WHITENING CHARACTERISTICS OF DIFFERENT RICE VARIETIES USING TWO DIFFERENT TYPES OF WHITENING MACHINES

MOHAMED M. EL-KHOLY

Agric. Eng. Res. Institute, ARC, Dokki, Giza

(Manuscript received 13 December 2007)

Abstract

A study was carried out to investigate the effects of two different types of whitening machines (friction and abrasive) and five different whitening times (30,45,60.75 and 90 sec) on whitening characteristics of short grain rice varieties (Giza177,Giza,178, Sakha101 and Sakha102) and long grain varieties (Yasmin and Giza182). The evaluation basis included total and head rice yield, whiteness degree of milled rice, nutrition constituents, and electric power consumption. The results showed that, for all studied varieties, the total and head rice yields decreased with the increase of whitening time and they were higher for the abrasive type whitening machine in comparison with the friction type. Meanwhile, prolonged continuous whitening (over 60sec) slightly increased the whiteness degree of milled rice but brought about a drastic reduction in head rice yield for both types of whitening machines. Also, as whitening progressed from low to high degree of whiteness, the levels of protein, lipids, ash, and minerals decreased, while the level of starch increased. On the other hands, the friction type whitening machine recorded higher power consumption in comparison with the abrasive type. However, the power consumption increased with the increase of whitening time for the abrasive type whitening machine, while it decreased for the friction type.

INTRODUCTION

The objective of rice milling is to obtain the maximum possible yield of whole kernels of white rice or "head rice". The yields of whole plus broken kernels or "total recovery" of milled white rice depend on the variety, purity percentage of mature kernels, moisture content, pre-milling procedure such as harvesting, cleaning and drying (Takai and Barredo, 1981). On the other side, the rice industry recognizes that breakage in rice milling depends to some extent on the mechanical stress applied to rice kernels. This mechanical stress greatly dependant upon the type and the operational adjustment of the machine used for milling (Radwan, 2001).

Rice milling operations in particular , are of two types (i) abrasion milling, in which brown rice is abraded by a hard abrasive surface at high speed and low pressure between two surfaces, and (ii) friction milling in which two or three body wear take place due to the rubbing of two bodies of similar nature, under high pressure. However, there is no pure form of abrasive or friction milling in rice polishing (Mohabatra and Bal 2004).

Andrews et al., (1992) reported that, the factors contributing to rice breakage during milling may be classified into two general categories (1) those related to the properties of the rice grain itself, and (2) those related to conditions under which the grain is milled. The properties of grain itself at the time of milling are the conditions to which the rice is subjected during growing, harvesting, drying, and storage. The condition of milling affecting breakage are temperature and moisture content of grains, type of milling machine, degree of milling and the mechanical setting of milling machine.

Lu and Siebenmoren (1995) stated that, there was a highly significant correlation between head rice yield and the average bending force for breakage of rough rice. They also added that, thinner kernels generally fail at a lower breakage force and were in turn more susceptible to break during milling process.

Mohapatra and Bal (2004) developed a mathematical model for predicting the temperature rise and energy utilization in an abrasion milling operation and its effect on milling quality of grain. The head rice yield was correlated with the final temperature of the grain and was found to decrease steadily with increasing the bulk temperature of grain. The developed model accurately predicted well the bulk temperature rise in the rice grain with milling time. Energy utilized for milling was found to be about 33%, whereas, about 10% of the energy was utilized to rise the temperature of the grains, and 55-60% of the total energy was utilized in running the machine in idle conditions.

Andrews et al, (1992) stated that, the removal of bran layers as milling duration increases results in reduction of milled rice yield and head rice yield with an increase in degree of milling.

Itani et al., (2002) reported that, The proteins, fats, vitamins, and minerals are concentrated in the germ and outer layer of the starchy endosperm. In course of milling these are removed, thus reducing the nutrition value of rice.

Radwan (2001) determined the potential energy consumption for milling some Egyptian rice varieties. The experimental results showed that, grain variety and moisture content had profound effects on energy consumption.

Roide and Nishigama (2001) measured the milling power during abrasive milling at five rotor revolutions by using a batch type abrasive milling machine. Results indicated that the power consumption of milling process increased by increasing rotor revolutions and milling time.

Mohapatra and Bal (2007) studied the effect of milling on specific energy consumption of rice milled in Satake laboratory abrasive polisher. They concluded that, as the milling progressed the energy consumption increased with degree of milling.

The present investigation aims to study and evaluate the effects of two different types of whitening machines (abrasive & friction) and five different whitening times on total and head rice yield, whiteness degree, nutrition constituents, and electric power consumption of different short and long grain rice varieties.

MATERIALS AND TEST PROCEDURE

Materials:

Rice samples used for the experimental work were obtained from four different short grain varieties(Giza 177, Giza 178, Sakha 101, Sakha 102) and two different long grain varieties (Yasmin and Giza.182)) grown in the experimental farm of Rice Mechanization Center (R.M.C), Meet El Dyba and Sakha research station in Kafr EL-Sheikh gov. The rice grains of each variety was cleaned, shade dried to final moisture content of about 14±1% (w.b) and stored in burlap sacks at aerated room until used. At the beginning of each experimental run, rough rice samples were taken out from the aerated room and the moisture content of the samples was determined using the standard oven method at 130 °C for 16 hr. as recommended by (AOAC, 1990).

Whitening machines:

For examining the effects of two different whitening mechanisms (friction and abrasive), two different rice whitening machines represented the two mechanisms were used. The friction type machine is a horizontal batch type model (Baldor L-12), the milling chamber consists of an iron screw with a milling roller at its center surrounded by hexagonal screen. The pressure inside the milling chamber is increased by giving resistance to the out coming rice by means of weight resistance placed on the machine outlet. While, the abrasive type whitening machine is a (Satake TM-15) horizontal batch type with abrasive rotor surrounded by a perforated steel plate and applies carborundum (Silicon carbide) grinding particles with sharp edges. The brown rice is conveyed forward from a screw roll and rice bran is scraped off the surface of brown rice and pass through the perforated steel plate out of the milling chamber. Figures (1) and (2) show a cross section for the friction and the abrasive types rice whitening machines used for the experimental work.

