# Mean Performance and Genetic Variability of some Grain Quality Characteristics of Rice (*Oryza sativa L.)*

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## ABSTRACT

**The main objectives of the present study were to determine the mean performance and genetic variability of grain quality characteristics for some Egyptian rice cultivars during 2013 and 2014 growing seasons. Certified seeds of nineteen rice cultivars; namely, Sakha 101, Sakha 102, Sakha 103, Sakha 104, Sakha 105, Sakha 106, Giza 159, Giza 171, Giza 172, Giza175, Giza 176 and Giza 177, as short grain, while, Giza 178, Giza 179, Hybrid 1 and Hybrid 2 as medium grain,on the other hand, Giza 181, Giza 182 and Egyptian Yasmin as long grain were tested. The results showed significant differences among cultivars for most studied characters. The highest values for gel consistency (GC), 1000-grain weight, water uptake, gelatinization temperature (GT), grain width, grain thickness, protein content, hulling and milling characters were noticed for short grain cultivars in both study seasons while, the highest values for broken %, elongation %, amylose content %, grain shape and grain length were recorded with long grain cultivars in both seasons. Among the studied characters, all traits had high heritability values and ranged from 81.25 to 99.85%. this indicates that the characteristics are not influenced by environmental factors and could be successfully inherited to the next generations. Different values of correlation coefficients between the studied traits were estimated. In general most studied characters showed significant correlation between each other in both study seasons.**


**Keywords: Grain quality characters; heritability; Egyptian rice cultivars; *Oryza sativa L.***

## INTRODUCTION

The world population is expected to reach 8 billion by 2030 and therefore, rice production must be increased by 50% in order to meet the growing demand (Khush 2005; Miah *et al*. 2013 and Rafii 2014). Rice (*Oryza sativa* L.) is one of the world's highest value crop and second leading cereal crop after wheat that produced 430 million metric tons in world's rice production (IRRI 2009). It is the major food source for more than half of the world's population (IRRI 2010). Over 95% of the world's rice crop is used for human food. Accordingly, Egypt has become self – sufficient in rice production for many years, till now, besides, an increasing amount of surplus is exported (Shaalan, 2003).

Rice is the only cereal crop cooked and consumed mainly as whole grains, and quality considerations are much more important than for any other food crop (Hossain *et al*., 2009).

After the achievement of sufficient yield in high yielding varieties, the demand for good quality rice is increasing day after day both locally either abroad. The Egyptian rice millers (public and private sectors) prefer varieties with high milling and head rice out-turn, whereas, consumers consider cooking and eating quality requirements. Yields of head rice vary in many factors, such as variety, grain type, chalkiness, and cultural practices, drying, storing and milling conditions (Dipti *et al*, 2002).

In the meantime, consumers of rice need not only the sufficient quantity of rice supply but also the high quality rice grains. Therefore, they ask for more palatable rice because they have become more affluent recently. In addition, the recent approach for rice production includes the improvement of both yield and grain quality to cater fo rmillers and consumers demand and also to increase the nutritional level of the general public. Besides grain yield, hulling and milling recovery, grain physico-chemical properties have far-searching significance in attracting consumers. Also, cooking quality is of most importance for consumers (Shaalan 2003).

Moreover, evaluation of the Egyptian rice quality involves many aspects, ranging from physical characters, such as grain dimensions and milling recovery, to chemical components, cooking and eating quality characters, nutritional assessment and the effect of grain quality on rice marketing in Egypt (El-Hissewy and El-Kady 1992). Furthermore, rice grain quality characteristics show a large amount of variability among cultivars, depending upon the genetic make-up (Shaalan 2003).

However, it has long been realized that the appearance of rice together with its cooking and eating quality are important to the consumer. Grain quality is, therefore,an important consideration in rice variety selection and development (Singh *et aI.* 2000, Abeywickrama *et al*. 2010 and Rebeira *et al.* 2014) concluded that grain quality is second only to yield as the major breeding objective.

Rice grain quality is determined by its physical and physicochemical properties. Physical properties include

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kernel size, shape, milling recovery, degree of milling and grain appearance (Cruz and Khush, 2000). Physical quality has a great importance in commercial rice production as it highly influences on the final output as well as the consumer demand which are directly contribute to the economic profitability of the grower and miller.

Physicochemical properties of rice are determined based on amylose content, gel consistency and gelatinization temperature besides eating and cooking qualities are mainly controlled by the physicochemical properties which greatly influence the consumer's affinity (Rohilla *et al.,* 2000).

