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DEVELOPMENT OF A FODDER MIXER

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ABSTRACT

A horizontal batch mixer was developed and evaluated to improve the mixing homogeneity in premix feed processing. It operates at low speed and has large impellers, which sweep the whole vessel to mix mash components. The developed mixer was evaluated within studying the effects of some engineering and operating parameters on the mixing homogeneity and energy requirement. These parameters included mixing time (3, 6, 9, and 12 min.), mixer speed (0.88, 1.1, 1.25, and 1.44 m.sec^{-1}) and blade setting angle (30, 45 and 60 degrees). The results indicated that increasing the mixing time more than 6 min caused a negative effect on the process under blade setting angle of 30 degrees, causing component segregation and an increase in energy requirement. While using blade setting angle of 45 and 60 degrees caused component segregation when mixing time exceeded 9 minutes. To achieve an adequate mixing homogeneity, mixing time must not exceed 3 minutes, blade setting angle 30° and mixing speed should be equal to 0.88 m.sec^{-1} to avoid extra cost in energy consumption. Based on the experimental results, the best mixing homogeneity of 99 % with low energy requirement of 2.624 kW.hr.Mg^{-1} were obtained by using the mixer with mixing speed of 0.88 m.sec^{-1}, mixing time of 3 min. and blade setting angle of 30 degrees.

Key words: Mixing homogeneity, horizontal batch mixer, paddle mixer.

INTRODUCTION

The problem of increasing human population in Egypt must be faced with increasing animal products. Mixing of powders is very common in the feed industry and represents a critical unit operation of the production process of both mash and pellet forms. The quality of products depends on the degree of mixing of their constituent materials, which guarantees the homogeneity of the final product.

There are some disadvantages to ribbon blenders as well; they permit stagnant regions ("dead spots") which lead to a large variability in the concentration of individual components. So that the main target of this study is to develop and raise the efficiency of a horizontal fodder mixer to avoid some disadvantages of which already exist in the studied mixer *i.e.* stagnant regions which lead to a large variability in the concentration of individual components, narrow spaces between the blade and the vessel walls which cause conglomerates may lead to formation of moldy feed parts.

Bockisch *et al.* (1992) stated that the exact mixing of animal feed is required to avoid selective intake by the animal, they recommended that the mixing time has not exceed 8 min., to avoid extra cost in labor and energy consumption.

Hassan (1994) recommended that auger speeds not to exceed 200 rpm as it resulted in low mixing efficiencies of 35-50% under all mixing time, hence he reported that optimum period time of mixing range from 12 to16 min., and from 10 to 16 min., under both auger speeds of 160 and 200 rpm. respectively, these speeds gave the highest mixing efficiencies of 84-99%.

Abdel-Tawwab *et al.* (2006) indicated that, the energy requirement increased by about 31 % when the impeller speed increased from 0.86 to 3.47 m.sec^{-1}. Where the energy was 1.61, 1.89, 2.11, and 2.31 kW.hr.Mg^{-1} when mixing time

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was 5, 10, 15, 20 minutes respectively. It can be concluded that mixing energy requirement increased by about 43% when mixing time increased from 5 to 20 minutes. Also the use of speed 1.73 m.sec^{-1} decreased energy requirement by about 8% and 15% than in case of mixing speeds of 2.6 m.sec^{-1} and 3.47 m.sec^{-1}, respectively with increasing in mixing homogeneity.

Olivera *et al.* (2009) mentioned that, mixing is one of the most essential and critical operations in the process of feed manufacturing. The objective in mixing is to create a completely homogeneous blend. In other words, every sample taken should be identical in nutrient content. A functional definition of uniform mixing can be summarized in one sentence. "All nutrients will be present in sufficient quantity in the daily feed intake of the target animal to meet minimum growth requirements".

John (2012) mentioned that, the propensity of free-flowing particles or aggregates of cohesive particles to segregate raises an important issue in the design and evaluation of mixing processes. About mixing time if a recipe is mixed too long, the quality deteriorates. For cohesion less particles this is caused by segregation. For cohesive particles this can be caused by allowing dough to form, rather than remaining as discrete aggregates.

The major task of this study is to develop and evaluate a horizontal batch mixer to improve the mixer performance by overcoming experimental mixer disadvantages in order to increasing mixing efficiency, reducing fodder losses and minimizing power requirements as well as the economic costs in premix feed processing.

MATERIALS AND METHODS

This study was conducted through 2013 at CLAR (Center Laboratory for Aquaculture Research), EL-Abasa village, Abohammad city, Sharkia Governorate. The experimental equipment was fabricated and assembled in a private workshop at Abohammad city. The experimental work and data collection were carried out to develop the performance of a horizontal fodder mixer to avoid some disadvantages of ribbon blenders as well; they permit stagnant regions (dead spots) which lead to a large variability in the concentration of individual components. Also, they may allow narrow spaces between the blade and the vessel walls which cause conglomerates may lead to formation of moldy feed parts.

Materials

The Experimented Feed Formula Composition

The combination of mash feed formula was (47% soy-bean meal, 26.5% corn yellow grain, 26.5% wheat bran).

Description of the Mixer Equipment

The mixer formed of U-shaped chamber made of stainless steel of 5mm thickness, the internal diameter and length of the chamber are 75 and 150 cm, respectively. The third area of upper part is coverless side with dimensions of 60 × 150 cm. The outlet open was fixed at one side of the middle bottom of the mixer of a chamber with 18×25×20 cm width, height, and length, respectively.

