EFFECT OF USING POULTRY BY-PRODUCT MEAL ON AQUATIC PELLETS QUALITY AND FISH GROWTH USING RING-DIE PELLETING MACHINE

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ABSTRACT

In present study, three feed blends containing 30% protein with an energy content of 350 Kcal/100 grams were formulated with three levels of poultry by-product meal (PBM) of 0.0, 50 and 100% as a cheaper protein source instead of Herring fish meal (HFM) along with appropriate levels of soybean meal, corn flour, vitamin mix and mineral mix and pelleted in a ring-die pelleting machine to fed Nile tilapia fingerlings (5.4 ± 0.13 g) .The ring-die pelleting machine was evaluated under three levels of replacement percentage of PBM in feed formula, roller clearances (0, 2 and 4mm) and levels of moisture content of (15, 20 and 25%). The evaluation included machine production rate, pelleting efficiency, specific energy consumption, pellets quality (durability, bulk density) and economical costs of aquatic feed pellets mass, in addition to growth performance of fish. The obtained data showed that, the highest values of machine productivity of 58.68 kg/h, pelleting efficiency of 95.48%, lowest specific energy consumption of 29.65 kW.h/Mg and the lowest cost per mass unit of 1976.68 L.E/Mg were recorded in the case of PBM percentage of 100% ,roller clearance of 0 mm and moisture content of 15%, while the highest values of durability(0.914 g/cm^3) and pellets bulk density (92.54%)were recorded at roller clearance of 2 mm, PBM percentage of 100% and moisture content of 15%.The results revealed that no disparity in growth response of fish and efficiency of feed utilization and did not affect fish composition of dry matter, protein, or fat levels in addition to the survival rate of Nile tilapia was high in all treatments. Hence, HFM can be replaced by PBM as a cheap source of protein in Nile tilapia diets because no significant effect for both HFM and PBM on pellet quality, machine performance and fish growth.

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INTRODUCTION

It is known that the conversion efficiency of feed into body tissue is generally much higher in fish than farm animals. Fish can convert up to 36% of feed protein into body protein, whereas beef-for example-typically converts only about 15%.So, fish meal considered one of the most important ingredients in aquatic feed formulation. Hence, the fish meal is the major protein source in aquatic feeds, but the cost of protein source accounts for more than half of fish feed ingredients .Thus, it is necessary to replace a cheaper protein source in aquatic feed formulation instead of fish meal. One of the alternative ingredients to fish meal is poultry by-product meal (PBM). PBM is made of ground, rendered, or clean parts of the carcass of slaughtered poultry. PBM has been tested at varying success so far in rainbow trout **(Alexis *et al.*, 1985),** tilapia **(El-Sayed, 1998), (Shepherd, 1998),(Diab and Ahmed, 2008).**Sea bream **(Nengas *et al.*, 1999),** common carp, catla, rohu **(Hasan and Das, 1993),** and Pacific white shrimp **(Davis and Arnold, 2000). Sevgili (2002)** reported that PBM could replace about 50% of fish meal in the diets for chinook salmon and rainbow trout. This study aimed to investigate the effect of replacement Percentage of PBM in the fish diet formulation using a ring-die pelleting machine and optimize some operational parameters affecting the machine performance for producing high quality fish feeds to maximize fish growth and reduce the total cost of fish diet production. **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 350 N at 6 % moisture to 50 N at 22% (w.b.). **Ouchiyama and Tanaka (1985),** found that main parameter during pelleting is the distance between roller and die(The clearance-size). Often the rollers are set to just touch the die. With increasing clearance-size, initially pellet hardness or durability will increase, thereafter pellet durability and hardness will deteriorate. **Robohm and Apelt (1989)** indicated that a maximum pellet durability exists depending upon the clearance-size between roller and die. They found an initial increase in pellet durability with the highest durability corresponding to a 2 mm clearance. A further increase in gap-size resulted in a decreased pellet durability to 97.2% corresponding with a 4 mm clearance. The main objective of this study to investigate the effect of replacement of fish meal by poultry by-product meal (PBM) in fish feed formula on 1) the ring-die pelleting machine parameters including productivity, pelleting efficiency; specific consumed energy and pelleting cost 2)pellets quality such as; durability and bulk density 3) fish growth performance (final weight, weight gain, daily gain), survival ratio and feed utilization.

MATERIALS AND METHODS

Experiments were carried out in Central Laboratory for Aquaculture Research in Abbassa, Abou Hammad district ,Sharkia Governorate.

1-Experimental ration

The experimental ration prepared by a hammer mill, the ration particles fineness were average 1mm mixed in forage mixer with about 15 , 20 and 25% moisture of total mass moisture content as wet basic (w.b). Three isocaloric ingredient blends were formulated with 30% protein with an energy content of 350 kcal/100 grams. The chemical analysis of Herring Fish Meal(HFM) and Poultry By-product Meal (PBM) used in the experiments are given in the Table (1) and the weight components of the different ingredients used in the experiment are given in Table (2).