Experimental Procedure and Measurements:

Hulling of rice samples:

The rubber roll huller (model ST-50) was used for hulling the samples of different rice varieties. The huller consists of two rubber rolls, one has a fixed position and the other is adjustable. The grain feeding rate was fixed at 125 g of paddy rice and the clearance between the two rolls was adjusted to give more than 90% brown rice. As the machine chatter was opened, the rough rice is fed between the two rolls and the grains are de-husked under the pressure of the rubber rolls and also the difference in speed of rolls.

Whitening tests:

For all runs of whitening tests, three sub samples of brown rice of each variety were used. The friction type whitening machine was fixed at a roller speed of 1780 (rpm) and adjusted using 1,500 g mass placed on the mill outlet arm to give proper resistance to the outgoing grains and also to create pressure inside the milling chamber as recommended by (Reid et al. 1998).While, the abrasive type machine adjusted with 36# mesh grind stone and a rotor speed of 1360 (rpm) as recommended by (Mohapatra and Bal, 2004). Following this, the brown rice was fed to the hopper of each machine and when the hopper gate was opened, immediately the stop watch started to record the whitening time and stopped just as the machine finished the run. The three sub samples of each variety were whitened for 30, 45, 60, 75 and 90 sec. The resulted white rice of each experimental run was weighed and fed to the rice grading machine model (Satake TRG-05A) for separating broken kernels from head rice kernels.

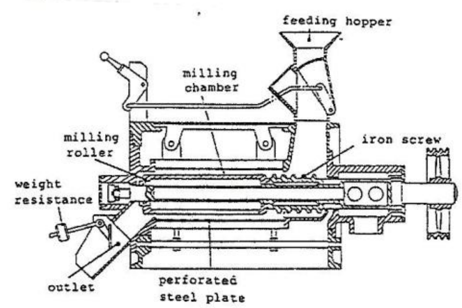

Fig. 1.Cross section for the friction type rice whitening machine.

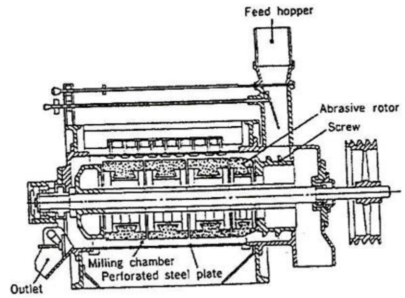

Fig. 2. Cross section for the abrasive type rice whitening machine.

Measurements and Calculations:

1-Physical and mechanical properties of different rice varieties:

-principal dimensions and related properties:

Length, width, and thickness of 100 grains in three replicates of each studied variety were measured using a digital venire caliber model (DAG-500) with accuracy of 0.01 mm. Grain length/width ratio, shape index of grain (k) and coefficient of contact surface (C.C) were also calculated using the following equations:

$$k = L/\sqrt{W.Th} \quad \text{................(1)} \quad \text{(Abd Alla, 1995)}$$

where:

k = shape index of grain, dimension less.

L= length of rice grain, mm

W= width of rice grain, mm

Th = thickness of rice grain, mm

At (k) >1.5, the grain is considered oval but at (k) <1.5, the grain is considered spherical.

$$CC\% = \frac{F_s - T_s}{T_s} x\,100 \quad \text{.....................(2)}$$

where:

Fs= area of oblong surface= $\frac{\pi}{4} x\, L\, x\, W$ mm^2

Ts= area of transverse surface= $\frac{\pi}{4} x\, W\, x\, Th$, mm^2

Mass of 1000 grains:

Three sub samples of different studied varieties each of 1000 grains were picked out. The mass of 1000 grains of each sub-sample was determined by an electric digital balance model Ditto 0-15 with accuracy of 0.01 g. and then average of the sub-samples was calculated.

Grain crack percentage:

For each treatment, a total weight of 100 grains of rough rice was manually de-husked and the resulted brown rice was inspected using the reflection type visual crack meter model (AG-43). The percent of cracked kernels was determined using the following relationship:

$$\%\ \text{Cracked Kernels} = \frac{\text{Number of cracked kernels}}{\text{Total number of inspected kernels}} \times 100 \quad \text{.............(3)}$$

Grain hardness:

Hardness of rice grains was measured using the hardness tester model Kiya-174866. Each grain was oriented on its flattest surface on the bottom plate of the tester, and the manual cross head was moved down until failure occurred. The hardness value of each sample was recorded in kilogram and converted to Newton.

2-Total and head rice yields:

The percentages of total and head rice yields were calculated using the following relationships:

$$\%\ \text{Total rice yield} = \frac{\text{total wt of milled rice}}{\text{wt of paddy sample}} \times 100 \quad \text{..................(4)}$$

$$\%\ \text{Head rice yield} = \frac{\text{wt of sound kernels}}{\text{wt of paddy sample}} \times 100 \quad \text{....................(5)}$$

3-Whiteness degree of milled rice:

Whiteness degree of milled rice was measured for each treatment using the Japanese Kett whiteness meter model C-300. The apparatus was calibrated using the calibration figure for white rice. The white rice samples was filled into the measuring figure and inserted into the meter tube for three minutes. Whiteness degree of the tested sample was displayed digitally into the meter screen.

4-Bulk temperature of milled rice:

Bulk temperature of milled rice was measured immediately after each whitening run using the infra-red spot thermometer model (HT-11).

5-Power consumption of the whitening process:

The electric power consumption (W/125 g. paddy) for each experimental run was measured using the German LVM-210 power consumption meter. The tested machine of each type was fixed to the power source and the power meter. The stabilized reading without load power was first recorded and it was subtracted from the power data collected when the machine was running under full load. The samples of each variety were fed to the hopper of the machine. As the hopper gate was opened the stop watch started and the power consumption recorded just after the sample had run through the machine for the required whitening time.

6-Nutrition constituents of milled rice:

Nutrition constitutes of milled rice were determined at the rice processing laboratory of the Food Technology Research Institute, Agric. Res. Center (A.R.C). Protein content was estimated using the Kiel-Dahl method. Starch content was determined by the Iodine color metric method (Juliano,197) and the lipid material was extracted from rice flour with N-Hexane as described by (Choudhury and Juliano(1980). Ash content was determined by igniting 2g of milled rice in muffle furnace at 550 °C to constant weight. Total content of Na, k, ca, Fe, Zn, and Mg were determined in the digested solution using atomic absorption FMD3. Phosphorus content in the digested material was determined using micro vanedate molybdate yellow method according to (Chapman and Pratt 1978).

