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MILLING ENERGY REQUIREMENTS AND FLOUR QUALITY EVALUATION OF RICE GRAINS

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ABSTRACT

The main outlet of Egyptian rice was estimated by 40 % in 1970, whereas it was 5.31 % in 2000. The decrease in rice exports is likely due to the increase in rice world production and the high competition in rice world market. This situation causes a great marketing problem for rice growers. Which reflected in lower prices of rice in the local market. One of the proposed alternatives is to improve the final rice quality to used as a stable food and for export market. The other alternative is to initiating a system regulating rice consumed for proposes other than stable food. The proposed system should be intended to supply rice for processing at a price lower than the price of rice used for a stable food, and to demand for rice while promoting the increase in production.

This research aims to study and evaluate the possibility of using the hammer mill for grinding two different rice varieties (Jasmine - long variety) and (Sakha 101 - short variety)), and the effect of some operating parameters affecting the grinding power and energy requirements, The quality of final rice flours during grinding process was also considered, The following parameters were examined. Four hammer revolving speeds (750,800,850 and 900 r.p.m.); three hammer clearance between fixed and rotating hammer edge (0.5, 1.0 and1.5 mm) and three rice polishing time of (zero, 0.5, and 1.0 s). Increasing hammer revolving speeds from 750 to 900 r.p.m, decreasing hammer clearance from (1.5 to 0.5 mm.) , and the time of rice polishing from (1.0 to zero s.) cause a corresponding increase in the power requirements as, no-load, loaded and useful power for both types of rice under study. Also, at the same operating conditions the energy consumption and degree of fineness percentage tends to increase using the two types of rice (jasmine and Sakha). The values of fineness degree were always higher during mill Sakha rice as comparing with fineness degree produced from jasmine rice. These results may be due to the hardness of Sakha rice than that of jasmine rice.

1- INTRODUCTION

Rice is one of the world three major crops wheat, corn and rice. It's total production amount of about 500 million tons in unhooked rice. Although rice shears about 20% of the total energy uptake of the world, about one half of the world people live on rice as a major stable food (RPHT, 1994). In Egypt rice support more human beings per feddan than any other grains. The planted area of rice in Egypt was 1,00 million feddan in 1984,and the production was 2,40 million-ton. In 2000, the planted area of rice increased only to 1, 040,872 fed. However, due to the breading of high yielding varieties the production increased nearly by 242 % and reached about 5.8 million-tons (Agric.Res.Center-Rice program, 2000). In 1970,about 40 % of Egypt's rice production was exported. However, due to the increase in rice world production and the high competition in rice world market, Egypt exports only about 5.31 % of the production (FAO, 2000).

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This situation causes a great marketing problem for rice growers. Which reflected in lower prices of rice in the local market, beside that, a great amount of paddy has accumulated in the stores of both farmer and commercial mills. Rice millers can no longer expect extravagant prices for their paddy buying without finding an alternative in their production and marketing policy. One of the proposed alternatives is to improve the final rice quality as it is might lead to a possible marketing competition with the rice exporting countries. The other alternative is to gradually shifting their main source of profit to more economical and less wasteful operation in order to promote and ensure a smooth continuation of marketing activities. One of the most important economical operations for the commercial rice mills are initiating a system regulating rice consumed for proposes other than stable food. The proposed system should be intended to supply rice for processing at a price lower than the price of rice used for a stable food, and to demand for rice while promoting the increase in production. On other hands, the approach involved directly in controlling the supply and distribution of lower quality rice, but not in purchasing and selling. On the other hands, high quality rice will be used primarily as a stable food and for export market.

Rice flour produced from broken or complete kernels is considered one of the most important sources for processing various kinds of food products (Pustaka, 1981; El-Rekabi et al., 1985; El-Gendi, 1986 ; Mostafa. 1987; and Nishio, 1991). There are many processed rice flour products used in many countries of the world. Some of these products are premixed pancake, rice flakes, rice crispy, various baby foods, rice snacks, noodles, bread containing rice power, snacks and sweets Goel,1989 ; Nishio, 1991, and FAO, 1991. However, to obtain rice flour with specific physical and nutrition characteristics a series of research work should be conducted to assess the proper grinding system to adopt the wheat grinding machines for grinding various varieties of rice. Hamza (1976) stated that in the milling process as a mechanical treatment, affects greatly the milling products characteristics. Consequently, any difference in the way of milling or treatments applied to the milling stock will actually affect the yield or the extraction rate of flour and consequently affects the composition and characteristics of the products. He added that in the milling of flour, the bran and germ of the kernel are removed as purification progresses. The resulting straight grade flour appears yellowish or creamywhite, owing to the prevalence of carotenoid pigments and absence of bran and germ particles.

Simmons (1963) and Kozmin (1988) classified the grinder or milling equipment's according to the principles of action of their working organs upon the treated product as; cutting (chipping off) machines; pressing (crushing) machine; and machines acting by free impact. Milling equipment may depend upon one or a combination of two or more of these types.

In recent years, as energy has become increasingly expensive, power costs have assumed much greater importance in the economics of flour mill operations. It is not surprising to learn that, milling energy estimated that as much as 75%of the energy used in a flour mill was associated with the actual milling process, and the remaining 25% was for processes such as grain cleaning, storage, flour blending, shipping and packing, and preparation of mill feed (Zwingelberg, 1980).

Hall and Davis (1979) reported that material type, moisture content, grinding fineness, rate of feed, type and condition of mill; affect the power requirements and milling capacity. Meanwhile, Hansen and Stewart (1965) stated that the energy required for any specific size reduction situation is dependent, first, on the kind of material being or method by which the reduction is being achieved, and, third, on the particular size range over which the comminution occurs. Kilborn et al. (1982) concluded that kernel hardness is only one factor that would be expected to affect energy requirements during milling. Other factors such as feed rate, roll gap, roll speed, and tempering procedure also play a significant role.