Table (1). Proximate chemical analysis of HFM and PBM, (%; on dry matter basis).

Chemical analysis	Herring fish meal (HFM)	Poultry by – product meal (PBM)
Dry matter	92.50	85.52
Crude protein	71.26	59.75
Total lipids	14.18	14.19
Ash	11.05	10.98
NFE*	2.81	14.78
Crude fiber	0.70	0.30
GE/100 g diet**	536.65	531.69

*Nitrogen-Free Extract (calculated by difference) = 100 – (protein + lipid + ash + fiber).

**Gross energy was calculated from (NRC, 1993) as 5.65, 9.45, and 4.1 kcal/g for protein, lipid, and carbohydrates, respectively.

Table (2): Ingredients and chemical composition of the experimental diets (on dry matter basis).

Ingredients	Replacement of HFM by PBM in experimental rations (%)		
	0	50	100
Herring Fish Meal (HFM)	9.50	4.75	0.0
Poultry By-Product (PBM)	0	5.66	11.33
Soybean meal	45.10	45.10	45.10
Corn meal	19.50	19.50	19.50
Wheat bran	15.20	15.20	15.20
Starch	5.11	4.40	3.55
Cod - liver oil	2.09	1.89	1.82
Corn oil	1.50	1.50	1.50
Vit1. +Min. premix2(1 :1)	2.00	2.00	2.00
Total	100	100	100
Chemical analysis (%)	**Replacement of HFM by PBM in experimental rations (%)**		
	0	50	100
Dry matter	92.14	92.05	92.12
Crude protein	30.10	30.19	29.99
Ether extract	6.98	7.11	7.09
Ash	7.13	7.31	7.29
Crude fiber	5.11	5.31	5.26

[1] Vitamin premix (per kg of premix): thiamine, 2.5 g; riboflavin, 2.5 g; pyridoxine, 2.0 g; inositol, 100.0 g; biotin, 0.3 g; pantothenic acid, 100.0 g; folic acid, 0.75 g; para-aminobenzoic acid, 2.5 g; choline, 200.0 g; nicotinic acid, 10.0 g; cyanocobalamine, 0.005 g; a-tocopherol acetate, 20.1 g; menadione, 2.0 g; retinol palmitate, 100,000 IU; cholecalciferol, 500,000 IU.

[2] Mineral pre-mix (g/kg of premix): $CaHPO_4.2H_2O$, 727.2; $MgCO_4.7H_2O$, 127.5; KCl 50.0; NaCl, 60.0; $FeC_6H_5O_7.3H_2O$, 25.0; $ZnCO_3$, 5.5; $MnCl_2.4H_2O$, 2.5; $Cu(OAc)_2.H_2O$, 0.785; $CoCl_3.6H_2O$, 0.477; $CaIO_3.6H_2O$, 0.295; $CrCl_3.6H_2O$, 0.128; $AlCl_3.6H_2O$, 0.54; Na_2SeO_3, 0.03.

2-The specifications of ring-die pelleting machine

The tested ring-die pelleting machine was fabricated in United State of America by CPM company to produce fish feed with diameter of 3 mm. The construction features of the ring-die pelleting machine mainly consists of the following units as shown in Fig.(2).

A-conditioning unit

1- Feeding hopper

Feeding hopper is the part in which the ration put before conditioning stage .It constructed of steel metal with 3 mm. thickness, 430 mm. length, 340 mm. width and 450 mm. height. Maximum capacity of feeding hopper is about 10 kg. As shown in Fig.(2) there is a gate at the bottom of the hopper to allow ration to flow through it to the vibrator which allow the ration to flow through it to conditioning unit.

2- Mixing and transport unit

The mixing and transport unit supported inside the conditioner cylinder by two end bearings. It consists of shaft with 1200 mm. length and, 33mm. diameter .The blades on the surface were distributed in equidistant and alternate putting with horizontal line to allow the ration to flow inside the cylinder and completing the mixing operation in high qualification.

B- Forming unit

This unit which is responsible for compressing the ration in the forming zone. It consists of die and roller as shown in Fig.(1) Clearance between the die and roller length is controlled by increasing and decreasing to obtain the optimum of pellet quality and lowest of specific energy consumption. The die speed is 350 rpm and dimensions are 200mm in diameter and 40 mm in total thickness, it is name die effective whole thickness which has

