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DEVELOPMENT OF AN SMALL EXPRESSION MACHINE TO PURPOSE PRODUCTION OF FISH FEED PELLETS

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ABSTRACT

Field experiment were carried during 2007 at the Sakha Aquaculture Research Station, Kafr El-Sheikh, Governorate, to evaluate the feasibility of using a small expression machine for oil extraction to suit production of fish feed pellets. The effect of some parameters such as, screw speeds (1.50, 1.90, and 2.25 m/s), moisture content of ration (12.8, 16.5, and 22.0 %), screw pitch (50.0 and 80.0 mm) and two different die shape (Perforated Cylinder - Internal Cone) on energy requirements, machine productivity, pellets bulk density, pellets durability, floating time and pelleting efficiency.

The obtained results showed that increasing screw speed from (1.50, 1.90,and 2.25 m/s) tends to increase machine productivity from (0.31, 0.37, and 0.47 ton/h), pellets durability from (92.5, 93.4, and 95.66 %), floating time from (270, 295, and 330 min.) and pelleting efficiency from (96.4, 97.2, and 98.4 %), respectively. And decreasing energy requirements from (9.27, 8.59 and 7.45 kW.h/ton), and pelleting bulk density from (0.96, 0.81 and 0.74 gm/cm^3), respectively. Increasing ration moisture content from (12.8, 16.5, and 22.0 %) led to increase energy requirements from (7.31, 7.95 and 9.27 kW.h/tom), floating time from (240, 250, and 270 min.) and pelleting durability from (92.50, 93.40, and 95.66 %), respectively. And decreasing machine productivity from (0.31, 0.26, and 0.23 ton/h), pellets bulk density from (0.96, 0.90, and 0.86 gm/cm^3) and pellets efficiency from (98.4, 97.9, and 97.2 %), respectively.

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By increasing screw pitch from (50.0 and 80.0 mm) tends to increasing machine productivity from (0.32 to 0.38 ton/h),pelleting efficiency from (95.9 to 97.2 %), and pellets bulk density from (0.90 to 0.96 gm/cm^3), respectively. and decreasing energy requirements from (9.27 to 8.82 kW.h/ton), floating time from (240 to 210 min.), and pellets durability from (90.15 to 88.11 %), respectively.

INTRODUCTION

In Egypt in general, there is a great shortage in animal feed stuff, which is one of the most serious problems facing the animal producer. The fish is among the most important sources of proteins. Fish production from the natural sources is 350 thousand ton yearly, which is not enough to satisfy local consumption. In Egypt the share of consumed fish is 16 kg/man/year.

Extrusion processing is considered one of the new processing of high technology in food and feed industry. Floating and sinking extruded fish feed industry is used as a new technology in a large scale all over the world to optimize the quantity of fish feed meal in agricultural farms. Both the geometrical dimension of die and ration components are the most important parameters influencing the efficiency of extrusion machine and pellets quality. **Kholief (1996)** showed that when the moisture content in pellets increase led to decrease in power requirement, pellet hardness and stability of pellets. He indicated that the increase of the outlet diameter increased machine productivity and mass lost of pellets but decreased the density of pellets. **Soliman et al. (1999)** studied the quality of wheat bran pellets related to pelleting parameters. The quality index indicates the best pelleting treatments which was prepared at 13 % moisture content, pressing under compression of 56.98 Mp_a, at temperature of 90 C^o and cross head speed of 20 mm/min. **Afify (2001)** developed the mixing unit in local pelleting machine to avoid the strangulation in the unit with the high speed. The development was constructed and tested under different conditions of mixing speed 70, 150, 215, and 300 rpm, and concave hole diameter of 1, 2, and 3 mm. He mentioned that the increasing the production rate, pelleting efficiency, mixing efficiency, durability and bulk density and decreasing the energy requirement, total losses, operating cost, criterion cost and total cost for the residues diet than the control diet with the developed mixing unit. **Hegazy et al.(2002)** developed of an oil expression machine to suit production of livestock feed pellets. The results revealed that the optimum values for the operations conditions were obtained at 135rpm, screw revolving speed, 14mm die hole diameter and 13.3%(d.b) raw material average M.C. At these levels maximum machine productivity of (0.174ton/h), minimum energy consumption (33.07kW.h/ton), mixing efficiency(75.9%) and pellets hardness(13.2N) were obtained. **Kaddour (2003)** developed a local pelleting machine in the compaction pressure unit by single screw extrude to produce the cook pellets. The optimum results were recorded with the production rate of 362.77kg/h, energy requirement of 27.071 kW.h/ton, pellets bulk density of 0.91gm/cm^3, pelleting efficiency of 96.092%, pellets durability of 97.825% and cost of 896.22LE/ton using screw speed of 1.81m/s, fineness degree of 1mm, effective hole of 25.5mm and holes number 22. **El-Nono (2005)** investigated the possibility of molding compost of livestock into pellets .An auger machine prototype was used for pelleting cheep manure that mixed with (0.0 – 15%) for rice straw by weight, at 40% M.C. Dies of 5, 8, and 10mm hole diameter were used. He indicated that compost pellets is suitable for recycling, storing and handling. The pellets 5mm in diameter are strong enough to be applied and distributed evently by the machine without disintegrating or generating dust. They could be leached off their bases and release nitrogen and other minerals after several weeks of application. **Aboud et al. (2005)** used whey as a binder materials in pelleting process. The results showed that the whey was a good binder and the pellets properties were improved. The optimum why percent as binder gives durable pellets and high productivity in the rang of (10 to 15%) as solid content. **Kaddour et al. (2005)** studied the effect of using stem-lock on the efficiency of extruder pelleting machine to produce the floating fish feed mill pellets. The optimum results were recorded with (392.96 kg/h production rate),(93.74%pelletingefficiency),(0.6842 g/cm^3 bulk density), (447min.floating time) and (147.73 kW.h/ton energy requirements) using the optimum operation condition of the machine such as (type of screw of 4 single screw+1unit twin screw),(number of stem-lock of 3 units),(clearance between steam-lock and internal case of 1.5mm), and (width of flat sector in steam-lock of 0.048cm). **Kaddour et al.(2006)** evaluated the two previously kinds of ration and taken into account the effective design parameters. The obtained results were summarized as follows. The optimum conditions for producing a good quality of pellets from standard ration were 1.92L/D ration, 18mm hole entry diameter, 5.33% die opening area and 30mm thickness of die, when the evaluated parameters(machine productivity, energy requirements, total losses, pellets durability, pellets bulk density, and pellets hardness) were 0.399ton/h, 114.04kW.h/ton, 5.21%, 86.72%, 1.190g/cm^3, and 184.8N, respectively. **Morad et al.(2007)** studied the effect of some engineering parameters on the performance of fish pelleting machine to produce high quality fish pellets. The obtained results revealed that pelleting machine has a high efficiency 73.15%, high productivity 422kg/h and minimum production cost 1150LE/Mg at conditions of screw speed of 2.11m/s and feed rate of 432kg/h. In order to minimize pelleting energy 50.03 kW.h/Mg and high quality fish pellets, effective hole thickness of 15mm and 31 die holes were used.