Therefore, this study was conducted to evaluate the variability and performance of rice grain quality characteristics of some commercial rice cultivars based on physical and physicochemical properties that will provide highly important information for future rice breeding programs as well as for consumers benefit.

## MATERIALS AND METHODS

The mean performance of some rice cultivars, which differed in grain quality, charactisties was tested at grain quality Labs, Rice Research Technology Center (RTTC), Alexandria Egypt. Certified seeds of nineteen rice cultivars; namely; Sakha 101, Sakha 102, Sakha 103, Sakha 104, Sakha 105, Sakha 106, Giza 159, Giza 171, Giza 172, Giza175, Giza 176 and Giza 177 as short grain, while Giza 178, Giza 179, Hybrid 1 and Hybrid 2 as medium grain, on the other hand Giza 181, Giza 182 and Egyptian Yasmin as long grain that were provided by Rice Research Program, Field crop Research Institute, Agriculture Research Center, Sakha Kafr El Sheikh, Egypt during 2013 and 2014 seasons. They were arranged in a randomized complete block design, with four replicates.

The studied characteristics were hulling%, milling%, broken%, 1000 grain weight, grain length, grain width, grain thickness, grain shape, protein content, amylose content, gelatinization temperature, gel consistency, elongation and water uptake.

Rice samples (150 g for each) were taken randomly; samples were cleaned and dehulled with an experimental Satake huller machine and polished in Satake miller and estimated according to standerd evaluation system of IRRI (1996).

Length and width of milled rice kernel were measured using a micrometer and size and shape were classified according to the method described by Khush *et al* (1979), amylose content was estimated by the simplified procedure reported by Juliano,( 1971), gel consistency was determined by the procedure described by Cagampang *et al* (1973) and Gelatinization temperature was recorded according to little *et al*. (1958).

Protein content was determined for brown rice, according to the standard Micro – Kjeldahl method. Then, the estimated nitrogen content was multiplied by a factor of 5.95 to estimate the crude protein content.

The water uptake at 77°C was determined for milled rice samples, as described by Simpson *et al* (1965). Elongation ratio was calculated, according to Azeez and Shafi (1966).

The variance components and values of heritability were estimated following the formulae given by Burton and De Vane (1953) and Johnson *et al*. (1955) and applied by Mazid *et al.* (2013). $\sigma^2_G$ (Genotypic variance) = $(MS_G - MS_E)/r$, where $MS_G$ =mean square of accession, $MS_E$= mean square of error, and r = number of replications; $\sigma^2_E = MS_E$; $\sigma^2_P$ (Phenotypic variance) = $(\sigma^2_G + \sigma^2_E)$; PCV (Phenotypic coefficient of variation) = $\sqrt{\sigma^2_p} / X \times 100$, where $\sigma^2_P$= phenotypic variance and X = mean of the trait; GCV (Genotypic coefficient of variation) = $\sqrt{\sigma^2_G} / X \times 100$ where $\sigma^2_G$= genotypic variance and X= mean of the trait; and $H^2_B$ (Broad sense heritability) = $\frac{\sigma^2_G}{\sigma^2_p}$

Analysis of variance and correlation coefficients were estimated according to Gomez and Gomez (1984) using SAS program, version 8.0.

## RESULTS AND DISCUSSIONS

### I-Mean performance:

Table (1) shows the means of milling characters and 1000-grain weight of rice grains for the before mentioned cultivars. Data indicated that there were significant differences between cultivars on such characters. The short grain cultivars ranged between 78.66 to 81.50 % in hulling, from 70.08 to 72.58 % in milling, from 2.26 to 10.52 in broken % and from 22.12 to 28.39 gm in 1000 grain weight, while, the medium grain ones ranged between 77.99 and 79.63 % in hulling, from 68.97 and 72.01 in milling %, from 5.45 and 8.65 % in broken % and from 21.64 to 25.64 gm in 1000 grain weight. Moreover, the long grain cultivars ranged between 76.43 and 78.79 % in hulling, from 67.78 to 69.20 % in milling, from 7.20 to 15.62 % in broken and from 25.41 to 28.32 gm in 1000 grain weight. These results were in harmony with Mady (1994), Badawi (2002), Dipti *et al* (2002), Shaalan (2003) and Rebeira *et al* (2014).

Data in table (2), showed the physical properties of the rice grains for studied cultivars during 2013 and 2014 seasons. The short grain cultivars ranged between 5.12 and 5.86 mm in length, from 2.42 and 3.07 mm in width, from 1.78 and 2.50 mm in thickness and from 2.08 and 2.60 in shape. Furthermore, the long grain cultivars ranged between 6.12 and 6.91 mm in length, from 2.11 and 2.51 mm in width, from 1.73 and 2.15 mm in thickness and from 2.67 and 3.11 in shape. Shaalan (2003) and Rebeira *et al.* (2014) gave similar results.

