FACTORS AFFECTING THE PERFORMANCE OF AQUATIC FEEDS FLAT-DIE PELLETING MACHINE

Abdel Wahab, M.K .[1] **M.A. Tawfik[2]**
A.M. El Shal [2] **Y.A. El Hussiny[3]**

ABSTRACT

The overall goal of the present study is evaluating the performance of a local made flat-die pelleting machine to produce a strong and durable aquatic pelleted feeds with minimum cost. Some operating parameters affecting the performance of machine and pellets quality were studied. The flat-die pelleting machine was evaluated under two values of real hole diameter (4 and 5 mm),three different levels of formula particle size (1, 2 and 3mm), four values of die total thickness (25, 27.5, 30 and 32.5mm), three levels of roller clearance (0.5, 2 and 4mm) and three values of roller teeth width(4, 6 and 8mm) using constant values of die speed of 300 rpm(4.71m/s), average ration moisture content of 15% (w.b) and hole entry diameter of 9 mm taking into consideration machine production rate, pellets quality (durability, bulk density) pelleting efficiency, specific energy consumption, economical costs of aquatic feed pellets mass and pellet water stability. From the obtained results ,the flat-die pelleting machine could be operate with particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2 mm , roller teeth width of 8mm and real hole diameter of 4 mm to achieve the highest values of bulk density of 0.915 g/cm3,pellet durability of 95.38%,pelleting efficiency of 95.56%, and pellet water stability of 70% (up to 4 minutes in water) with values of production rate of 107.10 kg/h, consumed energy of 97.95 kW.h/Mg and pelleting total cost of 2386.58 L.E./Mg. Under the same operating conditions, the highest values of bulk density of 0.850 g/cm^3,pellet durability of 91.65%,pelleting efficiency of 94.84%, and pellet water stability of 60% (up to 4min.) were recorded at real hole diameter of 5 mm with production rate of 143.65kg/h,consumed energy of 58.41 kW.h/Mg and pelleting total cost of 2374.72 L.E./ Mg.

[1] **Professor, Agric. Eng. Dept., Fac.of Agric., Zagazig Univ.,Egypt.**
[2] **Lecturer, Agric. Eng. Dept., Fac. of Agric., Zagazig Univ., Egypt.**
[3] **Post- graduate student, Agric. Eng. Dept., Fac. of Agric .,Zagazig Univ., Egypt.**

INTRODUCTION

The main goal of pelleted feeds manufacturers and nutrienists is provide a balanced nutritious feeds with a high levels of quality features in an attempt to maximize nutrient use, utilize the complete or supplemental feed in aquaculture, boost productivity per unit of area, reduce feed wastage and consequently, maintain water quality in either ponds or aquarium in addition to decrease the consumed energy during pelleting operation as well as operation cost. Extrusion agglomeration using a flat die has proved to be a universally acceptable and economic method for compacting any lumpy, long-fibred, powdery, and pasty materials which have not been pre-ground. Therefore, there was a necessity to study the factors affecting the machine performance and pellet quality. **Heinemans(1991)** recommended a low peripheral die speed of 4–5m.s^{-1} for low bulk density materials, where a large volume of air must be expelled during pelleting. **Turner (1995) , Franke and Rey (2006)** recommended particle size of 0.6–0.8mm for good pellet quality. Particle sizes of greater than1.0 mm will act as predetermined breaking points in the pellet. Although fine particles produce more durable pellets, fine grinding is undesirable because of increasing cost of production. **Grover and Mishra (1996)** mentioned that mixture of different particle sizes would give optimum pellet quality because the mixture of particles will make inter-particle bonding with nearly no inter-particle spaces**.** **Thomas *et al*.(1997)** found that high die speed (about 10ms^{-1}) and low die speed (about6–7ms^{-1}) is suggested for small pellets (3–6mm diameter) and large pellets and cubes respectively. In reality, factors related to the feed material characteristics, pre-conditioning processes, and densification equipment variables interact with one another. Therefore, these variables should be optimized using statistical- or mathematical-based optimization procedures to produce strong and durable densified products. To optimize these variables, in addition to strength and durability, specific energy consumption, production rate, maintenance or production cost would also be considered (**Dec, 1999).** According to **Obernberger and Thek (2004)**, production of high quality pellets is possible only if the moisture content of the feed is between 8.0 and 12.0%(w.b.), and water contents above or below this range would lead to lower quality pellets. Hence**,** the main objective of this study is to evaluate, optimize some operating parameters affecting the performance of flat-die pelleting machine and pellets quality during the aquatic feeds production process.

MATERIALS AND METHODS

The practical experiments were carried out at a private workshop in Zagazig city, Sharkiah Governorate, Egypt.

A-Materials

-Experimental ration

The experimental ration prepared by a swinging hammer mill with three different diameters of screen holes to determine three categories of ration particles as 1,2 and 3mm in average. The ration formula was mixed in forage mixer with about 15% moisture of total mass moisture content using the standard method as wet basic(w.b).The composition of the experimental ration is shown in Table (1) .

Specifications of flat-die pelleting machine

The flat-die pelleting machine was fabricated and assembled in a private workshop in Zagazig,Sharkiah governorate, Egypt. The machine mainly consists of the following parts as shown in Fig. (1).

1-Main frame

Main frame is a base which carrying feeding unit, pressing unit and main electric power motor. It is made from iron steel L-sections with 200 cm length, 105 cm. width and 98 mm height.

2- Feeding hopper

The feeding hopper was made of steel sheet with 2 mm thickness with 60cm length, 30 cm width and 50cm height with maximum capacity of about10 kg provided with sliding gate at the bottom to control the ration flow from the hopper to the forming unit.

3- Forming unit

Forming unit consists of die and rollers. The die is a metal disk made from hard steel (52 carbon) with dimensions of 30 cm in diameter. Each die profile has working area of 6 cm width at the middle track surface of the die face. The forming unit consists of two rollers fabricated from hard steel (52 carbon), each roller has a cylindrical shape with dimensions of 100 mm diameter and 6 cm in width having corrugated external surface.

Table (1): Composition of experimental ration

Composition	Percentage, %
Fish meal	8
Soy-bean meal	32.1
Corn(yellow grain)	31
Wheat bran	21.33
Fish oil	2.38
Grain oil	1.19
Vitamin + min. Premix	2
Binding agent (starch)	2
Total	100

*** *According to the obtained knowledge from fish feeding research section, central laboratory for aquaculture research, agriculture research center.***

The roller constructed and fixed on horizontal axis. The horizontal axis fixed on the top end of main moving shaft, which the movement of rollers has stable motion around horizontal axis.