Mixer directly driven by V belt and pulley from an electric motor 10 hp (7.4 kW), 1420 rpm., motor speed controled by using a gear box mounted on the left side of the mixer. Therefore, this machine is a totally enclosed batch mixer (Fig. 1).

Description of Mixing Shaft Before Development

Mixing shaft before development is a circular section of 8 cm for diameter and 150 cm for length equipped with a triple auger of 25.9 cm diameter and 61 cm as a pitch length for the vast one and 12.8 cm diameter and 34 cm as a pitch length for the duo small augers (Fig. 2).

Description of the Developed Mixing Shaft

Performance optimization of a mixer is an issue of great significance in many industrial technologies that deal with particle processing.. In industrial processes, blades are widely used for granular mixing, granulation and granular transportation, with this in mind in this study mixing process carried out by 24 paddle impellers mounted upon a horizontal mixing shaft which has the effect of conveying the

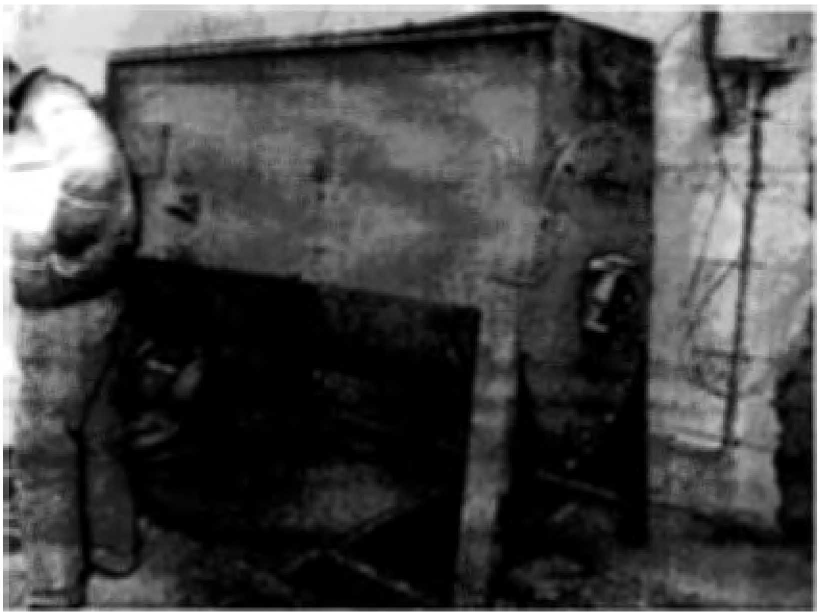
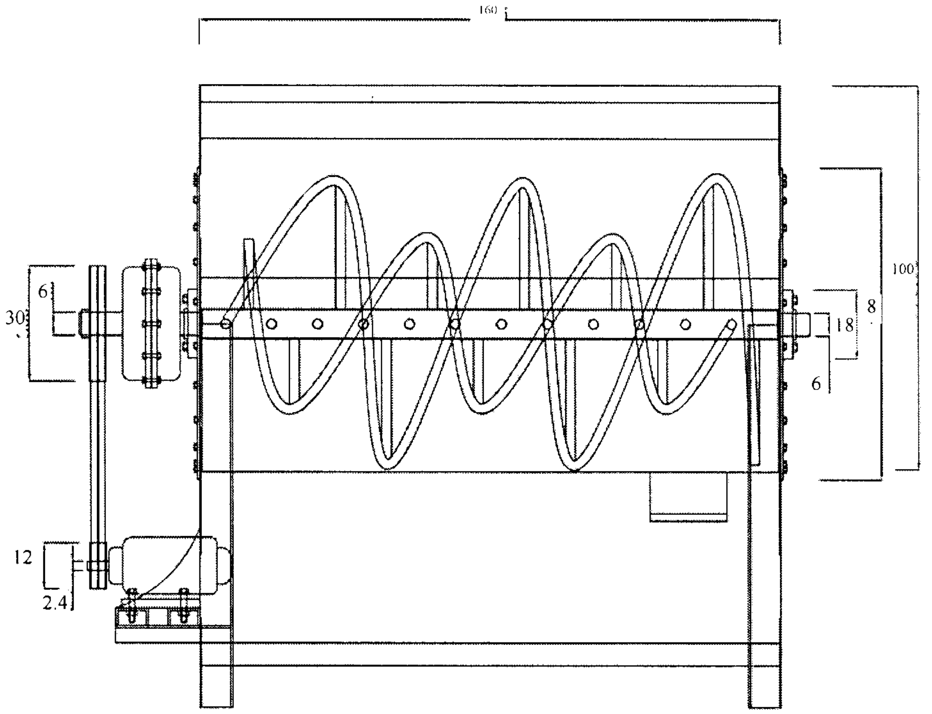


Fig. 1. Body of the mixing equipment



Dim. in cm.

Fig. 2 Sec. Elevation of mixer before development ingredients and forwards until they are thoroughly mixed. The dimensions of the mixing shaft are 160 cm long and 8 cm diameter. Paddles considered as trapezoidal blades each blade has dimensions of 17, 9, 18 cm for bases and length, respectively with percentage of overlap 25.4% between blades, each blade fixed at the tip of bolt with 2 cm diameter and 30 cm lengthr. The radius of the blade rotation from the center of the mixing shaft is 29.9 cm can be changed to control clearance between blades and the vessel wall to avoid conglomerates formation in order to prevent moldy feed parts (Fig. 3).