RESULTS AND DISCUSSION

Physical properties of different rice varieties:

Table (1) presents some physical properties related to the milling characteristics of different studied rice varieties. As shown in the table, the obtained ranges of different studied properties were (14.25 to 14.77) % w.b for grain moisture content, (3.59 to 5.33) for L/H ratio, (2.94 to 4.52) for shape Index (K), (69.88 to 81.25) for coefficient of contact surface (C.C), (21.59 to 29.06 g) for the weight of 1000 grain, (3.20 to 6.71) % for the grain crack percentage and (51.18 to 63.37) N. for the grain hardness.

The results in table (1) show that, short grain varieties (G.177, G.178, Sakha 101, and Sakha 102) recorded lower values of L/Th ratio, shape Index (K), coefficient of contact surface (C.C), grain crack percentage and higher values of weight of 1000 grain in comparison with long grain varieties (Yasmin and G.182). On the other hands, short grain variety G.177 recorded the highest grain hardness of 63.37 N., and variety G. 178 recorded the lowest value of 51.18 N.

Total and Head Rice Yields:

Figures (3) and (4) illustrate the variations in total and head rice yields for different studied rice varieties, different types of whitening machines, and different whitening times. As shown in Fig.(3), for both types of whitening machines the total rice yield decreased with the increase of whitening time and it was higher for short grain varieties in comparison with long grain varieties. The recorded total rice yields for short grain varieties G.177, G.178, Sakha 101, and Sakha 102 ranged from (63.17 to 74.20 %) for the friction type whitening machine and from (64.23 to 74.81%) for the abrasive type. While, the total rice yield for long grain varieties Yasmin and G.182 ranged from (64.81 to 71.01%) for the friction type whitening machine in comparison with(66.32 to 72.88%) for the abrasive type.

Table1. Some physical and mechanical properties related to milling process of different studied rice varieties.

Variety	Grain M.C %(w.b)	Grain Dimensions (mm)			L/Th	k	Coefficient of contact surface (C.C)	Mass of 1000 grains	Grain crack (%)	Grain hardness (N)
		L	W	Th						
G 177	14.77	7.39	3.03	2.05	3.60	2.96	72.26	27.05	4.50	63.37
G.178	14.59	7.32	2.83	1.90	3.85	3.15	69.88	23.59	3.90	52.98
Sakha101	14.74	8.10	3.33	2.18	3.71	3.01	73.08	29.06	3.20	58.58
Sakha102	14.57	7.55	3.14	2.10	3.59	2.94	72.18	27.59	4.30	59.27
Yasmin	14.37	9.55	2.57	1.79	5.33	4.45	81.25	25.52	6.32	53.62
G.182	14.25	9.38	2.37	1.81	5.18	4.52	80.70	25.36	6.71	55.72

The observed reduction in total milling yield with the increase of whitening time may be due to further whitening of broken kernels with prolonged whitening time which converted to a rice powder usually lost with the discharged bran.

Meanwhile, as shown in Fig.(4) , the percent head rice yield decreased with the increase of whitening time, and it was higher for the abrasive type whitening machine in comparison with the friction type. It was also higher for short grain varieties in comparison with long grain varieties. The recorded percentages of head rice yield for short grain varieties G.177, G.178, Sakha 101, and Sakha 102 were ranged from (51.36 to 67.03%) for the friction type whitening machine in comparison with (53.29 to 71.80 %) for the abrasive type. While, the corresponding values for the long grain varieties Yasmin and G.182 ranged from (50.72 to 60.16%) for the friction type and from (55.75 to 66.20%) for the abrasive type.

The lower head rice yield produced by the friction type whitening machine in comparison with the abrasive type may be due to the fact that, the grain milled with the friction type whitening machine receives higher pressure and more shearing and bending stresses on the starchy endosperm of the milled kernels. While, the abrasive type milling machine can shape off the surface of rice grain which tends to bend and break during the milling process.

Meanwhile, the variations in total and head rice yield for different studied varieties not only affected by the type of milling machine and the milling time, but also by the differences in their physical and mechanical properties. Varieties with lower values of (L/Th) , (K), (C.C) and crack percentage and higher values of weight of 1000 grains and hardness showed higher total rice yields and lower broken percentages in comparison with other varieties.

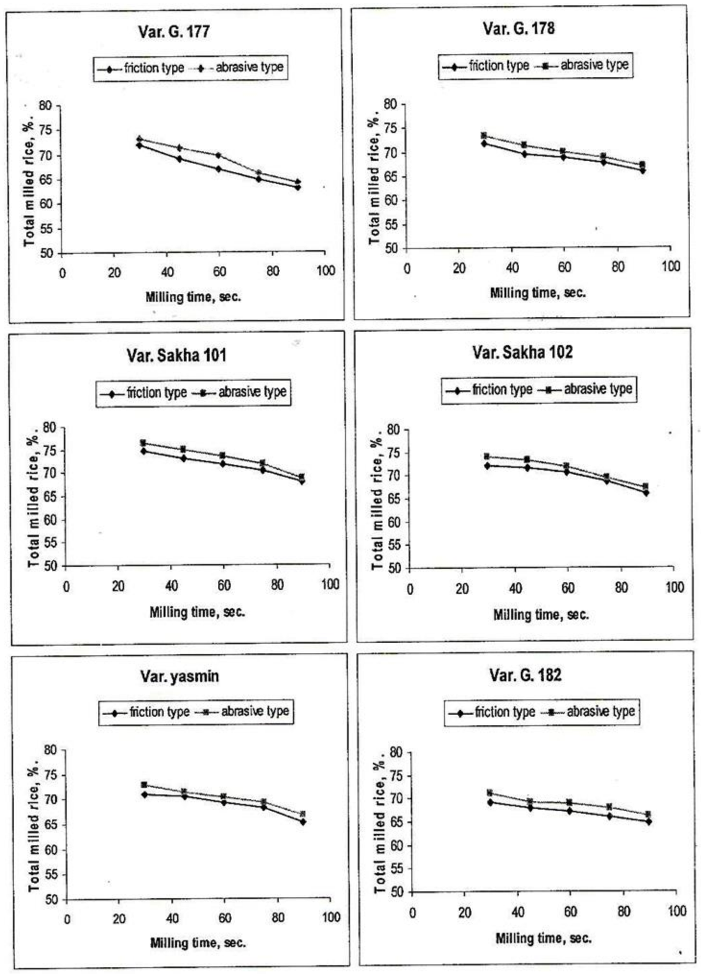

Fig. 3 .Total rice yield as related to milling time for different types of milling machines and different rice varieties.