Hegazy (1995) concluded that at any feeding rate, increasing milling speed and decreasing the clearance between working surfaces, were found to be important factors in increasing flour fineness degree, flour degree, flour components (protein and fat), flour color degree, while, the required horsepower for milling operation increased. Meanwhile, Hassan (1994) showed that grinding capacity increased and grinding energy decreased as fineness of grinding increased by increasing screen size from 3.2 mm to 6.35 mm which in turn gave an increase of 68.1% in grinding capacity and a decreased of 55 % in grinding energy.

Refai, 1965, and Elkady and Elshazely, (1971) reported that color has long been a criterion for flour quality. The flour color depends on several factors, including the carotenoid pigments, stains and discoloration caused by microbial infestation and the percent extraction of flour. The extent and composition of the pigments of bran and endosperm vary in different grains classes. Flour may have a carotenoid pigment content varying from 2.95 to 4.11 ppm. depending on the wheat from which it is derived. While, Gallagher (1984) and El-Rekabi et al.(1985) indicated that granularity influences flour color. Within normal limits, the finer flour, the brighter and whiter it will appear.

The main goal of this research work is to study and evaluate the possibility of using the hammer mill for grinding two different rice varieties. The effect of some operational parameters and grain conditions on the grinding power and energy requirements. Studying the effect of such process on the final rice flour quality was also considered as one of the aims this investigation.

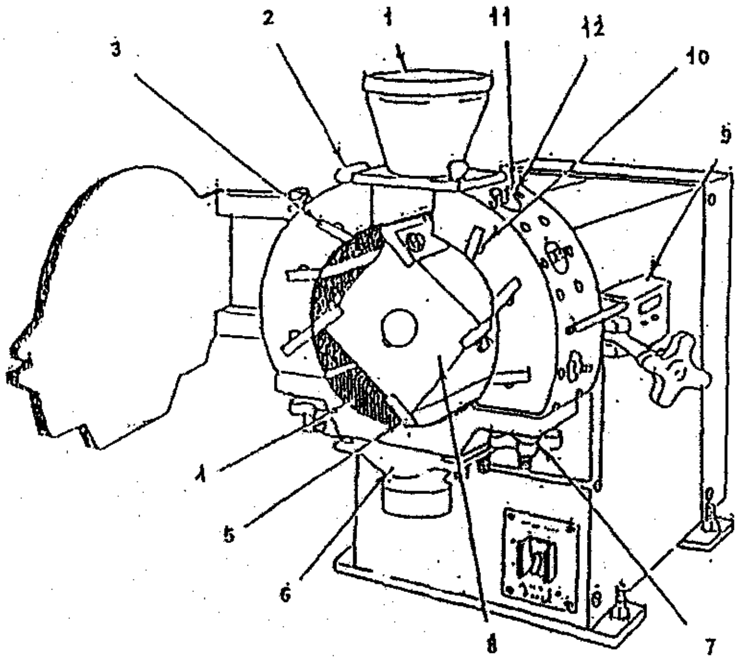
2- EXPERIMENTAL PROCEDURE AND MEASURMENTS

The main experiment was carried out at the Rice Mechanization Center (RMC) of Agric.Eng.Res.Institute (AEnRI), in Meet El-Dyba, Kafr El-Sheik Governorate.

The experimental work was divided into two stages. The first stage was carried out to study some of the physical and mechanical properties of two different rice varieties of (Jasmine - long variety) and (Sakha 101 - short variety) used in this study. The second stage was carried out to study the effect of some operating parameters affecting the grinding energy requirements, and to study the effect of such process on the final rice flour quality (physical properties).

For the duration of these experiments, some of the independent variables were taken into consideration, such as, four hammer revolving speeds (750,800,850, and 900 r.p.m.), three clearance between fixed and rotating hammer edge (0.5, 1.0 and1.5 mm) and three polishing time of rice (zero, 0.5, and 1.0 s). Flour color degree is affected by polishing time of rice and hence quality.

To fulfill the objective of this research work, a hammer mil, (which was most popular type in the Egyptian village), was used to mill the rice samples. The grinding chamber of the machine was a chromium-plated steel block (30-cm diameter), with has into it six stationary knives of high-grade tool steel in projected the periphery of the chamber, hardened and ground. Four similar hammer cutters fixed to the spindle of electric motor, rotating at high-speed. Turning the knurled bolthead at the outer surface of the grinding chamber, which alters the gap between the fixed and the rotating knives can control the fineness of the product. Hopper, with dust-proof cover was fixed on the top of the mill. A stainless-steel sieve of (1.0-mm circular hole) closes the lower part of the grinding chamber and the rice is reduced in size passes through this sieve to the outlet (as shown in Fig.1). The specifications of this machine is shown in table (1).



1- Feed hopper 2- Sliding shutter 3- Stationary knife 4- Screen
5- Rotor knife 6- Delivery chute 7- Screen handwheel 8- Rotor
9- Micro switch 10- Clamping par 11- Threaded stud 12- locknut

Fig. (1): A schematic diagram for hammer cutter mill (Wiley mills, model- 4).

Table (1): The specifications of hammer mill used in this study.

Specifications	Hammer Mill
Manufacture;	USA, Wiley mills
Type;	Hammer cutter mill
Model;	4
Overall length, cm;	40
Overall width, cm;	30
Overall height, cm;	50
Hammer speed, r.p.m.	800
Power source.	single phase electric motor
Power requirement, kW.	(0.746 kW)

2.1-Test procedures:

The paddy or rough rice samples were cleaned thoroughly and the foreign seeds and materials were rejected by hand picking followed by sieving. The rough rice of each variety was passed through a Satake rubber roll machine model THU-

35A, to give a brown rice in one pass. The resulting brown rice was poured into the polishing chamber of the McGill # 2 miller, for milling the brown rice at different times (zero, 30 and 60 s). After milling process, the samples were taken to determine the milling degree and whiteness of milled rice.