Instruments

Digital clamp meter

This Digital clamp meter No: DT/DM 6266, used to measure the line current strength in amperes.

Stop watch

A stopwatch features 30 minutes inner register and 60 seconds sweep with 0.1 second resolution. It is used to record the time of all operations.

Balances

A balance with accuracy of 1 g was used to weight the ingredients of feed formula.

Methods

The ingredients of experimental ration was prepared from different materials as sources of plant protein, and then put in the vessel for mixing. A comparison study conducted to compare the performance of the mixer before and after development, the mixer performance was studied as a function of change of the following parameters.

Mixer speed

Four different levels of mixer speed of 0.88, 1.1, 1.25 and 1.44 m.sec^{-1} (28, 34, 40 and 46 rpm) were studied.

Mixing time

The performance of the mixer was evaluated under four different levels of mixing time 3, 6, 9 and 12 minutes.

Blade setting angle

Three different angles of blade setting were chosen as 30, 45 and 60 degrees around horizontal axis.

Measurements and Calculations

The mixer performance before and after development was measured taking into consideration the following indicators.

Mixing homogeneity

The mixture homogeneity is an issue of serious concern in the course of adding insignificant amount of feed components in the mixture. After a mixing experiment, 3 samples were taken from different locations in the mixer at evenly spaced points in time. Protein analysis was performed for the samples at the Center for Agricultural Research and Experiments, Central Laboratory at Faculty of Agriculture Zagazig Univ. The crude protein percent was determined for each sample. It was calculated according to the following formula which cited from Abdel-Tawwab *et al.* (2006):

$$\text{Crude protein percent} = \frac{Cp_a}{Cp_b} \times 100$$

Where:

Cp_a = Crude protein after mixing, %.

Cp_b = Crude protein determined according to its ingredients before mixing, %.

Power requirements

The power requirements were calculated through the following equation cited from Ibrahim (1982)

$$\text{Power requirement} = \frac{\sqrt{3}.I.V.\eta.\cos\theta}{1000}$$

Where:

I = Line current strength in amperes.

V = Potential difference (Voltage) being equal to (380 V).

$\sqrt{3}$ =Coefficient current three phase (being equal 1.73).

$\cos\theta$= Power factor being equal to (0.84).

η = Mechanical efficiency assumed (95 %).

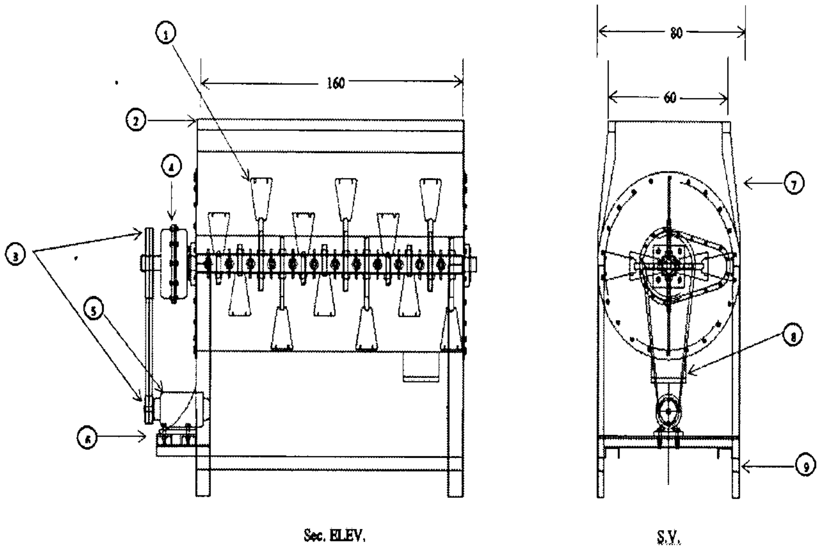
The power associated with labors for system management determined as following equation (Hunt, 1983).

Human power = 0.0746 x N_L, kW.

Where:

N_L =Number of laborers required to perform operation, man.

0.0746 = Human power equivalent, kW.



No.	Part name
1	Blade
2	Mixer cover
3	Pulley
4	Speed reduction unit
5	Electrical motor
6	Motor base
7	Mixing hopper
8	Outlet open
9	Mixer frame

Dim. in cm.

Fig. 3. Mixer after development

Specific energy consumed

Energy consumed was calculated by using the following equation:

$$\text{Specific energy consumed} = \frac{\text{Power consumed (kW)}}{\text{Actual productivity (Mg.hr}^{-1}\text{)}}, \text{kW.hr.Mg}^{-1}$$

Operation cost

The cost analysis was performed considering the conventional method of estimating both fixed and variable cost.

RESULTS AND DESCUSSION

The data were collected to evaluate the performance of a developed fodder mixer and compare between mixer performance before and after development. Different criteria such as mixing homogeneity, power requirements, specific energy consumed (kW.hr.Mg^{-1}) and operational cost.

Mixing Homogeneity

Influence of development on mixing homogeneity

By comparing the developed mixer with the initial mixer before development as shown in Fig. 4 at original mixing speed of 1.1 m.sec^{-1} the highest value of mixing homogeneity was 91% obtained by using the developed mixer with blade sitting angle of 30 degrees after only 3 minutes whereas the best mixing homogeneity before development was 89% achieved after 9 minutes.

