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DETERMINATION OF PHYSICAL PROPERTIES FOR SOME CEREAL CROPS

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ABSTRACT

Fundamental physical properties for rice, wheat, corn and barley were measured, evaluated and calculated as a function of grain moisture content. The studied properties included length, width, thickness, mass of 1000 grain, coefficient of contact surface, shape index-k and grain projection area. The measured and calculated data of the studied properties showed a variation between the four studied crops and also between the varieties of each crop. The studied properties were also related to the change in grain moisture contents at a range of (10 – 26%) through a group of empirical equations represent various varieties of each crop. The reflected changes in coefficient of contact surfaces, shape index-k and projection area for the studied varieties of each crop were also determined.

INTRODUCTION

In recent years, more emphasis has been placed on cereal crops in Egypt. Breeders have bred many cereal varieties. The varieties of each crop are nearly similar in their characteristics and different in their properties. Hence, care must be taken in designing and adjusting the machines dealing with these varieties. This could be accomplished through a wide and precise database for the physical and mechanical properties of the new varieties.

Mohsenin (1984) mentioned that, physical properties of the materials such as shape, size, volume and surface area are important in many problems associated with design or developing a specific machine, analysis of the material behavior during handling process and stress distribution in the material under load.

Islam et al. (1981) designed and constructed a manually operated grain cleaning and grading machine. The machine was designed on the basis of physical and aerodynamical properties of paddy grain. The principle of falling bides and the fall velocity of paddy grain, including the weight and dimensions has been determined in the laboratory.

Klenen et al. (1985) stated that, the agricultural product is cleaned and graded according to various criteria governing each material. These criteria are: geometric size of each particle, their aerodynamic properties,

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the shape and state of the surface, density and specific weight, electric conductivity and color.

Chakraverty (1987) reported that, the knowledge of important physical properties such as, shape, size, volume, surface area, density, porosity, color, etc., of different grains is necessary for the design of various handling, separating, drying and storing systems. The density and specific gravity values are also used for the calculation of thermal diffusivity and Reynolds number. He added that, the angle of repose and frictional properties of grain play an important role in selection of design features of hoppers, chutes, dryers, storage bins and other equipment for grain flow.

Waszkiewicz and Sypula (1995) studied the effect of moisture content on changes in grain thickness, width and length of some varieties of wheat. The grain dimensions tended to increase with moisture content, but not proportionately and the distribution characteristics varied in different grain thickness and with classes.

Muthukumarappan et al., (1992) conducted experiments to obtain information on volumetric changes of rough, brown, and milled rice due to changes in moisture content and temperature. Volumetric change of rough, brown, and milled rice was linearly related to the changes in moisture content and temperature. For all the three forms of rice kernels, the coefficient of cubical and linear hygroscopic expansion were higher during adsorption than during desorption. The coefficient of linear hygroscopic expansion of thickness was higher than that of length and width during desorption and adsorption; and it was higher for brown rice than for rough and milled rice during desorption.

Arora (1991) conducted an experiment to study the engineering properties such as size, diameter, volume, bulk density, particle density, porosity, terminal velocity, drag coefficient and resistance coefficient of three varieties of rough rice (Oryza Sativa, L) at five levels of grain moisture content of (8.1, 14.20, 18.23, 23.40, 27.23% d.b). He found that, physical properties were linearly dependent upon moisture content.

The objective of this study was to measure, evaluate and calculate the effect of grain moisture content on some fundamental physical properties of different varieties of rice, wheat, corn and barley. Also, to develop a mathematical relationship relating the studied physical properties with the changes in grain moisture content at a rang represents different stages of harvesting, handling and processing of the studied crops.

MATERIALS AND TEST PROCEDURE

Materials

Samples of different varieties of rice, corn, wheat and barley were obtained from the research station of Agricultural Research Center (A.R.C), Sakha, Kafer El-Sheikh Governorate to grantee the purity of the selected varieties. These varieties are; Giza 177, Giza 178, Sakha 101, Sakha 102, Giza 181 and Yasmin for rice crop; Giza 168, Sakha 93, Sids 1 and Gemiza 9 for wheat crop; Triple hybrid 310, Triple hybrid 321, Single hybrid 10 and Balady for corn crop; Giza 123, Giza 124, Giza 125 and Giza 126 for barley crop. These varieties were selected based on its recent coverage area and the expected future expansion according to Ministry of Agriculture yearly bulletins. The samples were cleaned to remove impurities, immature kernels and foreign materials. The grain of each variety was stored in a burlap sacks inside a ventilated storage room.

Equipment:

Grain moisture-conditioning apparatus

The grain moisture-conditioning apparatus (Fig.1) was designed and fabricated by the research team to obtain the desired grain moisture content for different experiments. As shown in the figure, the apparatus consists of a plastic barrel horizontally rested over two iron bars covered with rubber and operated by two rotating pulleys and 0.5 kW electrical motor. To obtain lower speed for the rotating barrel, an electrical inverter was used. An electrical timer was connected to the motor in order to control the rotating time of the barrel. The calculated amount of water required for each level of grain moisture content is added to the grain inside the plastic barrel and the mixing process is continued for at lest 72 hours to obtain the desired grain moisture level.

Adjustment of different levels of grain moisture content

Before each experiment the stored grain was taken out of the storage sacks and the initial moisture content of each variety was determined. Then, the five desired moisture levels of each variety were adjusted by adding a calculated amount of water to the grain and mixing them using a grain moisture-conditioning apparatus, which operated for 72 hours for each level of moisture content. The grain samples then were sealed in separate polyethylene bags and stored in a freezer at around – 5 ± 1 oC to prevent moisture loss and fungal growth. Before each test, the required amount of grains for each test was taken out from the freezer and allowed to attain the normal room temperature. The moisture content of each sample was determined again before each test.