The objectives of the present study are:-

1- Development of an oil small expression machine to production of fish feed pellets.

2- To study the effect of energy requirement, machine productivity, pellets bulk density, pellets durability, floating time and pelleting efficiency on performance of developed machine.

MATERIAL and METHODS

The experimental ration prepared by a hammer mill and mixed in forage mixer for mixture. The composition of the experimental ration is shown in Table 1.

Table 1: Composition of experimental ration.

Composition	Percentage
Corn (yellow grain)	45
Soy- bean meal	24.5
Wheat bran	10
Fish meal	15
Fish oil	5
Premix	0.30
Dl. Methionine	0.20

Taken from Sakha Aquaculture Research Section.

The experiments were carried out at Sakha Aqua cultural Research Section, Kafr El-Sheikh Governorate during season of 2007. The technical specifications and operating parameters of the developed machine to production of fish feed pellets is shown in Fig. 1and Table 2.

To fulfill the objective of this study an production fish feed pelleting machine which was tested and hoped to participate in solving the serious problems of feed shortage of fish feed pellets in Egypt.

Was used machine oil extraction locally manufactured without modification of the production and squeeze the components of pellets in order to obtain a paper pellets form using a internal cone.

Was replaced with a hay-maker internal cone feed maker is a perforated cylinder with holes 3 mm diameter circular distributed to the area around the cylinder. The amendment was also the end of cape screw bottoming kind of cone of the external cylindrical commensurate with the pellets cylindrical as shown in Fig. 2.

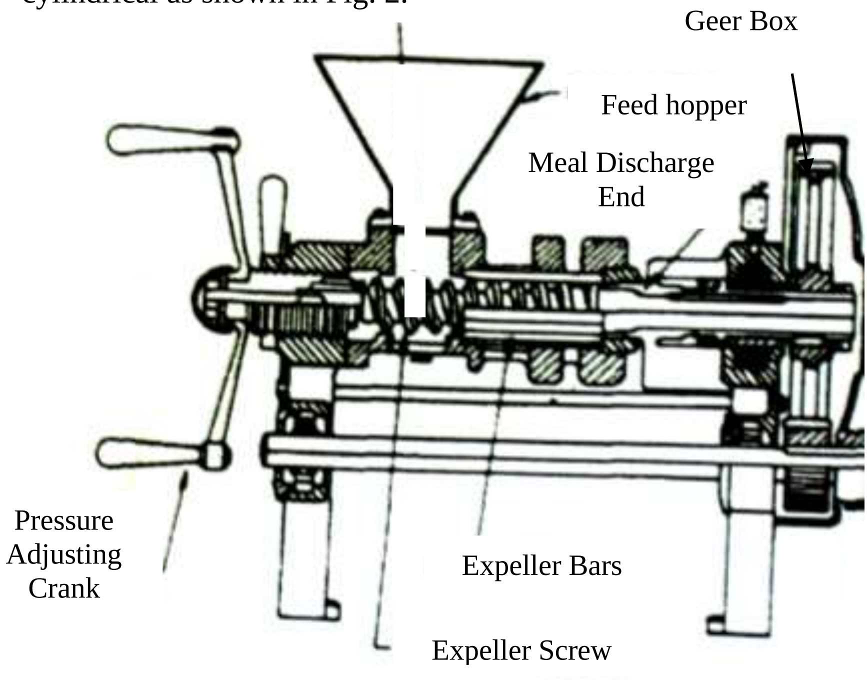
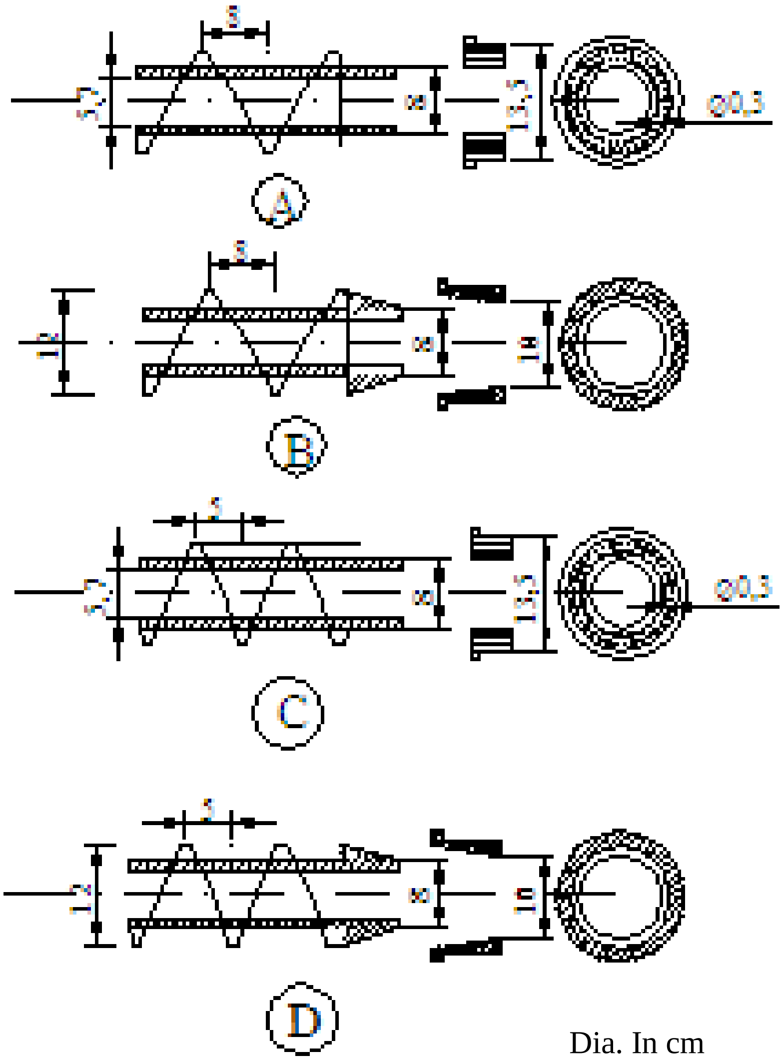


Fig. 1: Skematic digram for developed machine to production of fish feed.

Also, have been using the pulley of alimonies different diameters for give different linear velocities of screw compression



Dia. In cm

Fig. (2) : Type of die shapes:

A and C internal cone at 8.0 and 5.0 screw pitches

B and D perforated cylinder at 8.0 and 5.0 screw pitches

A and C machine after modification B and D machine before modification

Table 2: The technical specifications of the developed machine to production of fish feed pellets.