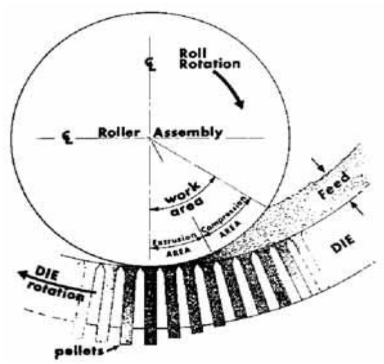
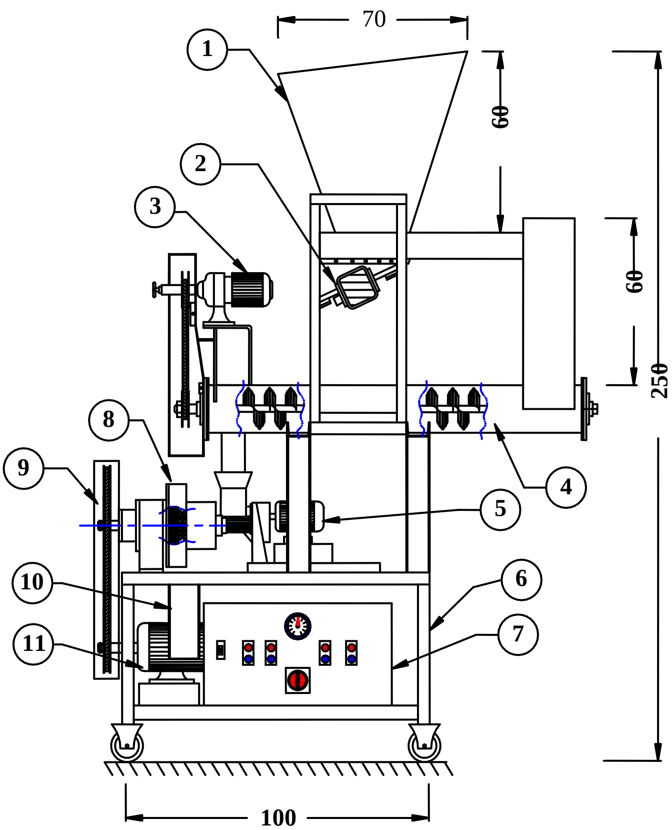


Fig.(1): Die and roller

a straight distance to press and form ration throw the hole to get the final product (pellets). On the surface of the die there are holes. Each hole has 3 mm diameter, the roller diameter is 90 mm. The surface of the roller has incisions to obtain the optimum of compressed pellet. There are two holes in forming unit. The first hole to receive the ration from feeding screw, the second hole finds in the bottom of forming unit to allow the compressed pellet to discharge.

C-Cutter knife

Cutter knife was fixed on ring die surface to cut the final product into small parts. It consists of one sharp blade, the obtained pellets length is controlled by increasing and decreasing the clearance between knife and the out-put port.



Part No.	Part name
1	Pre-conditioner feeding hopper
2	Pre-conditioner feeding motor (vibrator)
3	Pre-conditioner motor
4	Mixing and transport unit
5	feeding motor
6	Main frame base
7	Electric control switchboard
8	Forming unit
9	Operating pulley
10	Pellet outside
11	Main electric motor

Fig. (2): The ring-die pelleting machine

d- Power unit:

The main power unit including motor with rated power 2 kW at 1400 rpm rotational speed, with 5.4 A. It was used to operate the pelleting machine through reducer pulley and belt. The second motor is the conditioner motor, used to operate conditioning unit.

-Pelleting machine experiment

Experiments were conducted to evaluate a ring-die pelleting machine using constant values of roller speed of 350 rpm (motor speed 1400rpm) and feed rate of 60kg/h to optimize some operating and engineering parameters affecting its performance and pellets quality using ground Poultry By-product Meal (PBM) in fish feed formulation instead of Herring Fish Meal (HFM), these parameters are:

1- Three levels of replacement percentage of PBM in the fish feed formula (0, 50 and 100 %) were studied.

2-Three levels of roller clearance (0, 2 and 4 mm) were studied.

3- Three levels of moisture content (15, 20 and 25%) were studied.

2- Description of fish experiment:

This study was carried out at the Central Laboratory for Aquaculture Research, Abbassa, Abou-Hammad district, Egypt. Nile tilapia fingerlings (5.4 ± 0.13 g) were obtained from Abbassa fish hatchery and acclimated to laboratory condition for two weeks and were fed a commercial diet containing 35 % crude protein. Fifteen fish were frozen at – 20 C^o for proximate analysis. Acclimated fish were distributed randomly at 10 fish / 100 L glass aquarium. Each aquarium was supplied with well–aerated tap water. Three quarters of aquarium water was siphoned every day for removing the excretory products and refilled with well-aerated fresh water. Each aquarium was also supplied with air produced by a small compressor. The photoperiod was set on a 12 hour light – dark cycle using fluorescent tubes as the light source. These experiments were carried out to study the effect of using poultry by-product meal (PBM) in fish feed formulation, fish growth performance (weight, weight gain and daily gain), survival rate and feed utilization.

-Machine parameters and pellets quality

1- Productivity (capacity)

The productivity of the machine was measured as the mass of pellet collected per hour. During the experiments the compressed pellets were collected for every 60 seconds and the productivity was calculated as follows:

$$Productivity = \frac{W_P}{T} \times 3.6$$

Where Wp: pellets mass (g). T: consumed time (sec.).