Test procedure measurements and calculations:

Some physical properties of rice, wheat, corn and barley varieties were measured, evaluated and calculated as a function of grain moisture content. The studied properties included grain dimensions, mass of 1000 grain, shape index-k, coefficient of contact surfaces and projection area.

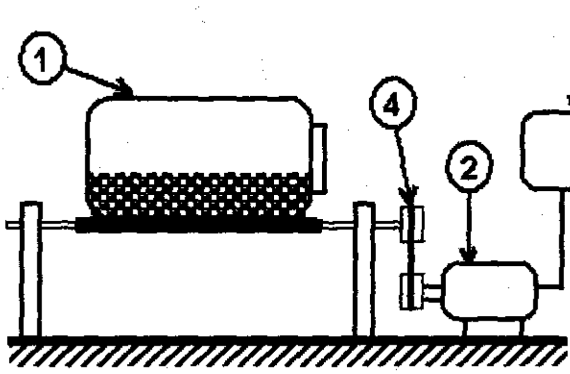


Fig. (1): Apparatus used for adjusting the levels of grain moisture content.

1. Grain moisture content adjustment and determine

The moisture content (MC) of grain samples was determined by the standard air oven method using 25 g sample placed in air oven at 130o C for 16 hr (Matouk et al., 2000). The obtained moisture content was an average of three replicates. It should be mentioned that all moisture contents presented in this paper are expressed in wet basis, other wise will be mentioned.

2. Grain principal dimensions:

Two different methods were used to measure the grain principal dimensions as follows:

a-The digital caliper method

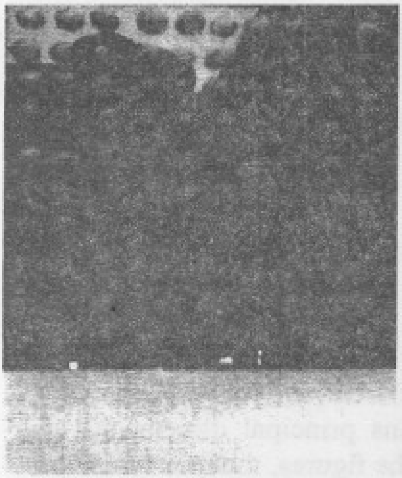
A digital caliper with accuracy of 0.01 mm. was used to measure the length, width and thickness of grains for different studied varieties at different levels of grain moisture content. The average length, width and thickness of 100 grain were considered for each variety.

b- AutoCAD software method

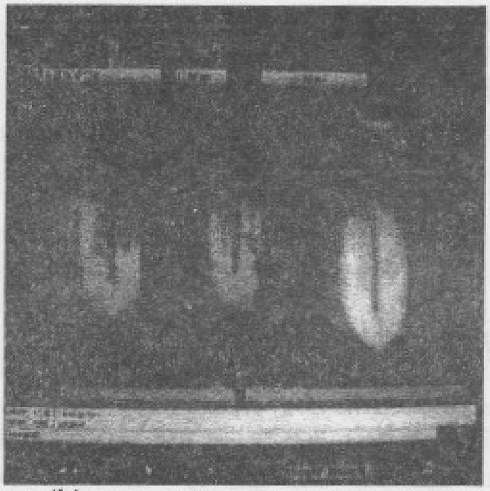
Length, width and projection area of 100 grains of different studied varieties were measured accurately using scan processing methods with a computer programs (1 photo express and Auto-Cad programs) with accuracy up to 10 -10. The measuring process was conducted as follows:

1- Sub-sample of 100 grains from each variety was picked out and the grains were lined up on a calibrated square paper.
2- Scanning the grains of each variety as illustrated in figure (2a) and save the files as image.
3- Inserting the image file into Auto-Cad program, using the Auto-cad (zoom) with suitable enlarging ratio.

4- Using the Auto-Cad order (spline) and the mouse courser as a tracer point for drawing a tracer line for the outer perimeter of each grain as shown in fig. (2b).
5- length, width and area of the tracing can be measured using the Auto-Cad orders (inquiry and area).
6- To compensate the errors of image enlargement during the installation process, the area of the calibrated square paper was measured to find the enlargement ratio which was used for calibrating all the measured areas.
7- The thickness of the same grains was previously measured directly using the digital caliper.



(a)



(b)

Fig. (2): Scanning and drawing a tracer line for the outer perimeter of each grain.

3. Mass of 1000 grains

To determine the 1000 grains mass, a sample of 0.5 kg was drawn from the bulk of each moisture content level and 10 sub-samples each of 1000 grains were picked out. The mass of 1000 grains of each sub-sample was determined by an electronic balance with accuracy of 0.01 gm, then the average of the sub-samples was calculated.

4. Coefficient of contact surface (C.C)

Coefficient of contact surface (C.C) is considered an important parameter to determine the contact surface area between grains and machine parts. It was calculated for different studied varieties of each crop according to (Abd Alla, 1995):

$$C.C\,\% = \frac{F_s - T_s}{F_s} * 100$$

Where:

F_f = area of oblong surface = $(\Pi/4) * L * W$, mm^2

T_s = area of transverse surface = $(\Pi/4) * W * H$, mm^2

5. Shape of grain (index-k)

Grain shape (Index-k) was calculated using the measured values of the principal dimensions of grain samples and was used to describe shape of different studied crop varieties using the following equation (Abd Alla, 1995):

$$Index - k = L / \sqrt{(W.H)}$$

Where:

L = length of grain, mm.

W = width of grain, mm.

H = thickness of grain, mm.

At shape index-k > 1.5, the grain is considered oval but at shape index-k ≤ 1.5, the grain is considered spherical.

RESULTS AND DISCUSSION

Grain principal dimensions

The measured principal dimensions of rice, wheat, corn and barley were varied for different crops and also for different varieties of each crop. The effect of grain moisture content on grains principal dimensions are shown in figures (3 through 14). As shown in the figures, the grain principal dimensions (length, width and thickness) increased linearly with the increasing of grain moisture content for all studied varieties.