4- The main shaft

The main shaft is fixed in a vertical position and constructed on the gearbox which contacted with electric motor to transfer the power and the motion to the die. The main shaft made from hard steel (52 carbon) and there are central hole with diameter of 5mm through the shaft length. The maximum length efficiency of the main shaft was 677.92mm with different extend diameters. Main shaft is supported by three bearings two conical and flat in shape, the first one is fixed on the die in horizontal position.

5-Cutter knife

The cutter knife made of stainless steel (37 carbon) with dimensions of 12 cm in length and 5 mm in thickness .The cutter blades consists of 4 blades with sharp edges and constructed on the main shaft under the die directly.

Part No.	Part name
1	The main base
2	Vertical gear box
3	Oil pump
4	Outlet chute
5	Forming die
6	Bearing
7	Feeding hopper
8	Main shaft
9	The roller
10	Electric current indicator
11	Indicating lamp
Scale 1:10 Dim.in cm	

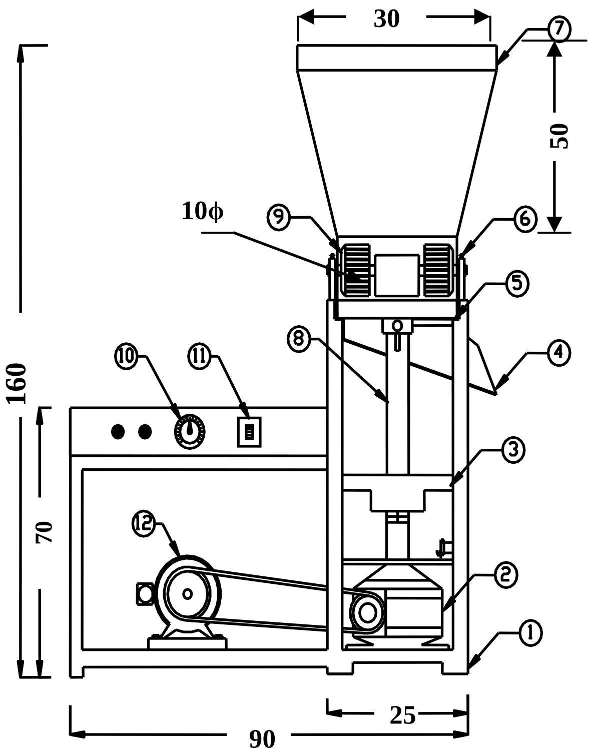

Fig. (1): The flat-die pelleting machine

6- Power unit:

The main power unit was including motor with rated power of 14.7 kW at 1400 rpm rotational speed of the motor shaft with 22 A. The speed of motor was reduced at main shaft using 7:1 gearbox. The power transmitted from the motor shaft to gear box through a pulley (8 cm in diameter) using three V belts.

B-Methods

Experiments were carried out to evaluate a local made flat-die pelleting machine under constant die speed of 300 rpm(4.71m/s) , feeding of 5kg/treatment, ration moisture content of 15% (w.b) and hole entry diameter of 9 mm to optimize some operating parameters affecting the machine performance and pellets quality, these parameters were:

1- Two real hole diameters (4 and 5 mm).

2- Three formula particle sizes (1, 2 and 3mm).

3- Four die total thickness (25, 27.5, 30 and 32.5mm).

4- Three different levels of roller clearance (0.5, 2 and 4mm).

5- Three different values of roller teeth width (4, 6 and 8mm).

Evaluation of the above mentioned parameters was taking into consideration the following indicators:

1- Production rate

$$Production\ rate = \frac{W_P}{T} \times 3.6$$

Where: Wp: pellets mass (g) T: consumed time (s)

2-Pelleting efficiency

$$Pelleting\ \ efficiency\ (\%) = \frac{Wp}{Wm} x100$$

Where: W_p: pellets yield mass (g). W_m: ration sample mass (g).

3- Pellet durability:

The durability of pellets was determined according to **ASAE standard (1996).** Since pellets were sieved on the appropriate sieve to remove fines. A sample mass of about 500g placed in the tumbling box device for tumbling up to 10 min, the sample will be removed , sieved and the percent of the whole pellets calculated as follows:

$$Durability\ (\%) = \frac{Wa}{Wb} x100$$

Where: Wa: pellets mass after tumbling (g). Wb: pellets mass before tumbling (g)

4-Pellets bulk density

$$Bulk\ \ density\ (g/cm^3) = \frac{Wd}{Vd}$$

Where: W_d: pellets sample mass (g). V_d: pellets sample volume (cm^3).

5- Total consumed power

The consumed power was calculated according to the following equation **(Ibrahim, 1982).**

$$Total\ consumed\ \ power, (kW) = \frac{\sqrt{3}\ \ I\ \ V\ \eta\ \ \ \cos\theta}{1000}$$

Where:

I : Line current strength, Amperes.

V : Potential difference (Voltage) being equal to 380 V.
Cos θ : Power factor (being equal to 0.84).
$\sqrt{3}$: Coefficient current three phase (being equal 1.73).
η : Mechanical efficiency assumed (90 %).

6- Specific consumption energy

$$\textit{Specific consumption energy (kW. h / Mg)} = \frac{\textit{Consumed power (kW)}}{\textit{Machine productivity (kg/h)}}$$

7- Total Cost per mass unit:

$$\textit{Cost per mass unit of production (L.E / Mg)} = \frac{\textit{Total cost (L.E/h)}}{\textit{Machine productivity (Mg/h)}}$$

The machine cost was determined (according to the prices at the period of experiment) by using the following formula (**Awady *et al.*, 2003):**

$$C = \frac{p}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + (W.e) + \frac{m}{144}$$

Where:
C : Machine hourly cost, L.E./h.
P : Price of machine, L.E.
h : Yearly working hours.
a : Life expectancy of the machine, year.
i : Interest rate/year .
t : Taxes and over heads ratio,%.
R : Repairs and maintenance ratio,%.
W : Power of motor, kW.
e : Hourly cost/kW.h.
m : The monthly average wage, L.E.
144: The monthly average working hours.

8-Pellets water stability

Pellets water stability was determined as a period of pellet stability in water using glass filling up with water. Sample mass of pellets placed inside the glass for time that pellets start to disintegrate, then the percentage of persevered pellets during the period (in minutes) was calculated.