2-Pelleting efficiency

Pelleting efficiency (%) $= W_p / Wm$

Where: W_p: pellets 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 whole pellets calculated as follows:

Pellet durability = (Mass of pellet after tumbling/Mass of pellet before tumbling)

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

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

4-Pellets bulk density

Pellets density $(g/cm^3) = W_d / V_d$

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

5- Total consumed power

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

Where:

I = Line current strength in 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

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

7- Cost per mass unit:

The total cost is estimated according to the conventional method of estimating both fixed and variable costs. While the cost per mass unit was calculated using the following equation:

$$Cost\ per\ mass\ unit\ of\ pellets\ (L.E/Mg) = \frac{Total\ cost\ (L.E/h)}{Productivity\ (Mg/h)}$$

<u>B-Growth performance of fish:</u>

Fish growth and feed utilization were evaluated by using the following equations:

1- Weight gain:

$$Weight\ gain = W_2 - W_1$$

2- Specific growth rate (SGR):

$$Specific\ growth\ rate = 100\ (lnW_2 - lnW_1) / T$$

Where W_1 and W_2 are the initial and final weight, respectively, and T is the experimental period (days).

3- Feed conversion ratio:

Feed conversion ratio (FCR) = feed intake / weight gain

Statistical analysis

The obtained data were analyzed by computer program of SPSS to determine the main and interaction effects of levels of PBM in fish feed formulation, roller clearance and moisture content on machine performance, pellets quality and fish growth.

RESULTS AND DISCUSSION

1-Effect of PBM percentage, roller clearance and moisture content on machine productivity:

The effect of different levels of PBM, moisture content and roller clearance on the productivity of the ring-die pelleting machine is shown in Fig. (3). The increase of machine productivity by increasing PBM could be due to the lubricating effect of fats which decrease the friction through the die holes compared to HFM, so the ration quantities which passed through the compressed unit and outputted from the die holes was increased, and also the interaction of PBM, with other components in feed formula played an important role in the mass flow rate of the ring-die pelleting machine. The roller clearance had clear effect in the productivity of the ring-die pelleting machine. This was expected because the compression force for the movement of the mixture in die holes decreases as the roller clearance was increased which leads to clear decrease in mass flow rate resulting in less productivity. It was also noticed that, the productivity decreases as the moisture content increased. This decrease of productivity by increasing moisture content could be due to the ration quantities which had excessive moisture tend to escape from the clearance between roller and forming die, for this reason the roller can not compress the rations so, ration quantities in forming unit increased gradually with the time resulting in high decrease in production rate. The highest value of machine productivity of 58.68kg/h was obtained at PBM of 100%, roller clearance of 0 mm. and moisture content of 15%.

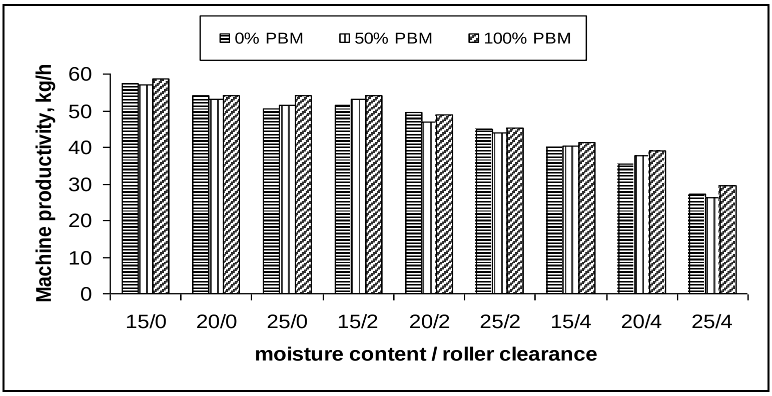


Fig.(3): Effect of PBM percentage, roller clearance and moisture content on machine productivity .

2-Effect of PBM percentage, roller clearance and moisture content on pellets durability:

Pellets durability is considered one of the most important indicators of pellets quality. The effect of percentage of PBM, moisture content and roller clearance on the pellet durability is illustrated in Fig.(4). The results showed that no significant effect on pellet durability by increasing PBM percentage in feed formula. The amount of carbohydrate in PBM(according to Table 1) which play an important role in the strength of binding of the pellets whereas the amount of solved carbohydrate and lipids which caused a hardness in the pellets and increasing the pellets resistance for cracking. Regarding to the influence of the roller clearance. It is observed an increase in pellet durability by increasing the roller clearance from 0 to 2 mm, but the increase of the clearance more than 2 mm, durability tend to decrease rapidly. This can be explained that the increase of the pressure inside die zone in forming unit which caused more compaction for the ration granules, but the increase of roller clearance more than 2 mm may be reduce the capability of roller to compress the accumulated ration in forming unit. It is noticed that the pellet durability increased as the moisture content decreased. The best values of pellet durability of 88.54 and 90.55 % were obtained at roller clearance of 0 and 2 mm respectively with moisture content of 15% and PBM of 100%.