Item	Specifications
Main dimension:	
Overall length, cm.	**196**
Overall width, cm.	**65**
Overall height, cm.	**155**
Total mass, kg.	**620**
Screw:	
Length, cm.	**62**
Diameter, cm.	**12.5**
Pitch (tough width), cm.	**5 – 8**
Peak height (trough depth), cm.	**1.5**
Hopper:	
Average diameter, cm.	**68**
Power source:	**Three phase electric motor**
Power req. HP (kW).	**20 (15)**

The present study was conducted and taking the following factors into consideration:

1- Screw speeds (1.50, 1.90, and 2.25 m/s),
2- Moisture content of ration (12.8, 16.6, and 22.0 %),
3- Screw pitch (50.0 and 80.0 mm), and
4- Two different die shapes (Perforated Cylinder - Internal Cone).

1-Estimation of power consumption:-

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

$$P = \sqrt{3}.I.V.\eta.\cos\theta / 1000 \quad ,kW \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where:

I = Current strength Amperes;

V = Potential difference (Voltage), Volts;

Cos = Power factor, decimal (being equal 0.71) and

η = Mechanical efficiency of motor assumed 95 %.

2- Energy requirement to produce a mass unit of pellets yield:

$$Energy\ requirment = \frac{Power,(kw)}{Production\ rate,\ (ton/h)},\ kW.h/ton \ldots\ldots\ldots.2$$

3- Production rate: It was calculated from the following relation:-

$$Production\ rate = \frac{wp\ x\ 3.6}{T}\quad ,kg/h. \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots....3$$

Where:

WP = Pellets mass (g) T = Consumed time (s)

4- Pelleting efficiency: It was calculated from the following relation:-

$$Pelleting\ efficiency = \frac{Wp}{Wm}\ x\,100\ ,\% \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots...4$$

Where:

Wm = Ration sample mass (g)

5- Pellets bulk density: It was calculated from the following relation:-

$$Density\ after\ for\min g = \frac{Wd}{Vd}\ ,\ (g/cm^3)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots5$$

Where:

Wd = Pellets sample mass(g) Vd = Pellets sample volum(cm^3)

6- Durability of pellets: It was calculated from the following relation:

$$\text{Durability} = \frac{Wa}{Wb}\ x100\ ,(\%)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots6$$

Where:

Wa = Pellets mass after shaker treatment(g)

Wa = Pellets mass before shaker treatment(g)

<u>RESULTS and DISCUSSIONS</u>

The developed machine was used to produce fish feed pellets. The experimental study in pelleting process confined to evaluate the effect of screw speed, moisture content of ration, two type screw pitchs with two type of die shapes on the following factors: (energy requirements, machine productivity, pellets bulk density, pellets durability, floating time and pelleting efficiency).

1- <u>Energy requirement, (kW.h/ton):</u>

The results indicated that the moisture content of ration increase from 12.8 to 22.0% led to increase energy requirements from 7.31 to 9.27, 7.00 to 8.59 and 6.30 to 7.45 kW.h/ton, as shown in Fig. 3 at screw speed of 1.50, 1.90 and 2.25 m/s, die shape(Perforated Cylinder), and screw pitch of 50 mm, respectively. This is due to the increasing of moisture content of ration tends to reduce the machine productivity.

Also, it can be noticed that screw speed increase from 1.50 to 2.25m/s tends to decrease energy requirements from 6.95 to 5.92, 7.50 to 6.51 and

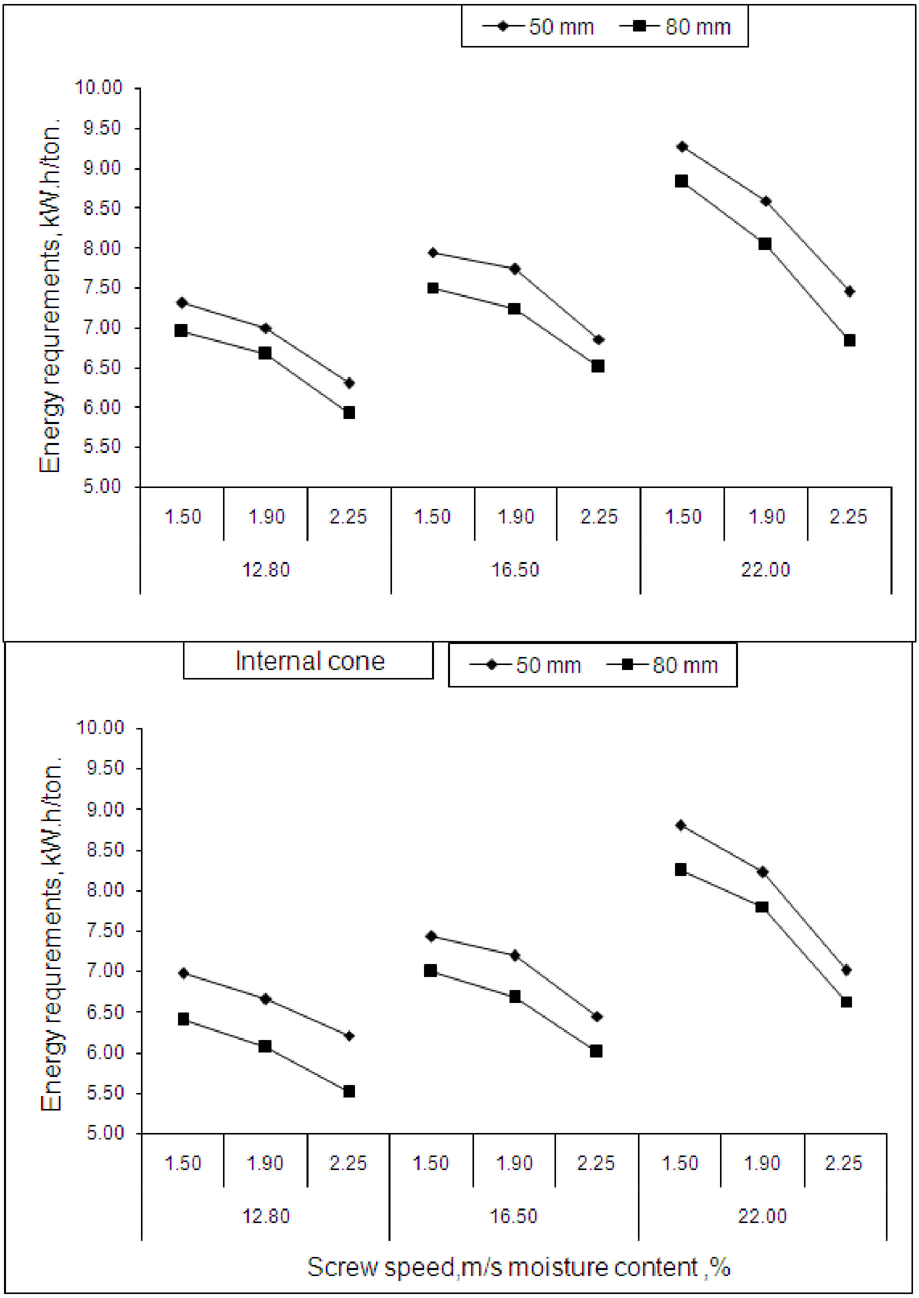


Fig (3) : Effect of screw speed, moisture content of ration and two screw pitches with two type of die shapes (perforated cylinder and internal cone) on energy requirements, kW.h/ton.