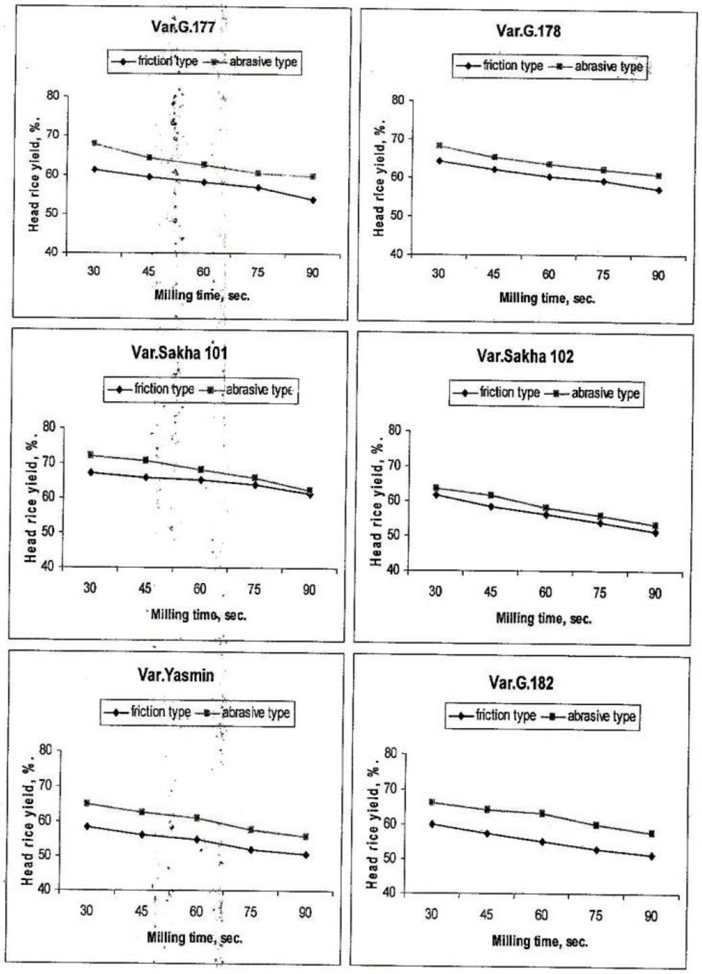

Fig. 4. Head rice yield as related to milling time for different types of milling machines and different rice varieties.

Effect of milled rice temperature on head rice yield:

Figure (5) illustrates the variations in milled rice temperature and head rice yields as related to whitening time for different studied varieties and different types of whitening machines. As shown in the figure, the temperature of milled rice increased with the increase of whitening time and it was higher for the grain whitened with the friction type whitening machine in comparison with the abrasive type. The increase in rice bulk temperature has causes a noticeable reduction in head rice yield for all studied varieties. At the minimum whitening time of 30 sec, the final bulk temperature of milled rice ranged from (44.26 tc 52.76 ^{0}C) and the head rice yield ranged from (58.5 to 67.20 %) for the friction type whitening machine in comparison with (27.82 to 30.81^{0}C) and (62.39 to 71.80 %) for the abrasive type. While, at the maximum whitening time of 90 sec, the rice bulk temperature ranged from (62.31 to 79.05 ^{0}C) and the head rice yield ranged from (50.72 to 61.28 %) for the friction type whitening machine in comparison with (35.98 to 45.16 ^{0}C) and (55.75 to 64.91 %) for the abrasive type. The higher temperature of milled rice for the friction type whitening machine in comparison with the abrasive type, may be due to the friction forces generated between the grains, grain and the perforated screen, or grain and the revolving roll as mentioned by (Mohapatra and Bal 2004).

To relate the change in rice bulk temperature with the head rice yield of different studied varieties, a simple regression analysis was employed. The results of analysis show a linear simple relationship of the form of:

$$HRY\ (\%) = A + B\ (T_b) \qquad \text{.........................(6)}$$

Where:

HRY = head rice yield, %.

T_b = bulk temperature of milled rice, °C.

A, B = regression constants

The values of regression constants A and B for different studied varieties and different types of milling machines are presented in table (2).

Table 2. Constants of Eq. (6) relating the change in milled rice temperature with the heated rice yield.

Variety	Friction type			Abrasive type		
	A_f	B_f	R^2	A_a	B_a	R^2
G.177	73.948	-0.258	0.96	87.567	-0.6992	0.97
G.178	92.782	-0.5735	0.99	82.585	-0.5092	0.95
Sakha101	79.899	-0.2835	0.96	87.956	-0.5405	0.94
Sakha102	88.707	-0.5627	0.96	87.956	-0.8168	0.97
Yasmin	71.527	-0.2605	0.99	106.28	-1.3781	0.95
G.182	74.896	-0.3094	0.97	92.798	-1.0012	0.98

Whiteness degree of milled rice:

The effects of whitening time and type of whitening machine on whiteness degree of milled rice are presented in Fig.(6). As shown in the figure, the whiteness degree of milled rice increased with the increase of whitening time and it was higher for the grain whitened with the friction type whitening machine in comparison with the abrasive type. For short grain varieties (G.177, G.178, Sakha 101, and Sakha 102), the recorded whiteness degree of milled rice ranged from (33.60 to 48.29%) using the friction type whitening in comparison with (28.63 to 46.17 %) for the abrasive type. However, for long grain varieties (Yasmin and G.182), the whiteness degree of milled rice ranged from (34.90 to 42.15 %) using the friction type whitening machine and from (30.9 to 39.72%) for the abrasive type.

