Effect of shelling time and Sheller feeding rate of locally Sheller in some mechanical and physical traits of the process of Maize shelling

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Abstract

The experiment was conducted to study the effect of the time shelling process by two levels of 30 and 40 seconds, and Sheller feeding rate with three levels of 4, 7, and 10 kg on the specific energy, specific capacity, unshelled grains, and broken kernels maize. The statistical analysis showed that increasing shelling time from 30 to 4 seconds led to a significant increase in specific capacity and broken kernels, moreover leading to a significant decrease in specific energy and unshelled grains. The increase in sheller feeding from 4 to 7 then to 10 kg, to increase specific capacity, unshelled grains, decrease in specific energy and broken kernels. The least specific energy was 0.154 kw.kW.kg-1 and the highest specific capacity was 6.66 kg/kw.h^{-1} with the time of shelling 40 second and feeding rate of 10 kg. Whereas that results shows there is no significant effect of the interaction between the time of shelling and sheller feeding rate in the unshelled grains and kernels.

Keywords: Maize shelling, Time of shelling, unshelled grains, Specific energy.

Introduction

The maize crop is considered one of the pillars of the national economy because it's a strategic crop of economic importance, ranked third after wheat and rice crops. (1). Maize is considered an important resource of raw material such as animal feed production in addition to many other industries, (18). Shelling maize is considered among the most important process that is done after the harvesting (10), shelling is considered very important in terms of separation the grains from the rest of the plant, hence preparing it for marketing. The grains are separated from the cobs after maturing using manual or mechanical methods known as shelling. This process is considered very tedious work for the farmers (2). There is several electrical operated maize shelling machines for mass shelling. Mostly farmers used to take their unshelled Maize to such industries were they get their final product that is shelled maize and then they used to sell this product to the market (7). The Agricultural machinery consume energy and fuel for the production activities .use of energy in agricultural production has been increased in response to the growing demand for food production to meet the rapid growth of the population. The share of energy in agricultural production differs according to production practices and sector (17). Chuan - Udom (8) showed that shelling mechanism is the most important part that affects electricity consumption and Sheller productivity moreover shelling unit rotational speed and Sheller feeding rate are considered among the important factors affecting the Sheller performance. Experiment carried out to determine the effect of the feeding rate 8, 12 and 14 kg on the shelling rate, the results showed the increasing of feeding rate caused an increasing in shelling rate by using L.S.D at the 0.05 level where the superiority feeding rate 14 kg on feeding rate 8 and 12 kg (15). Study was carried out to evaluate the shelling time 20, 30 and 40 second, increasing the shelling time led to a decrease in specific energy and increase shelling rate(10). Al-Bannah (3) mentioned the importance of determining the grain lost in threshing unit is noticed through the remaining some of the grains attached to the kernels, the reason is due to the moisture content of the grains or the rotational speed of the shelling unit, furthermore emphasized the importance of allocating the kernels entering the shelling unit for optimizing a good separation of grains. Al-Hadithi (4) showed in an economic study of wasting in maize s, that this waste is considered of the important economic problems, this problem is obvious in the high wasting rate of 11.08 %. Olaoye (13) mentioned that among the primary factors affecting maize shelling process alongside its circumstances by using the mechanical Sheller, is the feeding rate, whereby is being changed according to the grains state and Sheller condition. The study aims to investigating the effect of Shelling time and Sheller feeding rate with cobs in some physical and mechanical traits of shelling process of maize.

Material and Methods

The experiment was conducted using a locally manufactured maize sheller in the mechanical workshop, Department of

Agricultural Machines and Equipment, College of Agricultural Engineering Sciences, University of Baghdad, as illustrated in figure (1), The traditional cylinder and concave were replaced by metal chains. Using maize cobs bought from the local market. The moisture content was 7%. The dimensions of the shelling cylinder were: length 100cm, diameter 46 cm, engine speed 1420 rpm. Shelling time was chosen of 30 and 40 sec, along with Sheller feeding rate of 4, 7 and 10 kg by three replications. The treatments were statically analyzed using a completely randomized design (CRD) according to least significant differences (LSD) to investigate the differences among the treatments at 0.05. Data were analyzes by the ready statistical analyses SAS (14).

