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# Chemical and Technological Evaluation of Some Egyptian Rice Cultivars

[1]Gewaily E.E., W. T Abd El-Rahem[2], Soheir T. El-Hadide[3] and Maha M. Tawfik[3]

[1]*Rice Res. and Training Center, Field Crops Res. Inst., Agricultural Res. Center, Sakha - Kafr El-Sheikh, Egypt.*
[2]*Seed Technology Dept., Field Crops Res. Inst., Agricultural Res. Center, Giza, Egypt.*
[3] *Field Crops Technology Res. Dept., Agricultural Res. Center, Giza, Egypt.*

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## ABSTRACT

A field experiment was carried out at the farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Shiekh, Egypt, in 2015 and 2016 seasons. The experiment was conducted to estimate the agronomical, technological of seed characteristic and some chemical composition of different rice cultivars namely Giza 178, Giza 179, Sakha101, Sakha104, Sakha105 and Sakha106. The rice cultivars were grown in randomized complete bloke design with three replications. The main results revealed that Giza 178 and Sakha 101 cultivars surpassed all the other tested cultivars and produced the greatest grain yield and its attributes. The tallest plants were observed with Sakha 104 and Sakha 101 cultivars and the longest duration was found with Giza 178, Sakha 101 and Sakha 104 rice cultivars. Concerning seed vigor, there were any significant differences among all tested cultivars in germination percentage. Sakha 104 and Sakha 101 cultivars produced the heaviest 1000-seed weight and the highest electrical conductivity was observed with Sakha 101 and Sakha 104, while Giza 179 gave the greatest seed vigor index. Hulling and milling percentage were the highest in Sakha 104, 105 and 106, while Giza 179 gave the highest head rice. As for cooking characters, results indicated that Giza 178 gave the highest value in water uptake and Giza 179 produced the greatest volume expansion. All the tested cultivars had the same time for cooking time except Giza 179 and Sakha 104 cultivars, which gave the lowest value in this aspect. The two Giza cultivars (178 and 179) plus Sakha 101 had higher amylose content than the other Sakha cultivars under study. Results also indicated that Giza cultivars under study gave the greatest values in protein content, ash and either extract than the tested Sakha cultivars, while the fiber crud percentage reached to the maximum with Sakha 104 and total carbohydrate with Sakha 101 rice cultivars.

***Keywords:*** Egyptian rice cultivars, agronomical, technological of seed characteristic and chemical composition.

## Introduction

Rice (*Oryza sativa L.*) is a food crop of worldwide importance and forms the foundation of the diet of over 3 billion people, constituting over half of the world's population (Cantral and Reeves 2002). It is widely cultivated throughout the world and has become the second most important cereal in the world after wheat in terms of cultivation (Jones, 1995). Rice provides about 75% of the calorie and 55% of the protein in the average daily diet of the people (Anonymous, 2002). It is estimated that half of the world's population depends on rice as main source of food.

Genetics plays a major role in determining rice functionality. Environment and cultural practices also have been shown to significantly affect composition and consequently, cooking characteristics of rice (Dang and Copeland 2004).

Egypt has the largest acreage under rice growing countries of world that ranks first in productivity, to sustain its high production and productivity, a number of high yielding cultivars and hybrid have been developed and notified recently past, out of which many cultivars are now in seed production.

Significant variation in physical and mechanical properties has been shown among rice cultivars produced in different parts of the world with the influence of diverse genetic and environmental factors (Izawa 2008; Mir *et al*. 2013). Physical and mechanical properties play an

**Corresponding Author**: Gewaily E.E., Rice Res. and Training Center, Field Crops Res. Inst., Agricultural Res. Center, Sakha - Kafr El-Sheikh, Egypt. E-mail: sgewaily@yahoo.com

important role in deciding the rice processing operations, which directly affect the quality of rice at industrial scale and hence determine its consumer acceptability. Several authors have reported about the physical and mechanical characteristics of rice, which influence the milling, cooking quality and consumer preference (Mohapatra and Bal 2006; Correa et al. 2007; Varnamkhasti *et al*. 2008). The differences in the physical properties of rice grain are of practical concern for processing, handling and storage. The knowledge of physical properties of grain is helpful for designing appropriate machineries for process operations like sorting, drying, heating and milling and finds the solutions to problems associated with these processes (Sahay and Singh 1994; Mir *et al*. 2013). These properties are also important in the construction of storage condition and the calculation of the dimensions of storage bins of a particular capacity (Thompson and Ross 1983).