**Table 1. Mean values for milling characteristics and 1000 - grain weight in 2013 and 2014, seasons**

| Cultivars | Hulling (%) | | Milling (%) | | Broken (%) | | 1000 grain wt. (g) | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Sakha101 | 80.64 | 80.19 | 71.41 | 70.97 | 5.55 | 5.70 | 27.56 | 27.35 |
| Sakha102 | 80.82 | 80.56 | 71.23 | 70.55 | 4.54 | 3.87 | 28.39 | 28.10 |
| Sakha103 | 81.43 | 81.10 | 72.00 | 71.77 | 3.93 | 4.33 | 25.11 | 25.37 |
| Sakha104 | 80.54 | 80.21 | 71.31 | 70.72 | 4.78 | 4.13 | 26.66 | 26.47 |
| Sakha105 | 80.53 | 80.22 | 71.11 | 70.77 | 5.36 | 5.76 | 25.11 | 26.37 |
| Sakha106 | 81.50 | 81.11 | 71.02 | 71.35 | 5.77 | 6.00 | 28.35 | 28.11 |
| Giza159 | 80.62 | 80.31 | 70.84 | 72.12 | 3.15 | 3.45 | 26.33 | 26.56 |
| Giza171 | 81.34 | 81.13 | 72.33 | 72.58 | 2.39 | 2.56 | 24.65 | 25.81 |
| Giza172 | 80.40 | 80.23 | 72.04 | 72.16 | 2.26 | 2.39 | 25.75 | 24.51 |
| Giza175 | 78.66 | 78.92 | 70.08 | 70.56 | 2.76 | 3.12 | 26.35 | 25.12 |
| Giza176 | 79.67 | 79.79 | 71.01 | 70.76 | 2.33 | 3.38 | 25.86 | 25.62 |
| Giza177 | 80.57 | 80.24 | 71.12 | 70.85 | 10.52 | 9.44 | 24.32 | 24.02 |
| Giza178 | 79.63 | 79.50 | 68.41 | 69.86 | 8.23 | 8.65 | 22.64 | 23.72 |
| Giza179 | 79.32 | 79.14 | 70.01 | 69.13 | 6.56 | 7.11 | 24.44 | 24.07 |
| Hybrid 1 | 79.21 | 77.99 | 70.00 | 69.42 | 5.77 | 5.45 | 28.48 | 24.65 |
| Hybrid 2 | 79.20 | 78.11 | 70.03 | 68.97 | 5.85 | 5.56 | 25.37 | 25.64 |
| Giza181 | 76.82 | 76.43 | 67.78 | 68.34 | 15.62 | 13.87 | 25.32 | 25.11 |
| Giza 182 | 78.79 | 78.33 | 69.20 | 68.90 | 9.33 | 10.51 | 26.00 | 26.44 |
| Yasmine | 77.97 | 77.53 | 69.00 | 68.30 | 7.20 | 7.99 | 25.41 | 25.65 |
| L.S.D.0.05 | 0.24 | 0.37 | 0.22 | 0.12 | 0.31 | 0.16 | 0.25 | 0.40 |

