the pellets varied from 350N at 6% moisture to 50N at 22% (w.b.). The pelleting machine has been developed and evaluated to overcome the separation of the fodder components during the pelleting process and to increase the machine productivity.

## **MATERIALS AND METHODS**

The present study was devoted to develop and evaluate ramming machine for pellets production. It was accomplished at private workshop in Kafrelsheikh city and experiments were carried out at Rice Mechanization Center, Meet El-Deeba village, Kafrelsheikh governorate during the year of 2011.

### **Ramming machine:**

The machine consists of two main parts (feeding hopper and compression chamber). The two parts were fixed with the frame by means of bolts.

**a- Feeding hopper:**

It was made of galvanized steel sheet and it was tapered from the bottom having conical shape. The hopper has a large vertical auger rotates continuously. It takes its motion an electric motor fixed on the side of hopper.

**b- Compression chamber:**

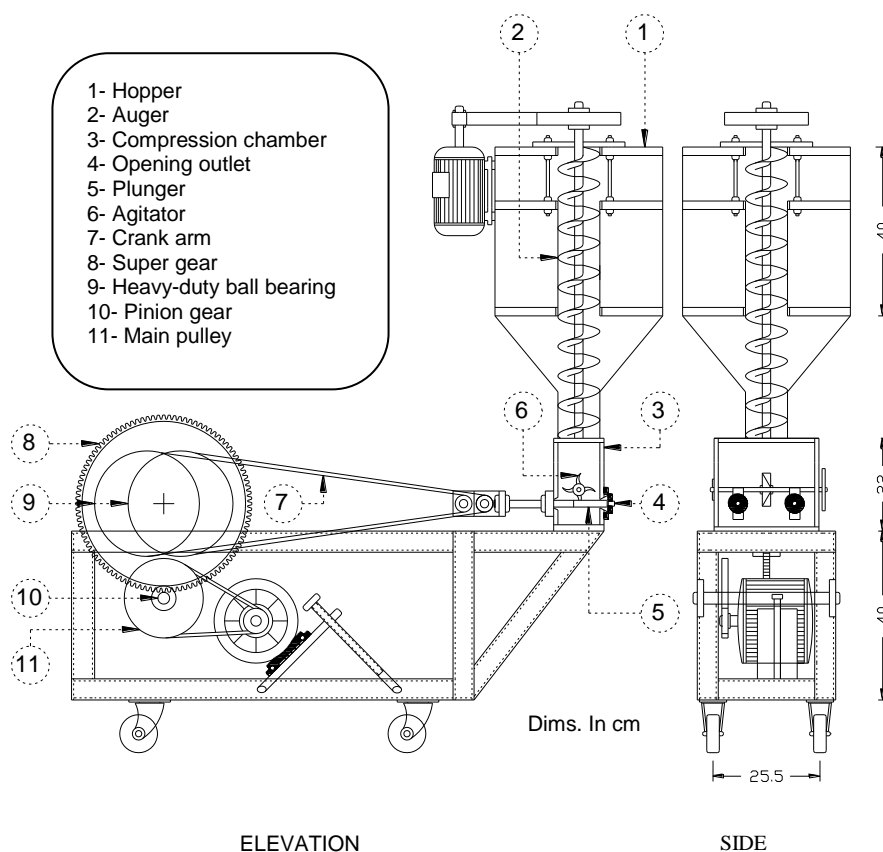
The compression chamber was made from hard steel and powered by using another electric motor. There was an agitator inside the compression chamber to give easy configuration pellets.

**c- Power transmission device:**

Two different size of electric motors were used to operate the ramming machine. The main one has a power of 2hp (1.5kW) and the auxiliary with 0.54hp (0.40kW). the main motor drives the plunger and the agitator inside the compression chamber. Hence the main motor was used to driving the main shaft by means of V-belt pulley variator. The variator consists of four aluminum alloy pulleys to give the required speed for each run. The main shaft was used to reducing the speed obtained from the main motor and give the required speed to spur gear by pinion gear. The spur gear was fitted at the center of secondary shaft and rotates on two ball bearing fitted on both side of spur gear. This mechanism will produce a reciprocating plunger force. The raw materials (fodder) pressed inside the compression chamber discharged as pellets by selecting an appropriate extension outlet length and diameter. The machine has two exits (holes) on the compression chamber. The engineering drawing of the pelleting machine is shown in Fig. 1 and a detailed description of the whole machine is illustrated in Table 1.

**Table 1: Specifications of ramming machine.**

Items	Specifications
<b>Overall dimensions:</b>	
Length, cm	150
Width, cm	50
Height, cm	140
Mass, kg	180
<b>Feeding hopper:</b>	
Length, cm	70
Diameter, cm	40
<b>Auger:</b>	
Length, cm	78
Diameter, cm	10
Pitch, cm	3.5
Power, hp (kW)	0.54 (0.40)
<b>Compression chamber:</b>	
Length, cm	25
Width, cm	12
Height, cm	22
Number of exit holes	2
Diameter of spur gear, cm	40
Diameter of pinion gear, cm	2.8
Diameter of heavy ball bearing, cm	25
Length of stroke, cm	8
Power, hp (kW)	2 (1.5)



**Fig. 1: Engineering drawing of the pelleting machine.**

**Suggested modifications:**

The two exit holes of compression chamber were eliminated and replaced by two dies for forming pellets with the desired diameter. The die was made from hard steel with dimensions of 10cm diameter and 3cm thick. Each die has 4 holes with 3, 6, 9 and 12mm diameter with a wider conical shape from the entry side. For achieving the compression of the raw materials inside compression chamber, the agitator was cancelled and two rammers were fixed on compressing shafts from the end. The rammer made from cast iron with dimensions of 10cm diameter and 2cm thick. Dimensions of compression chamber was altered from 25x12x22cm to 27x12x20cm (Figs. 2 and 3).