For rice crop, Yasmin variety (long grain) showed the highest values of grain length which increased form 9.86 to 10.20 mm with the increasing of grain moisture content from 12.80 to 25.11%. While, Giza178 variety (short grain) showed the lowest values of length which increased from 7.35 to 7.45 mm with the increasing of grain moisture content form 12.57 to 26.22%. On the other hand, short grain variety Sakha 102 recorded the highest values of grain width which increased form 3.29 to 3.39 mm with the increasing of grain moisture content from 12.17 to 25.09%. While, long grain variety, Giza 181 showed the lowest values of width, which increased from 2.64 to 2.74 mm with the increasing of grain moisture content form 12.39 to 25.82%. For the thickness values, short grain variety Giza 177 showed the highest values of grain thickness, which increased from 2.23 to 2.31 mm with the increasing of grain moisture content form 12.58 to 24.90%. While, long grain variety Yasmin showed the lowest values, which increased form 1.94 to 2.10 with the increasing of grain moisture content from 12.80 to 25.11%.

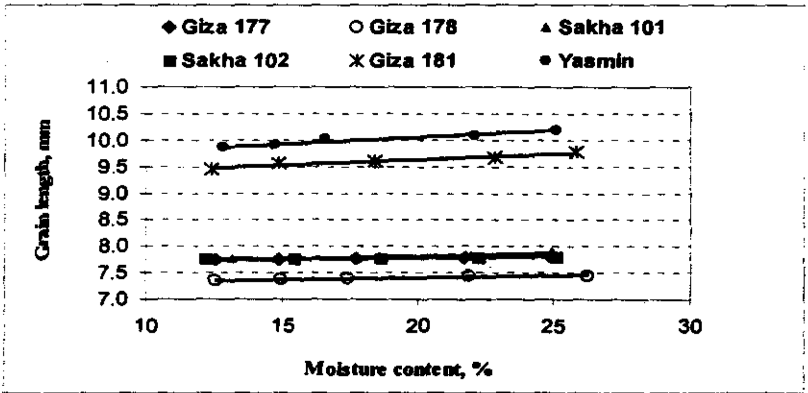


Fig. (3): Effect of grain moisture content on grain length for different rice varieties.

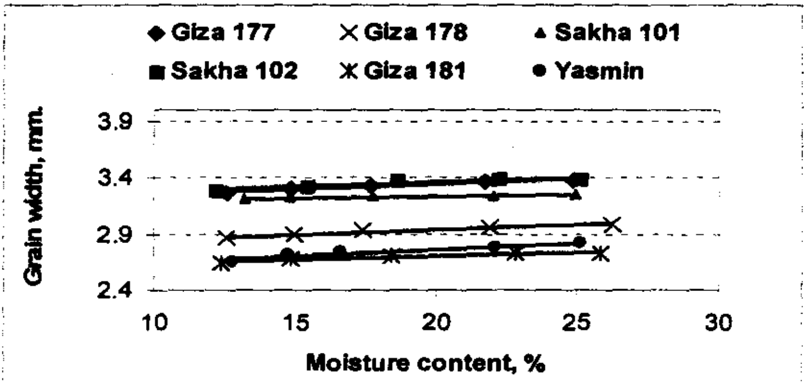


Fig. (4): Effect of grain moisture content on grain width for different rice varieties.

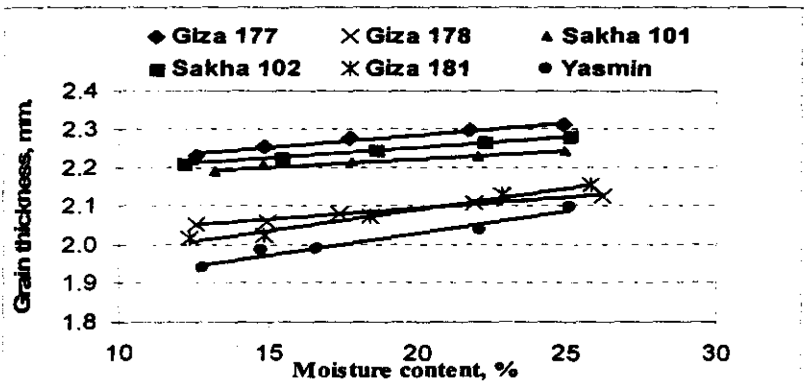


Fig. (5): Effect of grain moisture content on grain thickness for different rice varieties.

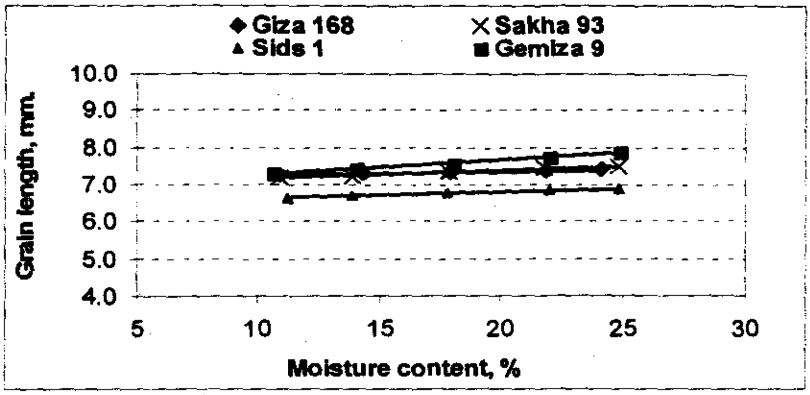


Fig. (6): Effect of grain moisture content on grain length for different wheat varieties.