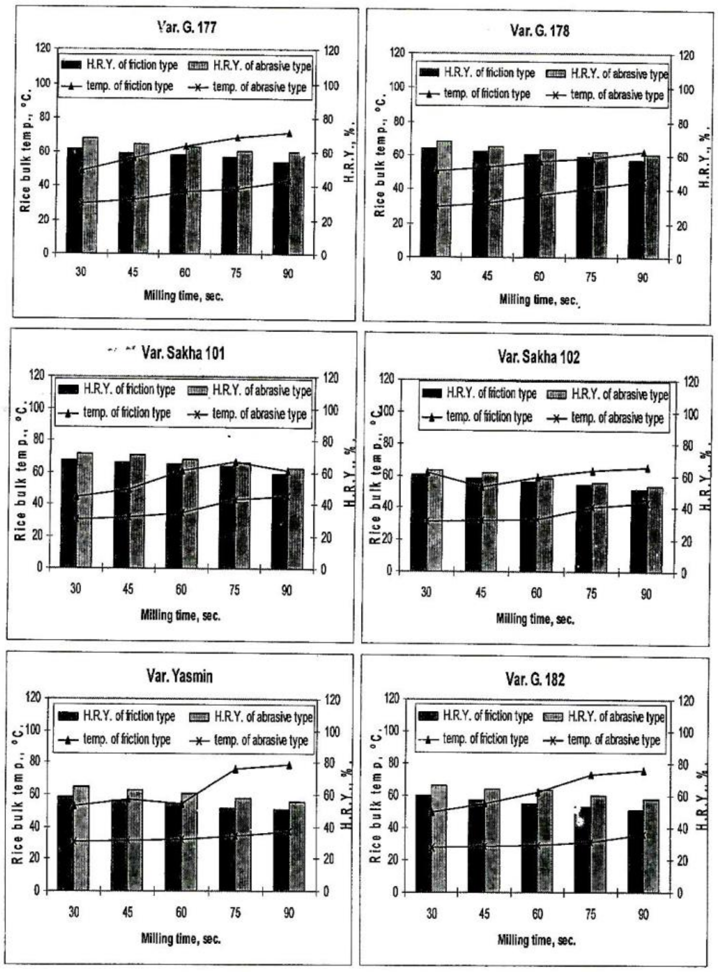

Fig. 5. Relation between rice bulk temperature and the head rice yield (HRY) for different types of milling machines and different milling time.

In general, the increasing in whiteness degree of milled rice was much reduced after 60 sec of whitening and it was ranged from 33.85 to 46.20% for all studied varieties. However, since the detectable change in whiteness degree of milled rice by the human eye yielded whiteness meter readings not over than 30-32% as mentioned by (Fukazawa, 1993), the milling time of 60 sec may be considered as the maximum time at which the polishing process should be stopped. At this time, not only the whiteness degree of milled rice is acceptable, but also the head rice yields and the nutrition constituents of the kernels.

Power Consumption:

Electric power consumption as a function of whitening time for different types of milling machines is plotted in fig. (7). As shown in the figure, the power consumption increased with the increase of whitening time for the abrasive type whitening machine , while it was decreased for the friction type. Also, the power consumption for the friction type whitening machine was higher that of the abrasive type. For short grain varieties (G.177, G.178, Sakha 101, and Sakha 102), the power consumption ranged from (107.4 to 278.7 W/125 g paddy) for the friction type whitening machine in comparison with (41.76 to 110 W/125 g paddy) for the abrasive type. However, for long grain varieties (Yasmin and G.182) the energy consumption ranged from (83.30 to 237.63 W/125 g paddy) for the friction type whitening machine in comparison with (57 to 96.93 W/125 g paddy) for the abrasive type. The above mentioned results reflect the effects of machine working mechanism on power consumption. For the friction type whitening machine, at the early stage of milling the bran peeled off by the higher friction force generated between the grains, grain and the perforated screen, or grain and the revolving roll. With increasing milling time the bran layer is further removed and both the pressure and the friction forces decreased causing a noticeable reduction in power consumption .On the other side, the abrasive type whitening machine does not polish the rice grain under pressure, but it depends upon the centrifugal force of the roll and the impact forces between the grain and the roll which causes an increase in power consumption with milling time as mentioned by (Mohapatra and Bal, 2007).

Nutrition constituents of milled rice

Tables (3 and 4) present the effect of whitening time and type of whitening machine on moisture content, ash, protein, lipids, amylase and minerals contents of different studied varieties. The results show that moisture contents are slightly decreased with the increase of whitening time and it was lower for the friction type whitening machine in comparison with the abrasive type. This means that the moisture contents of rice kernels was affected directly by the bulk temperature of milled rice. Also ash, protein, lipids and mineral contents of milled kernels decreased with the increase of whitening time while, the amylase content was increased. The observed reduction in ash, protein, lipids and mineral contents may be due to further removal of bran layers. While, the detected increase in amylase content may be due to the increase of starch percentage in the milled rice.

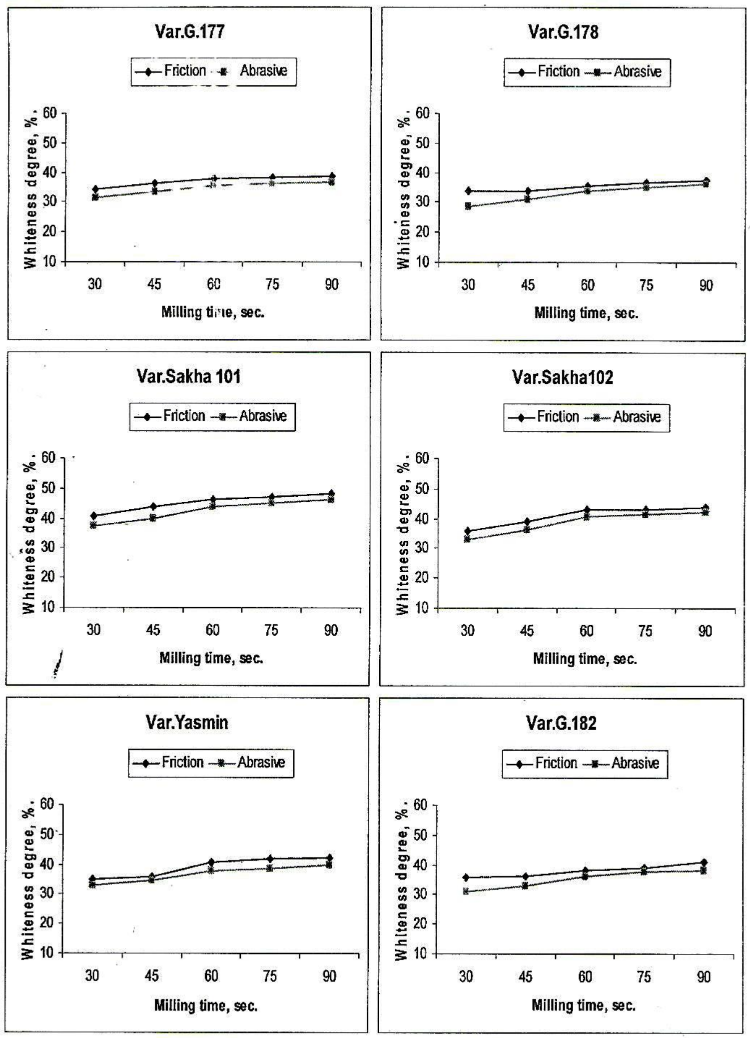

Fig. 6. Whiteness degree of milled rice as related to milling time for different types of milling machines and different rice varieties.