**Table 2. Mean values for physical characteristics in 2013 and 2014, seasons**

| Cultivars | GrainLength(mm) | | GrainWidth(mm) | | GrainThickness(mm) | | GrainShape(L/W) | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Sakha101 | 5.71 | 5.43 | 2.65 | 2.82 | 1.98 | 2.26 | 2.15 | 1.93 |
| Sakha102 | 5.65 | 5.35 | 2.84 | 2.62 | 2.02 | 2.28 | 1.99 | 2.04 |
| Sakha103 | 5.33 | 5.42 | 2.91 | 2.76 | 2.09 | 2.33 | 1.83 | 1.96 |
| Sakha104 | 5.58 | 5.76 | 2.78 | 3.01 | 2.01 | 2.50 | 2.00 | 1.91 |
| Sakha105 | 5.86 | 5.61 | 2.88 | 3.07 | 2.13 | 2.28 | 2.03 | 1.83 |
| Sakha106 | 5.56 | 5.78 | 2.80 | 2.99 | 2.27 | 2.46 | 1.99 | 1.93 |
| Giza159 | 5.13 | 5.43 | 2.87 | 2.94 | 1.99 | 2.38 | 1.79 | 1.85 |
| Giza171 | 5.61 | 5.37 | 2.71 | 2.55 | 1.96 | 2.07 | 2.07 | 2.11 |
| Giza172 | 5.36 | 5.55 | 2.89 | 2.65 | 2.03 | 2.26 | 1.85 | 2.09 |
| Giza175 | 5.32 | 5.12 | 2.42 | 2.60 | 1.78 | 2.01 | 2.20 | 1.97 |
| Giza176 | 5.51 | 5.40 | 2.78 | 3.00 | 1.97 | 2.54 | 1.98 | 1.80 |
| Giza177 | 5.43 | 5.52 | 2.91 | 3.00 | 2.04 | 2.46 | 1.87 | 1.84 |
| Giza178 | 5.28 | 5.39 | 2.38 | 2.52 | 1.81 | 2.06 | 2.22 | 2.14 |
| Giza179 | 5.65 | 5.88 | 2.72 | 2.61 | 1.90 | 2.15 | 2.08 | 2.25 |
| Hybrid 1 | 5.60 | 5.74 | 2.44 | 2.21 | 1.77 | 2.02 | 2.30 | 2.60 |
| Hybrid 2 | 5.59 | 5.76 | 2.33 | 2.45 | 1.80 | 2.01 | 2.40 | 2.35 |
| Giza181 | 6.23 | 6.57 | 2.33 | 2.11 | 1.76 | 2.11 | 2.67 | 3.11 |
| Giza182 | 6.12 | 6.42 | 2.26 | 2.40 | 1.73 | 2.15 | 2.71 | 2.68 |
| Yasmine | 6.78 | 6.91 | 2.33 | 2.51 | 1.74 | 2.06 | 2.91 | 2.75 |
| L.S.D.0.05 | 0.10 | 0.06 | 0.04 | 0.07 | 0.03 | 0.05 | 0.02 | 0.06 |

Table (3) shows the means of protein content, amylose content and gelatinization temperature during 2013 and 2014 seasons. Sakha 106 showed the highest values (8.68 and 8.44%) for protein content while, the lowest values (7.44 and 7.65 %) were noticed for Giza 177 rice cultivar in both seasons respectively. Moreover, the highest amylose % (22.70 and 22.44 %) were recognized with Yasmine cultivar while, the lowest values (18.31 and 18.06 %) were found with Giza 175 rice cultivar in both study seasons respectively. Gelatinization temperature (spreading and clearing) determines the water uptake and the time required for cooking. It, also, may reflect the hardness of rice starch granules for cooking (Mady, 1994). Furthermore, Sakha 103 rice cultivar showed superiority in spreading (5.29 and 5.18) while, the lowest values (3.68 and 3.52) were noticed with Hybrid 2 rice cultivar during both seasons respectively. As for clearing of rice grain the highest values (4.59 and 4.72) were indicated with Giza 179 while, the lowest values (3.11 and 3.05) were noticed with Yasmine rice cultivar in both seasons respectively. These results were in agreement with those reported by El Hissewy and El Kady (1992), Badawi (2002) and Shaalan (2003).

Gel consistency, Elongation % and water uptake were presented in table (4). Data in this table showed that there were significant differences between cultivars for such characteristics. Sakha 101 showed the highest values (95.12 and 96.48 mm) for gel consistency while, Giza 181 showed the lowest values (83.55 and 82.06 mm) for such characteristics in both seasons respectively. The highest values (63.72 and 64.17 %) for elongation % were recognized with Giza 177 rice cultivar while, the lowest values (55.46 and 55.86) were noticed with Giza 178 in both seasons respectively. Moreover, the highest water uptake values (464.2 and 469.9 ml water/100 gm milled grains) were noticed with Sakha 105 while, the lowest values (335.3 and 365.8 ml water/100 gm milled grains) were noticed with Giza 172 rice cultivar in both seasons respectively. These results agreed with those reported by several workers, such as, El-Hissewy and El-Kady (1992), Mady (1994), Badawi (2002) and Shaalan (2003).