The rice samples were fed from the feed hopper into the hammer mill; the hammers strikes and cutting it with great force and rapidly pulverizes it. The samples of grounded rice were taken periodically from the machine outlet. Packed in polyethylene sacks and stored in a refrigerated room at (0 - 4 C), to avoid insects attack and microbial contamination in rice flour during the experimental study, till different examinations and analysis were used.

2.2 - Measurements:

2.2.1.Physical and mechanical properties of rice grains determination:

A digital sliding caliper accurate to the nearest 0.05 mm was used to measure length, width and thickness of grain rice.

Hardness of rice grains was tested using Hardness Tester # 174886 kiya Seisakusho, L.T.D.

The whiteness and milling degree of milled rice were measured after the tests directly using a Kett meter, model (C-300).

2.2.2. Determination of grains moisture content:

Moisture content of grain samples were performed according to A.A.C.C. (1983). The standard air oven method using 25 g sample placed in air oven at 130 C for 16 hours was used to determine grain moisture content.

2.2.3. Determination of the grinding power and energy requirements:

During grinding the brown rice, the consumed time from the instant of full dropping of rice until the instant of end time was measured. Then the energy (kWh) for flour milling was calculated by knowledge of the grinding power (k W) for each test according to (Lockwood and Dunstan, 1971) as follows:

Energy requirements = The consumed power (kW)) x Time consumed (h).

Where:

The grinding power consumed (Pc.) for single -phase electric motor, was determined using super clamp meter –700k Japan made to measure the line current strength and potential difference value. Then the power consumed was calculated as follows:

$$Pc. = A . V . \cos \theta . \eta_m / 1000 \quad kW.$$

Where:

A = Current strength in amperes;

V = Voltage (being equal to 220 volt);

η_m =Mechanical efficiency (assumed 80%);

Cos θ = power factor (being equal to 0.70).

The useful power (the difference between horsepower consumed and horsepower required for running the mill empty) was calculated as follows:

Useful power = power with load – power without load kW.

2.2.4. Flour physical analysis (particle size distribution) determination:

The rice flour granulation and sieve analysis were determined using a laboratory automatic sieve shaker (PaSakha Teraoka – type SNF-7) Japan made as follow: After milling all sample, a 250 grams of flour sample was placed on the top of sieves and the shaker was run for 5 minutes, using a sieve series of 28, 32, 48, 100, and 150 mesh respectively. After each test period the percentage of through and overtails were recorded.

3- RESULTS AND DISCUSSION

In order to evaluate the milling efficiency during actual milling tests of rice grains, the different criteria of rice flour as technological properties of flour and other factors related to the power and energy requirements during milling operation were taken into consideration. The obtained results were discussed as follows:

3.1. Physical and mechanical properties of rice grains:

Knowing the physical and mechanical characteristics of rice grains is very important characteristics to select the adjusted clearance between fixed and rotating hammer edge. This clearance was adjusted in reference to the minor axis of the kernels on the assumption that each kernels would receives some grinding. Also, physical and mechanical characteristics are considered as the most important factors affecting the working performance, and the physical and mechanical characteristics of the final product. Three principle dimensions including length, width and thickness are considered as the main physical characteristics. For both types of rice under study, the average of these values were decreased as the polishing time of rice increased from zero to 60 second respectively

Table (2) :Some physical and mechanical properties of the studied rice varieties .

Rice Varieties	Sakha-101 (short variety)			Jasmine (long variety)		
	Polishing Time, s.					
Characteristics	(zero) Brown rice	(30) Milled rice	(60) Milled rice	(zero) Brown rice	(30) Milled rice	(60) Milled Rice
Dimensions: Length ,mm.	5.57	5.21	4.07	6.79	6.74	6.44
Width, mm.	2.82	2.73	1.72	2.20	2.19	2.18
Thickness, mm.	1.94	1.86	0.81	1.56	1.55	1.54
Hardness deg., N.	60.53	52.68	49.44	58.96	51.99	46.00
Whiteness., %.	24.30	39.10	48.3	23.23	29.97	38.57
Milling Degree, %.	—	86.33	133	—	46.33	88.67

As shown in Table (2), the average grain dimensions (length, width and thickness, respectively) at moisture content of 16.2 ± 0.5 % (wet basis), and polishing time at zero, 30, and 60 second were (5.57, 5.21 and 4.07mm.), (2.82, 2.73, and1.72 mm.) and (1.94, 1.86, and 0.81 mm for rice variety (Sakha-101) respectively. The corresponded results for jasmine rice variety were (6.79, 6.74 and 6.44mm.), (2.2, 2.19,and 2.18 mm.), and (1.56, 1.55, and 1.54 mm.) respectively.

Grain hardness as an effective factor in grinding process was also presented in Table (2). The data revealed that the hardness degree of rice sample decreased as the time of rice polishing increased from zero to 60 second for both varieties of rice under study. The data also showed that during milling process, and at all times of rice polishing, the values of grain hardness were always higher for rice variety (Sakha-101) in comparison with that of rice variety (jasmine), as shown in Table (2). This is may be due to increase fiber content in (Sakha-101) rice variety than that for (jasmine) rice variety.

Table (2) illustrates the effect of polishing time on the whiteness and milling degree for both rice varieties under study. It was evident that increasing of polishing time from zero to 60 second tends to increase grain whiteness degree, and milling degree for both rice varieties. These two factors might be altered during the process of converting the grain into flour

3.2. Milling Power and Energy Requirements:

Figs (2, 3, 4 and 5) illustrate the milling power and energy requirements under different operational parameters. The results showed that different drum speed, different hammer clearance, at different times of rice polishing and the interaction between these factors have a highly effect on the power requirement and useful power needed for rice grinding.

The data indicated that increasing drum revolving speeds from 750 to 900 r.p.m. cause a corresponding increase in the power requirements as, no-load, loaded and useful power for both types of rice under study. At any drum revolving speed, the power (kW) and energy (kW .h) requirements were increased as the hammer clearance decreased from 1.5 to 0.5 mm, and as the time of rice polishing decreased from 60 to zero second.