8.82 to 6.82 kW.h/ton, at moisture content of ration 12.8,16.5 and 22.0%, die shape(Perforated Cylinder), and screw pitch of 80 mm, respectively.

2- <u>Machine productivity, (ton/h):</u>

Machine productivity was measured during the experimental work.

Inspection of Fig. 4 illustrated that the increasing of screw speed from 1.50 to 2.25m/s tends to increase the machine productivity from 0.31 to 0.47, 0.26 to 0.38 and 0.23 to 0.32 ton/h, at moisture content of ration 12.8, 16.5 and 22.0% , die shape (Internal Cone), and screw pitch 80 mm,

respectively.

In the same manner, the increase moisture content of ration from 12.8 to 22.0% led to decrease the machine productivity from 0.25 to 0.18, 0.30 to 0.20 and 0.37 to 0.24 ton/h, at screw speed of 1.50, 1.90, and 2.25 m/s, die shape(Perforated Cylinder) and screw pitch 80 mm, respectively, due to increase evaporation moisture in ration during compression

operation in high moisture content.

Also, the machine productivity in die shape (Internal Cone) more than in die shape (Perforated Cylinder) at the same screw speed, screw pitch and moisture content due to increase of outlet in die hole shape.

3- <u>Pellets bulk density, (gm/cm^3):</u>

Samples of pellets were taken from each treatment to measure their mass and volume to determine the bulk density of pellets.

Fig. 5 concluded that the density of pellets decreased from 0.90 to 0.65, 0.85 to 0.62 and 0.79 to 0.60 gm/cm^3 by increasing screw speed from 1.50 to 2.25 m/s, at ration moisture content of 12.8, 16.5 and 22.0%, die shape (Internal Cone) and screw pitch 50 mm, respectively. The decrease in pellets bulk density by increasing the screw speed may be due to the fact that high speed can not help the diet to import ticking in the die hole and the decrease in pelleting consumed time.

The increment of ration moisture content from 12.8 to 22.0% tends to decrease pellets bulk density from 0.85 to 0.71, 0.75 to 0.64 and 0.60 to 0.45 gm/cm^3 , at screw speed of 1.50, 1.90 and 2.25m/s, die shape(Perforated Cylinder) and screw pitch 80 mm, respectively.

By increasing screw pitch led to increase pellets bulk density, could be due to decrease in the pressure inside pelleting unit.

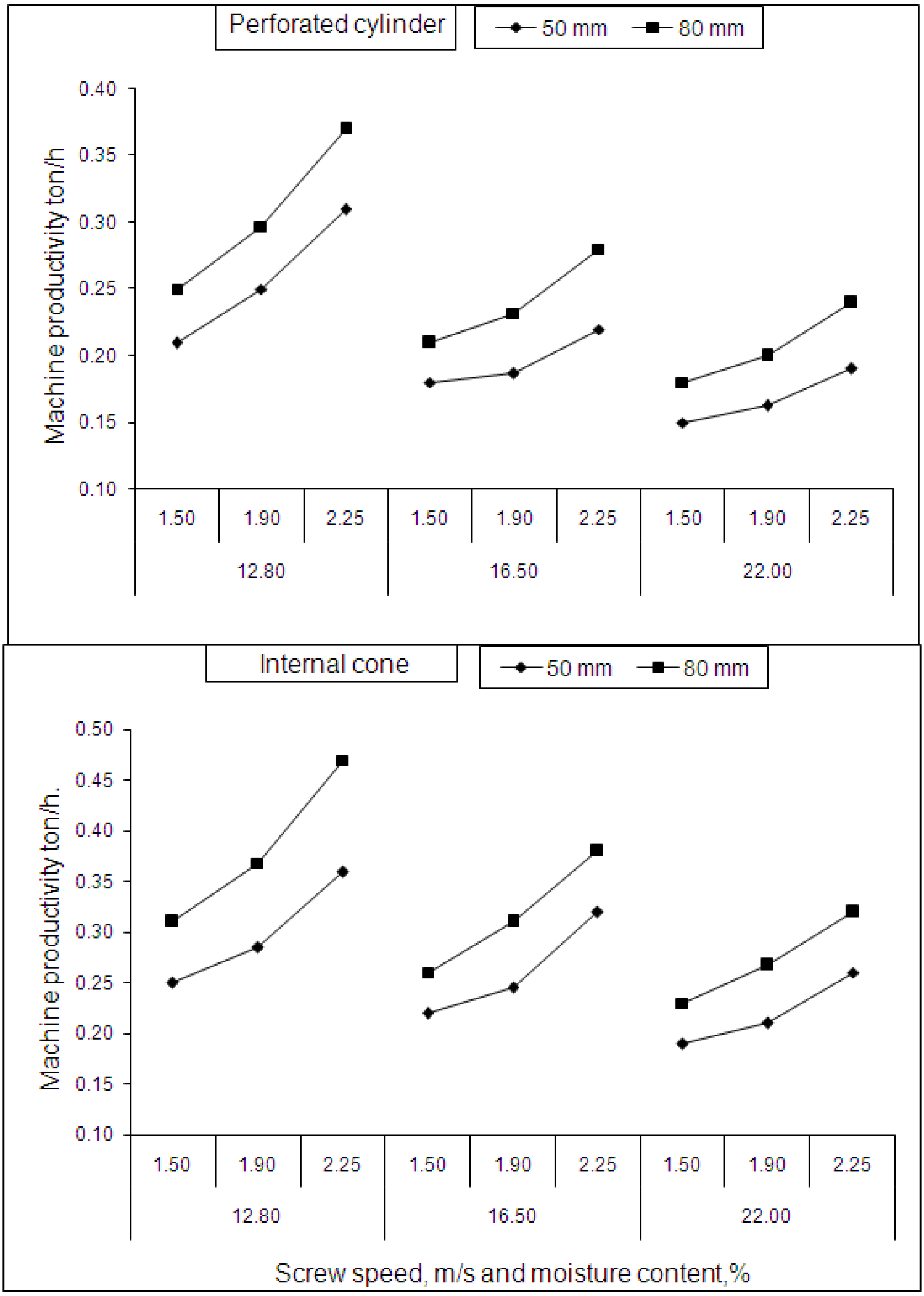


Fig (4) : Effect of screw speed, moisture content of ration and two screw pitches with two type of die shapes (Perforated cylinder and internal cone) on machine productivity, ton/h.