Influence of mixer speed and blade setting angle according to mixing time on the mixing homogeneity

Generally mixing homogeneity was greatly affected by mixer speed. From Fig. 5 it can be reported that the mixing homogeneity decreased from 99 to 91% with increasing the impeller speed from 0.88 to 1.1 m.sec^{-1}, meanwhile when speed increased from 1.1 to 1.25 m.sec^{-1} lead to decrease mixing homogeneity about 8%, but increasing mixer speed from 1.25 to 1.44 m.sec^{-1} kept mixing homogeneity as 83% that was for blade setting angle of 30 degrees. For blade setting angle of 45 degrees mixing homogeneity decreased from 90 to 88% when mixer speed increased from 0.88 to 1.1 m.sec^{-1} but increasing speed from 1.1 to 1.25 and 1.44 m.sec^{-1} leading to decrease mixing homogeneity 2% for each once. According to blade setting angle of 60 degrees, mixing homogeneity decreased from 92 to 87% when mixer speed increased from 0.88 to 1.1m.sec^{-1} but increasing speed from 1.1 to 1.25 and 1.44 m.sec^{-1} leading to increase mixing homogeneity 3 and 4%, respectively.

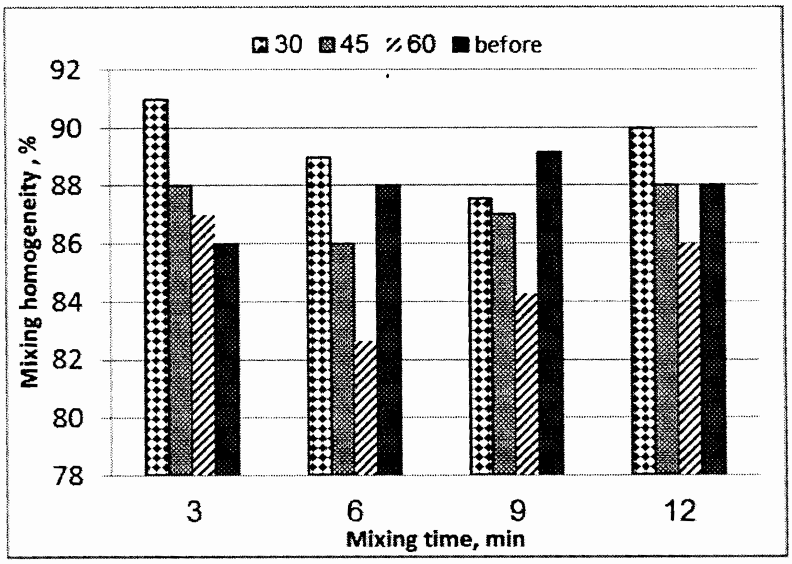


Fig. 4. Mixing homogeneity before and after development according to mixing time

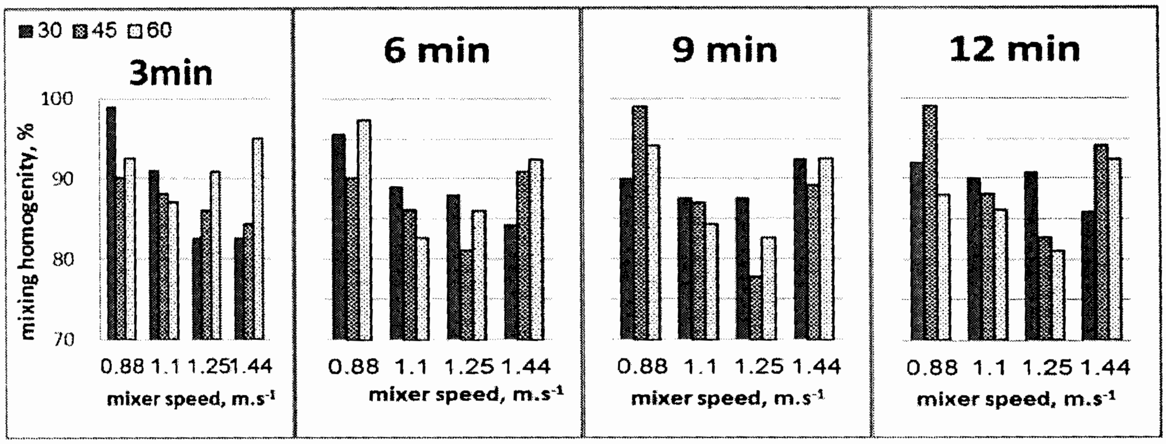


Fig. 5. Effect of mixer speed and blade setting angle on the mixing homogeneity according to different mixing time

Concerning of mixing time of 6 minutes, mixing homogeneity decreased from 96 to 89% with increasing the impeller speed from 0.88 to 1.1m.sec^{-1}, meanwhile when speed increased from 1.1 to 1.25 and 1.44 m.sec^{-1} lead to decrease mixing homogeneity about 1 and 4%, respectively that was for blade setting angle of 30 degrees. For blade setting angle of 45 degrees, mixing homogeneity decreased from 90 to 86% when mixer speed increased from 0.88 to 1.1 m.sec^{-1} but increasing speed from 1.1 to 1.25 m.sec^{-1} leading to decrease mixing homogeneity 5%, increasing mixer speed to 1.44 m.sec^{-1} lead to increase mixing homogeneity about 10%. According to blade setting angle of 60 degrees, mixing homogeneity decreased from 97 to 83% when mixer speed increased from 0.88 to 1.1 m.sec^{-1} but increasing speed from 1.1 to 1.25 and 1.44 m.sec^{-1} leading to increase mixing homogeneity 3 and 6%, respectively.