**Pellets component:**

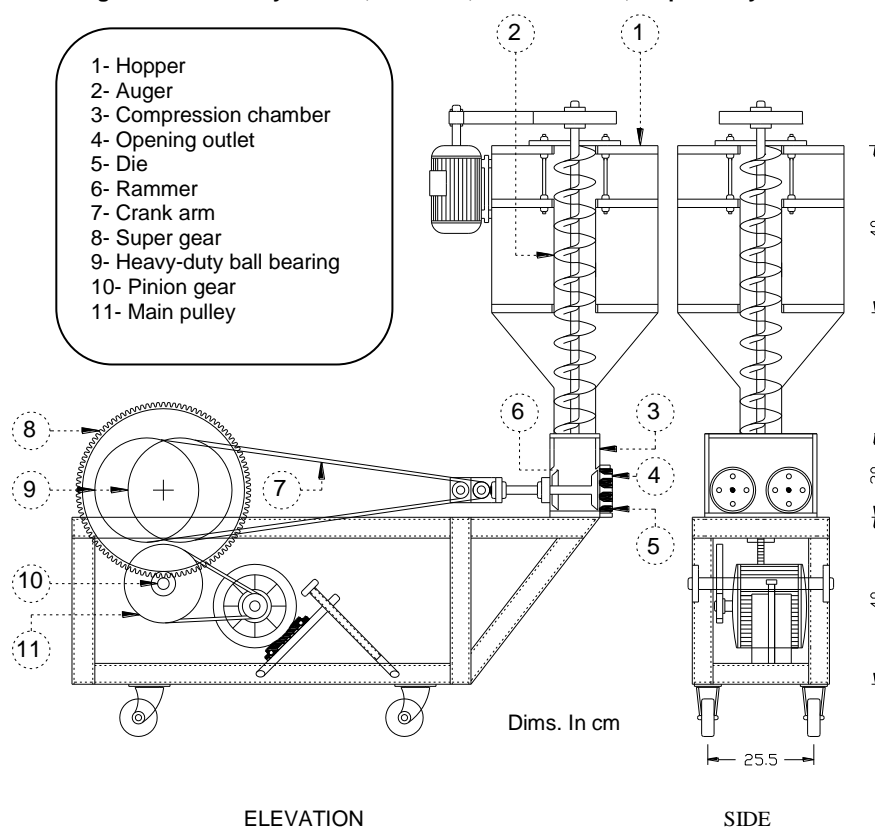
Rabbits and calves fodders were used in the present study. The main components of rabbits and calves fodder were Berseem hay and Cottonseed respectively. Dry Berseem hay was grinded by using roller mill grinding machine. Cottonseed is the second important product after lint cotton

production. About 7.5% of the produced seeds is used for oil extraction and animal feed production. Cottonseed meal is a high protein for livestock. Both Berseem hay and Cottonseed were mixed by hand with other concentrates ingredients and manufactured as the complete pelleted rations as shown in Table 2.

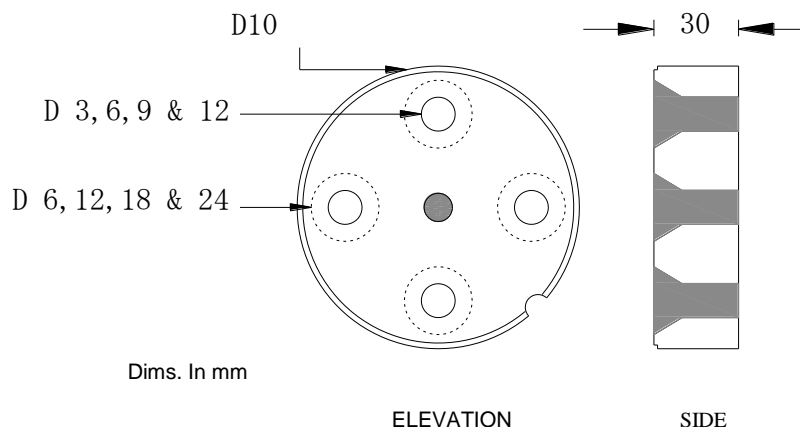
**Table 2: Pellets components of ingredients.**

Ingredient (rabbits fodder)*	Weight basis,%	Ingredient (calves fodder)**	Weight basis,%
Berseem hay	36	Uncorticated cottonseed	35
Grind barley	15	Grind yellow corn	23
Wheat bran	34	Wheat bran	33
Soybean	10	Molasses	5
Molasses	3	Limestone	3
Limestone	1	Common salt	1
Common salt	1		

\* & \*\* Agriculture ministry manual, in Arabic, 2007 and 2008, respectively.



**Fig. 2: Engineering drawing of the modified pelleting machine.**



**Fig. 3: The modified die.**

**Studied factors of modified machine:**

Performance description of the modified machine was shown by studying the influence of operating treatments as follows:

- Two types of fodder namely: Berseem hay (rabbits fodder) and Cottonseed (calves fodder);
- Three moisture content of fodder of about 22.83, 27.61 and 32.58% (w.b.);
- Four crank arm speeds of 45, 70, 90 and 120rpm and
- Four die hole Diameters of 3, 6, 9 and 12mm.

Hence auger speed was kept constant at 200rpm during pelleting process (Kholief, 1996).The rotational speed was measured by a digital tachometer with rpm.

**Procedures:**

**Moisture content, %:**

The desired moisture content of pellets component ingredient was adjusted by drying or rewetting. However the moisture content was determined using the oven method ( at 70°C to constant mass )according to AOAC, 1994.