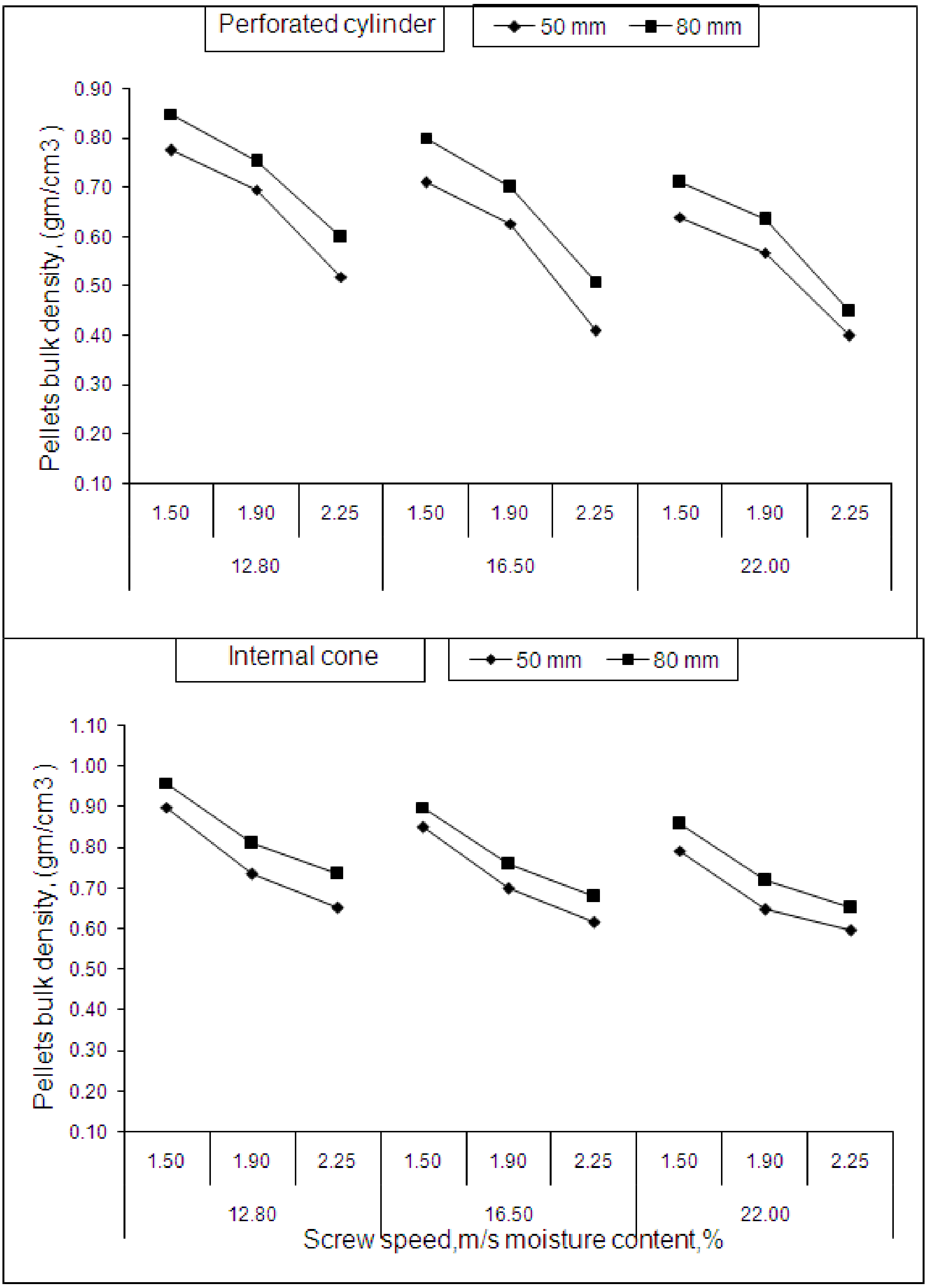


Fig (5) : Effect of screw speed, moisture content of ration and two screw pitches with two type of die shapes (Perforated cylinder and internal cone) on pellets bulk density, gm/cm^3 .

By increasing pellets bulk density from 0.65 to 0.74 gm/cm^3 led to decrease floating time from 240 to 210 min. That is due to reduction in bulk density and consequently increasing the compaction pressure to pellets and on collapsed with water reactions as shown in Fig. 6.

4- <u>Pellets durability, (%):</u>

The most critical factor in the performance of pelleting machine is pellets durability.

Fig.7 indicated that by increasing the screw speed from 1.50 to 2.25m/s tends to increase pellets durability from 87.01 to 90.01, 88.50 to 91.80 and 89.40 to 92.92 % at ration moisture content of 12.8, 16.5 and 22.0%, die shape (Perforated Cylinder) and screw pitch 50 mm, respectively.

However, by increasing the ration moisture content from 12.8 to 22.0 % led to increase the pellets durability from 87.01 to 89.40, 87.90 to 90.60 and 90.01 to 92.92 % at screw speed of 1.50, 1.90 and 2.25m/s, die shape(Perforated Cylinder) and screw pitch 50 mm, respectively.

The decrease in pellets durability by increasing the ration moisture content due to the hardness and drying pellets out put cause the high temperature inside the pelleting unit.

Also, by increasing screw pitch from 50 to 80 mm tends to decrease the pelleting durability due to decrease compression during compression operation.

5- <u>Pelleting efficiency, (%):</u>

Pelleting efficiency is considered the most important measurements in pelleting industry. The increase of screw speed from 1.50 to 2.25m/s tends to increase pelleting efficiency from 95.5 to 97.0, 94.7 to 96.3 and 94.4 to 96.0 % at ration moisture content of 12.8, 16.5 and 22.0%, die shape(Perforated Cylinder) and screw pitch 50 mm, respectively as shown in Fig. 8. This could be due to decrease in consumed time, pelleting losses and the increase in the production rate.

Relating to the effect of ration moisture content on pelleting efficiency in Fig. 8 it is interested to notice that the pelleting efficiency decreased from 94.8 to 93.4, 95.4 to 94.0 and 96.5 to 95.1 % by increasing ration moisture content from 12.8 to 22.0% at screw speed of 1.50 1.90 and 2.25 m/s, die shape(Internal Cone) and screw pitch 50 mm, respectively.