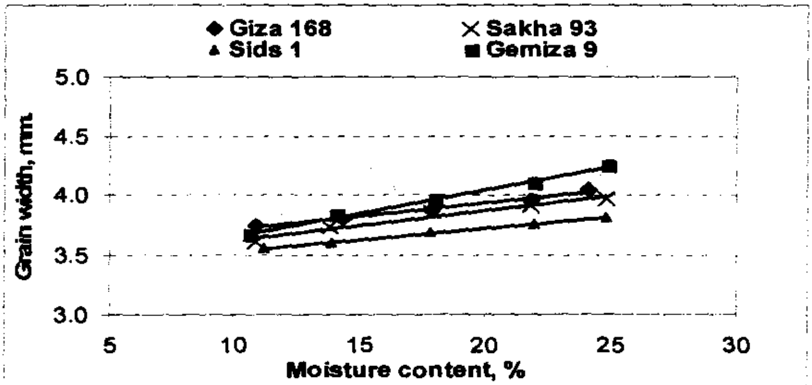


Fig. (7): Effect of grain moisture content on grain width for different wheat varieties.

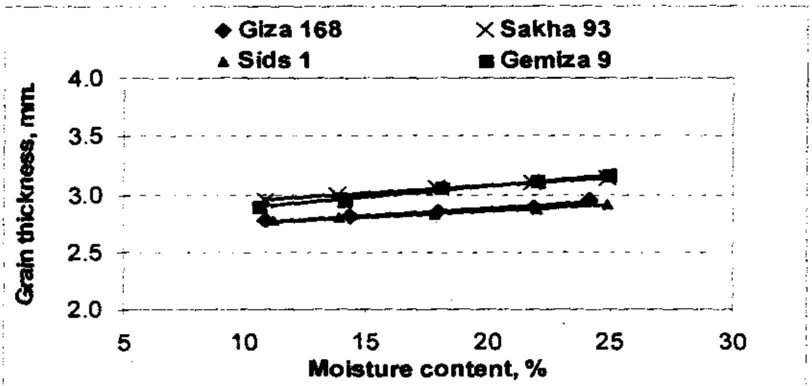


Fig. (8): Effect of grain moisture content on grain thickness for different wheat varieties.

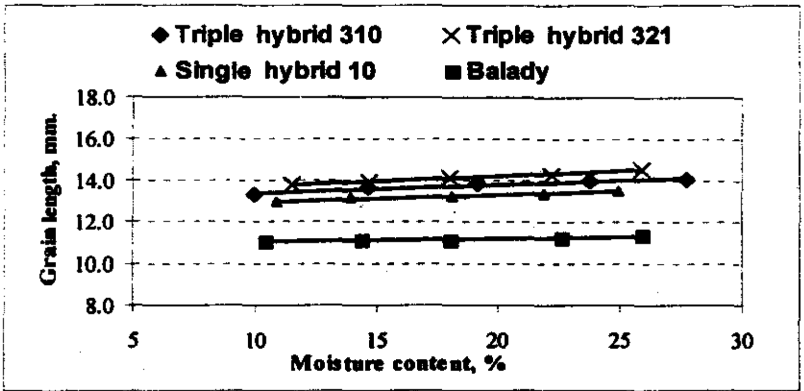


Fig. (9): Effect of grain moisture content on grain length for different corn varieties.

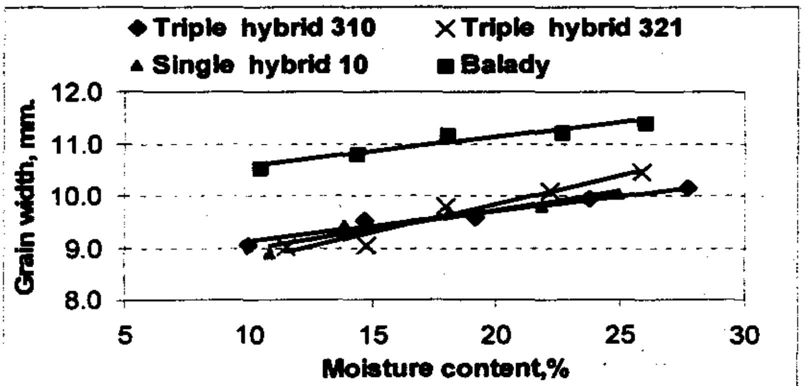


Fig. (10): Effect of grain moisture content on grain width for different corn varieties.

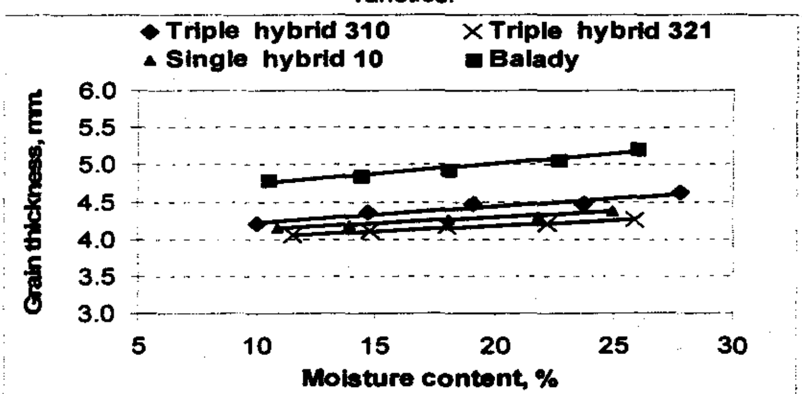


Fig. (11): Effect of grain moisture content on grain thickness for different corn varieties.