**Pellet durability, %:**

Durability is the most important aspect of pellet quality. It means the ability of pellets to withstand the rigors of handling and delivery without breaking-up (Payne, 2006). The durability of pellets was determined according to ASAE standard, 1996. The shaking device was used for testing purpose under 50rpm for one minute and the durability index was calculated by using the following equation:

$$Durability\ index,\ \% = \frac{Mass\ of\ pellets\ after\ shaking,\ g}{Mass\ of\ pellets\ before\ shaking,\ g} \times 100 \dots\dots\dots 1$$

**Pellet bulk density, g/cm<sup>3</sup>:**

It was calculated by using the following equation:

$$Pellets\ bulk\ density, g/cm^3 = \frac{Pellets\ sample\ mass, g}{Pellets\ sample\ volume, cm^3} \dots\dots\dots 2$$

**Pellet stiffness, N:**

A portable stiffness tester (174866-Kiyo-Seisakusho, L.T.D) was used to determine the rupture in Newton. The stiffness of pellets were measured just after drying to find out its ability for breaking-up.

**Productivity, Mg/h:**

The productivity of the modified machine was measured as the mass of pellet collected per hour. During the experiments the compressed pellets were collected for two minutes and the productivity was calculated.

**Power and energy consumption:**

Ammeter and voltmeter were used for measuring the current strength and potential difference respectively. Readings of Amperes and Volts were taken before and during each treatment. The power consumption was calculated by using the following formula (*Lockwood and Dunstan, 1971*):

$$Power\ consumption, kW = \frac{\sqrt{3}}{1000} (IV \cdot \cos \theta \cdot \eta) \dots\dots\dots 3$$

Where:

- I* current strength, Amperes;
- V* potential difference, Volts;
- $\cos \theta$  power factor, decimal (being equal to 0.71) and
- $\eta$  mechanical efficiency of motor assumed to be 80%.

The energy requirement was calculated by using the following equation:

$$Energy\ requirement, kW.h / Mg = \frac{Power\ consumption, kW}{productivity, Mg / h} \dots\dots\dots 4$$

**Total cost, LE/h:**

- Fixed costs:

a- Depreciation:

Declining balance method was used to determine the depreciation (*Hunt, 1983*). In this method the depreciation value is different for every year of the machines life. Depreciation value was determined by using the following equation:

$$D = V_n - V_{n+1}, LE / Yr \dots\dots\dots 5$$

$$V_n = P \left( \frac{L - X}{L} \right)^n, LE / Yr \dots\dots\dots 6$$

$$V_{n+1} = P \left( \frac{L - X}{L} \right)^{n+1}, LE. / Yr \dots\dots\dots 7$$

Where:

- D* value of depreciation charged for year, (*n+1*);

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- P* purchase price, *LE* ;
- L* time between buying and purchasing, *Yr* ;
- n* number representing age of the machine in year at the beginning of year;
- V* remaining value at any time and
- X* ratio of depreciation rate for used machine (the maximum rate is 1.5).

b- Interest on investment, shelter taxes and insurance: They were estimated as 17.5% of the remaining value.

- Variable costs:

Variable costs include the cost of repairs and maintenance, electricity, lubricant and labor. For machinery, repairs and maintenance is about 5.77% as a percent of purchase price.

**Operating cost, LE/Mg:**

The operating cost was calculated by using the following formula:

$$\text{Operating cost, LE/Mg} = \frac{\text{Total cost, LE/h}}{\text{Producivity, Mg/h}} \dots\dots\dots 8$$

## RESULTS AND DISCUSSION

**Pellet durability:**

Fig. 4 shows the effect of crank arm speed, die hole diameter and pellets ration moisture content for both Berseem hay and Cottonseed fodder on the durability percentage of pellets. It can be generalized that trend of the durability percentage of pellets decreased by increasing the die hole diameter. At pellets ration moisture content of 22.83% and crank arm speed of 45rpm, the durability percentage of Berseem hay pellets decreased from 95.45 to 92.68% when the die hole diameter was increased from 3 to 12mm. The same increase in die hole diameter decreased the durability percentage of Cottonseed pellets from 93.47 to 90.71% at the same above mentioned conditions. At pellets ration moisture content of 32.85% and die hole diameter of 3mm, the durability percentage of Berseem hay pellets increased from 92.86 to 95.64% when the crank arm speed was increased from 45 to 120rpm. The same increase in crank arm speed increased the durability percentage of Cottonseed pellets from 90.03 to 93.21% at the same above mentioned conditions. This trend may be due to the increase in the pressure and compaction occurred during pelleting process. At crank arm speed of 120rpm and die hole diameter of 12mm, the durability percentage of Berseem hay pellets decreased from 95.64 to 93.16% when the pellets ration moisture content increased from 22.83 to 32.58%. The same increase in pellets ration moisture content decreased the durability percentage of Cottonseed pellets from 93.66 to 90.56% at the same above mentioned conditions. Briefly, it was noticed that the highest values of durability percentage of Berseem hay and Cottonseed pellets were found to be 98.93 and 96.95% respectively, at ration moisture content of 22.83%, crank arm speed of 120rpm and die hole diameter of 3mm. On the other hand, the lowest values of durability percentage of Berseem hay and Cottonseed pellets were reached 89.58 and



87.85% respectively, at ration moisture content of 32.58%, crank arm speed of 45rpm and die hole diameter of 12mm.

**Pellet bulk density:**

Fig. 5 shows the influence of crank arm speed, die hole diameter and pellets ration moisture content for both Berseem hay and Cottonseed fodder on the pellets bulk density. General trend was observed where, the pellets bulk density decreased by increasing the die hole diameter at constant moisture content and crank arm speed. At pellets ration moisture content of 22.83% and crank arm speed of 45rpm, the bulk density of Berseem hay pellets was decreased from 2.45 to 1.76g/cm<sup>3</sup> when the die hole diameter was increased from 3 to 12mm. The same increase in die hole diameter decreased the bulk density of Cottonseed pellets from 2.28 to 1.67g/cm<sup>3</sup> at the same above mentioned conditions. At crank arm speed of 95rpm and die hole diameter of 9mm, the bulk density of Berseem hay pellets was decreased from 2.22 to 1.74g/cm<sup>3</sup> when the pellets ration moisture content increased from 22.83 to 32.58%. The same increase in pellets ration moisture content decreased the bulk density of Cottonseed pellets from 2.18 to 1.71g/cm<sup>3</sup> at the same above mentioned conditions. The highest bulk density of Berseem hay and Cottonseed pellets were found to be 2.73 and 2.71g/cm<sup>3</sup> respectively, at die hole diameter of 3mm, crank arm speed of 120rpm and pellets ration moisture content of 22.83%. In the opposite side, the lowest values of bulk density of Berseem hay and Cottonseed pellets were reached 1.40 and 1.21g/cm<sup>3</sup> respectively, at ration moisture content of 32.58%, crank arm speed of 45rpm and die hole diameter of 12mm.