With regard to mixing time of 9 minutes, mixing homogeneity decreased from 90 to 88% with increasing the impeller speed from 0.88 to 1.1 m.sec^{-1}, while when speed increased from 1.1 to 1.25 mixing homogeneity remained 88% and decreased about 4% when mixer speed was 1.44 m.sec^{-1} that for blade setting angle of 30 degrees. For blade setting angle of 45 degrees mixing homogeneity decreased from 99 to 87% when mixer speed increased from 0.88 to 1.1 m.sec^{-1} it also led increasing speed from 1.1 to 1.25 m.sec^{-1} to decrease mixing homogeneity 9%, increasing mixer speed to 1.44 m.sec^{-1} led to increase mixing homogeneity about 11%. Related to blade setting angle of 60 degrees, mixing homogeneity decreased from 94 to 84 and 83% when mixer speed increased from 0.88 to 1.1 and 1.25 m.sec^{-1} but increasing mixer speed to 1.44, increased mixing homogeneity by 9%.

Regarding mixing time of 12 minutes, mixing homogeneity decreased from 92 to 90% with increasing the impeller speed from 0.88 to 1.1 m.sec^{-1}, meanwhile when speed increased from 1.1 to 1.25 m.sec^{-1} lead to increase mixing homogeneity to 91%, but increasing mixer speed from 1.25 to 1.44 m.sec^{-1}, mixing homogeneity decreased to 86%, that was for blade setting angle of 30 degrees. With blade setting angle of 45 degrees, when mixer speed increased from 0.88 to 1.1 and 1.25 m.sec^{-1} mixing homogeneity decreased from 99 to 88 and 83%, but increasing speed to 1.44 m.sec^{-1} leading to increase mixing homogeneity to 94%. According to blade setting angle of 60 degrees, mixing homogeneity decreased from 88 to 86 and 81% when mixer speed increased from 0.88 to 1.1 and 1.25m.sec^{-1} but increasing speed to 1.44 m.sec^{-1} leading to increase mixing homogeneity by 11%.

The reason was that the tendency to segregate is determined by the balance between external and inter particle force in a mixture. External force can be characterized by an average shear rate which is positively related to the rotational speed of the impeller. Segregation occurs because of the varying response of different particles to this external force. If the external forces predominate, then the powder is free flowing and the segregation potential is high and thus delays the mixing homogeneity.

This study has shown that, to achieve an adequate mixing homogeneity, the developed mixer must operate at mixing speed of 0.88m.sec^{-1} and blade setting angle as close to 30 degrees as possible just for 3 minutes.

Energy Requirement

Specific energy consumed for mixing operation before and after development

The difference in mixer before and after development must to be illustrated particularly for energy consumption. It is explicitly evident energy consumption greatly affected by the development occurred on the studied mixer. Generally specific energy consumed decreased by using the developed mixer as shown in Fig. 6, where specific energy consumed before development at mixing time of 3 minutes was 3.04 kW.hr.Mg^{-1} then decreased to 2.647,2.571 and 2.523 kW.hr.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees respectively. When mixing time was 6 minutes specific energy consumed was 3.84 kW.hr.Mg^{-1} before development decreased to 3.635, 3.531 and 3.464 kW.hr.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees, respectively. At mixing time of 9 minutes, specific energy consumed was 4.99 kW.hr.Mg^{-1} before development decreased to 4.627, 4.495 and 4.410kW.hr.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees, respectively. For mixing time of 12 minutes, specific energy consumed was 6.370kW.hr.Mg^{-1} before development decreased to 5.620, 5.460 and 5.357kW.hr.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees, respectively.

The decrease of specific energy consumed by using the developed mixer could be due to the decrease of power requirement and the increase of actual operating productivity so that lead to reduce specific energy consumption.

Specific energy consumed for mixing operation of the developed mixer

Specific energy consumed for mixing operation are related to the mixer speed, mixing time and blade setting angle as shown in Fig. 7. Results show that specific energy consumed increased whenever the mixer speed increased and blade setting angle decreased according to the experimental levels on this study.

Relating to mixing time of 3 min., increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-}1, specific energy consumed increased from 2.624 to 2.647 , 2.677 and 2.7 kW.hr.Mg^{-1} when the blade setting angle was 30^{0}, although at blade setting angle of 45^{0} specific energy consumed increased from 2.501 to 2.571 , 2.642 and 2.673 kW.hr.Mg^{-1}, while at blade setting angle of 60^{0}, specific energy consumed increased from 2.470 to 2.523 , 2.598 and 2.638 kW.hr.Mg^{-1}.