Seed technologists must be well equipped to identify both different cultivars and hybrids, at field and at seed levels. Varietals descriptions given by the breeders most often relate to field characters and not sufficient to identify genotypes or seed lots adequately. Frequently, information is required rapidly, which can be only provided by identification at the seed or seedling level or some chemical tests, which should be rapid, reliable and reproducible.

Chemical composition of seeds is determined according genetic its background as sources for different raw materials. Modern genotypes of rice have been developed for higher content of carbohydrates, which represent significant improvement over earlier cultivars. Al-Bahrany (2002) studied the chemical composition of some rice genotypes seeds, who reported that the chemical composition analysis showed that seeds contained moisture (8.83-9.20%), protein (9.24-10.68 %), oils (2.04-2.29%) and carbohydrates in the form of starch, (75.69 -77.38%). Therefore, the objective of present study was to estimate the agronomical, technological of seed characteristic and some chemical composition of six Egyptian rice cultivars.

## Materials and Methods

The field experiment was carried out at the farm of the Rice Research and Training Center (RRTC), Sakha, Kafr Elshiekh, Egypt, during 2015 and 2016 rice growing seasons to estimate the agronomical, technological of seed characteristic and some chemical composition of some Egyptian rice cultivars, namely Giza 178, Giza 179, Sakha101, Sakha104, Sakha105 and Sakha106. Nursery area was identified and well prepared. The phosphorus fertilizer was applied during land preparation and nitrogen fertilizer was applied after dry leveling and the nursery immediately irrigated. Seeds at rate of 144 kg $ha^{-1}$ were soaking 24 hr, and incubated 48 hr. The pregermanated seeds were broadcasted in nursery after slight wet leveling. The zinc sulfate was applied before seeds broadcasting. The weeds were chemically controlled using saturan 50% after 7 days from seed broadcasting. The permanent land area was prepared the same as nursery area. Phosphorus and potassium fertilizer were applied during land preparation as recommended and nitrogen fertilizer was applied after dry leveling. Thirty day old seedling of each cultivar was individually bulled and transferred from nursery to the permanent field and transplanted. Weeds were chemically controlled using Saturn 50%, 7 days after transplanted. The plot size was 12 $m^2$ and spacing between hills and rows was 20x20 cm. The statistical design was complete randomized block design with three replications. All other cultural practices were done as recommended.

### Studied characters:

Each rice cultivar under study was harvested according to its duration. At full maturity of the tested cultivar the following characters were estimated excepted the date of heading which estimate as number of days from sowing up to 50% heading. Three days before harvesting ten samples hill were randomly collected to estimate and count the following characters.

1- Plant height was estimate from the surface of soil up to the end of panicle in the ten samples and the average of plant height was recorded.
2- Number of panicles was counted in the ten samples and the average of number of panicles was recorded.
3- Ten panicles were collected and both length of panicle and number of filled grain were estimated.

4- Grain yield: ten central square meter (10 $m^2$) were identified and harvested then threshes 3 days after harvesting. The weights of grain were adjusted to 14 % moisture content and transferred to t $ha^{-1}$.

In addition, the laboratory analysis was conducted for seeds samples of each rice cultivar after harvest to estimate the grain quality and chemical components at Giza Agric. Res. Station and Lab of Seed Technology Dep., Field Crops Res. Instit., ARC. Observations on seed and 1000 seed weight were recorded, Also, shoot and root length of seedling were recorded. Four replications of 100 seeds for each cultivar were used to measure test weight.

Laboratory test: seed vigor and seedling characters.

**Seed germination percentage:**

Fifty pure seeds of each cultivar and three replications were placed in Petri dishes containing filter paper soaked with distilled water. The Petri dishes were placed in an incubator at 25± 1°C for 14 days. Normal seedlings were counted according to the international rules of ISTA (1993). Germination percentage was calculated using the following formula outlined by Krishnasamy and Seshu (1990):

$$\text{Emergence \%} = \frac{\text{Number of emerged seedlings}}{\text{Number of seeds sown}} \times 100$$

**Seed vigor index**:

It was calculated using the following formula (Copeland 1976)

$$\textbf{Seed vigor index} = \frac{\text{Number of seeds germinated (1st count)}}{\text{Number of days to first count}} + \frac{\text{Number of seeds germinated (last count)}}{\text{Number of days to last count}}$$

**Electrical conductivity test**:

The electrical conductivity of the leachate was determined according to procedures described by AOSA (1983). Four sub- samples of 50 seeds of each cultivar were weighed and placed into plastic cups with 250 ml of distilled water, and held at 25°C. After 24 h, the electrical conductivity of the leachates was determined using EC meter. The mean values were expressed in $\mu S\ cm^{-1} g^{-1}$ seed weight.