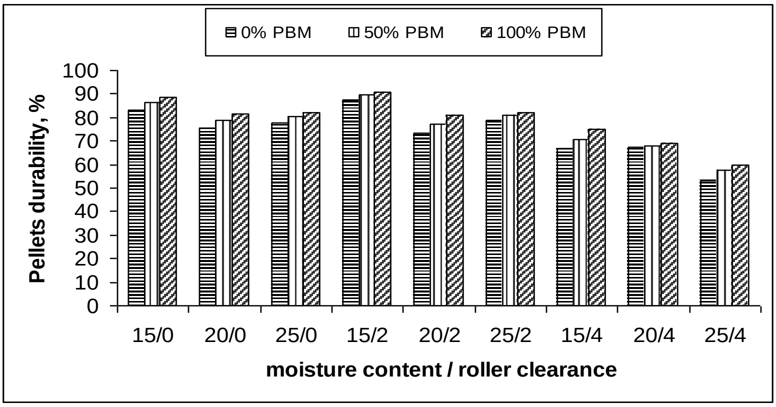


Fig.(4). Effect of PBM content, roller clearance and moisture content on pellet durability.

3-Effect of PBM percentage, roller clearance and moisture content on pellets bulk density:

Pellets bulk density is the major aquatic feed pellets quality indicator. The effect of changing the levels of PBM, roller clearance and moisture content on the bulk density of pellets is illustrated in the Fig.(5). Table(3) showed that the variation in levels of the PBM , roller clearance and moisture content in the feed ingredient mix had insignificant difference ($P < 0.05$) on the bulk density of the compressed pellets by the ring-die pelleting machine. Results showed that pellets bulk density increased by increasing PBM because the amount of carbohydrate presented in PBM improved the compaction of pellets resulting in increasing bulk density. The obtained results showed that pellets bulk density increased by increasing the roller clearance from 0 to 2 mm, but increasing the clearance more than 2 mm, bulk density tend to decrease. It is obvious that increasing roller clearance will increase the pressure inside the die zone during pelleting process, so high compaction occurs when the mix inside compression zone, but the increase of roller clearance more than 2 mm will reduce the pressure inside compression zone. The results showed that pellets bulk density decreases as the moisture content was increased because the increase of moisture content in the compressed ration will reduce the binding strength among particles. The best values of pellet bulk density of 0.898 and 0.944g/cm^3 were obtained at roller clearance of 0 and 2 mm respectively with moisture content of 15% and PBM of 100%.

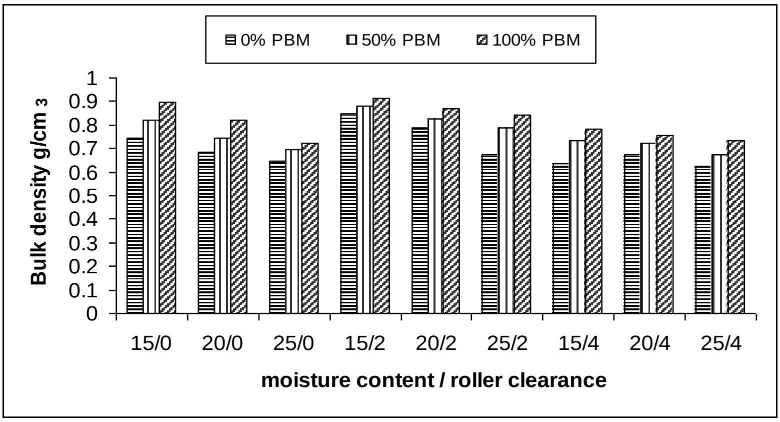


Fig.(5) Effect of PBM content, roller clearance and moisture content on Pellets bulk density. .

4-Effect of PBM percentage, roller clearance and moisture content on pelleting efficiency:

Pelleting efficiency is an important indicator to the percentage of the coming out product as pellets shape not as mash or broken shape .The effect of changing the levels of PBM, roller clearance and moisture content on pelleting efficiency is displayed in the Fig.(6). Regarding to the influence of PBM on pelleting efficiency, the results showed that the pelleting efficiency of the compressed pellets in the ring-die pelleting machine increased by increasing PBM .This was expected because, as PBM increased, the lubricant effect of oil in the ration leads to increase binding and mass flow of the compressed material which resulting in increasing pelleting efficiency. The obtained results indicate that, as the roller clearance in ring die pellleting machine increased, the compressed force to move the compacted mixture in die holes decreased which leads to prevent the mixture to get out through die holes caused pellets deformation and decreasing in machine productivity. Looking to moisture content effect on pelleting efficiency, it noticed that the pelleting efficiency of the compressed pellets in the ring-die pelleting machine decreased as the moisture content was increased. The highest value of pelleting efficiency of 95.48% was obtained at PBM of 100%, roller clearance of 0 mm and moisture content of 15%.