The date also showed that during grinding process, and at any drum revolving speed, hammer clearance, and time of rice polishing the Sakha rice variety needed more power and energy in comparison with jasmine rice variety. The observed increase in the power and energy consumption Sakha rice variety may be attributed to the higher grain hardness of this variety in comparison with jasmine variety, as shown in Table (2). The results also revealed that increasing revolving drum speed from 750 to 900 r. p. m. causes a corresponding increase in the energy consumption during the grinding process of brown rice at any hammer clearance in the range of 0.5 to 1.5 mm. for the two different rice varieties under study.

Generally, data reported in Figs. (2, 3, 4 and 5) show that, The highest power and energy consumption was recorded when grinding process was conducted to grind the brown rice (zero polishing time) at 900 r. p. m. drum speed and 0.5 mm. of hammer clearance, which were, (3.75 kW and 0.069 kW. h) and (3.67 kW and 0.067 kW. h) for Sakha and jasmine rice varieties respectively.

The lowest power and energy consumption was recorded during grinding process of rice grain polished at 60 sec., drum revolving speed of (700 r. p. m.) and clearance of hammer (1.5 mm), which was (2.93 kW and 0.061 kW. h) (2.87 kW and 0.059 kW. h) for Sakha and jasmine rice varieties respectively.

Another parameter related to the power and energy consumption must be also taken into consideration, such as degree of fineness for the produced rice flours, which appeared that, the power requirements for grinding increases as the fineness degree of rice flours increases.

Generally, during grinding the two different rice varieties, the milling power as well as energy consumption were related to hammer clearance relationship exponentially, which had high R^2 values, as shown in Figs. (2, 3, 4 and 5) and the regression equation of the best fit was as follows:

$$y = ae^{bx}$$

Where:

y = Machine milling power (kW) or energy (kWh);

x = Hammer clearance, mm.;

a, b = constants.

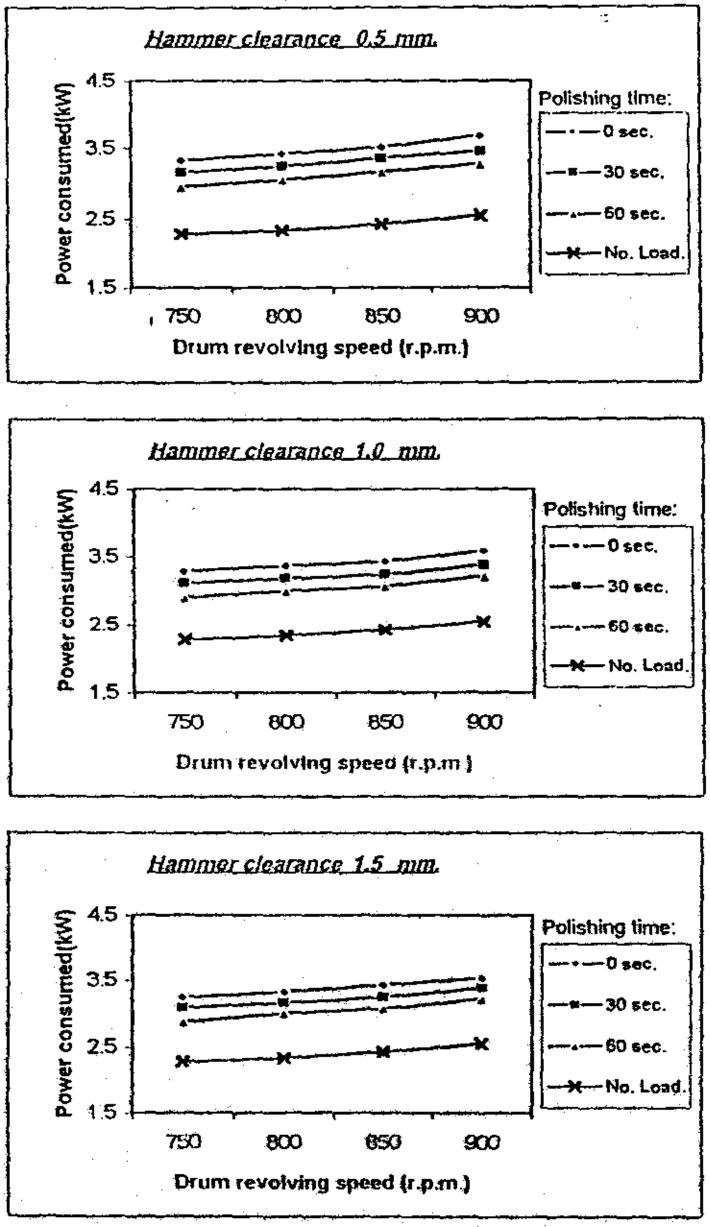


Fig.(2) : Power requirements as affected by different milling drum speeds and different hammer clearances at different polishing times for jasmine rice variety.