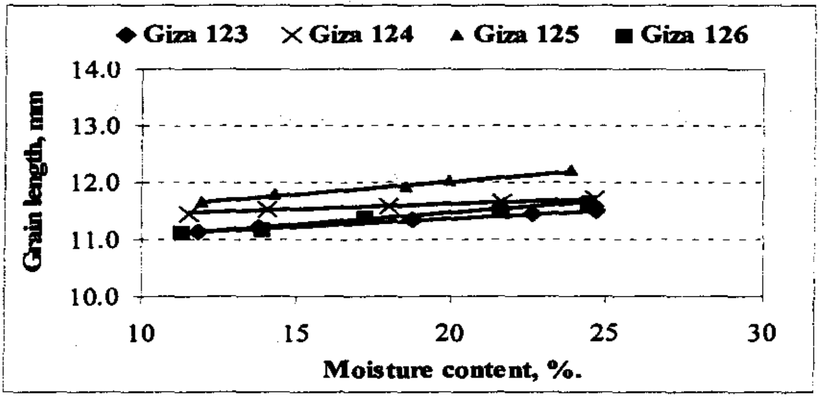


Fig. (12): Effect of grain moisture content on grain length for different barley varieties.

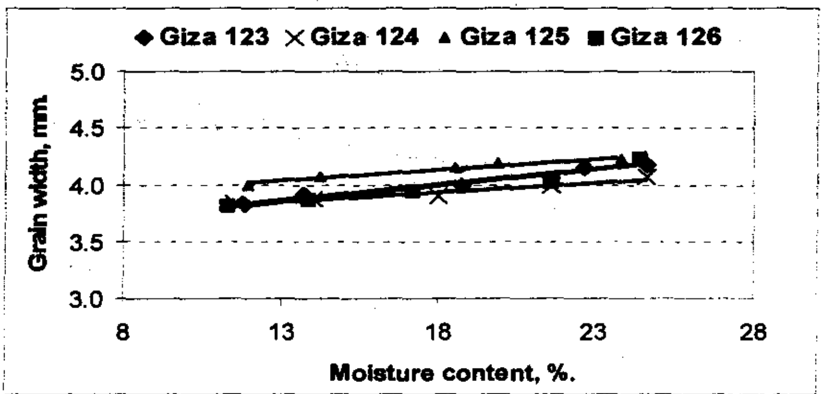


Fig. (13): Effect of grain moisture content on grain width for different barley varieties.

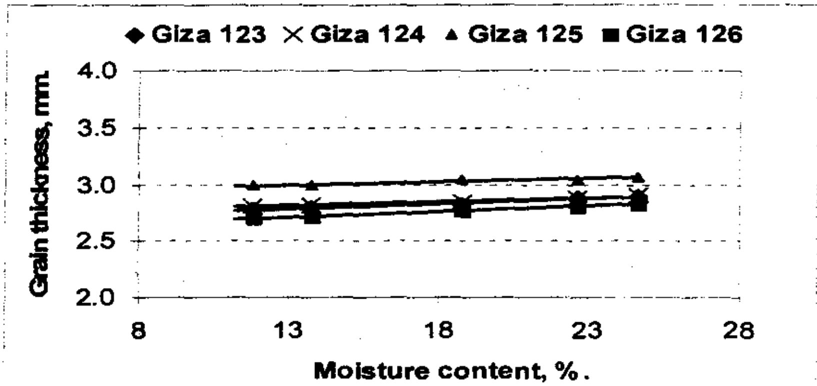


Fig. (14): Effect of grain moisture content on grain thickness for different barley varieties.

For wheat crop, Gemiza (9) variety showed the highest values of grain length (7.32 to 7.89 mm), width (3.66 to 4.25 mm) and thickness (2.90 to 3.16 mm) for increasing grain moisture content from 10.60% to 24.92%. While, Sids (1) variety showed the lowest values of length (6.63 to 6.90 mm), width (3.55 to 3.81 mm), and thickness (2.77 to 3.16 mm) for increasing grain moisture content from 11.17 to 24.85%.

For corn crop, Triple hybrid 321 variety showed the highest values of grain length, which increased from 13.82 to 14.58 mm for increasing grain moisture content from 11.50 to 25.90%. While, Balady variety showed the lowest values which increased from 11.05 to 11.38 mm with the increasing of grain moisture content from10.40 to 25.93%. Also Balady variety showed the highest values of grain width which increased from 10.53 to 11.41 mm for the same range of grain moisture content. While, single hybrid 10 recorded the lowest values of grain width which increased from 8.90 to 10.04 mm for increasing grains moisture content from 10.87 to 24.94%. Also, Balady variety showed the highest values of grain thickness (4.81 to 5.21 mm), while Triple hybrid 321 variety showed the lowest values (4.05 to 4.26 mm) for increasing grains moisture content from 11.50 to 25.90%.

For barley crop, Giza 125 variety showed the highest values of grain length (11.66 to 12.20 mm) for increasing grain moisture content from 11.95% to 23.87%. While, Giza 123 variety showed the lowest values which increased from 11.14 to 11.51 mm with the increasing of grain moisture content from 11.81 to 24.68%. On the other hand, Giza 125 variety showed the highest values of grain width (4.00 to 4.23 mm) for the same range of grain moisture content. While, Giza 124 variety showed the lowest values of grain width which increased from 3.84 to 4.07 mm for the increasing of grain moisture content from 911.51 to 24.67%. On the other hand, Giza 125 variety showed the highest values of grain thickness which increased from 2.99 to 3.07 mm with the increasing of grain moisture content from 11.95 to 23.87%. While, Giza 126 variety showed the lowest values of thickness (2.70 to 2.83 mm) for increasing grain moisture content from 11.22 to 24.41%.

Mass of 1000 grains

Mass of 1000 grains considers a good indicator for crop yield and it has a good influence on crop processing such as rice and wheat milling. The effect of grain moisture content on mass of 1000 grains are shown in figures (15,16, 17 and 18). The results revealed that, the mass of 1000 grains increased linearly with the increasing of grain moisture content.

For rice crop, Sakha 101 variety showed the highest values of mass of 1000 grains, which increased from 27.41 to 30.2 g with the increasing of grains moisture content from 13.18 to 24.95%. While, Giza 178 variety showed the lowest values which increased from 21.23 to 24.40 g for increasing grains moisture content from 12.57 to 26.22%.