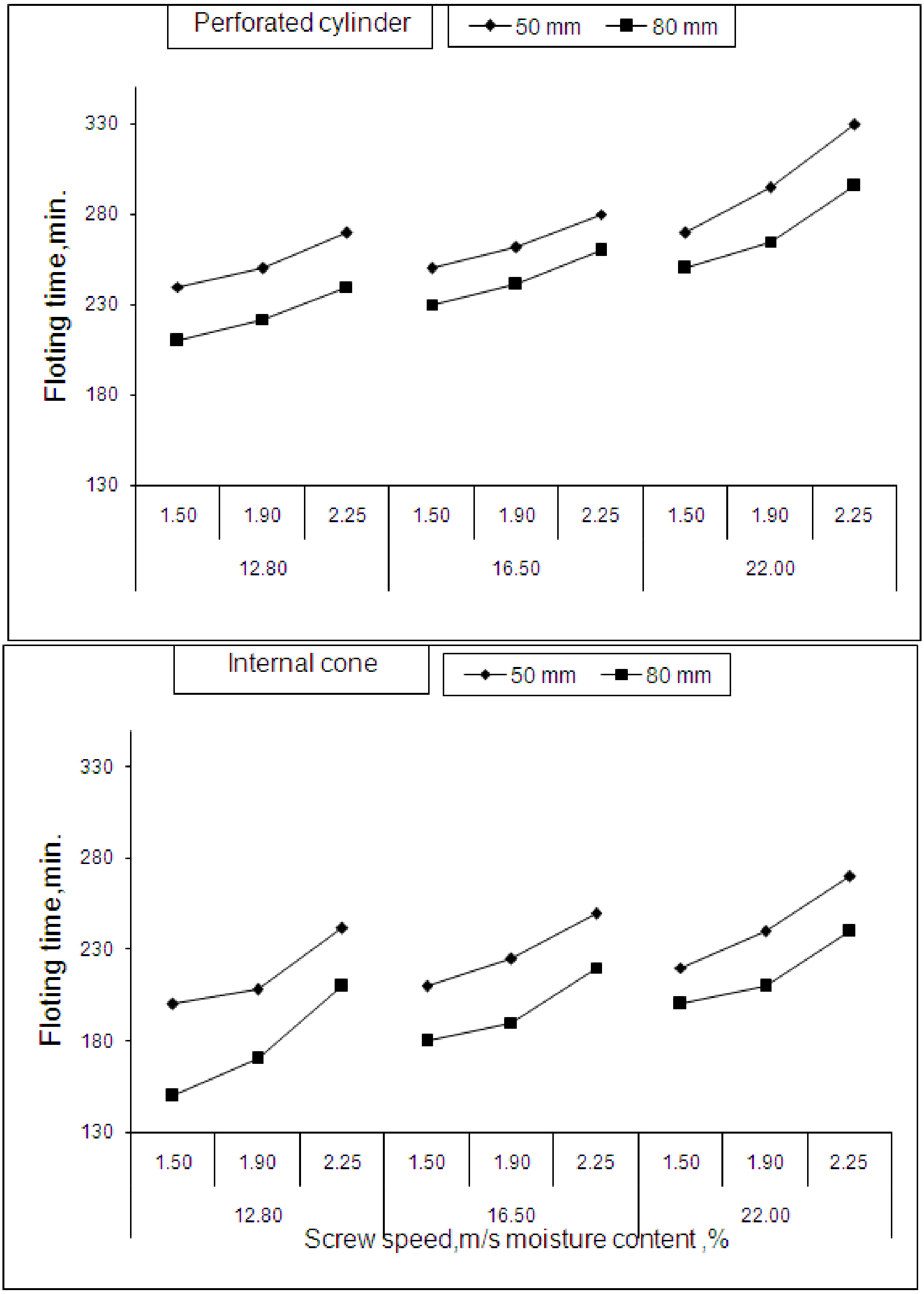


Fig (6) : Effect of screw speed, moisture content of ration and two screw pitches with two type of die shapes (Perforated cylinder and internal cone) on Floating time, min.