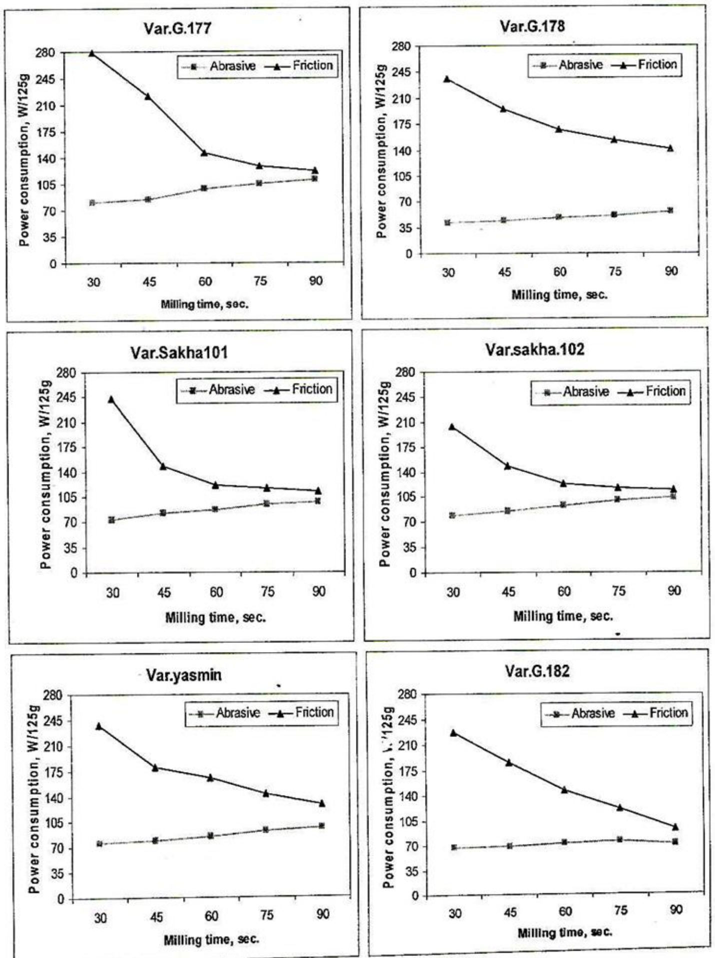

Fig. 7. Power consumption as related to milling time for different types of milling machines and different rice varieties.

Table 3. Changes in nutrition constituents of milled rice as related to milling time for different types of milling machines and different rice varieties (%).

Variety	Time, (min)	Moisture content		Ash		Protein		Lipids		Amylase	
		Fric.	Abras.	Fric.	Abras.	Fric.	Abras.	Fric.	Abras.	Fric.	Abras.
G177	0	12.25	12.25	0.99	0.99	9.0	9.0	1.9	1.9	20.4	20.04
	30	12.16	12.21	0.92	0.94	8.4	8.6	1.1	1.2	20.91	20.42
	45	12.15	12.19	0.83	0.91	8.2	8.4	0.95	1.1	21.23	20.59
	60	12.13	12.17	0.17	0.20	7.9	8.3	0.68	0.8	21.5	20.79
	75	12.06	12.14	0.15	0.16	7.5	7.8	0.51	0.6	21.93	21.24
	90	12.02	12.12	0.13	0.15	7.3	7.5	0.27	0.4	22.98	22.52
G.178	0	12.39	12.41	0.86	0.86	8.63	8.39	1.39	1.39	20.1	20.1
	30	12.26	12.34	0.38	0.42	8.27	8.21	0.98	1.16	20.98	20.36
	45	12.18	12.28	0.31	0.36	8.15	8.16	0.86	0.97	21.17	20.48
	60	12.1	12.21	0.15	0.17	7.95	7.75	0.65	0.72	21.52	20.6
	75	11.98	12.02	0.11	0.13	7.43	7.56	0.42	0.59	21.93	21.18
	90	11.75	11.89	0.08	0.12	7.29	9.56	0.23	0.27	22.59	22.39
Sakha101	0	12.46	12.46	1.26	1.26	9.56	9.56	2.51	2.51	21.5	21.5
	30	12.39	12.43	0.68	0.71	8.69	8.93	2.1	2.26	21.95	21.72
	45	12.37	12.42	0.48	0.52	8.38	8.51	1.73	1.95	22.31	21.98
	60	12.35	12.41	0.31	0.35	8.01	8.26	1.59	1.63	22.59	22.18
	75	12.31	12.37	0.29	0.31	7.78	8.15	0.96	1.1	22.93	22.36
	90	12.26	12.32	0.23	0.25	7.41	7.82	0.58	0.72	23.17	22.95
Sakha102	0	12.35	12.35	1.24	1.24	9.3	9.3	2.4	2.4	20.42	20.42
	30	12.29	12.34	0.61	0.63	8.21	8.3	1.91	2.1	21.17	20.93
	45	12.25	12.31	0.46	0.59	7.56	7.9	1.62	1.83	22.3	21.43
	60	12.21	12.30	0.25	0.27	7.4	7.7	1.38	1.5	22.51	21.79
	75	12.19	12.28	0.21	0.23	7.31	7.5	0.42	0.5	22.85	22.28
	90	12.16	12.27	0.16	0.18	7.19	7.3	0.25	0.3	23.19	22.59
Yasmin	0	12.49	12.49	1.18	1.18	8.4	8.4	1.7	1.7	18.54	18.54
	30	12.45	12.48	0.65	0.67	7.65	7.8	1.3	1.4	20.31	20.04
	45	12.39	12.47	0.60	0.62	7.31	7.6	1.1	1.25	20.72	20.15
	60	12.36	12.44	0.58	0.60	7.29	7.5	0.79	0.9	21.1	20.34
	75	12.33	12.41	0.32	0.33	7.18	7.4	0.53	0.6	21.38	20.52
	90	12.16	11.51	0.21	0.24	6.25	6.38	0.39	0.4	22.63	21.28
G.182	0	11.49	11.49	1.42	1.42	7.8	7.8	1.3	1.3	20.42	20.42
	30	11.27	11.29	0.89	0.93	7.51	7.6	0.87	1.1	20.95	20.79
	45	11.19	11.23	0.71	0.79	7.4	7.53	0.69	0.9	21.36	21.07
	60	11.15	11.21	0.65	0.69	7.28	7.42	0.6 1	0.72	21.75	21.24
	75	11.14	11.19	0.29	0.31	6.93	7.23	0.53	0.60	22.28	21.91
	90	11.12	11.16	0.23	0.26	6.75	7.16	0.4	0.53	22.91	22.65