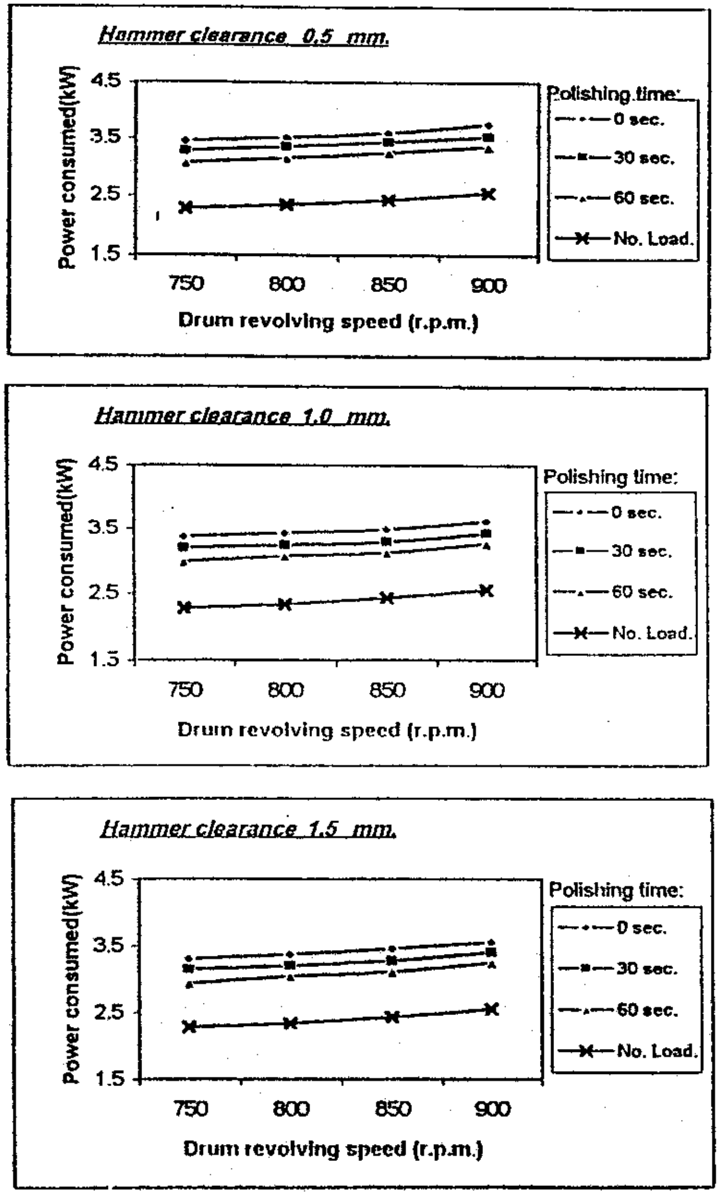
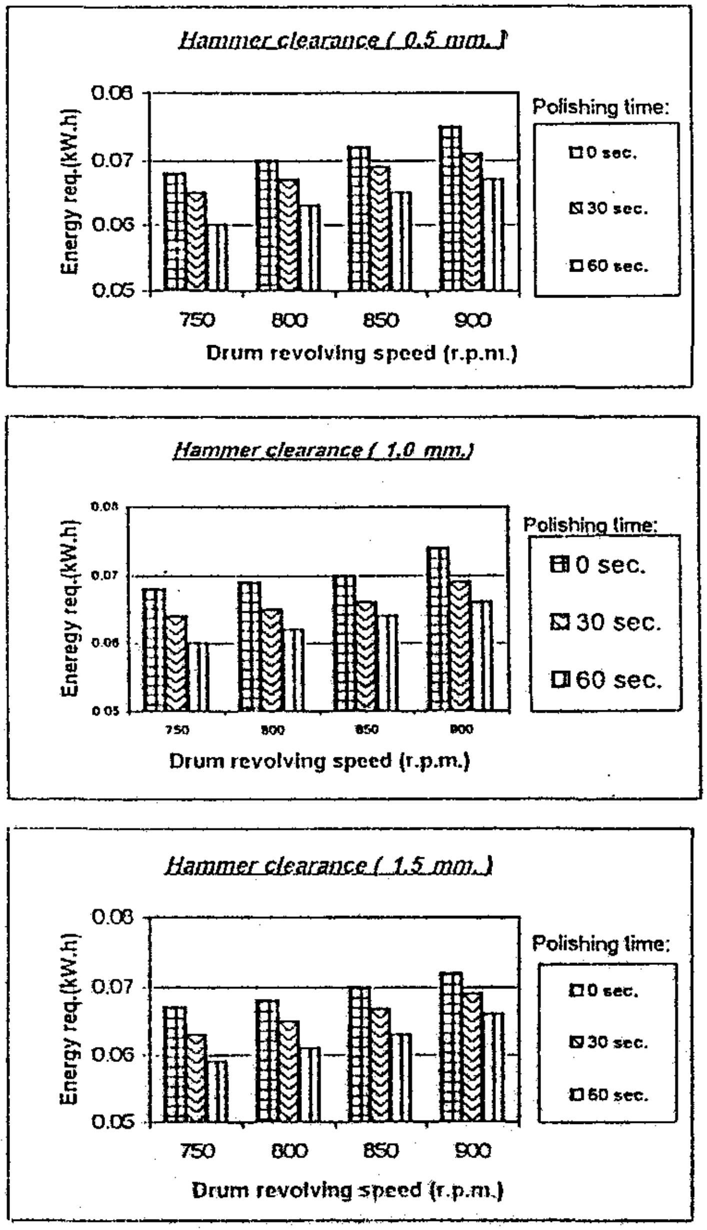


Fig.(3) : Power requirements as affected by different milling drum speeds and different hammer clearances at different polishing times of saka-101 rice variety .



(4) : Energy requirements as affected by different milling drum speeds and erent hammer clearances at different polishing times of jasmine rice variety .