**Seedling characteristics**:

Normal seedlings obtained from standard germination test were used for seedling evaluation according to the rules of the Association of Official Seed Analysis (AOSA 1983). Seedling shoot and root length were measured after 14 days of germination test. Twenty-five seedlings from each Petri dish were randomly selected and both shoot length and root depths of individual seedlings were recorded. The shoot and root were also dried at 70 °C for 72 hr.

**Seedling vigor index**:

It was calculated using data recorded on germination percentage and seedling growth according to International Seed Testing Association (ISTA 1985) by the formula:

**Seedling vigor index =** seedling length (cm) x germination percentage

**Determination of grain quality characteristics:**

Hulling, milling output and head rice percentages were estimated according to the method of Khan and Wikramanayake (1971).

**Determination of cooking quality:**

Water uptake, volume expansion and cooking time of rice cultivars were determined following to procedures of Simpson *et al.* (1965). Amylose content was measured according to procedure of Juliano *et al.* (1971).

**Determination of chemical composition:**

Moisture, ash, crude protein, ether extract and crude fiber contents were determined according to the methods of Association of Official Agricultural Chemists (A.O.A.C.2005). Total carbohydrates content was calculated by subtracting protein, ash, and ether extract from total mass of 100 as reported by A.O.A.C. (2005).
Data collected were statistically analyzed according to Gomes and Gomes (1984) using COSTAT Computer Program.

**Results And Discussion**

**Agronomical characteristics of the tested rice cultivars:**

Data in Tables (1 and 2) demonstrated that a significant difference was obtained among tested rice cultivars in respect of grain yield and its attributes in both seasons. Data in Table (1) inducted that the maximum number of days from sowing to 50% heading was recorded with Sakha101 and Sakha104 whereas the minimum days to 50% heading was recorded with Giza 179 cultivar. These results are in agreement with those obtained by Abd El-Megeed *et. al.,* (2016) who reported that the cultivars Giza 179 and Sakha 105 exhibited the lowest days to heading. On the other hand, Sakha 101 cultivar showed the highest values of days from sowing to heading. Most variation among the rice cultivars in total duration might be due to the genetic background differences.

Data also showed that Sakha104 was the tallest plant compared to the other rice cultivars, while Sakha101 had the lowest plant height compared to the other rice cultivars. The results are in agreement with those obtained by Sedeek (2001).

**Table 1**: Days to 50% flowering, plant height and number of panicles hill$^{-1}$ of some rice cultivars.

| Rice cultivar | Days to 50% flowering | | Plant height (cm) | | No. of panicles hill$^{-1}$ | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Giza 178** | 100.33b$^{\pm 7.15}$ | 102.00a$^{\pm 7.26}$ | 100.67b$^{\pm 8.21}$ | 102.3b 3$^{\pm 8.22}$ | 23.67ab$^{\pm 1.25}$ | 25.33a$^{\pm 2.21}$ |
| **Giza 179** | 89.00d$^{\pm 5.34}$ | 90.00c$^{\pm 5.44}$ | 97.33b$^{\pm 5.68}$ | 98.33d$^{\pm 5.49}$ | 22.67b$^{\pm 1.59}$ | 23.33ab$^{\pm 1.95}$ |
| **Sakha 101** | 103.00a$^{\pm 6.98}$ | 103.66a$^{\pm 6.82}$ | 92.67c$^{\pm 5.43}$ | 94.33e$^{\pm 4.22}$ | 24.67a$^{\pm 2.01}$ | 25.33a$^{\pm 1.73}$ |
| **Sakha 104** | 102.33a$^{\pm 6.57}$ | 103.66a$^{\pm 7.16}$ | 105.33a$^{\pm 6.41}$ | 106.00a$^{\pm 4.83}$ | 22.7b$^{\pm 1.95}$ | 23.00c$^{\pm 2.28}$ |
| **Sakha 105** | 93.00c$^{\pm 4.35}$ | 94.00b$^{\pm 5.74}$ | 99.69b$^{\pm 4.69}$ | 99.33c$^{\pm 5.12}$ | 19.33c$^{\pm 1.76}$ | 19.00d$^{\pm 1.28}$ |
| **Sakha 106** | 90.33d$^{\pm 4.82}$ | 90.00c$^{\pm 5.11}$ | 104.67a$^{\pm 7.19}$ | 105.67a$^{\pm 7.29}$ | 19.67c$^{\pm 1.84}$ | 20.00d$^{\pm 1.84}$ |
| **F. test** | ** | ** | ** | ** | ** | ** |