**Pellet stiffness:**

Fig. 6 shows the influence of crank arm speed, die hole diameter and pellets ration moisture content for both Berseem hay and Cottonseed fodder on the stiffness of pellets. As shown in the figure, it can be observed that the trend of the stiffness of pellets decreased by increasing the die hole diameter. At pellets ration moisture content of 22.83% and crank arm speed of 45rpm, the stiffness of Berseem hay pellets decreased from 175.5 to 172.7N when the die hole diameter was increased from 3 to 12mm. The same increase in die hole diameter decreased the stiffness of Cottonseed pellets from 173.1 to 169.1N at the same above mentioned conditions. At crank arm speed of 120rpm and die hole diameter of 12mm, the stiffness of Berseem hay pellets decreased from 175.6 to 163.2N when the pellets ration moisture content increased from 22.83 to 32.58%. The same increase in pellets ration moisture content decreased the stiffness of Cottonseed pellets from 172.7 to 160.3N at the same above mentioned conditions. Briefly, it was noticed that the highest values of stiffness of Berseem hay and Cottonseed pellets were found to be 178.9 and 176.3N respectively, at ration moisture content of 22.83%, crank arm speed of 120rpm and die hole diameter of 3mm. On the other hand, the lowest values of stiffness of Berseem hay and Cottonseed pellets were reached 159.6 and 155.7N respectively, at ration moisture content of 32.58%, crank arm speed of 45rpm and die hole diameter of 12mm.

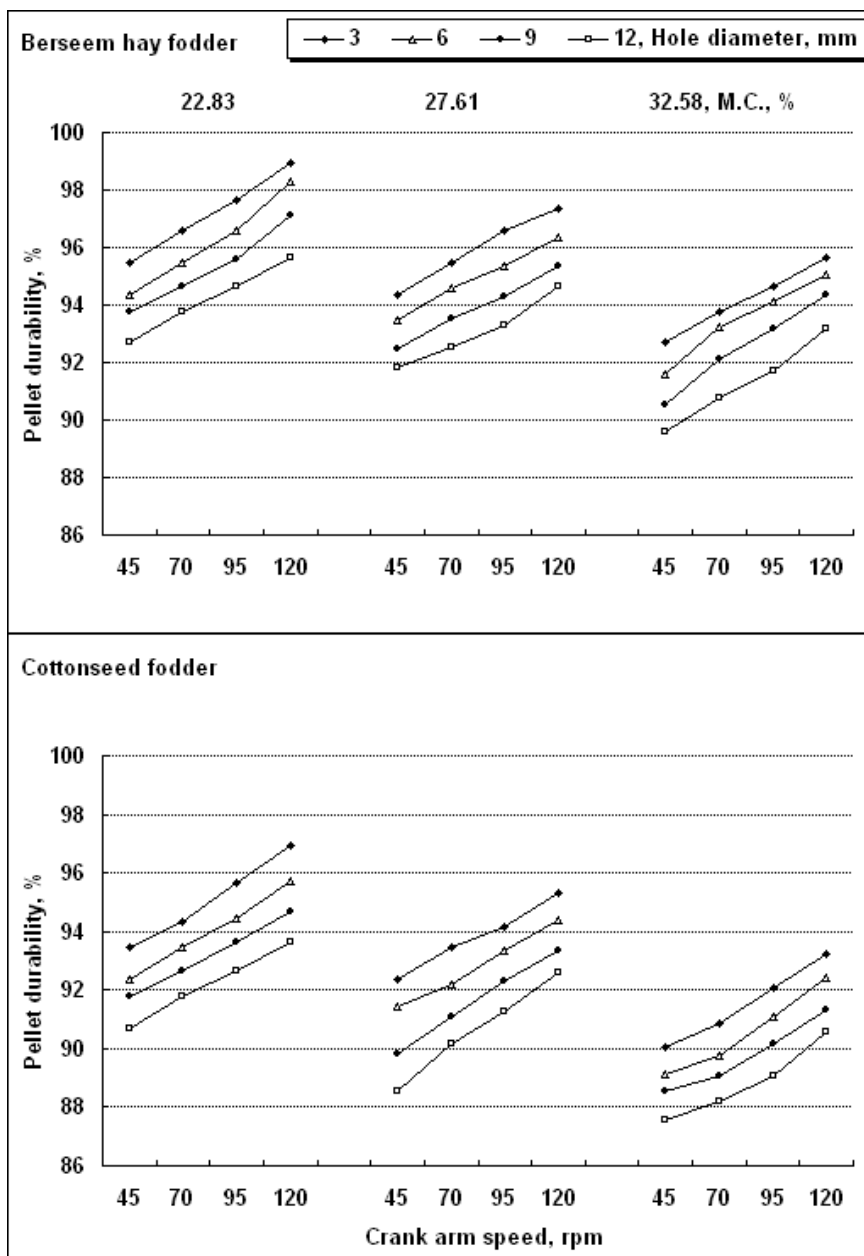
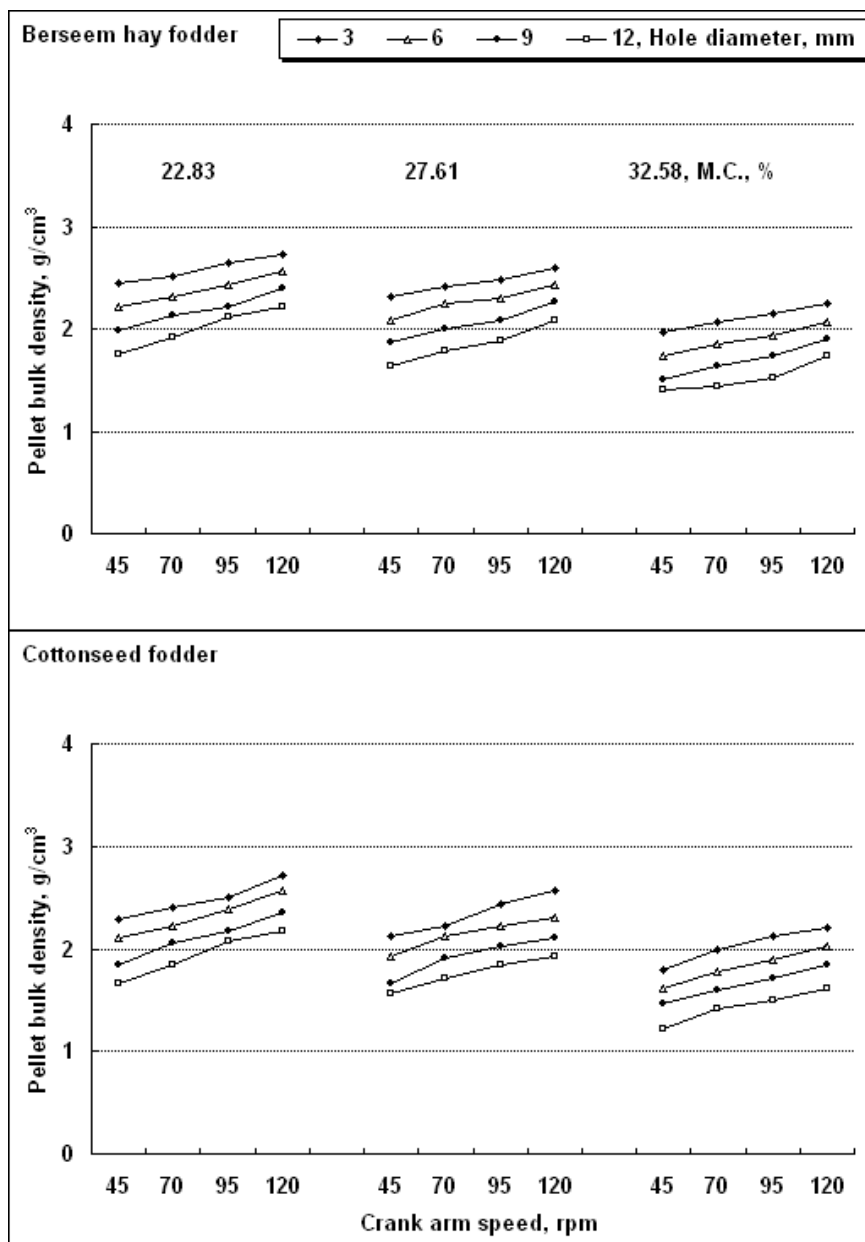