RESULTS AND DISCUSSION

1- Effect of some operating parameters on production rate

Fig. (2) showed that, as the particle size increased from 1 to3mm, the highest values of production rate decreased from151.8 to148.8 kg/h and 187.2 to 184.8 kg/h at real hole diameters of 4 and5mm respectively. The little decrease could be due to the large particles accepted less moisture, so the lubricant effect will disappear, that means less productivity. It is also observed that, the highest production rate of 151.8kg/h at real diameter of 4mm increased to 187.2kg/h at real hole diameter of 5mm.This increase may be due to the increasing of the output area that make the mass flow of ration to get out from die holes at less time. The obtained data showed that, by increasing the die total thickness from 25 to 32.5mm, the highest values of production rate at particle size of 1mm decreased from 151.8 to 137.4 kg/h and 187.2 to 172.8 kg/h for real hole diameters of 4 and 5mm respectively. This decrease could be due to the compressed ration will pass through a long distance inside the forming die that means increasing in the treatment consumed time. The results indicated that, the production rate decreased by increasing the roller clearance from 0.5 to 4mm as a general trend under the whole operating parameters. This decrease may attributed to the decrease in the compression force for the movement of the mixture in die holes which leads to a great reduce in mass flow rate. It is noticed that, the production rate increased by increasing the roller teeth width from 4 to 6 mm, but the increase of the teeth width more than 6mm, production rate tend to decrease. This could be explained as the increase of space between the roller teeth may be increase the pressure inside the clearance between roller and die, but increasing roller teeth more than 6mm may caused more compaction for the ration, that means less productivity. The optimum values of production rate which were recorded at the highest values of pelleting efficiency, pellet bulk density, durability and water stability.

2- Effect of some operating parameters on pellet bulk density

Pellet bulk density considered as the major aquatic feed controller. Fig. (3) showed that, as the particle size increased from 1 to3mm, the highest values of pellet bulk density decreased from 0.915 to 0.722 g/cm^3 and 0.830 to 0.643g/cm^3 at real hole diameters of 4 and5mm respectively.

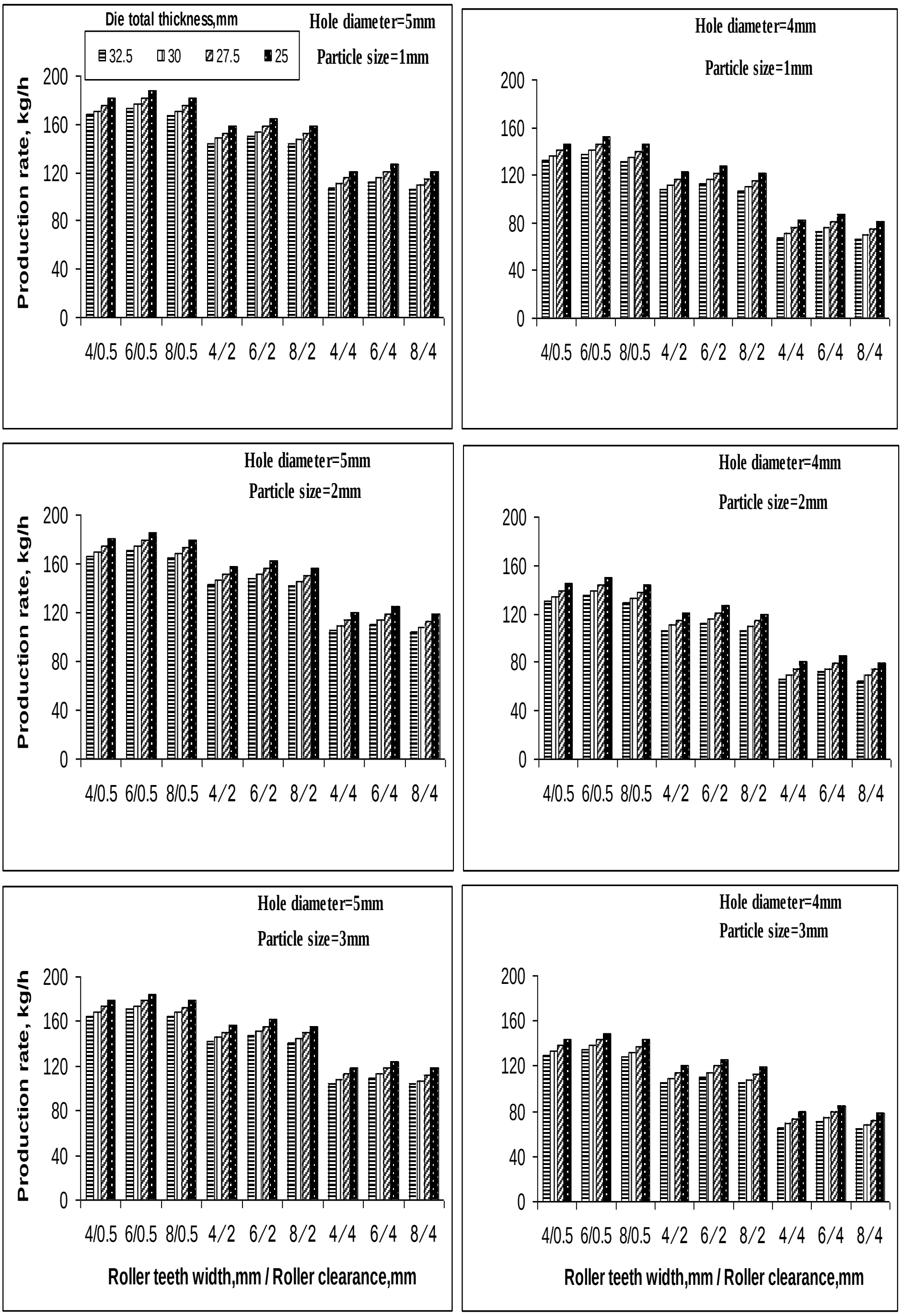

Fig.(2): Effect of some operating parameters on production rate.

This decrease could be due to the large inter-particles spaces between large particles resulting in reducing pellet bulk density. The results also showed that, the highest pellet bulk density of 0.915 g/cm^3 at real diameter of 4mm decreased to 0.830g/cm^3 at real hole diameter of 5mm. The decrease of pellet bulk density by increasing real hole diameter could be due to the reduce of compaction level inside the die hole that is mean decreasing of pellets volume with constant mass. The obtained data indicated that, the increase of die total thickness from 25 to 32.5mm was followed with an increase in pellet bulk density from 0.714 to 0.915g/cm^3 and 0.629 to 0.830g/cm^3 for real hole diameters of 4 and 5mm respectively at particle size of 1mm, clearance of 2mm and teeth width of 8mm. This increase could be attributed to the increase in materials retention time in die holes that mean more compaction to the ration granules. It was also found that, pellet bulk density decreased by increasing the roller clearance from 0.5 to4 mm. This is may be due to the high accumulation of the mixed ration at the larger clearance, which means the ration tend to escape from the gap between the roller and forming die. It is noticed that, pellet bulk density increases as the roller teeth width increased from 4 to 8mm. This increase may be due to the decrease of inter-teeth spaces, that means more compression for ration. The results stated that, the optimum values of pellet bulk density were 0.915and 0.850 g/cm^3 for real hole diameters of 4 and 5mm respectively, at particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2 mm and roller teeth width of 8mm.