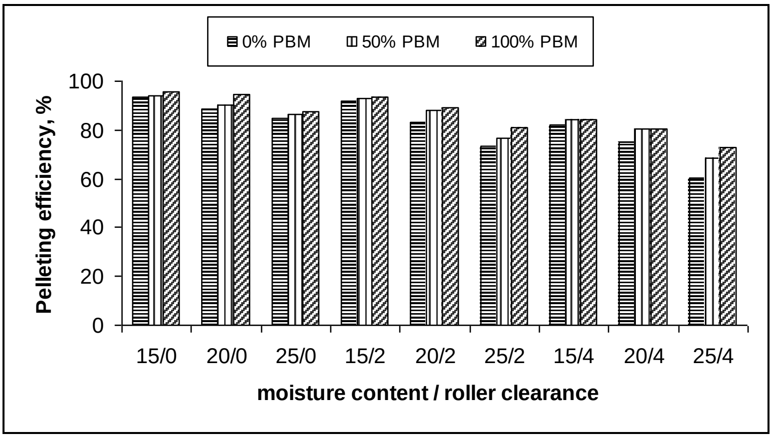


Fig.(6). Effect of PBM content, roller clearance and moisture content on pelleting efficiency.

5-Effect of PBM percentage, roller clearance and moisture content on specific energy consumption:

The aquatic feed pellets energy requirements depends theoretically on consumed power and production rate by the practically effect of the different operating parameters such as; the levels of the PBM, moisture content and roller clearance in diet formula. As illustrated in Fig.(7), the specific energy consumption decreases by increasing the percentage of PBM from 0 to 100 %, this decrease in energy requirements by increasing PBM percentage could be attributed to the increasing in the production rate in the same time unit more than the increase of power consumed during pelleting process. The obtained results showed that, as the roller clearance increased, sharply decrease in production rate with high load on the machine motor was occurred, that is mean high power consumption with low productivity at the same time in pelleting process. Regarding to moisture content effect on specific energy consumption, it noticed that the specific energy consumption increased by increasing moisture content. The lowest value of specific energy consumption of 29.65 kW.h/Mg was obtained at PBM of 100%, roller clearance of 0 mm and moisture content of 15%.

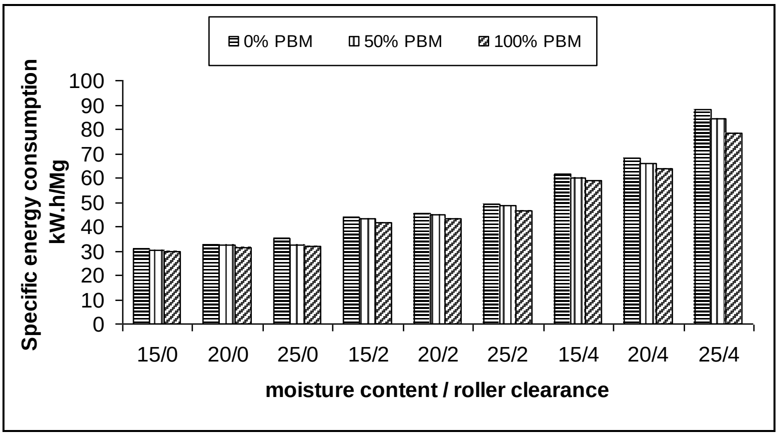


Fig.(7) Effect of PBM content, roller clearance and moisture content on specific energy consumption .

6-Effect of PBM percentage, roller clearance and moisture content on cost per mass unit:

Selecting of operating parameters which decreases operating cost of fish feeds with high quality production was and still the main goal of various researches in this field. The effect of changing PBM levels, roller clearance and moisture content on cost per mass unit is illustrated in Fig.(8).Regarding to the effect of PBM on the cost per mass unit of produced feeds, the maximum cost of 2665.99 L.E/Mg was achieved at 0 % PBM (HFM 100%) ,roller clearance of 4 mm and moisture content of 25%,while the minimum cost per mass unit of 1976.68 L.E/Mg was achieved at 100 % PBM, roller clearance of 0 mm and moisture content of 15%. From the obtained data, the increase of PBM percentage in the diet formula to 100% with the other proper operating factors saved about 689.31 L.E/Mg. The high decrease in cost per mass unit could be due to the increase in machine productivity and the decrease in the price of PBM in feed formula compared to the HFM fish diets. According to the obtained data it is obvious that, the cost per mass unit of the compressed pellets in the ring-die pelleting machine increased as the roller clearance was increased. The increase of cost per mass unit by increasing roller clearance can be due to the over load on machine motor, and the decrease of machine productivity, that is mean a high increase of operating cost. As the moisture content was decreased the cost per mass unit of the compressed pellets in the ring-die pelleting machine was decreased.