Fig. 4: Effect of crank arm speed, die hole diameters and ration moisture content on pellets durability for Berseem hay and Cottonseed fodders.



**Fig. 5: Effect of crank arm speed, die hole diameters and ration moisture content on pellets bulk density for Berseem hay and Cottonseed fodders.**

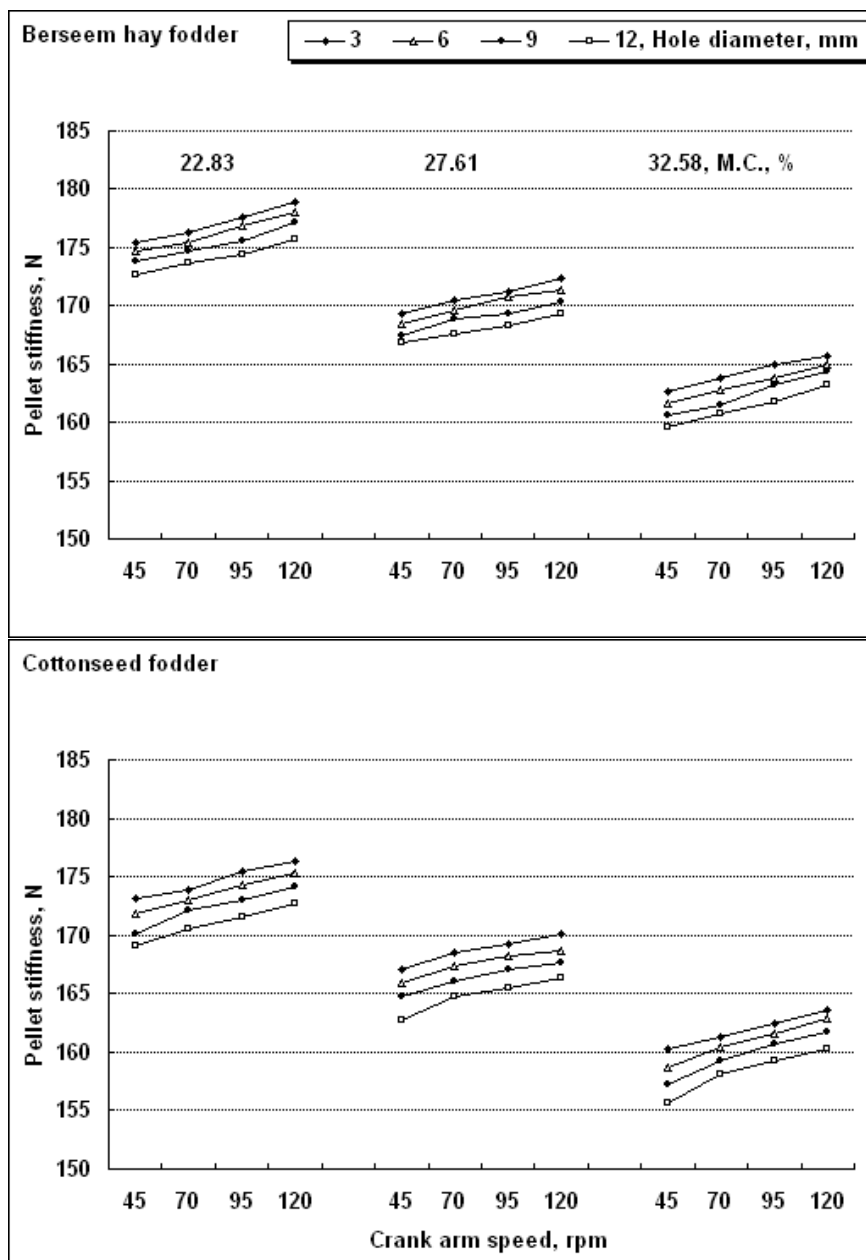


Fig. 6: Effect of crank arm speed, die hole diameters and ration moisture content on pellets stiffness for Berseem hay and Cottonseed fodders.

**Machine productivity:**

Fig. 7 illustrates the effect of crank arm speed, die hole diameter and pellets ration moisture content for both Berseem hay and Cottonseed fodder on machine productivity. It was found that, machine productivity increased by increasing crank arm speed, die hole diameter and pellets ration moisture content. Data presented in the same figure showed that the increase of crank arm speed from 45 to 120rpm increases the machine productivity of Berseem hay pellets from 0.102 to 0.192Mg/h respectively, at die hole diameter of 3mm and pellets ration moisture content of 22.83%. The same increase in crank arm speed increased the machine productivity of Cottonseed pellets from 0.113 to 0.199Mg/h at the same above mentioned conditions. At crank arm speed of 120rpm and die hole diameter of 12mm, the machine productivity of Berseem hay pellets increased from 0.248 to 0.354Mg/h when the pellets ration moisture content increased from 22.83 to 32.58%. The same increase in pellets ration moisture content increased the machine productivity of Cottonseed pellets from 0.255 to 0.384Mg/h at the same above mentioned conditions. This increase in machine productivity may be attributed to 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 compression chamber during the pelleting process by increasing both crank arm speed and die hole diameter. However, the data also showed that the increase of die hole diameter from 3 to 12mm tends to increase the machine productivity of Berseem hay pellets from 0.286 to 0.354Mg/h respectively, at pellets ration moisture content of 22.83% and crank arm speed of 120rpm. The same increase in die hole diameter increased the machine productivity of Cottonseed pellets from 0.322 to 0.384Mg/h at the same above mentioned conditions.

**Energy consumption:**

Fig. 8 explains the energy consumption as affected by crank arm speed for both Berseem hay and Cottonseed fodder at different levels of die hole diameter and ration moisture content. It was found that, the energy consumption decreased by increasing crank arm speed, die hole diameter and pellets ration moisture content. Data presented in the same figure showed that increase of crank arm speed from 45 to 120rpm decreases the energy consumption of Berseem hay pellets from 6.95 to 6.25kW.h/Mg respectively, at die hole diameter of 3mm and pellets ration moisture content of 22.83%. The same increase in crank arm speed decreased the energy consumption of Cottonseed pellets from 7.13 to 6.53kW.h/Mg at the same above mentioned conditions. At crank arm speed of 120rpm and die hole diameter of 12mm, the energy consumption of Berseem hay pellets decreased from 4.90 to 1.60kW.h/Mg when the pellets ration moisture content increased from 22.83 to 32.58%. The same increase in pellets ration moisture content increased the energy consumption of Cottonseed pellets from 5.13 to 1.71kW.h/Mg at the same above mentioned conditions.