Each value represents the mean ±SD. Mean followed by different superscript letters in each column are significantly different (p<0.05).

Moreover, significant differences were found in the production of number of panicles hill$^{-1}$ among rice cultivars (Table 1). Giza 178 and Sakha101 produced the higher number of panicles hill$^{-1}$, while Sakha105 produced lowest number of panicles hill$^{-1}$. The differences in panicles production among the tested cultivars might be attributed to varietals differences (Chandrashekhar *et.al.* 2001). Panicle length of the tested cultivars was significantly differed (Table 2). Giza 178 had the longest panicle (23.50 and 23.33cm, 2015 and 2016 seasons, respectively), witch was significantly at par with Sakha104 and Sakha106 in the first season and Giza 179, Sakha104 and Sakha106 in the second season. In contract Sakha105 gave the shortest panicle during both seasons under study.

Variations exerted influence in filled grains panicale$^{-1}$ (Table 2). Giza 178 cultivar produced the maximum number of filled grains panicale$^{-1}$ (158.33 and 156.00 in first and second seasons, respectively) which was statistically at par with Giza 179 cultivar in the second season. The lowest number of filled grains panicale$^{-1}$ was observed with Sakha105 cultivar in the two studied seasons. The other tested cultivars came in between. Concerning grain yield of the tested cultivars, data in Table (2) revealed that Sakha101cultivar produced the greatest grain yield followed by both Giza 178 and 179 cultivars without any significant differences between them in the first season. In the second season Sakha101, Giza 178 and Giza 179 cultivars produced nearly the same highest grain as Sakha101cultivar in the first season followed by Sakha104cultivar, while both Sakha105 and Sakha106cultivars gave the lowest grain yield without any significant differences between them. It could be attributed to the difference in genetic constitution. These results are in agreement with those obtained by Sedeek (2001).

**Table 2:** Panicle length, number of filled grains panicle$^{-1}$ and grain yield of some rice cultivars.

| Rice cultivar | Panicle length (cm) | | NO. of filled grains panicle$^{-1}$ | | Grain yield (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Giza 178** | 23.50a$^{\pm 2.18}$ | 23.33a$^{\pm 2.27}$ | 158.33a$^{\pm 8.25}$ | 156.00a$^{\pm 9.25}$ | 10.76ab$^{\pm 0.98}$ | 10.77a$^{\pm 1.05}$ |
| **Giza 179** | 22.00b$^{\pm 1.95}$ | 22.33b$^{\pm 2.38}$ | 148.67b$^{\pm 7.29}$ | 151.33ab$^{\pm 6.34}$ | 10.60ab$^{\pm 0.57}$ | 10.70a$^{\pm 0.98}$ |
| **Sakha 101** | 21.80c$^{\pm 1.16}$ | 21.96b$^{\pm 2.54}$ | 145.67bc$^{\pm 8.44}$ | 148.33b$^{\pm 6.73}$ | 10.87a$^{\pm 0.38}$ | 10.85a$^{\pm 1.11}$ |
| **Sakha 104** | 22.50b$^{\pm 2.11}$ | 22.50ab$^{\pm 2.69}$ | 145.00bc$^{\pm 7.29}$ | 143.66c$^{\pm 5.79}$ | 10.26b$^{\pm 0.19}$ | 10.31b$^{\pm 0.97}$ |
| **Sakha 105** | 20.70c$^{\pm 1.58}$ | 21.40b$^{\pm 1.91}$ | 115.00d$^{\pm 5.84}$ | 116.33d$^{\pm 4.23}$ | 9.50c$^{\pm 0.75}$ | 9.36c$^{\pm 0.81}$ |
| **Sakha 106** | 22.50b$^{\pm 1.92}$ | 22.33b$^{\pm 1.99}$ | 140.00c$^{\pm 6.89}$ | 140.33c$^{\pm 6.75}$ | 9.76c$^{\pm 0.82}$ | 9.66c$^{\pm 0.49}$ |
| **F. test** | ** | ** | ** | ** | ** | ** |

Each value represents the mean ±SD. Mean followed by different superscript letters in each column are significantly different (p<0.05).