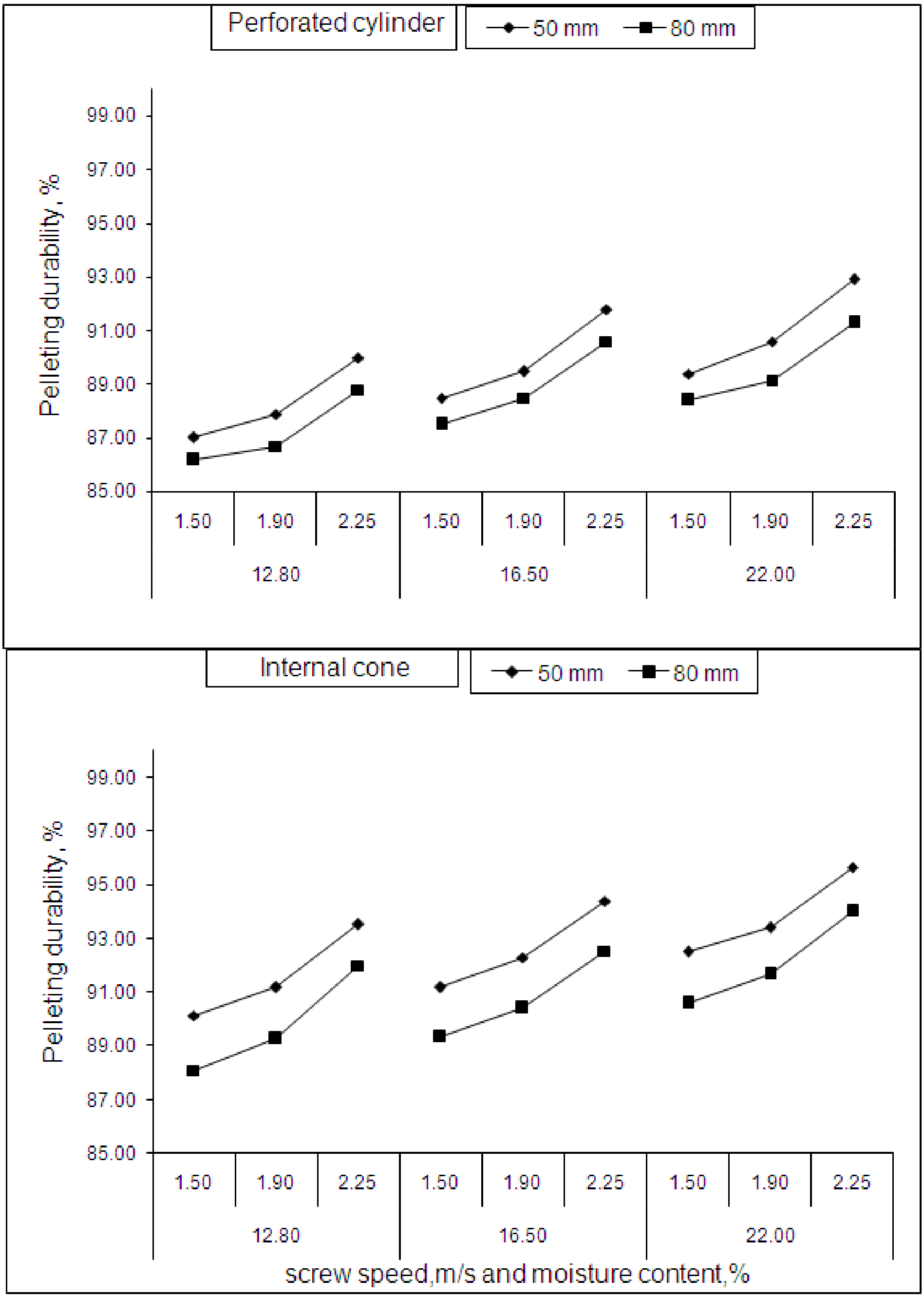


Fig (7) : Effect of screw speed, moisture content of ration and two screw pitches with two type of die shapes (Perforated cylinder and internal cone) on pelleting durability, %

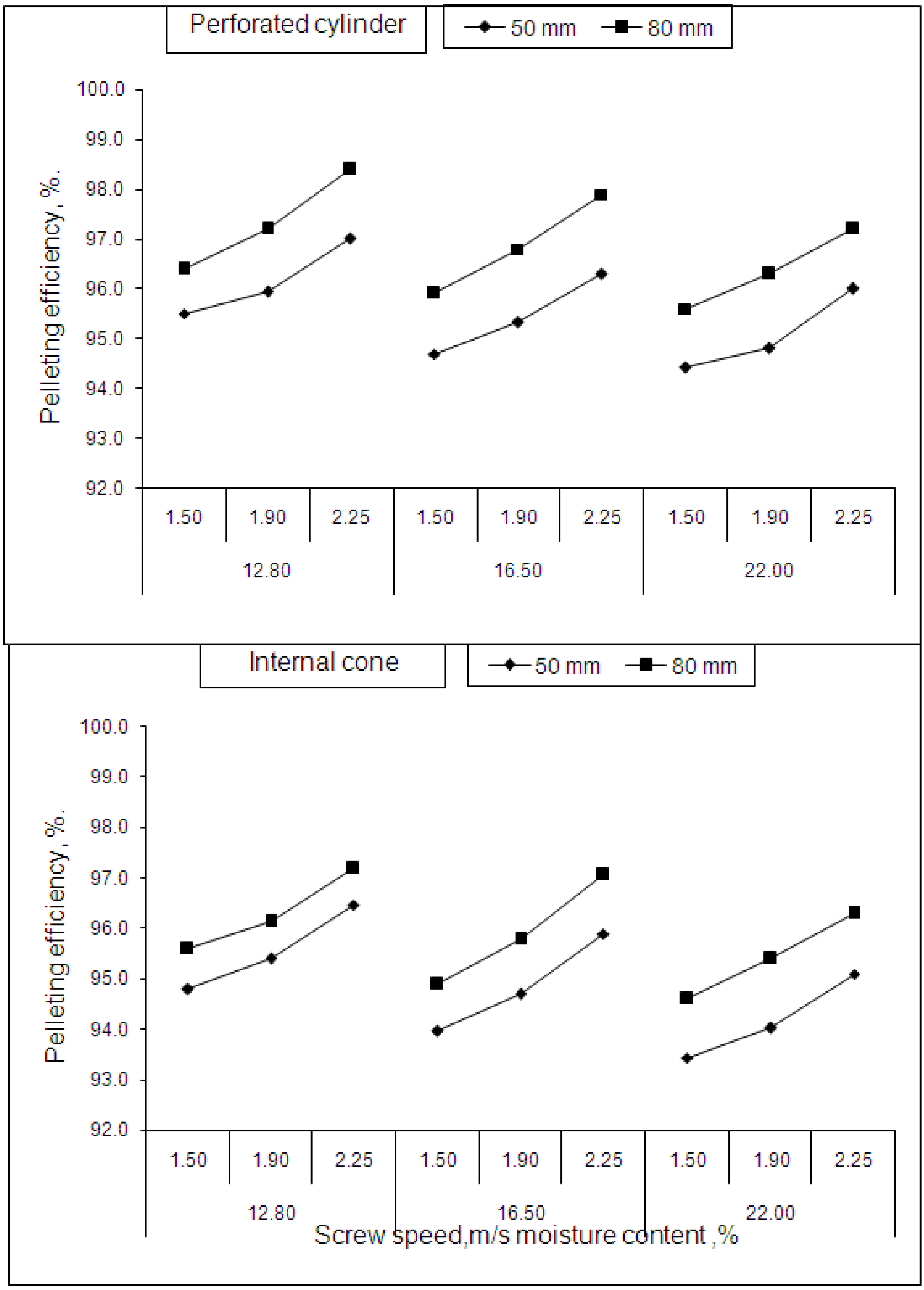


Fig (8) : Effect of screw speed, moisture content of ration and two screw pitches with two type of die shapes (Perforated cylinder and internal cone) on pelleting efficiency, %.

CONCLUSION

From this study, it can be concluded that ;

Results showed that increasing screw speed from (1.50, 1.90,and 2.25 m/s) tends to increase from machine productivity from (0.31, 0.37, and 0.47 ton/h), pellets durability from (92.5, 93.4, and 95.66 %), floating time from (270, 295, and 330 min.) and pelleting efficiency from (96.4, 97.2, and 98.4 %), respectively. And decrease energy requirements from (9.27, 8.59 and 7.45 kW.h/ton), and pelleting bulk density from (0.96, 0.81 and 0.74 gm/cm^3), respectively.

Results showed that increasing ration moisture content from (12.8, 16.5, and 22.0 %) led to increase energy requirements from (7.31, 7.95 and 9.27 kW.h/tom), floating time from (240, 250, and 270 min.) and pelleting durability from (92.50, 93.40, and 95.66 %), respectively. And decreasing machine productivity from (0.31, 0.26, and 0.23 ton/h), pellets bulk density from (0.96, 0.90, and 0.86 gm/cm^3) and pellets efficiency from (98.4, 97.9, and 97.2 %), respectively.

By increasing screw pitch from (50.0 and 80.0 mm) tends to increasing machine productivity from (0.32 to 0.38 ton/h),pelleting efficiency from (95.9 to 97.2 %), and pellets bulk density from (0.90 to 0.96 gm/cm^3), respectively. and decreasing energy requirements from (9.27 to 8.82 kW.h/ton), floating time from (240 to 210 min.), and pellets durability from (90.15 to 88.11 %), respectively.