Table 4. Minerals constituents of milled rice (mg/100g) as related to milling time for different types of milling machines and different rice varieties.

Variety	time (min)	Mg		Nq		Zn		Fe		K		Ca		P	
		Friction	Abrasive	Friction	Abrasive	Friction	Abrasive	Friction	Abrasive	Friction	Abrasive	Friction	Abrasive	Friction	Abrasive
G177	0	189.73	189.73	13.92	13.92	1.36	1.36	1.86	1.86	335.1	335.1	179.6	179.6	392.6	392.6
	30	156.21	163.7	11.76	13.35	1.1	1.11	1.32	1.47	259.6	273.7	132.5	141.6	360.52	372
	45	137.62	142.5	9.88	12.17	0.95	1.05	1.1	1.29	221.7	239.5	129.8	138.5	337.15	346.12
	60	101.25	104.9	8.92	11.32	0.81	0.97	0.98	1.2	210.3	214.8	125.6	132.9	302.45	312.11
	75	98.63	101.25	7.95	10.97	0.73	0.78	0.92	0.95	179.5	186.1	119.3	121.2	270.21	276.15
	90	90.97	93.4	7.92	10.64	0.62	0.67	0.81	0.82	146.1	153	115.1	118.2	261.43	265.12
G.178	0	189.95	189.95	15.2	15.2	1.26	1.26	1.9	1.9	331.9	331.9	179.36	179.36	387.6	387.6
	30	158.32	164.3	12.36	13.52	1.1	1.36	1.43	1.52	263.1	275.1	143.1	149.1	365.42	373.16
	45	139.86	145.21	11.79	12.1	0.95	1.2	1.29	1.46	246.1	250.31	138.62	141.52	341.56	349.2
	60	108.62	113.92	10.92	11.96	0.93	1.17	1.15	1.3	212.6	217.32	132	135.26	310.25	315.12
	75	106.49	109.61	10.76	11.17	0.91	0.97	1.02	1.19	181.7	185.2	125.76	129.63	291.41	298.53
	90	95.16	97.1	9.68	10.39	0.75	0.81	0.93	0.95	152.3	156.7	118.92	122.7	262.95	271.2
Sakha101	0	221.7	221.7	18.92	18.92	1.36	1.36	1.39	1.39	282.6	282.6	153.9	153.9	371.54	371.54
	30	136.25	147.4	15.36	16.86	1.17	1.42	1.27	1.36	201.3	208.6	123.72	130.86	326.1	332.11
	45	129.57	138.25	12.77	13.29	0.98	1.3	1.15	1.29	190.5	198.32	119.5	125.1	319.45	325.62
	60	102.34	110.9	10.81	11.96	0.95	1.16	1.1	1.22	183.6	192.5	110.3	113.9	305.62	311.2
	75	97.63	102.1	10.67	11.21	0.93	1.02	0.97	1.19	171	175.1	102.36	105.36	291.45	296.15
	90	91.05	93.27	9.59	10.93	0.91	0.96	0.92	1.16	148.3	151.5	95.52	97.5	280.76	282.1
Sakha102	0	237.63	237.63	19.78	19.78	1.43	1.43	1.37	1.37	359.2	359.2	159.31	159.31	382.51	382.51
	30	151.62	163.2	16.95	17.92	1.35	1.52	1.25	1.39	281	298	128	135.82	347.6	352.16
	45	143.62	150.25	15.86	16.3	1.21	1.36	1.16	1.37	243.6	250.36	121.75	130.17	338.25	341.25
	60	108.7	115.72	14.39	15.16	1.15	1.27	1.11	1.35	211.5	216.1	116.37	128.13	326.72	330.29
	75	102.91	109.36	12.83	13.5	0.98	1.19	0.98	1.26	195.6	203.67	112.51	116.1	319.46	325.62
	90	98.51	103.61	11.79	12.17	0.95	1.1	0.94	1.19	192.7	198.2	103.1	106.73	289.1	295.1
Yasmin	0	153.62	153.62	17.92	17.92	1.82	1.82	4.2	4.2	297.4	297.4	186.52	186.52	376.45	376.45
	30	129.1	136.4	15.39	16.15	1.71	1.77	3.15	2.33	253.6	269.7	167.1	173.7	312.56	320.2
	45	118.36	127.6	14.29	15.97	1.45	1.59	2.1	2.2	246.7	258.1	148.55	159.26	306.52	311.52
	60	113.72	115.1	13.97	15.62	1.39	1.42	1.97	2.19	240.3	245.1	142.36	148.3	293.4	299.23
	75	106.1	112.6	13.21	14.13	1.25	1.35	1.8	1.95	232.6	236.71	139.1	142.5	241.1	256.17
	90	102.31	109	13.1	13.38	1.18	1.21	1.71	1.88	221.9	226.2	135.81	139.4	232.59	237.39
G.181	0	139.25	139.25	14.25	14.25	1.17	1.17	1.28	1.28	239.61	239.61	129.59	129.59	381.5	381.5
	30	115.41	122.3	11.29	12.77	0.93	1.03	1.1	1.26	174.35	182.7	113.46	119.7	329.52	342.31
	45	93.68	98.53	10.9	12.15	0.85	0.98	0.97	1.17	168.2	179.36	107.25	113.95	318.95	325.63
	60	87.15	91.48	10.15	11.59	0.79	0.91	0.82	0.875	161.53	174.9	104.82	111.72	291.65	300.1
	75	76.29	83.5	9.36	9.72	0.73	0.89	0.75	0.8	157.25	162.5	96.1	97.63	279.85	285.36

CONCLUSION

1-For all studied varieties, the total and head rice yield decreased with the increase of whitening time. While, the abrasive type whitening machine produced higher total and head rice yield in comparison with the friction type.