3- Effect of some operating parameters on pellet durability

In the feed industry, high durability means high quality. Fig.(4) showed that, the highest values of pellet durability decreased from 95.38 to 82.65% and 91.65 to78.65% at real hole diameters of 4 and5mm respectively, at particle size of 1mm. This may be due to the large spaces among the larger particles which caused a weak bonds and consequently, decreasing the pellets resistance for broking .Whereas, the highest pellet durability of 95.38% at real diameter of 4mm decreased to 91.65% at real hole diameter of 5mm at particle size of 1mm .This decrease may due to the increase of output area which (the hole) caused a reduce in the pressure inside it, that means a low level of compaction and increasing air cells between the granules resulting in decreasing pellet resistance for

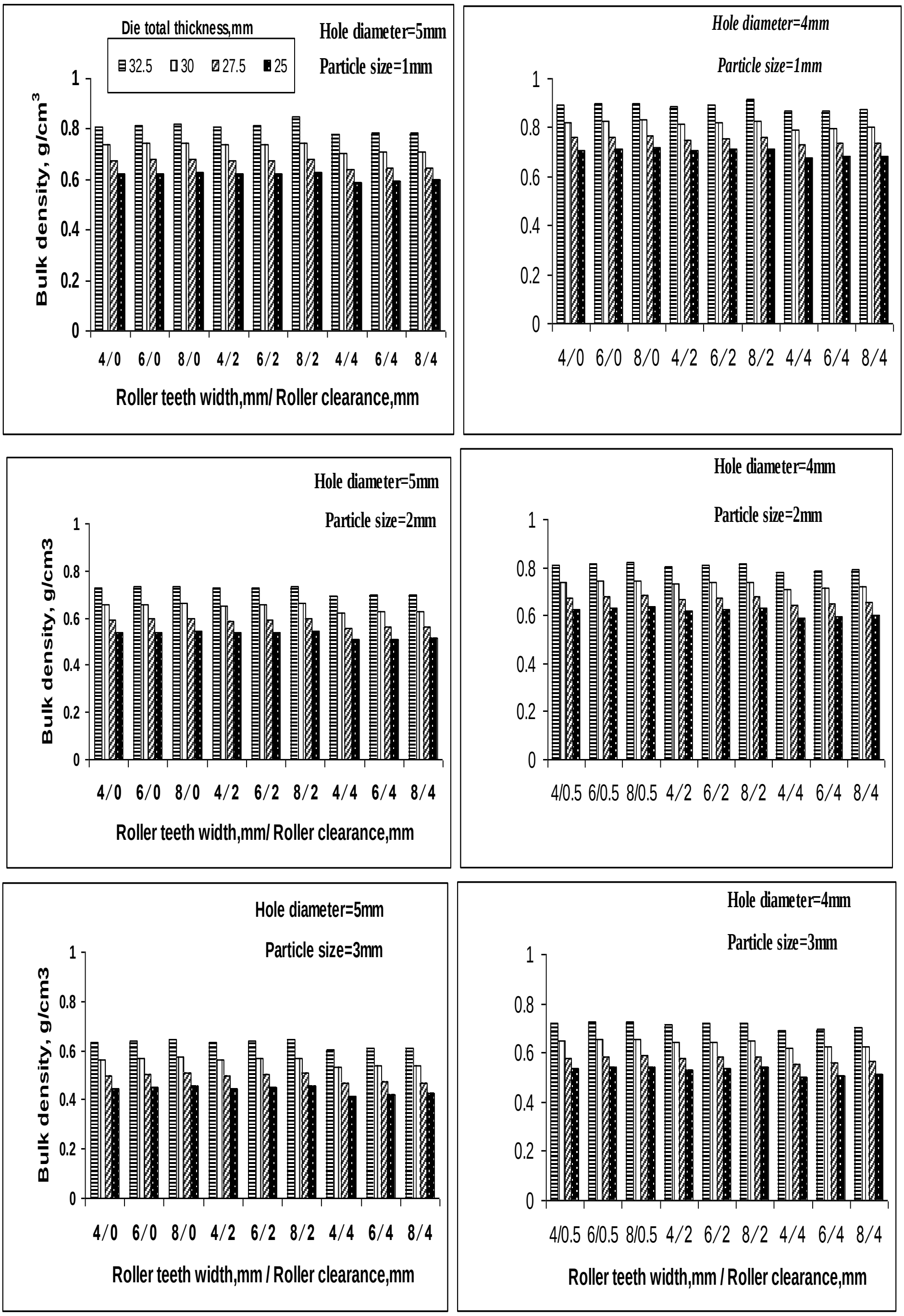

Fig.(3): Effect of some operating parameters on bulk density.

cracking. Fig.(4) showed that, the increase of die total thickness from 25 to32.5mm was followed with a decrease in pellet durability from85.61 to 95.38% and 78.96 to 91.65% for real hole diameters of 4 and 5mm respectively, at particle size of 1mm,clearance of 2mm and teeth width of 8mm.This decrease may due to the increase of retention time in the real hole and that increase the strength of pellet. It was also observed an increase in pellet durability by increasing the roller clearance from 0.5 to2mm, but increasing the clearance to 4 mm, will reduce the capability of roller to compress the accumulated ration in the roller gap. Results show that, increasing the roller teeth width from 4to8mm will increase pellet durability .This is may be due to the decrease of area between roller teeth, resulting in increasing the pressure inside hole. It is clear that, the highest values of pellet durability were 95.38 and 91.65% for real hole diameters of 4 and 5mm respectively, at particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2mm and roller teeth width of 8mm.