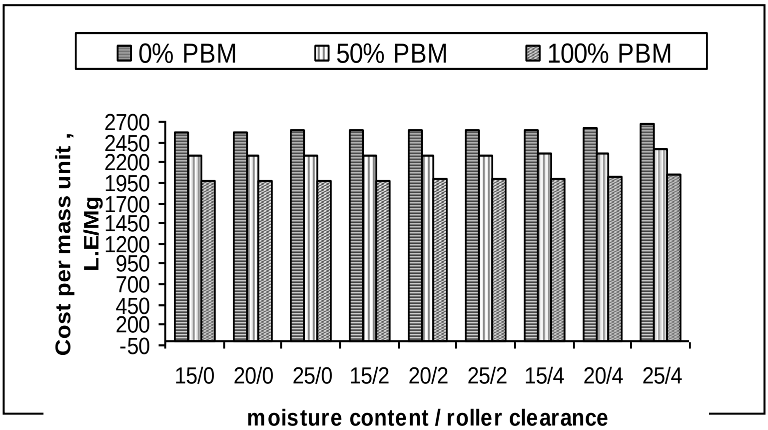


Fig.(8) Effec e content on cost per mass unit of ring-die pelleting machine.

7-Fish growth:

The results PBM analysis is a good alternative protein source and may replace Herring Fish Meal (HFM) protein in fish diets. All Nile tilapia became accustomed to the experimental diets and were observed to feed actively throughout the duration of this study. Initial body weigh at all experimental treatments did not differ significantly. The statistical analysis of the obtained data in Table (3) showed that growth performance (final body weight, weight gain and daily gain) and Feed efficiency (feed intake and FCR) was not significantly ($P > 0.05$) differed. All diets were well accepted by Nile tilapia. Diet utilization (feed conversion ratio) was not significantly ($P > 0.05$) affected by PBM levels. These results coincide with, **Abdelghany *et al.* (2005) & Diab and Ahmad (2008)** reported that fish fed diets, in which poultry by-product meal (PBM) replaced up to 100% of the protein supplied by Herring fish meal (HFM) had similar growth performance. These observations suggested that the PBM diets contained all the necessary growth factors required by Nile tilapia, that explained why there was no disparity in growth response of fish and efficiency of feed utilization. Survival rate of Nile tilapia fed all the treatments was high and ranged from 96.7 to 100 % without significant difference among them ($P > 0.05$) as illustrated in Table (3).

Table (3): Growth performance and feed utilization of Nile tilapia fed diets containing different levels of PBM.

Growth parameters	PBM levels (%)		
	0	50	100
Initial weight (g)	5.51±0.12[a]	5.29±0.01[a]	5.44±0.15[a]
Final weight (g)	28.33±0.39[a]	27.83±0.38 [a]	28.41+0.37[a]
Weight gain (g)	22.82±0.27[a]	22.54±0.31[a]	22.97±0.35 [a]
Growth (g/day)	0.272±0.02[a]	0.268±0.03 [a]	0.273±0.03[a]
FI (g feed/ fish)	30.12±0.48[a]	29.98±0.58 [a]	31.01±0.57[a]
FCR	1.32±0.04[a]	1.33 ±0.05[a]	1.35±0.05[a]
Survival rate (%)	97.78±2.22[a]	95.56±2.22[a]	97.78±2.22[a]

The same letter in the same row is not significantly different at P < 0.05.

Table (4):Effect of percentage of PBM, roller clearance and moisture content on machine performance and pellets quality.

parameters	Physical and mechanical properties of compressed pellet					
	Productivity	Durability	Bulk density	Pelleting efficiency	Specific energy consumption	Cost per mass unit
PBM = 0.0 %	46.09 [c]	76.56 [c]	0.733 [c]	83.36 [c]	50.75 [a]	2603.09 [a]
PBM =50 %	47.28 [bc]	76.43 [bc]	0.746 [b]	85.35 [b]	50.11 [b]	2302.05 [b]
PBM = 100 %	47.62 [b]	76.94 [b]	0.769 [a]	86.53 [b]	48.42 [c]	1998.74 [c]
Roller clear=0	54.81 [a]	82.27 [b]	0.713 [c]	92.13 [a]	31.81 [c]	2282.28 [c]
Roller clear= 2	50.08 [b]	82.44 [a]	0.816 [a]	87.20 [b]	45.20 [b]	2290.44 [b]
Roller clear= 4	36.31 [c]	65.21 [c]	0.720 [b]	75.21 [c]	72.28 [a]	2331.16 [a]
M.C.= 15 %	51.09 [a]	82.12 [a]	0.783 [a]	88.49 [a]	44.46 [c]	2291.19 [c]
M.C.=20 %	47.67 [b]	75.15 [b]	0.766 [b]	85.75 [b]	47.72 [b]	2297.73 [b]
M.C.= 25 %	42.23 [c]	72.66 [c]	0.700 [c]	81.01 [c]	57.12 [a]	2314.96 [a]