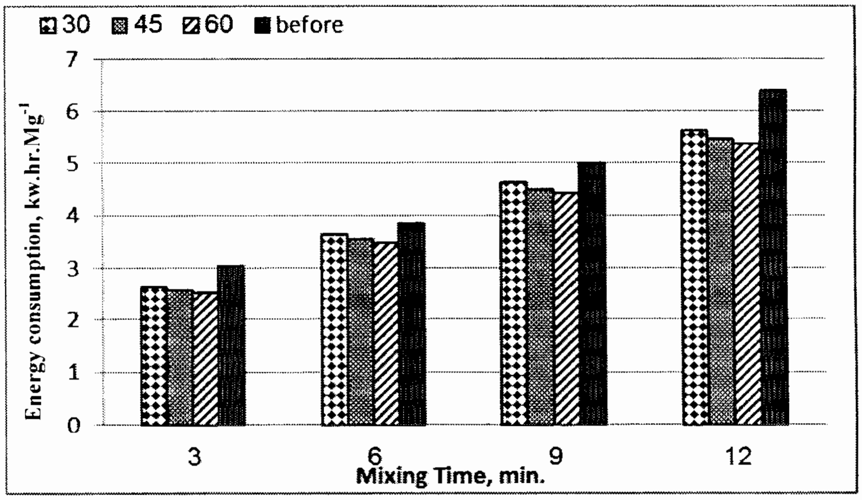


Fig. 6. Energy consumption before and after development according to mixing time

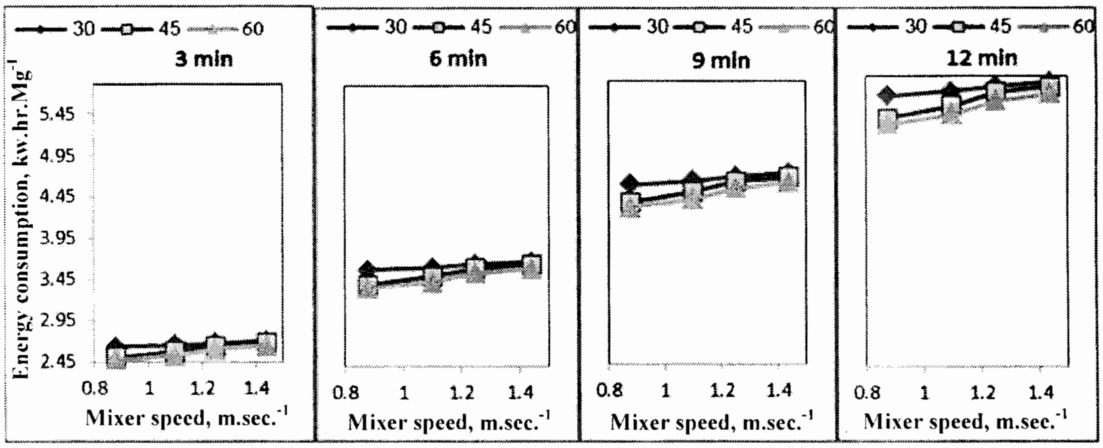


Fig. 7. Effect of mixer speed and blade setting angle on specific energy consumed according to mixing time

In relation to mixing time of 6 minutes, increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1} specific energy consumed increased from 3.604 to 3.635 , 3.677 and 3.708 kW.hr.Mg^{-1} when blade setting angle was 30^0, although at blade setting angle of 45^0, specific energy consumed increased from 3.434 to 3.531 , 3.629 and 3.671 kW.hr.Mg^{-1}, while at blade setting angle of 60^0 specific energy consumed increased from 3.391 to 3.464 , 3.568 and 3.622.

Concerning to mixing time of 9 minutes, increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1} increased specific energy consumed from 4.588 to 4.627 , 4.681 and 4.719 kW.hr.Mg^{-1} when the blade setting angle was 30^0, although at blade setting angle of 45^0 specific energy consumed increased from 4.372 to 4.495 , 4.619 and 4.673 kW.hr.Mg^{-1}, while at blade setting angle of 60^0, specific energy consumed increased from 4.317 to 4.410 , 4.542 and 4.611 kW.hr.Mg^{-1}.

According to mixing time of 12 minutes, increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1}increasing specific energy consumed from 5.573 to 5.620 , 5.686 and 5.733 kW.hr.Mg^{-1} when the blade setting angle was 30 degrees, although at blade setting angle of 45^0, specific energy consumed increased from 5.310 to 5.460 , 5.611 and 5.677 kW.hr.Mg^{-1}, while at blade setting angle of 60^0, specific energy consumed increased from 5.244 to 5.357 , 5.517 and 5.601 kW.hr.Mg^{-1}.

Cost Analysis

Complete cost analysis was made at different operating conditions and related with the actual mixing productivity for the studied mixer. The resulting operating cost was found to be affected by development and power requirements.

To be more accurate, the operational cost was used as an important indicator for selecting optimum parameters of the suited mixer.

Operational cost for mixing operation before and after development

Mixer development greatly affected the operating cost. Generally operating cost decreased by using the developed mixer as shown in Fig. 8 where operating cost before development at mixing time of 3 minutes was 7.95 LE.Mg^{-1}, by using the developed mixer operating cost decreased to 7.86, 7.84 and 7.83 LE.Mg^{-1} at blade setting angle of 30, 45 and 60 degrees, respectively. When mixing time was 6 minutes, operating cost was 11.19 LE.Mg^{-1} before development decreased to 11.13, 11.09 and 11.07 LE.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees, respectively. At mixing time of 9 minutes operating cost was 14.71 LE.Mg^{-1} before development decreased to 14.56, 14.51 and 14.47 LE.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees, respectively. For mixing time of 12 minutes operating cost was 18.56 LE.Mg^{-1} before development decreased to 18.19, 18.11 and 18.06 LE.Mg^{-1} by using the developed mixer at blade setting angle of 30, 45 and 60 degrees, respectively.

In general decreasing of operating cost by using the developed mixer could be due to decrease of specific energy consumed which is due to reducing power requirement.