4- Effect of some operating parameters on pellet water stability

Pellet water stability is an important indicator for pellet quality. Fig(5) showed that, the percentage of pellet water stability decreases by increasing the particle size from 1 to3mm.This an expected because the large particles will permit water to penetrate the granules of pellet and reduce the pellet stability period. It was also noticed that, the increase of real hole diameter from 4 to5 mm was followed with a decrease in the percentage of remained pellet in water after four minutes from70 and 50% at particle size of 1mm,die total thickness of 32.5,clearance of 2mm and teeth width of 8mm.The obtained results showed that, pellet water stability increased by increasing die total thickness and roller teeth width. This is could be due to the increase of retention time of ration inside die hole at large thickness of die (32.5mm) and the high compaction at the wider roller teeth of 8mm. The obtained result showed that increasing roller clearance from 0.5 to 2 mm would increase pellets durability so that, long period for pellet stability ,but any further increase in roller clearance, caused a reduce in the stable period. The best percentage of pellet water stability were 70% and 60% (up to 4 minutes) for real hole diameters of 4 and 5mm respectively, at particle size of 1mm,die total thickness of 32.5 mm, roller clearance of 2 mm and roller teeth width of 8mm.

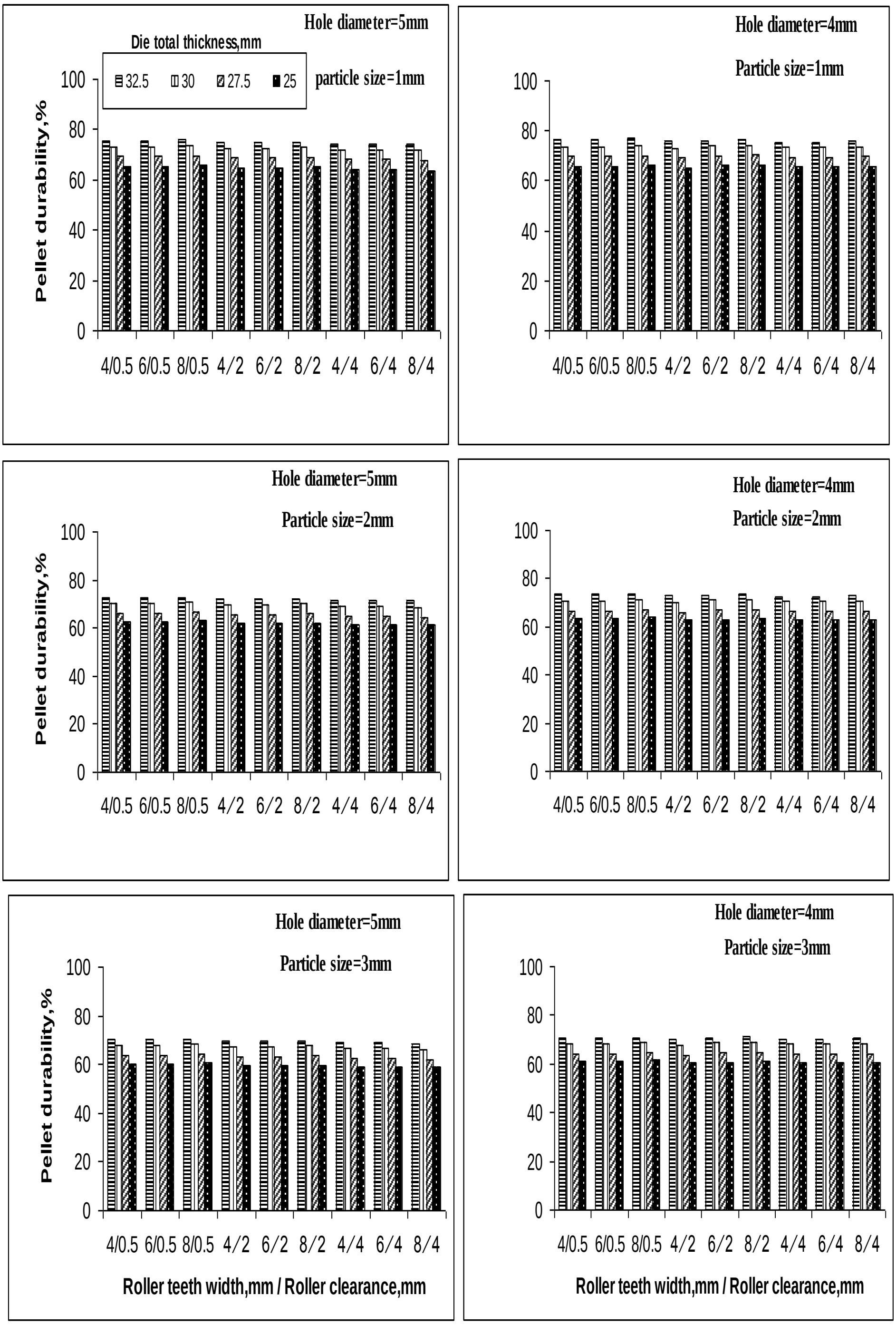

Fig.(4): Effect of some operating parameters on pellet durability.

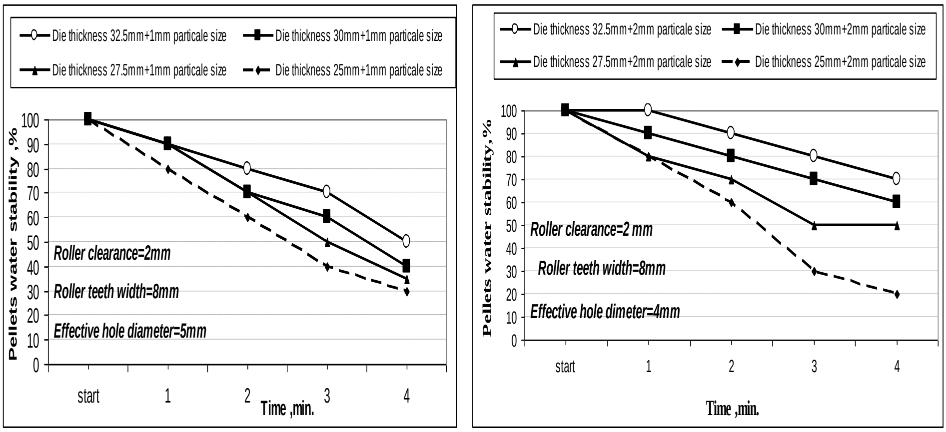

Fig. (5): Effect of some operating parameters on pellet water stability.