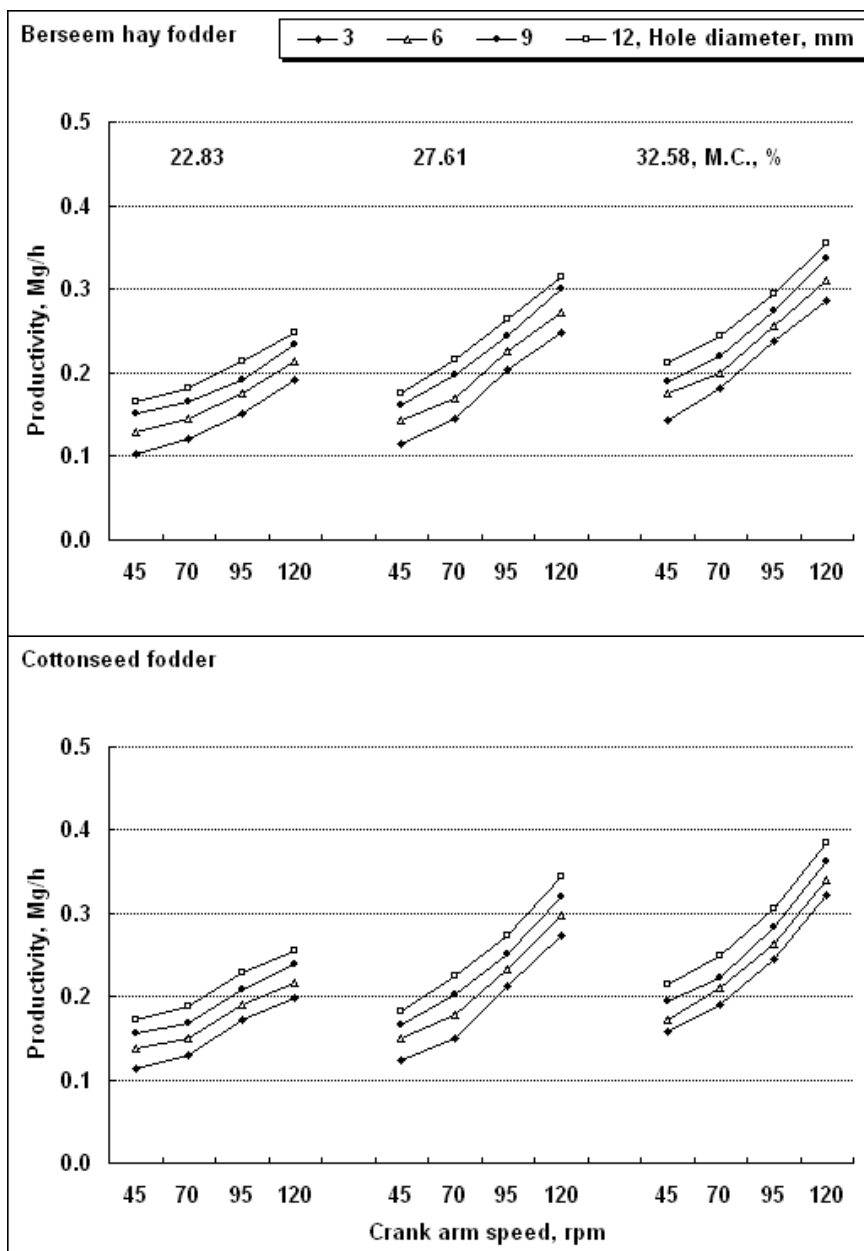
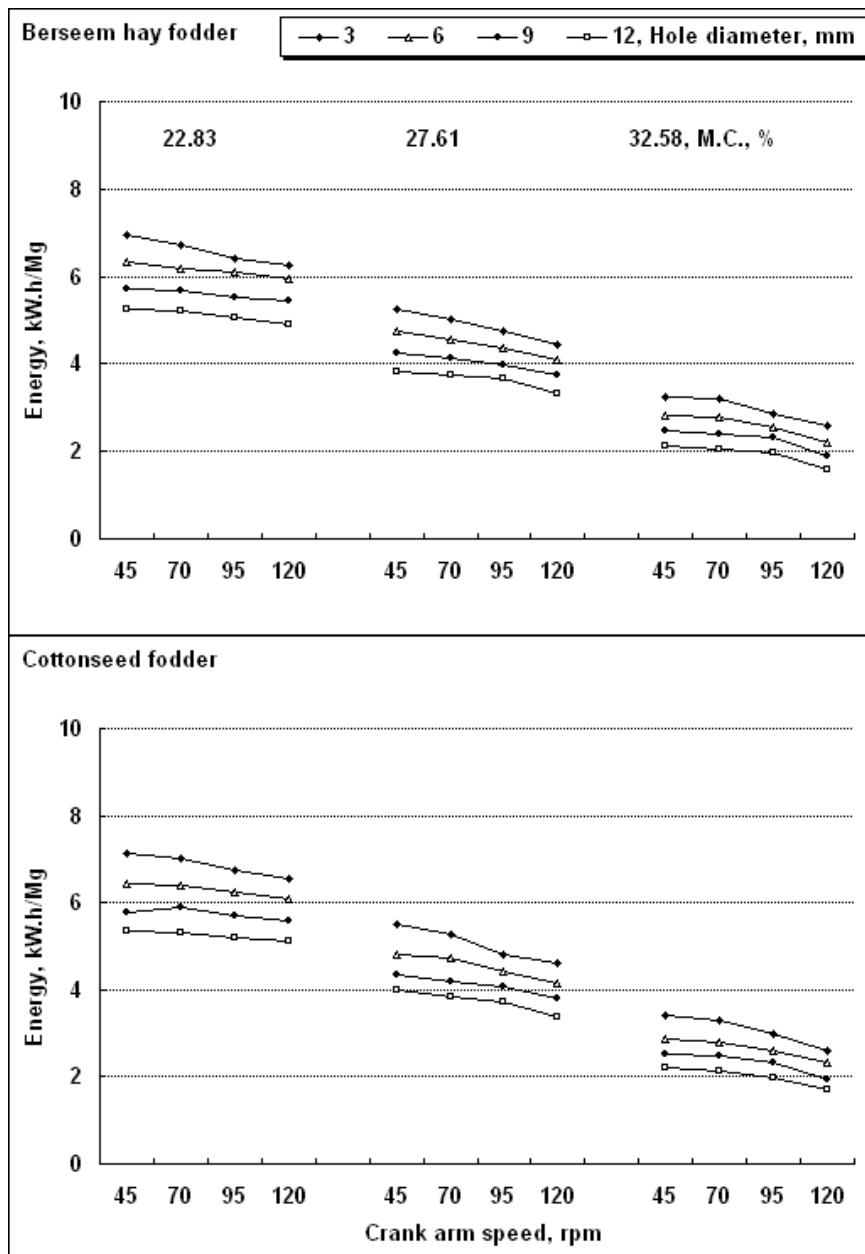


Fig. 7: Effect of crank arm speed, die hole diameters and ration moisture content on machine productivity for Berseem hay and Cottonseed fodders.



**Fig. 8:** Effect of crank arm speed, die hole diameters and ration moisture content on energy consumption for Berseem hay and Cottonseed fodders.

However, the data also showed that the increase of die hole diameter from 3 to 12mm tends to decrease the energy consumption of Berseem hay pellets from 2.95 to 1.60kW.h/Mg respectively, at pellets ration moisture content of 32.58% and crank arm speed of 120rpm. The same increase in die hole diameter increased the energy consumption of Cottonseed pellets from 2.60 to 1.71kW.h/Mg at the same above mentioned conditions.