**Table 3. Mean values for protein content, amylose content and gelatinizationCharacteristics in 2013 and 2014, seasons**

| Cultivars | Protein content (%) | | Amylose content(%) | | Gelatinization temperature (G.T) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spreading | | Clearing | |
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Sakha101 | 8.30 | 8.05 | 19.33 | 18.91 | 5.08 | 4.98 | 4.04 | 3.46 |
| Sakha102 | 8.46 | 8.13 | 19.03 | 18.88 | 5.23 | 5.04 | 4.37 | 4.00 |
| Sakha103 | 8.48 | 8.06 | 19.22 | 19.10 | 5.29 | 5.18 | 3.67 | 3.53 |
| Sakha104 | 8.53 | 8.22 | 19.43 | 19.21 | 5.20 | 5.13 | 3.72 | 3.63 |
| Sakha105 | 8.66 | 8.31 | 19.40 | 19.13 | 5.09 | 5.03 | 3.99 | 3.63 |
| Sakha106 | 8.68 | 8.44 | 19.65 | 19.31 | 5.04 | 4.80 | 3.77 | 3.40 |
| Giza159 | 7.65 | 8.01 | 18.48 | 18.33 | 4.64 | 4.41 | 3.41 | 3.13 |
| Giza171 | 7.70 | 7.99 | 18.48 | 18.20 | 4.75 | 4.54 | 3.33 | 3.06 |
| Giza172 | 7.61 | 7.94 | 18.43 | 18.11 | 4.74 | 4.69 | 3.27 | 3.08 |
| Giza175 | 7.56 | 7.82 | 18.31 | 18.06 | 4.71 | 4.56 | 3.14 | 3.32 |
| Giza176 | 7.51 | 7.75 | 18.57 | 18.22 | 4.47 | 4.25 | 3.39 | 3.48 |
| Giza177 | 7.44 | 7.65 | 18.99 | 18.50 | 4.86 | 4.55 | 4.26 | 4.45 |
| Giza178 | 8.57 | 8.23 | 20.02 | 19.45 | 4.66 | 4.36 | 3.76 | 3.90 |
| Giza179 | 8.63 | 8.38 | 19.04 | 19.71 | 4.89 | 4.73 | 4.59 | 4.72 |
| Hybrid 1 | 8.34 | 8.10 | 22.01 | 22.22 | 4.01 | 3.89 | 3.39 | 3.14 |
| Hybrid 2 | 8.44 | 8.03 | 22.21 | 22.35 | 3.68 | 3.52 | 3.71 | 3.47 |
| Giza181 | 8.26 | 8.10 | 22.59 | 22.23 | 4.02 | 3.78 | 3.35 | 3.50 |
| Giza182 | 8.16 | 8.32 | 22.61 | 22.20 | 4.33 | 4.02 | 3.36 | 3.21 |
| Yasmine | 8.05 | 8.37 | 22.70 | 22.44 | 3.99 | 3.64 | 3.11 | 3.05 |
| L.S.D.0.05 | 0.05 | 0.11 | 0.21 | 0.10 | 0.11 | 0.14 | 0.22 | 0.13 |

**Table 4. Mean values for Gel consistency, Elongation % and water uptakeCharacteristics in 2013 and 2014 seasons**

| Cultivars | Gel consistency (G.C) (mm) | | Elongation (%) | | Water Uptake (ml water/100gm milledgrains) | |
|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Sakha101 | 95.12 | 96.48 | 60.64 | 61.62 | 443.2 | 421.2 |
| Sakha102 | 93.67 | 93.18 | 61.66 | 60.11 | 449.9 | 421.8 |
| Sakha103 | 94.16 | 95.35 | 60.21 | 61.89 | 424.4 | 457.6 |
| Sakha104 | 94.14 | 92.26 | 60.50 | 60.92 | 459.5 | 466.8 |
| Sakha105 | 94.60 | 95.22 | 61.15 | 61.96 | 464.2 | 469.9 |
| Sakha106 | 93.43 | 94.12 | 60.92 | 61.38 | 454.2 | 465.5 |
| Giza159 | 90.48 | 89.86 | 59.10 | 59.76 | 435.5 | 466.3 |
| Giza171 | 91.55 | 92.23 | 60.11 | 60.35 | 424.3 | 456.7 |
| Giza172 | 9o.55 | 92.18 | 60.24 | 60.72 | 335.3 | 365.8 |
| Giza175 | 90.65 | 88.76 | 59.00 | 59.46 | 441.7 | 449.8 |
| Giza176 | 90.61 | 91.24 | 58.23 | 58.60 | 440.8 | 449.0 |
| Giza177 | 93.12 | 94.18 | 63.72 | 64.17 | 455.6 | 433.4 |
| Giza178 | 90.27 | 90.94 | 55.46 | 55.86 | 432.8 | 462.2 |
| Giza179 | 92.88 | 91.18 | 57.12 | 57.87 | 460.1 | 466.2 |
| Hybrid 1 | 87.31 | 88.76 | 62.00 | 61.04 | 439.2 | 427.0 |
| Hybrid 2 | 89.37 | 91.08 | 61.84 | 61.12 | 421.8 | 445.7 |
| Giza181 | 83.55 | 82.06 | 62.29 | 61.78 | 417.2 | 439.8 |
| Giza182 | 85.22 | 86.33 | 62.37 | 62.60 | 428.1 | 445.8 |
| Yasmine | 85.23 | 84.38 | 62.43 | 62.05 | 430.3 | 436.6 |
| L.S.D.0.05 | 0.21 | 0.39 | 0.25 | 0.11 | 3.22 | 2.13 |