5- Effect of some operating parameters on pelleting efficiency

Particle size is an important influencer of pelleting efficiency. Fig.(6) illustrated that ,by increasing the particle size from 1 to3mm, the best values of pelleting efficiency decreased from 95.65 to 93.26% and 94.84 to 89.98% for real hole diameters of 4 and5mm respectively . This could be due to the large inter-particles spaces between large particles resulting in increasing the deformation of the produced pellets. The same trend was observed with the real hole diameter. This decrease could be due to the decrease of the compaction of the ration at the same particle size of formula in the larger diameter holes. The obtained results showed that, the increase of die total thickness from 25 to32.5mm was followed with an increase in pellet efficiency from 88.37 to 95.65% and 85.49 to 94.84% for real hole diameters of 4 and 5mm respectively, at particle size of 1mm, clearance of 2mm and teeth width of 8mm. This increase could be due to the retention time of ration inside the die holes resulting in increasing the compaction of pellets. Fig.(5) showed that ,by increasing the roller clearance from 0.5 to 2mm the pelleting efficiency increased ,but the opposite trend was observed at clearance of 4mm. The ration may accumulate in large clearance, resulting in low durable pellet. It noticed also that, the pelleting efficiency increases as the teeth width increased from 4 to8mm. This increase may due to the increase of durable pellets. Finally, The obtained results revealed that, the highest values of pelleting efficiency of 95.56 and 94.84 % for real hole diameter of 4 and 5mm

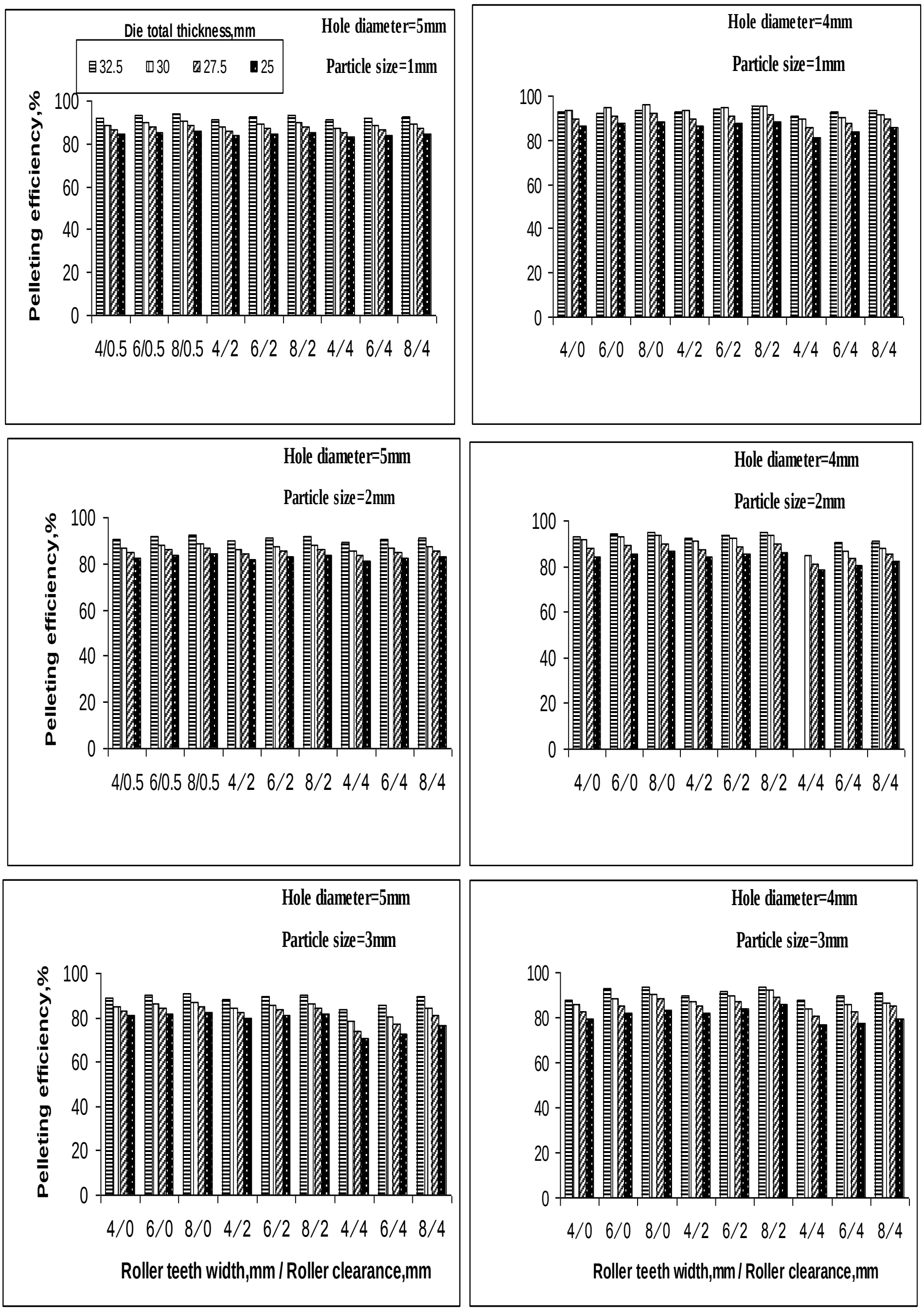

Fig.(6): Effect of some operating parameters on pelleting efficiency.

respectively, were recorded at particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2mm and roller teeth width of 8mm.

6- Effect of some operating parameters on power requirement

The aquatic feed pellets energy requirements depends theoretically on consumed power and production rate of the pelleting machine. Fig.(6) showed that, increasing the particle size from 1 to3mm, the energy requirement decreased from 97.95to 102.97 kW.h/Mg and 58.41 to 61.17 kW.h/Mg for real hole diameters of 4 and5mm respectively at die total thickness of 32.5mm, roller clearance of 2mm and roller teeth width of 8mm.Using large particle size may increase the friction inside the die hole resulting in reducing the production rate and increase the power requirement. At the same conditions, the energy requirement decreases from 97.95 to 58.41kW.h/Mg as the real hole diameter increased from 4 to5mm. This decreased could be attributed to the high increase in production rate .It was noticed also that, the increase of die total thickness from25 to32.5mm would increase the energy requirement from 48.48 to97.95 kW.h/Mg and 23.98 to58.41kW.h/Mg for real hole diameters of 4 and5mm respectively, at particle size of 1mm, roller clearance of 2mm and roller teeth width of 8mm for real hole diameters of 4 and5mm respectively, at die total thickness of 32.5mm, roller clearance of 2mm and roller teeth width of 8mm.This may be due to the increase of the retention time of the compressed ration in die hole, resulting in decreasing the productivity. The results showed that, increasing roller clearance from 0.5 to 4mm may cause a high accumulation of ration in gap between the roller and die resulting in increasing of consumed power. Fig.(6) indicated that, the increase of teeth width from 4 to 6 mm followed by a decrease in the required energy, but increasing of teeth width more than 6mm, the required energy tend to increase. This may be due to the decrease of production rate. The optimum values of energy requirement of 97.95 and 58.41 kW.h/Mg for real hole diameters of 4 and 5mm respectively, were recorded at the highest values of bulk density, pellet durability and pelleting efficiency using particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2 mm and roller teeth width of 8mm.