In fact we have to compare operating cost at the actual operating conditions before development with operating cost at the optimum operating conditions obtained after development; from this point of view actual operating conditions before development means 1.1 m.sec^{-1} for a period of 9 min. achieved operating cost about 14.71 LE.Mg^{-1} must compare with 0.88 m.sec^{-1} at blade setting angle of 30 degrees for a period of 3 min. which represents the optimum operating conditions obtained after development achieved operating cost about 7.85 LE.Mg^{-1} it means developed mixer reduced operating cost by about 46.6%.

The decrease of operating cost by using the developed mixer could be due to the decrease of specific energy consumed moreover reducing mixing time from 9 to 3 minutes so that lead to raise actual mixer productivity.

Operating cost for mixing operation of the developed mixer

Operating cost for mixing operation are related to mixer speed, mixing time and blade setting angle as shown in Fig. 9. Results show that operating cost increased whenever mixer speed increased and blade setting angle decreased according to the experimental levels on this study.

Relating to mixing time of 3 min, by increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1} operating cost increased from 7.85 to 7.86 and 7.87 LE.Mg^{-1} when the blade setting angle was 30^0, at blade setting angle of 45^0 operating cost increased from 7.83 to 7.84, 7.86 and 7.87 LE.Mg^{-1}, while at blade setting angle of 60^0, operating cost were 7.82, 7.83,7.85 and 7.86 LE.Mg^{-1} when mixer speed increased from 0.88, 1.1, 1.25, and 1.44 m.sec^{-1}.

In relation to mixing time of 6 minutes, increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1} operating cost increased to 0.01, 0.02 and 0.03 LE.Mg^{-1} when blade setting angle was 30^0, at blade setting angle of 45 degrees operating cost increased to 0.03, 0.07 and 0.08 LE.Mg^{-1} by increasing mixer speed from 0.88, 1.1, 1.25, and 1.44 m.sec^{-1}, while at blade setting angle of 60 degrees operating cost increased 0.02, 0.06 and 0.07 LE.Mg^{-1} by increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1}.

In relation to mixing time of 9 minutes, increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1} operating cost increased from 14.54 to 14.56, 14.58 and 14.60 LE.Mg^{-1} when blade setting angle was 30 degrees, at blade setting angle of 45 degrees operating cost increased from 14.46 to 14.51, 14.56 and 14.58 LE.Mg^{-1} by increasing mixer speed from 0.88, 1.1, 1.25, and 1.44 m.sec^{-1}, while at blade setting angle of 60 degrees, increasing of operating cost were 0.04, 0.10and 0.12 LE.Mg^{-1} when mixer speed increased from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1}, respectively.

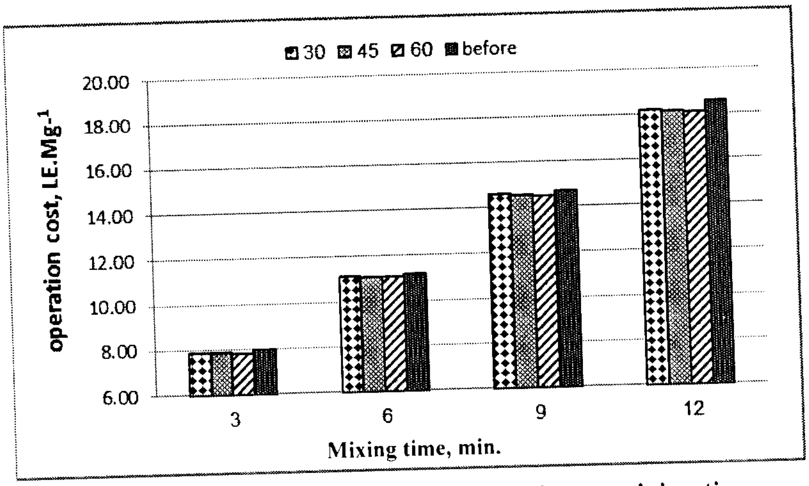


Fig. 8. Operating cost before and after development according to mixing time

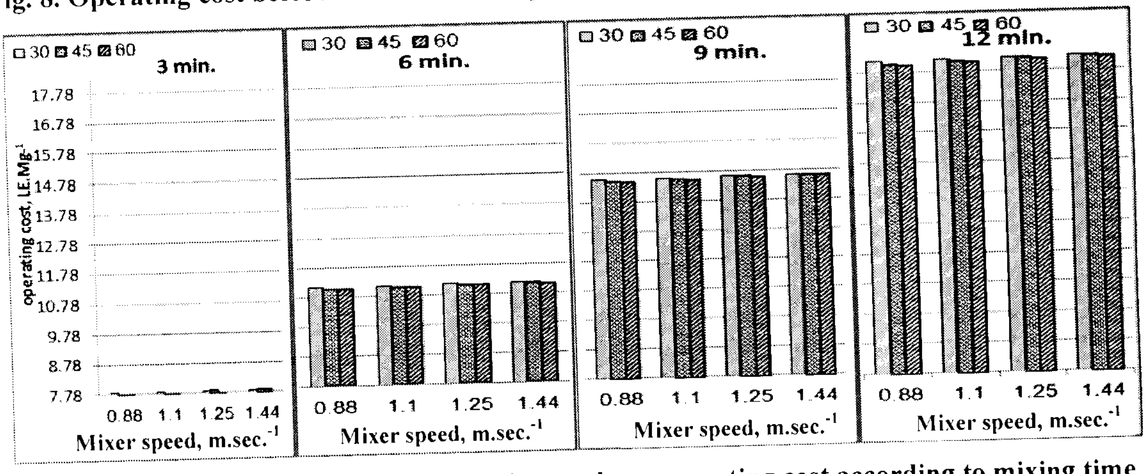


Fig. 9. Effect of mixer speed and blade setting angle on operating cost according to mixing time