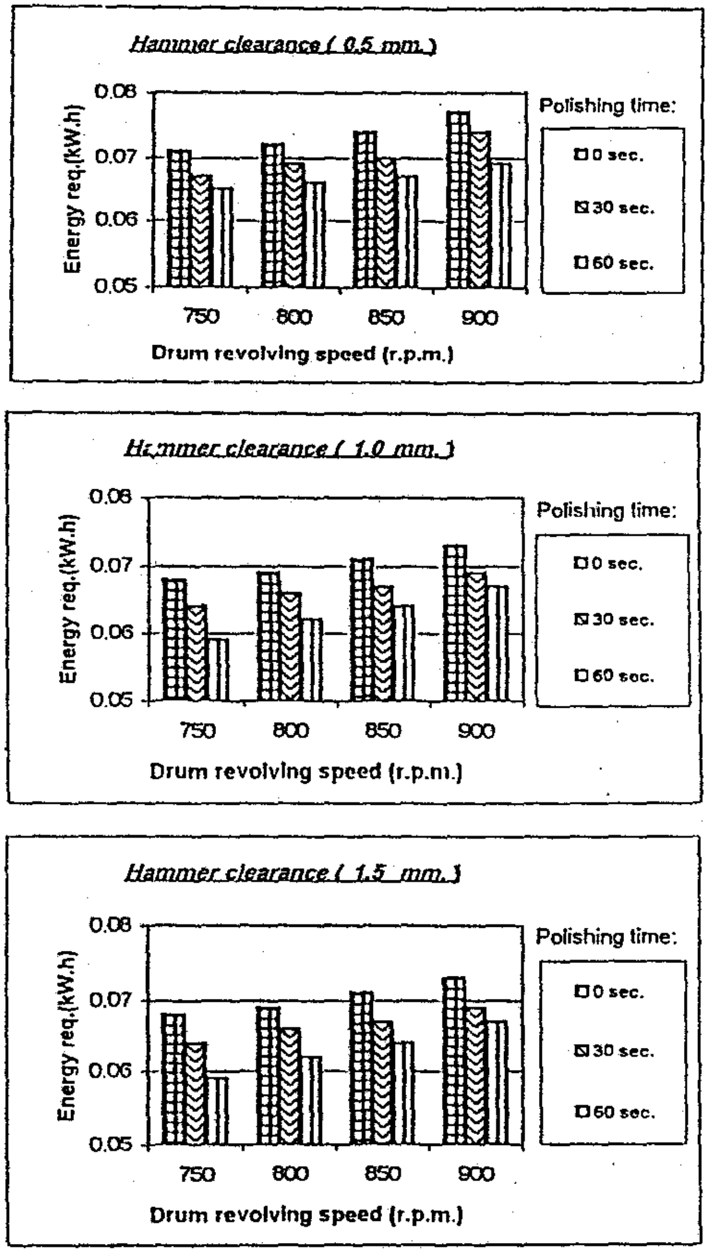


Fig.(5) : Energy requirements as affected by different milling drum speeds and different hammer clearances at different polishing times of sakah -101 rice variety .

The regression coefficient and the correlation coefficient (R^2) for machine milling power and energy requirements using Sakha and jasmine rice varieties are shown in Table (3).

Table (3): The regression coefficients and the correlation coefficients (R^2) for grinding power and energy using jasmine and Sakha-101 rice.

Rice Type.	Measured Parameters	Polishing Time, s.								
		Zero			30			60		
		a	b	R^2	a	b	R^2	a	b	R^2
Jasmine	**Power, kW.**									
	at 0.5 clearance;	3.210	0.032	0.98	3.053	0.031	0.99	2.839	0.036	0.99
	at 1.0 clearance;	3.192	0.027	0.96	3.017	0.027	0.96	2.799	0.034	0.98
	at 1.5 clearance.	3.147	0.029	0.99	2.978	0.030	0.98	2.770	0.037	0.98
	Energy, kW.h									
	at 0.5 clearance	0.066	0.032	0.99	0.063	0.029	0.99	0.058	0.036	0.98
	at 1.0 clearance	0.066	0.027	0.88	0.062	C.024	0.92	0.058	0.032	0.90
	at 1.5 clearance	0.065	0.025	0.98	0.061	0.030	0.99	0.057	0.037	0.99
Sakha-101	**Power, kW.**									
	at 0.5 clearance	3.338	0.273	0.95	3.165	0.025	0.99	2.972	0.029	0.98
	at 1.0 clearance	3.260	0.023	0.94	3.105	0.023	0.94	2.887	0.029	0.97
	at 1.5 clearance	3.215	0.025	0.98	3.046	0.026	0.97	2.838	0.032	0.98
	Energy, kW.h									
	at 0.5 clearance	0.069	0.027	0.96	0.065	0.031	0.94	0.064	0.019	0.97
	at 1.0 clearance	0.066	0.024	0.98	0.063	0.024	0.98	0.057	0.041	0.99
	at 1.5 clearance	0.066	0.024	0.98	0.063	0.024	0.98	0.057	0.041	0.99

Where; a, b = constants.

3.3. Size distribution and sieve analysis of rice flour:

The size reduction and sieve analysis of the produced rice flour was studied to throw light on the effect of mechanical action during the grinding process on the physical properties of flour and flour fractions.

Tables (4 and 5) illustrates the granulation data and degree of fineness (%) for the two types of rice flour, as affected by the interaction between the studied factors.

The results showed that increasing hammer revolving speed, decreasing hammer clearance, and increasing polishing time of rice tended to increase the percentage of fineness degree for the produced flour of the two different rice varieties of (jasmine and Sakha-101). The data also showed that at similar operational conditions the values of fineness degrees are higher for jasmine rice in comparing with fineness degrees produced from variety (Sakha-101) rice as shown in Tables (4 and 5) respectively. These results may be due to the higher hardness of Sakha rice variety in comparing with that of jasmine rice variety. The results also show that, the highest degree of fineness with regard to the fraction of particle size (less than 150 mesh) was obtained using a 900 r.p.m drum revolving speed, and 0.5 mm hammer clearance and zero time of rice polishing, which were 5.2 and 2.22 % for jasmine and Sakha rice flour respectively.

Meanwhile, using a minimum drum revolving speed of (700 r.p.m) at highest hammer clearance of (1.5 mm) and (60 s.) of rice polishing time, produced the highest degree of coarse fineness with regard to the fraction of particle size (less than 28 to 28 mesh), which were 25.04 and 32.38 % for jasmine and Sakha rice flour respectively.