CONCLUSION

From this investigation, it is recommended to operate the ring-die pelleting machine with PBM percentage of 100% ,roller clearance of 0 mm and moisture content of 15% to achieve the highest values of machine productivity of 58.68 kg/h, pelleting efficiency of 95.48%, lowest specific energy consumption of 29.65 kW.h/Mg and the lowest cost per mass unit of 1976.68 L.E/Mg, while the highest values of durability(0.914 kg/m^3) and pellets bulk density (92.54%)were recorded at roller clearance of 2 mm, PBM percentage of 100% and moisture content of 15%.The results indicated that, the complete replacement of HFM by PBM with roller clearance of 0 mm and moisture content of 15% saved about 689.31 L.E/Mg. For fish growth, results indicated that no disparity in growth response of fish and efficiency of feed utilization that is mean, partial or complete replacement of HFM by PBM in feed formula did not affect the dry matter, protein, or fat levels in fish body. Hence, PBM considered as cheap source of protein in Nile tilapia diets.

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الملخص العربى

تأثيرأستخدام مخلفات مجازر الدواجن علي جودة أعلاف الأسماك المصبعة ونمو الأسماك بأستخدام آلة التصبيع الحلقية

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في هذة الدراسة أستخدمت علائق تتفق فيما بينها فى نسب البروتين (٣٠%) ولكنها تختلف فى نسب احلال مسحوق مخلفات مجازر الدواجن كمصدربروتين رخيص الثمن بدلاً من مسحوق الأسماك المستورد، حيث كانت نسب الاحلال صفر ، ٥٠ ، ١٠٠% على أساس وحدة البروتين مختلطة بنسب مناسبة من فول الصويا, الذرة,وخليط من الفيتامينات و المعادن وتم تصبيعها باستخدام آلة التصبيع الحلقية لتغذية أصبعيات أسماك البلطى بأوزان أبتدائية (٥,٤±٠,١٣ جم). وتم تقييم الآلة من خلال دراسة تأثيرنسب الأحلال الثلاثة لمخلفات مجازر الدواجن و ثلاث قيم لخلوص قرص الضغط (صفر،٢،٤مم) و ثلاث قيم للمحتوى الرطوبى للخلطة (١٥ ،٢٠، ٢٥%) وذلك لمعرفة تأثير الأحلال والعوامل السابقة على قياسات أداء الآلة وتشمل معدل انتاج الآلة ،الطاقة اللازمة للتصنيع ، كفاءة التصبيع ، تكلفة وحدة الطن من العلف وأيضاً قياسات خاصة بجودة العلف وهى متانة وكثافة العلف،بالأضافة الي قياسات خاصة بنمو الأسماك .أوضحت النتائج المتحصل عليها أن أعلي قيمة لأنتاجية الالة (٥٨,٦٨ كجم/ساعة)،وكفاءة التصبيع (٩٥,٤٨%)،وأقل طاقة مستهلكة(٢٩,٦٥ كيلووات .ساعة/طن)وأقل تكلفة لطن العلف (١٩٧٦,٦٨ جنية/طن) قد تحققت بأحلال مخلفات المجازر محل مسحوق السمك بشكل كلي(١٠٠%) مع خلوص لقرص الضغط صفر مم و محتوي رطوبي حوالي ١٥%، بينما كانت أعلي قيمة لكل من متانة العلف (٩٢,٥٤%) والكثافة الحجمية (٠,٩١٤ جم/سم^{3}) قد تحققت عند خلوص لقرص الضغط ٢ مم و نسبة أحلال مخلفات المجازر ١٠٠% ومحتوي رطوبي حوالي ١٥%. أشارت النتائج الي أن عملية أحلال مخلفات المجازر في الخلطة أدت الي تقليل تكلفة وحدة الطن من العلف بحوالي ٦٨٩,٣١ جنية في المتوسط أذا ما قورنت بتكاليف االخلطة التي تحتوي علي مسحوق السمك المستورد (مخلفات المجازر= صفر%).اما بالنسبة لتأثيره على الاسماك، فقد أوضحت النتائج أنه لا توجد فروق معنوية من حيث أستجابة نمو الأسماك وكفاءة تحويل الغذاء حيث لم تتغير نسب المادة الجافة والبروتين والدهون بأجسامها كما أن نسبة الأسماك الحية لأسماك البلطي النيلي ظلت عالية ومتماثلة أحصائياً في المعاملات المختلفة. و من هن يمكن احلال مخلفات مجازر الدواجن محل مسحوق السمك في علائق أسماك البلطى كمصدر رخيص للبروتين النيلى لعدم وجود فروق معنوية بين مخلفات المجازر ومسحوق السمك علي قياسات جودة العلف وكفاءة الألة ومعدل نمو الأسماك.

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