2- The head rice yield was correlated with the final bulk temperature of milled rice and it was decreased steadily with the increase of rice bulk temperature.

3- For both types of whitening machines, prolonged continuous milling (over 60sec) slightly increased the whiteness degree of milled rice but brought about a drastic reduction in head rice yield.

4- As milling progressed from low to high degree of whitening, the levels of protein, lipids, ash, and minerals decreased while the level of starch increased.

5- Electric power consumption increased with the increase of whitening time for the abrasive type whitening machine while it was decreased for the friction type. Also, the friction type whitening machine consumed higher electric power in comparison with the abrasive type for all studied varieties.

REFERENCES

1. Abd Alla, H. E., S. M. Radwan and E. H. El Hanafy. 1995. "Effect of some physical properties of rice grains on milling quality". Misr. J. Agric. Engng. Vol. (12 (1): 143-155.
2. Andrews, S.B., T.J. Siebenmorgen and A. Mauromoustakus. 1992. Evaluation of the MC Gill No.2 rice miller. Cereal Chem. 69: 35-43.
3. AOAC, 1990. Official methods of analysis (15 th ED) Association of Official Analytical Chemists, Washington DC.
4. Chapman, H.D. and P.E. Pratt. 1978. " Method of analysis from soils, plant and water P.50 Univ. of California. Div. Agric. Sci. Priced Publication 4034.
5. Choudohury, N.H. and B.O. Juliano. 1980. " Lipids in developing and mature rice grain" Phytochemistry, 13, 1063-1069.
6. Fukazawa, A.K. 1993. Methods and parameters affecting rice milling Techniqes. report No. CO-18. pp- 25., O.I.R.C., ueno-5609-23C- Japan.
7. Itani, T., M. Tamaki, E. Arai and T. Horino. 2002. Distribution of amylase, nitrogen, and minerals with various characters. Journal of Agricultural and Food Chemistry, (50 (19), 5326-5332.
8. Juliano, B.O. 1971. A simplified assay for milled- rice analysis. Cereal Science Today 16:334-340, 360.

9. Lu, R. and J.J. Siebenmoren. 1995. Correlation of head rice yields to select physical and mechanical properties of rice kernels. Trans. Of ASAE 38: 3, 889-894.

10. Mohapartra, D. and S. Bal. 2004. Wear of rice in an abrasive milling operation. Part I : Prediction of degree of milling. Bio-system Eng. 88 (3): 337-342.

11. Mohapatra, D. and S. Bal. 2004. Wear of rice in an abrasive milling operation, Part IIP: Prediction of bulk temperature rise. Bio-system Engineering, Vol. 89 Issu I, 101-108.

12. Mohapatra, D. and S. Bal. 2007. Effect of milling on specific energy consumption, optical measurements and cooking quality of rice. Journal of Food Engineering, 80 (2007) 119-125.

13. Radwan, S.M. 2001. The potential energy consumption for milling some Egyptian rice varieties. Misr Journal of Agric. Eng. Vol. 18 No. (3): 537-551.

14. Reid, J.D., T.J. Siebenmorgen and A. Mauromoustakos. 1998. Factors affecting the slop of head rice yield Vs. degree of milling. Cereal Chemistry. Vol. 75 (5): 738-741.

15. Roide, S. and Y. Nishiyama. 2001. Studies on abrasive rice milling (part 2) Milling power and energy model. Journal of the Japanese Society of Agric. Machenery 63 (6): 63-67.

16. Takai, H. and I.R. Barredo. 1981. Milling characteristics of a friction laboratory rice mill. J. Agric. Eng. Res. 26, 442-448.

خصائص التبييض لأصناف الأرز المختلفة باستخدام آلتين مختلفتين لعملية التبييض

محمد مصطفى الخولي

باحث أول– معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – دقى – جيزة

أجريت هذه الدراسة لتحديد أهمية خصائص التبييض لبعض أصناف الأرز قصير الحبة (جيزة ١٧٧، جيزة ١٧٨، سخا ١٠١، سخا١٠٢) والأرز طويل الحبة (جيزة ١٨٢، الياسمين) وذلك باستخدام نظامين مختلفين لعملية التبييض شملا نظام (abrasive) باستخدام آلة التبييض المعملية (Satake TM-15) ونظام الـ (Friction) باستخدام الة التبييض المعملية (Baldor L-12) وأجريت التجارب المعملية عند أزمنة مختلفة لعملية التبييض تراوحت بين ٣٠–٩٠ ثانية.

وتمت عملية التقييم على أساس الاختلاف فى نسبة المحصول الكلى، نسبة الحبوب السليمة، درجة التبيض، التغير فى المكونات الغذائية للحبة وكذلك القدرة المستهلكة فى عملية التبييض. أظهرت النتائج تناقص نسبة كلاً من المحصول الكلى (T.R.Y)، الحبوب السليمة (H.R.Y) بزيادة زمن التبييض لكلا النظامين بينما كانت نسبة الحبوب السليمة أعلى فى حالة استخدام نظام الـ(abrasive)، بالمقارنة بنظام الـ(Friction)، وذلك لجميع الأصناف موضع الدراسة. من ناحية أخرى بزيادة زمن التبييض زادت درجة التبييض للحبوب بصورة ملحوظة حتى زمن ٦٠ ثانية ثم بدأت تلك الزيادة فى التناقص التدريجى مصحوبة بتناقص كبير فى نسبة الحبوب السليمة (H.R.Y) . من ناحية أخرى انخفضت نسبة كل من البروتينات، الدهون، الرماد وكذلك الأملاح المعدنية بينما زادت نسبة الأميلوزفى الحبوب بزيادة زمن التبييض أو بصورة أخرى بزيادة درجة التبييض للحبوب. أيضا زادت القدرة الكهربائية المستهلكة فى عملية التبييض بزيادة زمن التبييض باستخدام نظام الـ(abrasive) بينما انخفضت تلك القدرة فى حالة استخدام نظام الـ(Friction)، من ناحية أخرى كانت القدرة الكهربائية المستهلكة لنظام الـ(Friction) أعلى منها فى حالة نظام الـ(abrasive) وذلك لجميع الأصناف موضوع الدراسة.