## Seed vigour:

Means of percentage of seed germination, 1000- seed weight, electrical conductivity and seed vigour index of tested rice cultivars in 2015 and 2016 seasons are presented in Table 3.

**Table 3:** Seed germination percentage, 1000-seed weight, electrical conductivity and seed vigor index of some rice cultivars.

| Rice cultivar | Seed germination (%) | | 1000-seed weight (g) | | Electrical conductivity (EC) (µs 1g$^{-1}$) | | Seed vigor index | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Giza 178** | 89.30a$^{\pm 3.12}$ | 89.00a$^{\pm 4.39}$ | 21.20e$^{\pm 1.46}$ | 22.09d$^{\pm 1.38}$ | 13.26c$^{\pm 1.22}$ | 13.97c$^{\pm 1.34}$ | 12.38a$^{\pm 1.17}$ | 12.42a$^{\pm 1.64}$ |
| **Giza 179** | 82.67b$^{\pm 3.58}$ | 83.00b$^{\pm 4.84}$ | 26.10c$^{\pm 1.83}$ | 26.82b$^{\pm 2.41}$ | 10.56c$^{\pm 0.94}$ | 10.20e$^{\pm 0.91}$ | 10.00c$^{\pm 0.97}$ | 10.22c$^{\pm 0.93}$ |
| **Sakha 101** | 82.00b$^{\pm 3.79}$ | 82.50b$^{\pm 3.52}$ | 27.69a$^{\pm 2.01}$ | 27.33ab$^{\pm 3.54}$ | 24.95a$^{\pm 2.49}$ | 24.30a$^{\pm 2.61}$ | 10.84b$^{\pm 0.84}$ | 11.00b$^{\pm 0.97}$ |
| **Sakha 104** | 89.30a$^{\pm 4.11}$ | 90.20a$^{\pm 5.76}$ | 25.36d$^{\pm 2.11}$ | 26.00c$^{\pm 2.62}$ | 24.85a$^{\pm 3.48}$ | 24.10a$^{\pm 2.54}$ | 11.58ab$^{\pm 1.18}$ | 11.30b$^{\pm 1.04}$ |
| **Sakha 105** | 91.30a$^{\pm 5.29}$ | 90.50a$^{\pm 6.27}$ | 27.07b$^{\pm 2.46}$ | 27.17b$^{\pm 2.73}$ | 18.38b$^{\pm 1.52}$ | 18.24b$^{\pm 1.97}$ | 11.31b$^{\pm 1.17}$ | 11.45b$^{\pm 1.59}$ |
| **Sakha 106** | 88.00a$^{\pm 4.38}$ | 88.30a$^{\pm 5.43}$ | 27.85a$^{\pm 2.89}$ | 28.10a$^{\pm 3.22}$ | 12.31c$^{\pm 0.97}$ | 13.00d$^{\pm 1.12}$ | 11.20b$^{\pm 1.28}$ | 11.32b$^{\pm 1.67}$ |
| **F. test** | * | * | ** | ** | ** | ** | ** | ** |

Each value represents the mean ± SD. Mean followed by different superscript letters in each column are significantly different (p<0.05).

Data demonstrated that germination percentage was divided into three ranks. The first rank is 91% germination or more, the second rank ranged between 88 - 90% germination and the third rank is considered when the germination less than 83%. Sakha 105 cultivar came in the first rank and Giza 178, Sakha 106 and Sakha 104 cultivars come in the second rank, while Giza 179 and Sakha 104 cultivars came in the third rank. Data in the same Table indicated that Sakha 106 and Sakha 101 cultivars gave the heaviest 1000-seed weight followed by both Sakha 105 and Giza 178 rice cultivars, while Giza178and Sakha 104 produced the lowest value in this respect. These results were holding true in the two studied seasons. There are three types of electrical conductivity in seed water extract of the tested cultivars i.e. high, medium and low. Sakha 101and Sakha 104 cultivars came in the highest type followed by Sakha 105 cultivar which came in the medium type, while Giza 178, Giza 179and Sakha 106 cultivars came in the lowest type. Concerning seed vigor index data in Table (3) clarified that Giza 178 cultivar gave the highest value followed by Sakha 101, 104, 105 and 106 cultivars, while Giza 179 cultivar produced the lowest value in this aspect in the two studied seasons.