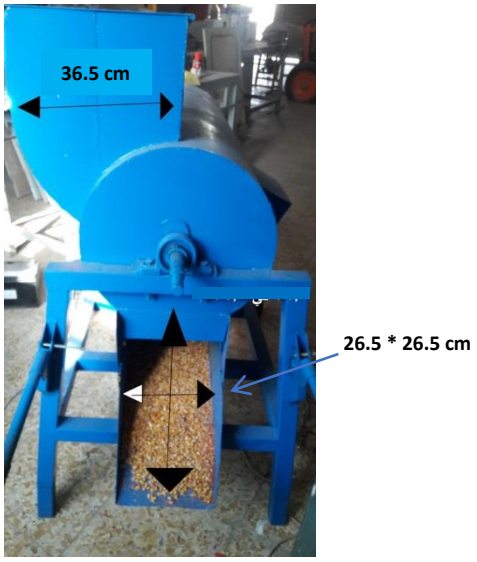

Figure (1): The local sheller used in the experiment

The data of the study were calculated as follows:

Specific Energy (kw. h.kg^{-1})

The specific energy was calculated after measuring the sheller productivity and the consumed electrical power during the shelling process. An electronic scale, timer watch and clamp meter. The specific energy was calculated according to the equation by Dabbour *et al.*, (9) as follows:

S.E= P/C …… (1)

Whereby:

S.E= Specific energy (kw. h.kg^{-1})

P= Consumed power (kw)

C= Sheller productivity (kg.h^{-1})

Specific Capacity (kg. kw.h^{-1})

The specific capacity was calculated after measuring the sheller productivity by using a timer watch and electronic scale for every trial, unit meanwhile the consumed electric current was measured in order to calculate the specific capacity according to the equation by Dabbour *et al.*, (9) as follows:

S.C= C/P …… (2)

S.C= Specific capacity (kg. kw.h^{-1})

C= Capacity (kg.h^{-1})

P= Consumed power (kw)

Unshelled Grains (%)

The unshelled grains of maize were measured by weighing the unshelled grains (lifted on the cobs) in comparison with the total shelled grains weight, the results were considered as percentage according to the equation by Vinay (16) as follows:

Unshelled grains = weight of unshelled grains / weight of total shelled grains *100 … (3)

Broken Kernels (%)

The broken kernels of maize cobs were measured after isolating it according to each treatment, in relation to the total broken kernels, thus calculated as percentage according to the equition by the Al-kakayee (5) as follows:

Broken kernels = (weight of the broken kernels (g)/weight of the initial cobs (g))*100 ..… (4)

Results and Discussion

Specific Energy (Kw. h.kg^{-1})

Results in table (1) showed effect the shelling time and sheller feeding rate in the specific energy. It's obvious the significant increasing of shelling time from 30 to 40 second presented a decrease in specific energy from 0.235 to 0.198 kw.h.kg^{-1}. That's due to the increase in productivity along with allocating more time for shelling, which led to a decrease in specific energy (10). Also table (1) shows that increasing feeding rate of the Sheller from 4 to 7 then to 10 kg led to a significant decreasing in specific energy from 0.284 to 0.200 then to 0.165 kw.h.kg^{-1}. The reason for that is increasing productivity along with increasing feeding rate of the Sheller led to a decreasing in the specific energy is owing to the fact of the presence of an inverse relationship between the productivity and the specific energy that is in consistence with Gomaa *et al.* (11).

Table 1. Effect of shelling time and feeding rate in the specific energy (Kw.h.kg^{-1})

Time of shelling (second)	Feeding rate (kg) 4	7	10	Mean of time effect
30	a 0.312	bc 0.216	bc 0.176	A 0.235
40	ab 0.255	bc 0.185	c 0.154	B 0.198
Mean of feeding rate effect	A 0.284	B 0.200	c 0.165	

LSD at level of 0.05

Time of shelling: 0.028 Feeding rate : 0.034 Interaction: 0.047

*Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to LSD test at significant level of 5%.

* LSD: least significant difference, at significant level of 0.05.

Table (1) illustrates significant effect of interaction between time of shelling and Sheller feeding rates in specific energy. The least specific energy recorded was 0.154 kw.h.kg^{-1} with the shelling time of 40 second and feeding rate of 10 kg, whereas the highest specific energy was 0.312 kw.h.kg^{-1} along with shelling time of 30 second and feeding rate of 4 kg.

Specific Capacity (kg.kw.h^{-1})

Table (2) showed that the effect of shelling time and sheller feeding rate on the specific capacity. With increasing time of Shelling from 30 to 40 second, the specific capacity increased from 5.02 to 5.55 kg.kw.h^{-1}. That's due to the increasing in Shelled grains and shelling rates along with the increasing of shelling time moreover a decreasing in the consumed power of Shelling with the increasing time of shelling that led to increasing Specific capacity (6). Also table (2) Shows increasing feeding rate from 4 to 7 then to 10 kg accompanied a specific capacity increasing from 3.93 to 5.57 then to 6.34 kg.kw.h^{-1}, the reason of that is due to increasing in the amount of shelled maize with increasing the feed rate of the cob shelling machine (8 and 12).