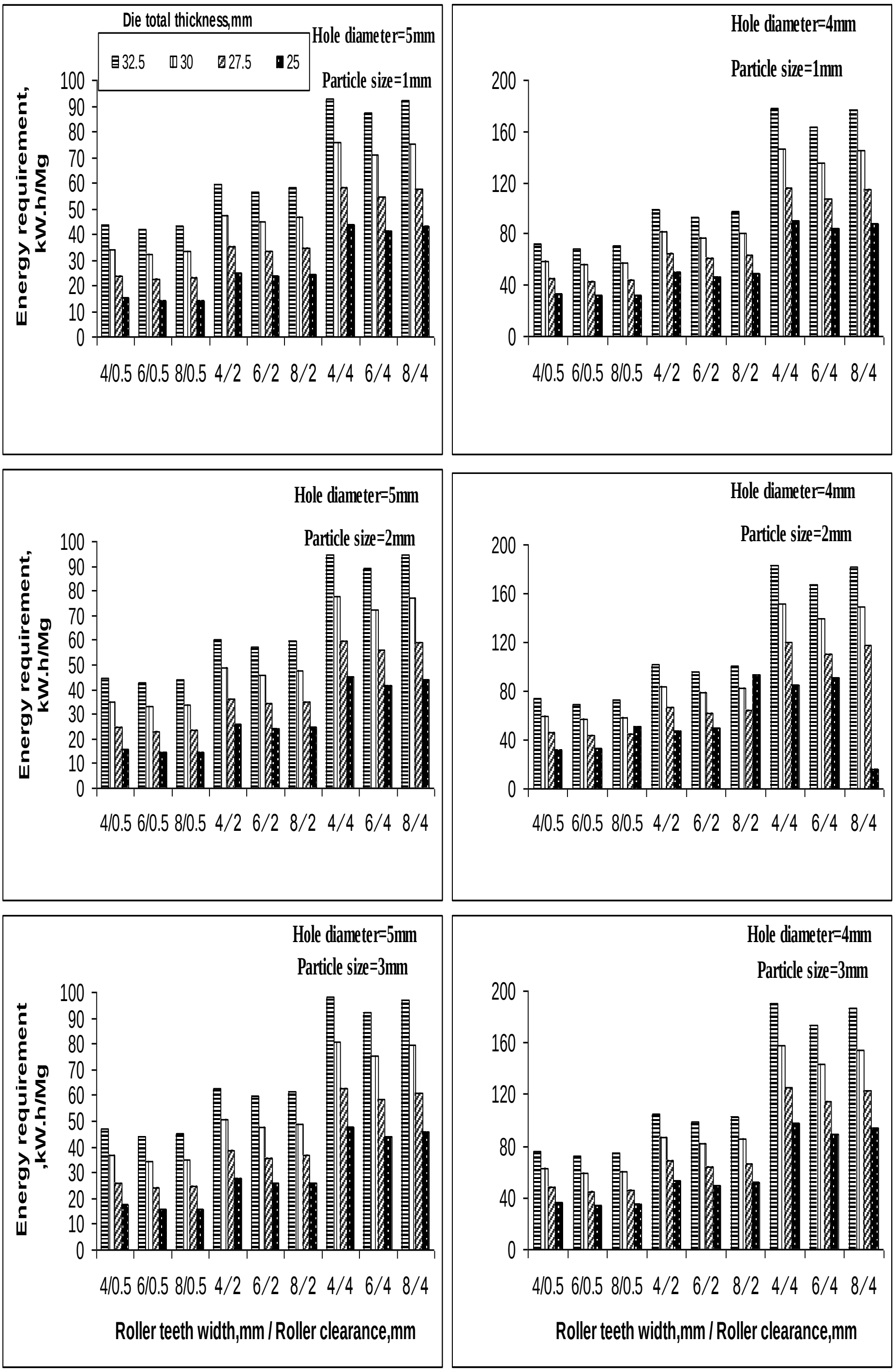

Fig.(7): Effect of some operating parameters on energy requirement.

7- Effect some operating parameters on cost per mass unit

Fig.(7) illustrated that, by increasing the particle size from 1 to3mm ,the total machine cost increased insignificantly from 2385.14 to 2388.03 L.E/Mg and 2364.39 to 2364.97 L.E/Mg for real hole diameters of 4 and5mm respectively, at die total thickness of 32.5mm, roller clearance of 2mm and roller teeth width of 8mm.The obtained results showed that, the machine cost decreased from 2385.14 to 2374.00 L.E/Mg by increasing real hole diameter from 4 to 5mm at particle size of 1mm,die total thickness of 32.5mm, roller clearance of 2mm and roller teeth width of 8mm.This decrease may be attributed to the compressed ration take a less time to pass through die hole, that means increasing the productivity. On the other hand, the total cost increased by increasing dies total thickness and roller clearance. This increase could be attributed to the decrease of productivity, in addition to the increase in the consumed power to over come the compacting ration in larger clearances. Insignificant increase in cost per mass unit occurred by increasing the roller teeth width was observed. This is could be due to the low increase in the productivity and the low increase in power consumed. The values of total costs of 2386.58 and 2374.72 L.E/Mg for real hole diameter of 4 and 5mm respectively, were recorded at the highest values of bulk density, pellet durability and pelleting efficiency using particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2 mm and roller teeth width of 8mm.

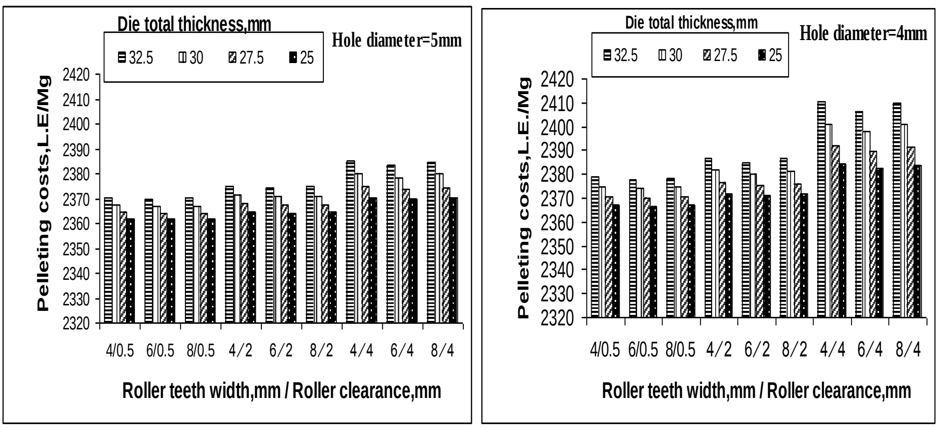

Fig.(8): Effect of some operating parameters on pelleting total costs at particle size of 1 mm.