**Operating cost:**

Values of the operating cost at different levels of pellets ration moisture content, crank arm speed and die hole diameter for Berseem hay and Cottonseed fodders are listed in Table 3. It can be noticed that the highest values of operating cost of Berseem hay and Cottonseed pellets were reached 112.86 and 101.78LE/Mg respectively, at ration moisture content of 22.83%, crank arm speed of 45rpm and die hole diameter of 3mm. On the other hand, the lowest values of operating cost of Berseem hay and Cottonseed pellets were found to be 32.52 and 30.00LE/Mg respectively, at ration moisture content of 32.58%, crank arm speed of 120rpm and die hole diameter of 12mm.

**Table 3: Values of the operating cost at different levels of pellets ration moisture content, crank arm speed and die hole diameter for Berseem hay and Cottonseed fodders.**

Pellet types	M.C.%	Crank arm speed, rpm	Operating cost, LE/Mg			
			3, mm	6, mm	9, mm	12, mm
Berseem hay	22.83	45	112.86	89.24	76.24	69.77
		70	95.14	78.85	69.77	63.25
		95	76.24	65.78	59.96	53.79
		120	59.96	53.79	49.41	46.42
	32.58	45	79.94	65.78	60.59	54.56
		70	63.60	57.85	52.57	47.37
		95	48.37	44.79	42.01	39.16
		120	40.25	37.02	34.16	32.52
Cottonseed	22.83	45	101.78	83.15	74.27	67.23
		70	88.89	77.10	68.30	61.19
		95	67.22	60.39	55.02	50.15
		120	57.78	52.94	48.37	45.23
	32.58	45	72.92	67.12	59.23	53.68
		70	60.27	54.82	51.86	46.23
		95	47.09	43.63	40.75	37.58
		120	35.80	33.92	31.75	30.00

**CONCLUSIONS**

The most important point from the present study could be summarized as follows:

- The optimum operating conditions gave the best pellets qualities in terms of durability of 95.64 and 93.66%, bulk density of about 2.22 and 2.18g/cm<sup>3</sup>, and pellet stiffness of 175.6 and 172.7N for Berseem hay and Cottonseed pellets respectively, at ration moisture content of 22.83%, crank arm speed of 120rpm and die hole diameter of 12mm.



- The machine productivity of 0.248 and 0.255Mg/h, seems to be acceptable, for Berseem hay and Cottonseed pellets respectively, under the optimum operating conditions.
- The consumed energy were 4.90 and 5.13kW.h/Mg for Berseem hay and Cottonseed pellets respectively, at ration moisture content of 22.83%, crank arm speed of 120rpm and die hole diameter of 12mm. In addition, the pelleting cost for Berseem hay and Cottonseed were 46.42 and 45.23LE/Mg respectively, at the same operating conditions.

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## **تطوير وتقييم أداء آلة تضاعفية لإنتاج مصبغات العلف**

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إن إنتاج الأساليب الفنية والتكنولوجية الحديثة في عملية إنتاج الأعلاف المضغوطة ومعاملاتها التكنولوجية للاستفادة من كل ما هو متاح لتحويله إلى أعلاف حيوانية ورفع قيمته الغذائية في حد ذاته يؤدي إلى تقليل تكاليف التغذية والتي تمثل حوالي ٧٥% من تكاليف الإنتاج الحيواني. وهذا يساعد في تقليل الفجوة العلفية كما ونوعاً للأنواع المختلفة من الإنتاج الحيواني. لذلك استهدف البحث تطوير آلة عمل المصبغات التضاعفية المصنعة محلياً للتغلب على انفصال مكونات العليقة من بعضها البعض داخل غرفة الكبس وزيادة إنتاجيته الآلة وكذا دراسة بعض العوامل المؤثرة في أداء الآلة لاختيار أنسب ظروف تشغيلية للآلة المطورة حيث تم استخدام الآتي:

- نوعين من العليقة (أرناب وعجول صغيرة والمكون الرئيسي لهما هو دريس البرسيم وبذرة القطن على الترتيب).
  - المحتوى الرطوبي للعليقة (٢٢.٨٣ - ٢٧.٦١ - ٣٢.٥٨ % على أساس رطب).
  - سرعة دوران عمود المرفق (٤٥ - ٧٠ - ٩٥ - ١٢٠ لفة/دقيقة).
  - قطر فتحة قرص التشكيل (٣ - ٦ - ٩ - ١٢ مم).
- وتأثير تلك المعاملات على إنتاجية الآلة والطاقة المطلوبة لإنتاج مصبغات العلف وكذا متانة وكثافة وصلابة العلف المصنع،  
وقد تم التوصل للنتائج التالية:

بلغت إنتاجية الآلة ٠.٢٤٨ و ٠.٢٢٥ ميغاجرام/ساعة لمصبغات علف دريس البرسيم وبذرة القطن على الترتيب عند ظروف التشغيل ١٢٠ لفة/دقيقة سرعة دوران نية لعمود المرفق و ١٢ مم قطر قرص التشكيل و ٢٢.٨٣% محتوى رطوبي للعليقة على أساس رطب، وكانت صفات الجودة المثلى لمصبغات علف دريس البرسيم وبذرة القطن ٩٥.٦٤ و ٩٣.٦٦% متانة و ٢.٢٢ و ٢.١٨ جم/سم<sup>٣</sup> كثافة ظاهرية و ١٧٥.٦ و ١٧٢.٧ نيوتن صلابة على الترتيب عند نفس ظروف التشغيل السابقة. وبينت النتائج أن الطاقة المستهلكة للآلة ٤.٩٠ و ٥.١٣ كيلووات ساعة/ميغاجرام وتكاليف تشغيل الآلة ٤٦.٤٢ و ٤٥.٢٣ جنية/ميغاجرام لمصبغات علف دريس البرسيم وبذرة القطن على الترتيب عند ظروف تشغيل مثلى ١٢٠ لفة/دقيقة سرعة دوران نية لعمود المرفق و ١٢ مم قطر قرص التشكيل و ٢٢.٨٣% محتوى رطوبي للعليقة على أساس رطب.

### **قام بتحكيم البحث**

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