Concerning to mixing time of 12 minutes increasing mixer speed from 0.88 to 1.1, 1.25, and 1.44 m.sec^{-1}increasing operating cost from 18.17 to 18.19, 18.22 and 18.25 LE.Mg^{-1}when blade setting angle was 30^0, although at blade setting angle of 45^0 operating cost increased from 18.04 to 18.11 , 18.19 and 18.22 LE.Mg^{-1}, while at blade setting angle of 60^0 operating cost increased from 18.00 to 18.06 , 18.14 and 18.18 for 0.88 , 1.1, 1.25, and 1.44 m.sec^{-}1, respectively.

Conclusion

The important results could be summarized in the following points:

1. It can be reported that the mixing homogeneity improved by about 10 % by using the developed mixer comparing with the original mixer.
2. To prepare the best mixture conditions, it is recommended to keep the blade resting angle on mixing shaft at 30°.
3. Using the developed mixer when mixing time increased above 6 minutes, mixing homogeneity decreased (segregation occurred).
4. The lowest energy requirement (2.47 kW.hr.Mg^{-1}) was accomplished with blade setting angle of 60 degrees .
5. Results clearly showed that the energy requirement highly increased by increasing mixer speed, mixing time and decreasing blade setting angle from 60 to 30 degrees.
6. The mixing time has not to exceed 6 min. to avoid extra cost in energy consumption.
7. The best mixing homogeneity 98 and 99% with the lowest energy requirement 2.47,

2.624 kW.hr.Mg^{-1} were achieved by using the developed mixer with speed of 0.88 m.sec^{-1}, with mixing time 3 min. and blade angle 60, 30 degrees, respectively.

8. It could be indicated that the developed mixer saved about 46.6% of operating cost when it operates at mixing speed of 0.88 m.sec^{-1} and blade angle of 30 degrees for mixing time of 3 minutes.
9. As a result of test, it was concluded that the developed mixer met the design objectives. It is believed that this mixer, simple in design and operation, would greatly improve mixing homogeneity of feed.

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تطوير خلاط أعلاف

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محمود عبد العزيز حسن - السادات إبراهيم عبدالعال

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يعتبر تزايد عدد السكان في مصر مشكلة هامة تستوجب زيادة معدلات إنتاج الغذاء وبالتالى زيادة المنتجات الحيوانية لتوفير الاحتياجات من البروتين، لذلك كان الاهتمام بصناعة الأعلاف من أهم الاعتبارات فى الوقت الراهن بهدف إنتاج غذاء حيواني جيد ورخيص الثمن، لذلك كان الهدف الأساسى من هذا البحث هو تطوير وتقييم خلاط أفقى بهدف تحسين أداء الخلاط بالتغلب على عيوب الخلاط لزيادة كفاءته وتقليل الفاقد من العلف وتقليل احتياجات القدرة مع الأخذ فى الاعتبار تقييم الخلاط من وجهة النظر الاقتصادية، وكانت أهم النتائج المتحصل عليها: زيادة نسبة تجانس الخلط حوالي ١٠% باستخدام الخلاط بعد التطوير مقارنة مع الخلاط قبل التطوير، ضبط الريش على عمود الخلاط على زاوية ٣٠ درجة لتحقيق أفضل ظروف للخلط، زيادة مدة الخلط عن ٦ دقائق باستخدام الخلاط بعد التطوير قد يؤدى لتقليل نسبة تجانس الخلط مع إضافة تكاليف أعلى فى استهلاك الطاقة، تم الحصول على أدنى استهلاك للطاقة ٢,٤٧ كيلو وات.ساعة.ميجا جرام$^{-١}$ مع زاوية وضع للريش ٦٠ درجة، أن معدل الاستهلاك النوعى للطاقة يزيد بزيادة سرعة الخلاط وزمن الخلط وتقليل زاوية الريش على عمود الخلط من ٦٠-٣٠ درجة، كان أفضل تجانس للخلط ٩٨، ٩٩% مع أدنى متطلبات الطاقة ٢,٤٧ ، ٢,٦٢٤ كيلو وات.ساعة.ميجا جرام$^{-١}$ باستخدام الخلاط بعد التطوير بسرعة ٠,٨٨ م.ث$^{-١}$، وزمن خلط ٣ دقيقة، وزاوية ٦٠ ، ٣٠ درجة على التوالي، توفير حوالي ٤٦,٦% من تكاليف التشغيل باستخدام الخلاط بعد التطوير عند سرعة خلط ٠,٨٨ م.ث$^{-١}$ وزاوية ٣٠ درجة وزمن ٣ دقائق مع تحقيق أعلى نسبة تجانس للمخلوط مقارنة بظروف تشغيل الخلاط قبل عملية التطوير، ونستخلص مما سبق أن استخدام الخلاط بعد التطوير أدى إلى زيادة تجانس المخلوط مع توفير فى الطاقة والتكاليف مقارنة باستخدام الخلاط قبل التطوير.

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