Table 2. Effect of shelling time and feeding rate in specific capacity (kg.kw.h^{-1})

Time of shelling (second)	Feeding rate (kg) 4	7	10	Mean of time effect
30	c 3.75	ab 5.27	a 6.02	B 5.02
40	bc 4.11	a 5.87	a 6.66	A 5.55
Mean of feeding rate effect	C 3.93	B 5.57	A 6.34	
		LSD at level of 0.05		
Time of shelling: 0.39		Feeding rate: 0.47		interaction: 145

* Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to LSD test at significant level of 5%.

*LSD: least significant difference, at significant level of 0.05.

Effect of interaction between time of shelling and feeding rate of the Sheller was significant. The least specific capacity 3.75 kg.kw.h^{-1} with time of 30 second and feeding rate of 4 kg, whereas the highest specific capacity 6.66 kg.kw.h^{-1} with the time of 40 second and feeding rate of 10 kg.

Unshelled Grains (%)

Table (3) shows the effect of shelling time and feeding rate in the percentage of unshelled grains. Hence increasing time of shelling from 30 to 40 second, led to a significant decreasing in the unshelled grains from 8.29 to 6.39 %. That's normal in a sense of increasing time of shelling led to a more shelling of the grains attached to the kernels which results in less unshelled grains (6). Also table (3) indicates that increasing sheller feeding rate from 4 to 7 then to 10 kg resulted in a significant increase in unshelled grains from 5.91 to 7.40 then 8.71 %. The reason for that is increasing the weight if the feeding led to increasing the opportunity of the not-touching between the sheller chains and kernels (8 and 12), whom asserted that the

necessity of regulating the feed rate of the sheller machine, this is in consent of (2).

Table 3. Effect of shelling time and feeding rate in the unshelled grains (%)

Time of shelling (second)	Feeding rate (kg) 4	7	10	Mean of time effect
30	a 6.82	a 8.50	a 9.55	A 8.29
40	a 5.01	a 6.30	a 7.88	B 6.39
Mean of feeding rate effect	B 5.91	AB 7.40	A 8.71	
LSD at level of 0.05				
Time of shelling: 1.55	Feeding rate: 1.90			interaction: N.S

*N.S: Not significant effect at level of 0.05.

It's obvious from the table (3) the interaction between time of Shelling and feeding rate of the sheller didn't recorded a significant effect in the unshelled grains.

Brocken Kernels (%)

Table (4) Indicates to the effect of shelling time and sheller feeding rate in breaking maize kernels. Obviously there is a significant effect in increasing time of shelling from 30 to 40 second represented in increasing broken kernels from 12.40 to 18.21 %, the reason is due to the longer time the cobs last which make it invulnerable to more hits by the shelling chains that results in turn in more breakings (2). Table (4) also indicates to the increasing of feeding rate from 4 to 7 then to 10 kg led to a significant decreasing in the percentage of broken kernels from 18.27 to 14.47 then to 13.18 %, the reason is due to the increasing in the feeding rate with maize cobs decreases the chances of the chains effecting the maize kernels which results in less breaking of both grains and kernels alike.

Table 4. Effect of shelling time and sheller feeding in the broken kernels (%)

Time of shelling (second)	Feeding rate (kg) 4	7	10	Mean of time effect
30	a 15.77	a 11.49	a 9.95	A 12.40
40	a 20.77	a 17.46	a 16.42	A 18.21
Mean of feeding rate effect	A 18.27	AB 14.47	B 13.18	
LSD at level of 0.05				
Time : 3.39	weight: 4.81			interaction: N.S

N.S: Not significant effect at level of 0.05.

The table (4) shows there is no significant effect of the interaction between time of shelling and sheller feeding rate in the broken kernels.

Conclusion

According to obtained results that the increasing of shelling time from 30 to 40 second led to a significant increase in specific capacity and broken kernels, moreover led to a significant decrease in specific energy and unshelled grains. The increasing in sheller feeding from 4 to 7

then to 10 kg led to increasing in specific capacity, unshelled grains, decrease in specific energy and broken kernels. The least specific energy and the highest specific capacity was with the time of shelling 40 second and feeding rate 10 kg. Whereas that the results shows there is no significant effect of the interaction between time of shelling and sheller feeding rate in the unshelled grains and kernels.

Conflict of Interest

The authors have no conflict of interest.

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