CONCLUSION

It is recommended to operate the flat-die pelleting machine using particle size of 1mm, die total thickness of 32.5mm, roller clearance of 2 mm , roller teeth width of 8mm and real hole diameter of 4 mm to achieve the highest values of bulk density of 0.915 g/cm^3,pellet durability of 95.38%,pelleting efficiency of 95.56%, and pellet water stability of 70% (up to 4 minutes in water) with values of production rate of 107.10 kg/h, required energy of 97.95 kW.h/Mg and total cost of 2386.58 L.E./Mg.The highest values of bulk density of 0.850 g/cm^3,pellet durability of 91.65%,pelleting efficiency of 94.84%, and pellet water stability of 60% (up to 4 min. in water) were recorded at real hole diameter of 5 mm with production rate of 143.65 kg/h, required energy of 58.41 kW.h/Mg and total cost of 2374.72 L.E./ Mg.

REFERENCES

ASAE. 1996. American society of Agricultural Engineers Standards-Engineering practices, and Data, ASAE standard book.

Awady, M.N., I. Yehia, M.T. Ebaid and E.M. Arif. 2003. Development and theory of rice cleaner for reduced impurities and losses. Misr J. Ag. Eng., 20(4) : 53-68.

Dec, R.T.1999. Selection of proper roll press operating parameters. Proceeding of the Institute for Briquetting and Agglomeration (IBA),26:29–36.

Franke, M. and A. Rey. 2006 .Pelleting quality. World Grain:78–90.

Grover, P.D. and S.K. Mishra.1996. Biomass briquetting: technology andpractices. Regional Wood Energy Development Program in Asia, field document no. 46. Bangkok, Thailand: Food and Agriculture Organization of the United Nations (FAO).

Heinemans, H. 1991. The interaction of practical experience and the construction of new pelleting and cooling machinery. Advances in Feed Tech.,6:24–38.

Ibrahim, M. K. 1982. Wet milling of wheat grain. M. Sc. Thesis, Faculty of Agric., Mansoura Univ.,Egypt.

Obernberger, I. and G. Thek. 2004. Physical characterization and chemical composition of densified biomass fuels with regard to their combustion behavior. Biomass and Bioenergy : 27:653–69

Thomas, M., D.J. van Zuilichem and A.F. van der Poel.1997. Physical quality of pelleted animal feed. 2. Contribution of processes and its conditions. Animal Feed Science and Technology, 64:173–192.

Turner , R.1995. Bottom line in feed processing: achieving optimum pellet quality. Feed Management;46:30–39.

الملخص العربى

العوامل المؤثرة علي أداءآلة تصبيع أعلاف الأسماك ذات المشكل المسطح

محمد قدري عبد الوهاب[١]　　محمد على توفيق [٢]

أحمد محمد الشال[٢]　　ياسر عبد الحميد الحسيني[٣]

الهدف الرئيسي لهذة الدراسة هو تقييم أداء آلة تصبيع أعلاف الأسماك ذات المشكل المسطح لأنتاج أصبعيات علف علي درجة عالية من القوة و المتانة باقل تكاليف من خلال دراسة بعض عوامل التشغيل التي تؤثر علي اداء الآلة وصفات الجودة للأعلاف.تم تقييم الآلة بأستخدام أقطار فعلية لثقوب مشكل العلف (٤ و ٥ مم)،ثلاث قيم لأقطار حبيبات تركيبة العلف (١، ٢، ٣مم)،واربع قيم للسمك الكلي لمشكل العلف (٢٥، ٢٧.٥، ٣٠، ٣٢.٥ مم)،ثلاث قيم لخلوص البكرات (٠.٥، ٢، ٤ مم) وثلاث قيم لعرض أسنان البكرات (٤، ٦، ٨ مم) مع أستخدام قيم ثابتة لكل من سرعة قرص التشكيل (٣٠٠ لفة/دقيقة أو ٤.٧١ م/ث)، و محتوي رطوبي كلي لتركيبة العلف (١٥%) علي أساس رطب و قطر الدخول (٩مم) مع الأخذ في الأعتبار تأثير جمبع العوامل السابقة علي كل من معدل انتاجية الالة، كثافة العلف ، متانة العلف،كفاء التصبيع، الطاقة المستهلكة، تكاليف التشغيل و ثبات العلف في الماء.فقد أوضحت نتائج الدراسة أن أستخدام حجم للحبيبات حوالي ١مم،وسمك كلي لمشكل العلف ٣٢.٥مم، وخلوص للبكرات ٢مم ،عرض أسنان للبكرات ٨مم وقطر فعلي للثقب ٤مم ،أعطت أعلي قيم لكثافة العلف(٠.٩١٥ جم/سم^3)، متانة العلف (٩٥.٣٨%)،كفاءة التصبيع (٩٥.٥٦%) وأطول فترة ثبات للعلف في الماء لمدة ٤ دقائق بنسبة تصل الي (٧٠%) وذلك عند انتاجية مقدارها(١٠٧.١٠ كجم/ساعة) وطاقة مستهلكة (٩٧.٩٥ ك وات.ساعة/ميجا جرام) وتكلفة كلية للتشغيل (٢٣٨٦.٥٨ جنية/ميجا جرام)، وتحت نفس ظروف التشغيل، عند قطر فعلي للثقب (٥مم) كانت أعلي قيم لكل من كثافة العلف (٠.٨٥٠ جم/سم^3)، متانة العلف (٩١.٦٥%)،كفاءة التصبيع (٩٤.٨٤%) وأطول فترة ثبات للعلف في الماء بنسبة تصل الي (٦٠%) قد تحققت وذلك عند انتاجية مقدارها (١٤٣.٦٥ كجم/ساعة) وطاقة مستهلكة (٥٨.٩١ك وات.ساعة/ميجا جرام) وتكلفة كلية للتشغيل (٢٣٧٤.٧٢ جنية/ميجا جرام).

---

[١] أستاذ الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق- مصر

[٢] مدرس الهندسة الزراعية – كلية الزراعة - جامعة الزقازيق – مصر

[٣] طالب دراسات عليا بقسم الهندسة الزراعية– كلية الزراعة - جامعة الزقازيق – مصر