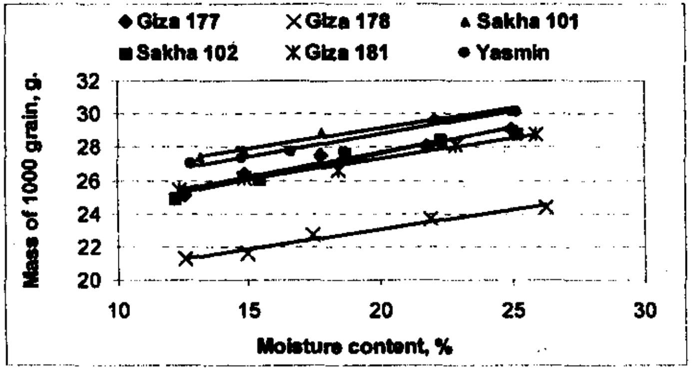


Fig. (15): Effect of grain moisture content on mass of 1000 grain for different rice varieties.

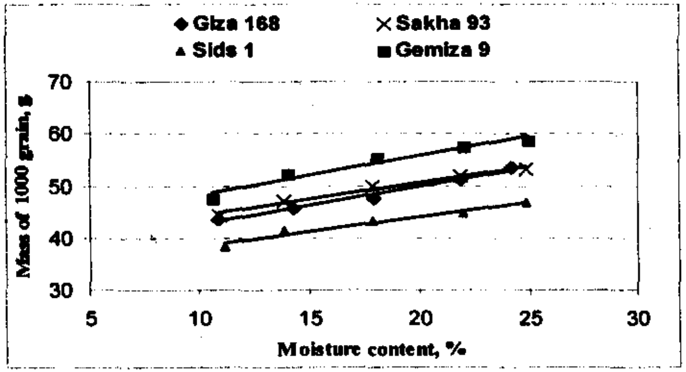


Fig. (16): Effect of grain moisture content on mass of 1000 grain for different wheat varieties.

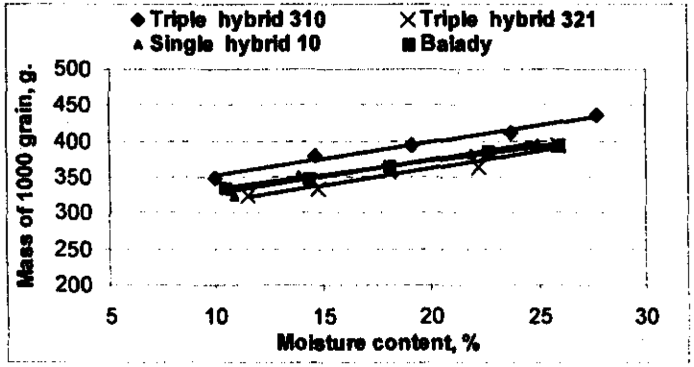


Fig. (17): Effect of grain moisture content on mass of 1000 grain for different corn varieties.

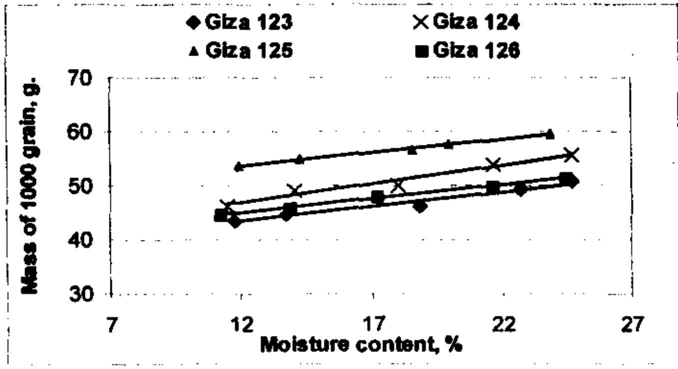


Fig. (18): Effect of grain moisture content on mass of 1000 grain for different barley varieties.

For wheat crop, Gemiza (9) variety showed the highest values of mass of 1000 grains, which increased from 47.54 to 58.74 g with the increasing of grain moisture content form 10.60 to 24.92%. While, Seds (1) variety recorded the lowest values of mass of 1000 grains, which increased from 38.26 to 46.75 g with the increasing of grain moisture content from 11.17 to24.85%.

For corn crop, Triple hybrid 310 variety, showed the highest values of mass of 1000 grains, which increased from 348.9 to 435.8 g for increasing grain moisture content from 9.95 to27.74%. While, Triple hybrid 321 variety showed the lowest values which increased from 323.2 to 394.6 g for increasing grains moisture content from 11.50 to 25.90%.

For barley crop, Giza 125 variety showed the highest values of mass of 1000 grains which increased from 53.73 to 59.50 g with the increasing of grains moisture content from 11.95 to 23.87%. While, Giza 123 variety showed the lowest values of mass of 1000 grains (43.53 to 50.78 g) for increasing grains moisture content from 11.81 to 24.68%.

Shape of grain (index-k)

The calculated shape index-k for different studied varieties of each crop and different levels of grain moisture content are presented in tables (1 through 4). As shown in the tables, shape index-k decreased with the increasing of grain moisture content. In general, for all studied varieties and all levels of grain moisture content, shape index-k was more than 1.5. Which means that, for all studied crops, the grain shape is oval except for corn variety (Balady) which showed a shape index-k values of lower than 1.5 and a spherical shape at grain moisture contents of 18.01, 22.61 and 25.93%.

Coefficient of contact surface (C.C)

Coefficient of contact surface for all varieties under study and the five different levels of grain moisture content are presented in table (1 through 4). As shown in the tables, the coefficient of content surface is generally decreased with the increasing of grain moisture content except for barley variety (Giza 125).

The tables also show that, Yasmin rice variety showed the highest values of coefficient of contact surface, which decreased from 80.32 to 79.45% with the increasing of grain moisture content from 12.80 to 25.11%. While, Giza 177 variety showed the lowest values of coefficient of contact surface which decreased from 71.18 to 70.33 % for increasing grains moisture content from 12.58 to 24.90%.