**II- Genetic variability and heritability estimates:**

Variance components of grain quality characteristics are shown in Table (5). Among the characteristics, hulling, milling, broken, 1000 grain weight, grain length, grain width, grain shape, grain thickness, protein content, amylose content, spreading, clearing, gel consistency, elongation and water uptake showed comparatively lower differences between PCV and GCV indicating relatively lower influence of environment factors on the expression of these characters. Amin *et al.* (1992) observed the closeness of PCV and GCV for a few characters and much difference between PCV and GCV for others in a study with rice genotypes.

Heritability is an important concept in quantitative genetics, particularly in selective breeding. Variance components with heritability values for grain quality characteristics are shown in Table (5). All the grain quality characters had high heritability values (>81%). The present results indicated that grain quality characters are not influenced by environmental factors. These rice cultivars could be used for breeding programmes and biotechnological research for the improvement of valuable grain quality traits (Rafii *et al.,* 2014).

These findings support the results from previous study by Vanaja and Babu (2008), who reported high degree of broad-sense heritability for grain quality characters.

**III-Correlation co-officiants between all studied characters**

Tables (6, 7, 8, 9, 10, and 11) showed the correlation between physical, milling and cooking and eating quality characters. Hulling was positively and significantly correlated with grain width, grain thickness, spreading and G.C while, it showed negative and significant correlation with grain length, grain shape, amylose and elongation in both study seasons. Moreover, hulling was not correlated with protein, clearing and water uptake in both seasons. These results were in harmony with those reported by Shaalan (2003).

Positive and significant correlation were estimated between milling and grain width, grain thickness, spreading and gel consistency while, significant negative correlation was detected with grain length, grain shape, protein, amylose, clearing, elongation and water uptake in 2013 and 2014 seasons. These results were in harmony with those reported by Shaalan (2003).

Furthermore, protein content and water uptake didn't show any correlation with physical and milling characters in both study seasons of study. One thousand grain weight showed positive and significant correlation with grain length and elongation and didn't show any

**Table 5. Heritability values in broad sense ($H^2_B$) for grains quality characteristics**

| Traits | $\sigma^2_G$ | $\sigma^2_E$ | $\sigma^2_P$ | $H^2_B$ (%) | PCV (%) | GCV (%) |
|---|---|---|---|---|---|---|
| Hulling | 1.5568 | 0.0298 | 1.5866 | 98.12 | 1.562 | 1.577 |
| Milling | 0.9768 | 0.0151 | 0.9919 | 98.48 | 1.394 | 1.404 |
| Broken | 8.8531 | 0.0135 | 8.8666 | 99.85 | 50.98 | 51.02 |
| 1000-grain weight | 4.0825 | 0.0319 | 4.1144 | 99.22 | 8.002 | 8.033 |
| Grain Length | 0.1662 | 0.0004 | 0.1666 | 99.75 | 7.155 | 7.163 |
| Grain Width | 0.0644 | 0.0012 | 0.0656 | 98.17 | 9.451 | 9.539 |
| Grain shape | 0.0039 | 0.0008 | 0.0048 | 81.25 | 4.557 | 4.981 |
| Grain thickness | 0.0226 | 0.0007 | 0.0233 | 96.99 | 7.773 | 7.893 |
| Protein content | 0.0998 | 0.0030 | 0.1028 | 97.08 | 3.832 | 3.889 |
| Amylose content | 2.5874 | 0.0129 | 2.6000 | 99.51 | 8.046 | 8.066 |
| Spreading | 0.2292 | 0.0076 | 0.2368 | 97.03 | 10.29 | 10.46 |
| Clearing | 0.1765 | 0.0252 | 0.2017 | 87.50 | 11.59 | 13.28 |
| Gel consistency | 11.452 | 0.0326 | 11.485 | 99.71 | 3.720 | 3.725 |
| Elongation | 3.929 | 0.0236 | 3.9531 | 99.39 | 3.273 | 3.283 |
| Water Uptake | 0.2019 | 0.0095 | 0.2114 | 95.51 | 12.60 | 12.89 |

Notes: $\sigma^2_G$- Genotypic variance, $\sigma^2_E$ - Error variance, $\sigma^2_P$- Phenotypic variance, $H^2_B$Broad sense heritability, PCV - Phenotypic coefficient of variation, GCV – genotypic coefficient of variation

Breakage percentage was positively and significantly correlated with grain length, grain shape, amylose, clearing and elongation while, negative and significant correlated with grain width, spreading and G.C and not correlated with protein, grain thickness and water uptake in both study seasons. These results were in a general agreement with those reported by El Hissewy and El Kady (1992).