Recommendation

The optimum conditions for operating the developed machine which gave the maximum machine productivity(ton/h), pelleting efficiency(%) and minimum energy requirement for pellets production(kW.h/ton) was screw speed of (2.25 m/s), ration moisture content of (12.8 %) and screw pitch of (80.0mm).

The future problems that can be studied in this field:

To study the possibility of using automatic control system to adjust the amount of each component for raw materials and production pellets.

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الملخص العربي

تطوير آلة عصر البذور الزيتية الصغيرة لغرض أنتاج أعلاف الأسماك المضغوطة

د/ حمادة على الخطيب١ د/ عبد الفتاح محمود دريس٢ د/ سمير خضر عبد العاطى٣

تعتبر الأسماك من أهم مصادر البروتين اللازمة لسد الفجوة الغذائية في أنتاج البروتين الحيواني ومن أهم الصعوبات التي تواجة التوسع في مجال الثروة السمكية هي التغذية وارتفاع

١ـ باحث أول بمعهد بحوث الهندسة الزراعية – الدقي – الجيزة – مصر ٠
٢ـ مدرس الهندسة الزراعية – كلية الزراعة – جامعة الأزهر – فرع أسيوط – مصر ٠
٣ـ باحث بمعهد بحوث الهندسة الزراعية – الدقي – الجيزة – مصر ٠

أسعار آلات تصنيع الأعلاف السمكية . حيث إن الأعلاف تشكل أكثر من ثلاثة أرباع تكلفة إنتاج الأسماك المستزرعة مما يشكل عبء اقتصادي كبير على المنتج ويبلغ نصيب الفرد من الأسماك ١٦ كج /سنويا.

تعتبر آلات صناعة الأعلاف احد المحاور الهامة التي بدا الاتجاة لها لمواجهة ارتفاع أسعار المعدات المستوردة علاوة على الطاقة الإنتاجية الكبيرة لمثل هذه المعدات والتي لا تناسب صغار المنتجين.

وقد أجريت الاختبارات بقسم بحوث الثروة السمكية بسخا – محافظة كفر الشيخ موسم ٢٠٠٧م لتقييم آلة إستخلاص الزيوت الصغيرة والتي تم تعديلها لتعطى مصبعات لتغذية الأسماك.

وقد تم دراسة بعض العوامل المؤثرة على أداء الآلة المطورة وهى :-

١- سرعة بريمة التغذية (١,٥– ١,٩ – ٢,٢٥ م/ث)
٢- المحتوى الرطوبى للمواد الخام للعليقة المراد كبسها (١٢,٨ – ١٦,٥ – ٢٢,٠ ٪.)
٣- خطوة البريمة (٥٠ – ٨٠ مم)
٤- نوعان مختلفان من أقراص مشكل العلف (أسطوانة مثقبة – مخروط ذو سلب داخلي)

وقد تم دراسة ذلك العوامل على المؤشرات التالية وهى :-

الطاقة اللازمة لإنتاج العلف – الإنتاجية الكلية للآلة – كثافة العلف – تحمل العلف للنقل والصدمات – كفاءة التكعيب – زمن طفوا العليقة .

أهم النتائج المتحصل عليها كانت كالتالي :-

١- بزيادة سرعة بريمة التغذية من (١,٥ – ١,٩ – ٢,٢٥م/ث) أدى ذلك إلى زيادة كل من إنتاجية الآلة من (٠,٣١ – ٠,٣٧ – ٠,٤٧ طن /ساعة) و تحمل العلف للنقل والصدمات من (٩٢,٥ – ٩٣,٤ – ٩٥,٦٦ %) وزمن طفو العليقة من (٢٧٠ – ٢٩٥ – ٣٣٠ دقيقة) وكفاءة التكعيب من (٩٦,٤ – ٩٧,٢ – ٩٨,٤ ٪.) على التوالي ٠ونقص الطاقة اللازمة لإنتاج العلف من (٩,٢٧ – ٨,٥٩ – ٧,٤٥ كيلووات ساعة /طن) وكثافة العلف من (٠,٩٦ – ٠,٨١ – ٠,٧٤ حم /سم٣) على التوالي.
٢- بزيادة المحتوى الرطوبى للعليقة من (١٢,٨ – ١٦,٢ - ٢٢,٠ ٪.) أدى إلى زيادة الطاقة اللازمة لإنتاج العلف من (٧,٣١ – ٧,٩٥ – ٩,٢٧ كيلووات ساعة/طن)وزمن طفوا العليقة من (٢٤٠ – ٢٥٠ - ٢٧٠ دقيقة) و تحمل العلف للنقل والصدمات من (٩٢,٥٠ – ٩٣,٤٠ – ٩٥,٦٦ ٪.) على التوالي ٠وأيضا أدت إلى نقص إنتاجية الآلة من (٠,٣١ – ٠,٢٦ – ٠,٢٣ طن/ساعة) وكثافة العلف من (٠,٩٦ – ٠,٩٠ – ٠,٨٦ جم/سم٣) وكفاءة التكعيب من (٩٨,٤ – ٩٧,٩ – ٩٧,٢ ٪.) على التوالي .
٣- بزيادة خطوة البريمة من (٥٠ – ٨٠ مم) أدى ذلك إلى زيادة وإنتاجية الآلة من (٣٢و – ٣٨و طن/ساعة) وكفاءة التكعيب من (٩٥,٩ – ٩٧,٢ ٪.) وكثافة العلف من (٩٠و – ٩٦و حم/سم٣) ونقص كلا من تحمل العلف للنقل والصدمات من (٩٠,١٥ – ٨٨,١١ ٪.) والطاقة اللازمة لإنتاج العلف من (٩,٢٧ – ٨,٨٢ كيلووات ساعة/طن) وزمن طفوا العليقة من (٢٤٠ – ٢١٠ دقيقة) على التوالي .

<u>التوصيات:</u>

الظروف المثلى لتشغيل آلة أنتاج الأعلاف المطورة حيث أعطت أعلى إنتاجية للآلة (طن/ساعة) وأعلى كفاءة تكعيب (٪.) واقل طاقة لازمة لإنتاج العليقة (كيلووات.ساعة/طن) كانت عند استخدام سرعة بريمة التغذية (٢,٢٥ م/ث) ومحتوى رطوبى (١٢,٨٪.) وخطوة البريمة (٨٠ مم)٠

<u>المشكلات التي يمكن دراستها مستقبلا في هذا الاتجاه:</u>

دراسة أمكانية استخدام نظم التحكم الاليكتروني في ضبط نسب مكونات العليقة وإنتاج المصبعات.

حيث أن استخدام آلات أنتاج الأعلاف سوف يشجع على زيادة المساحة المنزرعة بالأسماك خاصة في الاراضى حديثة الاستصلاح