For wheat crop, Giza (168) variety showed the highest values of coefficient of contact surface, which decreased from 61.81 to 60.29% with the increasing of grain moisture content form 10.85 to 24.14%. While, Seds (1) variety recorded the lowest values, which decreased from 58.22 to 57.85 % with the increasing of grain moisture content from 11.17 to 24.85%.

For corn crop, Triple hybrid 321 variety, showed the highest values of coefficient of contact surface, which decreased from 70.73 to 70.70% for increasing grain moisture content from 11.50 to 25.90%. While, Balady variety showed the lowest values, which decreased, from 56.53 to 54.20 % with the increasing of grain moisture content from 10.40 to 25.93%.

For barley crop, (Giza 123, Giza 124 and Giza 126) varieties showed a very close values of coefficient of contact surfaces. While Giza 125 variety showed the lowest values which increased from 74.35 to 74.85 % with the increasing of grains moisture content from 11.95 to 23.87%.

Grain projection area

Projection areas as related to grain moisture content for different varieties of the studied crops are presented in tables (1 through 4). As shown in the tables, grain projection areas are generally increased with the increasing of moisture content for all the studied crops. The observed increment in grain projection areas with the increasing of grain moisture content could be attributed to the increasing of grain principal dimensions as mentioned before.

For rice crop, table (1) shows that, long grain variety Yasmin recorded the highest values of grain projection areas which increased from 21.210 to 22.440 mm^2 with the increasing of grain moisture content from 12.80% to 25.11%. While, Giza 178 variety recorded the lowest values, which increased from 16.883 to 17.389 mm^2 with the increasing of grain moisture content from 12.57 to 26.22%.

For wheat crop, table (2) shows that, Gemiza (9) variety recorded the highest values of grain projection areas, which increased from 21.68 to 25.93 mm2 with the increasing of grain moisture content from 10.60 to 24.92%. While, Sids (1) variety recorded the lowest values, which increased from 18.460 to 21.010 mm2 with the increasing of grain moisture content from 11.17 to 24.85%.

For different varieties of corn table (3) shows that, Treble hybrid 310 variety recorded the highest values of grain projection areas which increased from 92.964 to 116.687 mm^2 with the increasing of grain moisture content from 9.95 to 27.74%. While Balady variety recorded the lowest values which increased from 90.105 to 99.719 with the increasing of grain moisture content from 10.40 to 25.93%.

For barley varieties, table (4) shows that, the projection areas of different studied varieties are very similar and ranged from 29.540 to 32.990 mm^2. However, variety Giza 126 recorded the highest values of grain projection areas which increased from 29.950 to 32.990 mm^2 with the increasing of grain moisture content from 11.22 to 24.41%. While, Giza 124 variety recorded the lowest values, which increased from 29.580 to 32.490 mm^2 with the increasing of grain moisture content from 11.51 to 24.67%.

Table (1): Shape index-k, coefficient of contact surface (C.C) and projection area for rice varieties at different levels of grain moisture content.

Variety	M.C.,% (w.b)	F_s	T_s	C.C.,%	Shape index-k	Projection area,mm^2
Giza 177	12.58	19.81	5.71	71.18	2.87	20.287
	14.84	20.12	5.86	70.88	2.84	20.430
	17.71	20.29	5.95	70.68	2.82	20.539
	21.75	20.59	6.08	70.47	2.80	20.713
	24.90	20.70	6.14	70.33	2.79	20.824
Giza 178	12.57	16.52	4.62	72.03	3.03	16.883
	14.96	16.74	4.67	72.10	3.02	16.917
	17.41	17.00	4.78	71.88	3.00	17.152
	21.90	17.22	4.89	71.60	2.98	17.365
	26.22	17.47	4.98	71.49	2.96	17.389
Sakha 101	13.18	19.58	5.53	71.76	2.92	19.442
	14.79	19.65	5.59	71.55	2.91	19.658
	17.76	19.72	5.62	71.50	2.91	20.036
	22.00	19.87	5.67	71.47	2.91	20.397
	24.95	20.15	5.72	71.61	2.93	20.562
Sakha 102	12.17	20.06	5.71	71.54	2.88	19.228
	15.41	20.28	5.81	71.35	2.86	19.767
	18.61	20.60	5.95	71.12	2.83	20.020
	22.21	20.74	6.03	70.93	2.81	20.314
	25.00	20.78	6.07	70.79	2.80	20.446
Giza 181	12.39	19.56	4.18	78.63	4.09	19.534
	14.84	20.14	4.26	78.85	4.10	20.231
	18.43	20.35	4.39	78.43	4.06	20.567
	22.82	20.71	4.56	77.98	4.01	20.814
	25.82	21.01	4.63	77.96	4.02	21.045
Yasmin	12.80	20.58	4.05	80.32	4.34	21.210
	14.73	21.08	4.23	79.93	4.27	21.530
	16.59	21.56	4.28	80.15	4.28	21.700
	22.06	22.05	4.46	79.77	4.23	22.040
	25.11	22.58	4.64	79.45	4.20	22.440

Table (2): Shape index-k, coefficient of contact surface (C.C) and projection area for wheat varieties at different levels of grain moisture content.