Positive and significant correlation co-efficient were noticed between amylose and broken, grain length, grain thickness and grain shape while, negative correlation with milling, hulling and grain width. Furthermore, non significant correlation co-efficient was estimated between amylose and 1000-grain weight in both study seasons. These results were in a general agreement with those reported by El Hissewy and El Kady (1992).

Gelatinization temperature (spreading and clearing) showed significant correlation with most studied characters in both seasons. Positive and significant correlation were observed between spreading and hulling, milling, grain length and grain width while, negative and significant correlation with broken, grain thickness and grain shape and not correlated with 1000-grain weight in 2013 and 2014 seasons. Moreover, clearing showed positive correlation with broken and negative correlation with grain length, grain width, grain thickness and grain shape and not correlated with hulling, milling and 1000-grain weight in both seasons.

Non significant correlation was noticed between gel consistency and 1000-grain weight, grain length, grain width, grain thickness and grain shape while, negative and significant correlation with milling and broken and positive correlation with hulling in both seasons.

Elongation showed positive and significant correlation with milling, broken, 1000 grain weight and grain length while, it was not correlated with hulling, grain width, grain thickness and grain shape in both study seasons.

Grain length showed negative and significant correlation with hulling, milling, clearing and G.C while positive and significant correlated with broken, 1000 grain weight, amylose, spreading and elongation and not correlated with protein and water uptake in both seasons. Moreover, grain width showed positive correlation with hulling, milling, 1000 grain weight, spreading, clearing and G.C while negative correlated with broken, protein and amylose and not correlated with elongation and water uptake in 2013 and 2014 seasons. These results were in a general agreement with those reported by El Hissewy and El Kady (1992), Badawi (2002), Shaalan (2003) and Danbaba (2011).

Grain thickness showed negative and significant correlation with amylose while, positively correlated with hulling, milling, spreading, clearing and G.C and it was not correlated with broken, 1000-grain weight, protein, elongation and water uptake in both seasons.

Grain shape showed negative and significant correlation with hulling, milling, spreading, clearing and G.C while, positively correlated with broken, amylose and not correlated with 1000-grain weight, protein, elongation and water uptake in both seasons.

**Table 6. Correlation co-efficient among physical, milling and 1000 grain weight characteristics in 2013 season**

| Characters | Grain Length | Grain Width | Grain Thickness | Grain Shape |
|---|---|---|---|---|
| Hulling | -0.650* | 0.764** | 0.609** | -0.835** |
| Milling | -0.592** | 0.445** | 0.296* | -0.607** |
| Broken | 0.540** | -0.428** | -0.144 | 0.581** |
| 1000-grain weight | 0.309* | 0.045 | 0.392 | 0.154 |

**Table 7. Correlation co-efficient among physical, milling and 1000-grain weight characters in 2014 season**

| Characters | Grain Length | Grain Width | Grain Thickness | Grain Shape |
|---|---|---|---|---|
| Hulling | -0.396** | 0.355** | 0.433* | -0.653** |
| Milling | -0.452** | 0.652** | 0.487** | -0.432** |
| Broken | 0.748* | -0.515** | -0.335 | 0.764* |
| 1000-grain weight | 0.665** | 0.324 | 0.521 | 0.432 |

**Table 8. Correlation co-efficient among milling and cooking and eating quality characters in 2013 season**

| Characters | Hulling | Milling | Broken | 1000grain weight |
|---|---|---|---|---|
| Protein | 0.106 | -0.056 | 0.124 | 0.183 |
| Amylose | -0.791** | -0.669** | 0.603** | 0.211 |
| Spreading | 0.829** | 0.566** | -0.370** | -0.001 |
| Clearing | 0.132 | -0.067 | 0.352** | -0.072 |
| G.C | 0.854** | 0.531** | -0.505** | -0.115 |
| Elongation | -0.001 | -0.258* | 0.278** | 0.386** |
| Water Uptake | 0.160 | -0.133 | 0.098 | 0.098 |