In general, at any drum revolving speed from (700 – 900 r.p.m) and constant clearance, the fraction of particle size of (150 to 48 mesh) increased gradually by

Table. (4): Fineness Degree as affected by different milling drum speeds and different hammer clearances at different polishing times of Jasmine rice variety

Hammer clearance (mm.)	Fineness degree (Sieve size)	Drum revolving speed (r.p.m.)											
		750			800			850			900		
		Polishing time (sec.)											
		zero	30	60	zero	30	60	zero	30	60	zero	30	60
0.5	<150 Mesh	3.09	2.86	2.6	3.62	3.13	2.68	4.33	3.99	3.68	5.2	4.75	4.27
	150 Mesh	10.09	9.9	9.67	11.44	10.85	10.36	12.43	11.95	11.38	12.86	11.94	11.25
	100 Mesh	17.95	16.68	15.4	17.46	16.65	15.95	18.07	17.73	17.42	18.63	18.5	17.76
	48 Mesh	27.18	27.66	28.22	27.07	27.49	27.99	26.26	26.75	27.37	25.44	26.77	27.86
	32 Mesh	19.55	19.84	20.43	18.5	19.31	20.27	17.45	17.78	18.22	17.15	17.9	18.76
	28 Mesh	22.14	23.06	23.68	21.91	22.57	22.75	21.46	21.8	21.93	20.72	20.49	20.19
1.0	<150 Mesh	2.87	2.62	2.34	3.44	2.99	2.58	4.18	3.88	3.56	4.95	4.51	4.44
	150 Mesh	9.89	9.56	9.37	11.24	10.69	10.28	12.27	11.75	11.24	12.54	12.15	11.77
	100 Mesh	17.54	16.25	14.99	17.25	16.44	15.79	17.8	17.62	17.35	18.59	18.24	17.85
	48 Mesh	26.96	27.48	28.14	26.79	27.26	27.79	26.17	26.58	26.89	25.33	26.45	27.19
	32 Mesh	19.92	20.34	21.27	18.98	19.79	20.37	18.07	18.54	18.99	17.79	18.1	18.42
	28 Mesh	22.82	23.75	23.89	22.3	22.99	23.23	21.51	21.63	21.97	20.8	20.55	20.33
1.5	<150 Mesh	2.57	2.3	2.12	3.19	2.79	2.45	4.06	3.85	3.63	4.79	4.28	4.17
	150 Mesh	9.56	9.33	9.18	10.97	10.48	10.19	12.1	11.72	11.04	12.35	12	11.82
	100 Mesh	17.21	15.96	14.66	16.87	16.12	15.57	17.66	17.39	17.32	18.27	17.59	17.25
	48 Mesh	26.59	27.11	27.84	26.47	26.97	27.43	26	26.32	26.66	25.19	26.57	27.26
	32 Mesh	20.61	21.1	22.16	19.33	20.26	20.92	18.54	18.82	19.12	17.9	18.22	18.38
	28 Mesh	23.46	24.2	25.04	23.17	23.38	23.44	21.64	21.9	22.23	21.5	21.34	21.12

Table. (5): Fineness Degree as affected by different milling drum speeds and different hammer clearances at different polishing times of Sakha -101 rice variety.

Hammer clearance (mm.)	Fineness degree (Sieve size)	Drum revolving speed (r.p.m.)											
		750			800			850			900		
		Polishing time (sec.)											
		zero	30	60	zero	30	60	zero	30	60	zero	30	60
0.5	<150 Mesh	0.91	0.69	0.44	1.26	1.12	0.77	1.5	1.29	1.15	2.22	2	1.85
	150 Mesh	2.15	1.14	0.93	2.59	2.16	2	3.12	2.87	2.7	3.27	3.15	2.96
	100 Mesh	10.03	8.78	7.52	10.6	10.35	9.97	11.28	11	10.85	11.47	11.29	11.18
	48 Mesh	36.73	37.24	37.71	37.16	37.27	37.55	37.77	37.85	38.1	38.02	37.94	37.62
	32 Mesh	18.89	19.19	19.8	19.91	20.05	20.17	20.13	20.52	20.56	21.26	21.44	21.57
	28 Mesh	31.29	32.96	33.6	27.97	29.04	29.54	25.75	26.47	26.55	23.67	24.18	24.82
1.0	<150 Mesh	0.82	0.67	0.4	1.19	0.98	0.81	1.41	1.18	1.03	2.18	1.96	1.77
	150 Mesh	2.06	1.74	1.55	2.52	2.24	2.1	3.03	2.79	2.62	3.17	3.06	2.9
	100 Mesh	9.87	8.56	7.28	10.49	10.17	9.92	11.74	11.65	11.47	11.25	11.09	10.86
	48 Mesh	36.55	37	37.45	36.99	37.25	37.46	37.22	37.5	37.68	38.19	37.96	37.57
	32 Mesh	19.22	19.65	20.59	19.6	19.75	19.99	20.47	20.7	20.82	21.52	21.78	21.9
	28 Mesh	31.48	32.47	32.73	29.21	29.6	30.53	25.43	26.27	26.38	23.69	24.15	25
1.5	<150 Mesh	0.75	0.42	0.36	1.14	1.02	0.86	1.39	1.18	1.05	2.1	1.89	1.67
	150 Mesh	1.94	1.75	1.62	2.47	2.12	2.04	2.85	2.02	1.77	2.95	2.82	2.6
	100 Mesh	9.76	8.97	7.75	10.35	10.07	9.88	11.96	11.75	11.45	11.17	11.07	10.92
	48 Mesh	36.4	36.76	36.95	36.82	37.1	37.23	37.05	37.21	37.46	38.26	38.17	38
	32 Mesh	19.5	20.7	20.94	19.4	19.77	19.97	21.39	21.6	21.66	21.64	21.96	22.58
	28 Mesh	31.65	31.4	32.38	29.82	29.92	30.02	25.36	26.24	26.61	23.88	24.09	24.23

increasing the time of rice polishing (zero time to 60 s.) for the two types of rice flour as shown in Tables (4 and 5).

4 - CONCLUSIONS

The foregoing study can lead to the following conclusions:

*Using hammer mill and by using fractionation after milling, produced a wide range of fineness degree of the milled products ranged from less than 150 to 28 mesh and hence these flours may be suitable different industries.