Variety	M.C.,% (w.b)	Fs	Ts	C.C.,%	Shape index-k	Projection area,mm2
Giza 168	10.85 14.29	21.29	8.13	61.81	2.25	20.610
	17.90 21.85	21.75	8.38	61.47	2.23	21.060
	24.14	22.27	8.66	61.11	2.21	21.560
		22.91	8.98	60.80	2.18	21.950
		23.47	9.32	60.29	2.15	22.320
Sakha 93	10.87 13.82	20.35	8.36	58.92	2.20	20.140
	17.86 21.81	21.20	8.78	58.59	2.16	20.600
	24.86	22.15	9.25	58.24	2.14	21.190
		22.87	9.52	58.37	2.14	21.770
		23.37	9.79	58.11	2.12	22.290
Sids 1	11.17 13.86	18.48	7.72	58.22	2.11	18.460
	17.82 21.97	18.96	7.91	58.28	2.11	18.960
	24.85	19.59	8.18	58.24	2.10	19.580
		20.11	8.45	57.98	2.08	20.550
		20.64	8.70	57.85	2.07	21.010
Gemiza 9	10.60 14.06	21.03	8.33	60.39	2.25	21.680
	18.03 21.98	22.34	8.84	60.43	2.21	22.300
	24.92	23.35	9.46	59.49	2.17	23.480
		24.88	10.04	59.65	2.16	24.760
		26.32	10.54	59.95	2.15	25.930

Table (3): Shape index-k, coefficient of contact surface (C.C) and projection area for corn varieties at different levels of grain moisture content.

Variety	M.C.,% (w.b)	Fs	Ts	C.C.,%	Shape index-k	Projection area,mm2
Triple hybrid 310	9.95	94.86	29.91	68.47	2.16	92.[illegible]
	14.65	102.00	32.54	68.10	2.12	99.093
	19.12	104.49	33.64	67.81	2.12	104.393
	23.72	109.32	34.91	68.07	2.10	109.155
	27.74	112.20	36.82	67.18	2.06	116.687
Triple hybrid 321	11.50	97.78	28.62	70.73	2.29	87.477
	14.73	99.05	29.20	70.52	2.28	96.951
	18.01	108.48	31.99	70.51	2.21	100.710
	22.20	113.27	33.27	70.62	2.20	109.772
	25.90	119.45	34.99	70.70	2.18	112.089
Single hybrid 10	10.87	90.36	29.02	67.88	2.13	91.384
	13.89	97.53	31.00	68.22	2.10	96.394
	18.10	100.58	32.43	67.76	2.06	99.404
	21.86	102.77	33.12	67.77	2.06	101.084
	24.94	106.49	34.49	67.61	2.04	105.704
Balady	10.40	91.34	39.71	56.53	1.55	90.105
	14.35	93.97	41.16	56.20	1.53	92.531
	18.01	97.55	43.25	55.66	1.50	94.324
	22.61	99.14	44.61	55.00	1.49	96.660
	25.93	101.89	46.66	54.20	1.48	99.719

Table (4): Shape index-k, coefficient of contact surface (C.C) and projection area for barley varieties at different levels of grain moisture content.

Variety	M.C.,% (w.b)	Fs	Ts	C.C.,%	Shape index-k	Projection area,mm2
Giza 123	11.81	33.49	8.36	75.04	3.41	29.540
	13.74	34.47	8.59	75.08	3.39	30.330
	18.79	35.58	8.86	75.10	3.37	31.130
	22.65	37.33	9.38	74.87	3.32	32.310
	24.68	37.77	9.48	74.90	3.31	32.810
Giza 124	11.51	34.55	8.47	75.49	3.49	29.580
	14.05	35.00	8.57	75.51	3.49	30.350
	18.00	35.42	8.70	75.44	3.48	31.070
	21.65	36.49	9.02	75.28	3.44	31.730
	24.67	37.42	9.30	75.15	3.40	32.490
Giza 125	11.95	36.61	9.39	74.35	3.37	29.830
	14.27	37.64	9.59	74.52	3.37	30.400
	18.55	38.83	9.90	74.50	3.36	31.340
	19.94	39.54	10.03	74.63	3.36	32.040
	23.87	40.51	10.19	74.85	3.39	32.900
Giza 126	11.22	33.35	8.10	75.71	3.46	29.950
	13.83	34.00	8.26	75.71	3.45	30.330
	17.15	35.32	8.59	75.68	3.44	31.440
	21.58	36.42	8.89	75.59	3.42	32.270
	24.41	38.78	9.42	75.71	3.36	32.990

CONCLUSIONS

Grains principal dimensions, mass of 1000 grain and grain projection area are generally increased with the increasing of grain moisture content. However, both shape index-k and coefficient of contact surface are decreased with the increasing of grain moisture content. Mathematical relationships relating the changes of the above-mentioned properties with the grain moisture contents are developed.

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دراسة الخصائص الطبيعية لبعض محاصيل الحبوب

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أجريت تلك الدراسة على بعض الأصناف المختلفة لمحاصيل الحبوب (الأرز – القمح – الذرة – الشعير) والتى تم اختيارها بناء على دراسة ميدانية مسبقة تضمنت حصر للمساحات المنزرعة وكذلك إنتاجية الفدان للأصناف المختارة. وقد اشتملت الخواص الطبيعية التى تم دراستها لتلك المحاصيل على الأبعاد الرئيسية للحبوب (الطول – العرض – السمك) ، وزن ١٠٠٠ حبة ، معامل الشكل shape index-k ، مساحة التلامس coefficient of contact surface وكذلك مساحة الإسقاط الضوئى (projection area) للأصناف المختلفة لكل محصول عند خمس محتويات رطوبية مختلفة تمثل مراحل الحصاد والتداول والتصنيع لتلك المحاصيل.

وقد أظهرت النتائج اختلاف الخصائص الطبيعية للمحاصيل المختلفة وكذا الأصناف الخاصة بكل محصول باختلاف المحتوى الرطوبى للحبوب حيث أظهرت النتائج وجود علاقة خطية طردية بين التغير فى المحتوى وخصائص الطول، العرض ، السمك، كتلة الألف حبة.

كما أظهرت النتائج أيضا انخفاض قيم كل من معامل الشكل ومساحة التلامس لحبوب الأصناف من المحاصيل التي تم دراستها بزيادة المحتوى الرطوبى بينما زادت قيم الإسقاط الضوئى لتلك الحبوب بزيادة المحتوى الرطوبى.

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