**Table 9. Correlation co-efficient among milling and cooking and eating quality characters in 2014 season**

| Characters | Hulling | Milling | Broken | 1000-grain weight |
|---|---|---|---|---|
| Protein | 0.433 | -0.212 | 0.311 | 0.264 |
| Amylose | -0.558* | -0.545** | 0.532* | 0.355 |
| Spreading | 0.627** | 0.439** | -0.524** | -0.104 |
| Clearing | 0.322 | -0.113 | 0.488** | -0.148 |
| G.C | 0.566* | 0.387* | -0.635** | -0.271 |
| Elongation | -0.063 | -0.413* | 0.386** | 0.512* |
| Water Uptake | 0.311 | -0.197 | 0.115 | 0.159 |

**Table 10. Correlation co-efficient among physical and cooking and eating quality character in 2013season**

| Characters | Grain length | Grain width | Grain Thickness | Grain shape |
|---|---|---|---|---|
| Protein | -0.059 | -0.017 | -0.042 | -0.026 |
| Amylose | 0.714** | -0.753** | -0.528** | 0.861** |
| Spreading | 0.527** | 0.727** | 0.565** | -0.746** |
| Clearing | -0.208* | 0.254* | 0.204* | -0.286** |
| G.C. | -0.749** | 0.738** | 0.538** | -0.874** |
| Elongation | 0.343** | 0.038 | 0.153 | 0.175 |
| Water uptake | -0.122 | 0.123 | 0.159 | 0.149 |

**Table 11. Correlation co-efficient among physical and cooking and eating quality character in 2014 season**

| Characters | Grain length | Grain width | Grain Thickness | Grain shape |
|---|---|---|---|---|
| Protein | -0.137 | -0.131 | -0.155 | -0.132 |
| Amylose | 0.597** | -0.662** | -0.676** | 0.766** |
| Spreading | 0.665** | 0.818** | 0.711** | -0.911** |
| Clearing | -0.363* | 0.332* | 0.339* | -0.365** |
| G.C. | -0.874** | 0.592** | 0.717** | -0.775** |
| Elongation | 0.513** | 0.113 | 0.214 | 0.133 |
| Water uptake | -0.195 | 0.198 | 0.212 | 0.201 |

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## الملخص العربي

# تحديدالأداء المظهرى والسلوك الوراثى لصفات جودة الحبوب لبعض أصناف الأرز المصرى

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أجريت هذه الدراسة لتحديد السلوك والتباين الوراثى لصفات جودة الحبوب لبعض أصناف الأرز المصرية خلال موسمى الزراعة٢٠١٣- ٢٠١٤وهى سخا١٠١، سخا١٠٢، سخا١٠٣، سخا ١٠٤، سخا١٠٥، سخا١٠٦، جيزة ١٥٩، جيزة ١٧١، جيزة ١٧٢، جيزة ١٧٥، جيزة ١٧٦، جيزة ١٧٧، أصناف قصيرة الحبة، وجيزة ١٧٨، جيزة ١٧٩، هجين١، وهجين ٢ أصناف متوسطة الحبة، وجيزة ١٨١، جيزة ١٨٢، وصنف ياسمين المصري أصناف طويلة الحبة. وبإجراء التحليل الإحصائى للبيانات المتحصل عليها أوضحت النتائج اختلافات معنوية بين الأصناف تحت الدراسة لمعظم الصفات المدروسة. وقد سجلت الأصناف قصيرة القيم الأعلى لصفة محتوى الجل، وصفة وزن ١٠٠٠ حبة، صفة امتصاص الماء، وصفة درجة حرارة الجلتنة، وصفة عرض الحبة، وصفة سمك الحبة، وصفة محتوى البروتين، وصفتى التقشيير والتبييض خلال موسمى الدراسة. بينما سجلت الأصناف طويلة الحبة القيم الأعلى فى الصفات التالية: النسبة المئوية للكسر، نسبة الاستطالة، نسبة الأميلوز، شكل الحبة، وطول الحبة خلال موسمى الدراسة. تم حساب قيمة درجة التوريث لجميع الصفات المدروسة والتى أعطت قيما" مرتفعة تراوحت ما بين ٨١,٢٥% إلى ٩٩,٨٥% ويدل هذا على عدم تأثر هذه الصفات بالعوامل البيئية مما يمكن من الانتخاب لهذه الصفات فى مراحل مبكرة. كما تم حساب قيم مختلفة من معاملات الارتباط بين الصفات المدروسة والتى أظهرت ارتباطا" معنويا" فيما بينها فى كل من موسمى الدراسة.