*The highest power and energy consumption was recorded when grinding process was conducted to mill the brown rice (zero polishing time) at 900 r. p. m. drum speed and 0.5 mm. of hammer clearance, which were, (3.75 kW and 0.069 kW. h) and (3.67 kW and 0.067 kW. h) for Sakha and jasmine rice varieties respectively. While, the lowest power and energy consumption was recorded during grinding process of grain rice polished at 60 sec., drum revolving speed of (700 r. p. m.) and hammer clearance of (1.5 mm), which was (2.93 kW and 0.061 kW. h) (2.87 kW and 0.059 kW. h) for Sakha and jasmine rice varieties respectively.

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الملخص العربي

متطلبات الطاقة اللازمة لطحن حبوب الأرز وتقييم خصائص الجودة للدقيق الناتج

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يعتبر الأرز من المحاصيل الغذائية والتصديرية الهامة بجمهورية مصر العربية، في عام ١٩٨٤ كانت المساحة المنزرعة بمحصول الأرز في مصر حوالي مليون فدان تنتج حوالي ٤و٢ مليون طن أرز ، وفى عام ٢٠٠٠م زادت المساحة المنزرعة بمحصول الارز في مصر لتصل إلي مليون و ٤٠٨٧٢ ألف فدان تنتج حوالي ٥,٨ مليون طن أرز ، في عام ١٩٧٠ كانت كمية الأرز المصدرة للخارج تصل إلى حوالي ٤٠ %، ورغم زيادة المساحة المنزرعة بمحصول الارز في عام ٢٠٠٠م انخفضت نسبة الأرز المصدرة إلى حوالي ٥,٣١ % ، ويرجع النقص في كميات الأرز المصدرة للخارج إلى زيادة المنافسة العالمية و انخفاض صفات الجودة في الأرز المصري ، مما ترتب عليه زيادة كميات الأرز المعروضة بالأسواق المحلية وانخفاض أسعارها، الأمر الذي يدعوا إلي ايجاد حلول سريعة و فعالة تهدف إلى الاستفادة من فائض الكميات المعروضة بالأسواق ، بالإضافة إلى إمكانية الاستفادة من كسر الأرز الناتج من عمليات تبييض الأرز والتي تتراوح نسبته بين ١٠ – ٤٠ % بالكتلة من الأرز الأبيض والذي يؤدى إلي خسائر كبيرة في الدخل القومي، ويتم ذلك بطحن الأرز

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لـتحويله إلـــى دقيق يمكن الاستفادة منه في تصنيع العديد من المنتجات الغذائية مثل الحلويات والمقــر مشـــات ورقـــائق الحبوب والمنتجات المنتفخة بالسكر، وبعض أنواع من المكرونات ، وخلطـــات الكـــيك الجاهزة ، كما يدخل في تصنيع الكثير من أغذية الأطفال وأغذية الفطور في كثير من البلدان العربية والأجنبية.

– لـــذا أجريـــت هـــذه الدراسة بمركز ميكنة الأرز بميت الديبة – محافظة كفر الشيخ بهدف اســـتخدام طاحونـــة دقاقة لطحن صنفين مختلفين من الأرز هما صنف أرز قصير الحبة (سخا–١٠١) ، وصـــنف أرز طويـــل الحـــبة (ياسمين) ، وأثر ذلك على احتياجات الطاقة والقدرة لآلة الطحن المستخدمة في الدراسة ؛ ودراسة خواص الجودة لدقيق الأرز الناتج من الناحية التكنولوجية (درجة النعومة). كما اشتملت الدراسة على أربعة مستويات لسرعة درفيل الطحن (٧٥٠ – ٨٠٠ – ٨٥٠ – ٩٠٠ لفة/دقيقة) وثلاث مستويات لقيمة الخلوص بين ا لمطارق الثابتة والمتحركة (٥ و٠ – ٠و١ – ٥و١ مم) ، وثلاث مستويات لحالة الحبوب متمثلة في زمن التبييض للأرز المستخدم في عملية الطحن لما لها من أثر كبير على درجة اللون لدقيق الأرز الناتج (صفر – ٣٠ – ٦٠ ثانية).

وفيما يلي ملخص لأهم النتائج المتحصل عليها:

*أوضـــحت الدراســـة أن احتـــياجات الطاقة والقدرة المستفادة واللازمة لطحن حبوب الأرز ، ودرجة النعومة لدقيق الأرز الناتج تتأثر بدرجة كبيرة بصنف الأرز المستخدم و بسرعة دوران درفيل الطحن و مقدار الخلوص بين المطارق الثابتة و المتحركة وبحالة الحبوب المراد طحنها (زمن التبييض) ، كما أظهرت النتائج أن احتياجات القدرة اللازمة لتشغيل الطاحونة وهي فارغة بدون حمل تتأثر أساسا بسرعة دوران درفيل الطحن وتزداد بزيادتها.

*أوضحت الدراسة أن احتياجات الطاقة والقدرة المستفادة اللازمة لطحن حبوب الأرز ، ودرجة النعومة لدقيق الأرز الناتج تزداد بزيادة السرعة ألد ورانية لدرفيل الطحن (من ٧٥٠ إلى ٩٠٠ لفة / دقيقة)، كما تـــزداد بـــنقص مقـــدار الخلوص بين المطارق الثابتة و المتحركة (من ١,٥ إلى ٠,٥مم) و بنقص زمن التبيـــيض لحبوب الأرز (من ١,٠ إلى صفر ثانية)، وكانت الزيادة أكبر ما يمكن عند طحن صنف الأرز قصـــير الحبة (سخا–١٠١) عند مقارنتها بصنف الأرز طويل الحبة (ياسمين) وذلك عند طحنها تحت نفس الظروف ويرجع ذلك إلي زيادة صلابة حبوب الأرز صنف (سخا–١٠١) .

*أكـــدت الدراســـة أنه باستخدام الطاحونة الدقاقة لإجراء عملية الطحن لحبوب الأرز، وباستخدام عملية الفصـــل بالمناخل لنواتج عملية الطحن أمكن الحصول علي مدى واسع من درجات النعومة لدقيق الأرز الناتج والتي تناسب استخدامات أو صناعات مختلفة.