**Seedling characters:**

Regarding to the seedling characters, most of seedling characters parameters have significant differences except shoot length (Table 4). Data indicated that Sakha106 cultivar produced the greatest root length followed by Sakha 104 and Giza 179 rice cultivars, while both Sakha 105 and Giza 178 cultivars gave the least in both seasons. Meanwhile, seedling dry weight, both Sakha 106 and 101 cultivars gave the highest value followed by Sakha 104 and 105 cultivars in the first season, while in the second season only Sakha 101 cultivar produced the highest value followed by both Sakha 05 and 106 and the other tested cultivars gave the lowest value in this respect in the two studied seasons. Data in the same Table revealed that all the Sakha cultivars produced the greatest seedling vigour index without any significant difference among them, while the tested Giza cultivars gave the lowest values in this aspect in the first season. In the second season, only Sakha 106 cultivar produced the greatest seedling vigour index followed by Sakha 105 cultivar, while the lowest value was observed with Giza 178 and 179 cultivars and the other tested cultivars came in between. The difference among the tested cultivars in all seedling characters could be attributed to the differences in their genetic structure

**Table 4:** Root depth, shoot length, seedling dry weight and seedling vigor index of some rice cultivars.

| Rice cultivar | Root depth (cm) | | Shoot length (cm) | | Seedling dry weight (mg) | | Seedling vigor index | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Giza 178** | 4.67d$^{\pm0.23}$ | 5.34f$^{\pm0.24}$ | 6.60a$^{\pm0.39}$ | 6.43a$^{\pm0.49}$ | 8.59c$^{\pm0.94}$ | 8.90d$^{\pm0.81}$ | 1004.73b$^{\pm50.67}$ | 1007.45b$^{\pm52.58}$ |
| **Giza 179** | 7.00b$^{\pm0.54}$ | 8.05b$^{\pm0.64}$ | 7.18a$^{\pm0.76}$ | 8.02a$^{\pm1.14}$ | 8.83c$^{\pm0.92}$ | 7.95e$^{\pm0.73}$ | 1167.53ab$^{\pm40.86}$ | 1165.24ab$^{\pm43.27}$ |
| **Sakha 101** | 6.77c$^{\pm0.38}$ | 6.40d$^{\pm0.27}$ | 7.93a$^{\pm0.51}$ | 7.40a$^{\pm0.92}$ | 10.82a$^{\pm1.15}$ | 11.40a$^{\pm1.57}$ | 1205.53a$^{\pm46.37}$ | 1201.95a$^{\pm51.67}$ |
| **Sakha 104** | 7.67b$^{\pm0.34}$ | 7.57c$^{\pm0.61}$ | 6.17a$^{\pm0.43}$ | 6.80a$^{\pm0.76}$ | 10.63a$^{\pm1.24}$ | 10.40b$^{\pm1.34}$ | 1235.87a$^{\pm60.38}$ | 1226.00a$^{\pm64.27}$ |
| **Sakha 105** | 6.27c$^{\pm0.18}$ | 6.75d$^{\pm0.26}$ | 7.38a$^{\pm0.91}$ | 8.24a$^{\pm0.94}$ | 9.16b$^{\pm0.97}$ | 9.24c$^{\pm0.86}$ | 1249.60a$^{\pm51.28}$ | 1254.33a$^{\pm59.37}$ |
| **Sakha 106** | 8.47a$^{\pm0.76}$ | 9.00a$^{\pm0.58}$ | 6.27a$^{\pm0.73}$ | 7.12a$^{\pm0.61}$ | 10.92a$^{\pm1.33}$ | 10.85b$^{\pm1.17}$ | 1295.20a$^{\pm64.29}$ | 1291.30a$^{\pm71.38}$ |
| **F- test** | ** | ** | NS | NS | ** | ** | ** | ** |

Each value represents the mean ±SD. Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

**Grain quality characteristics:**

Significant differences were found in the hulling percentage among rice cultivars in both seasons (Table 5). Sakha104 cultivar gave the highest hulling % with very slight significant difference with the other tested Sakha cultivars, while the lowest hulling percentage was obtained with Giza178 and Giza179 cultivars. RRTC (2002) stated that hull percentage in different cultivars ranges from 16 to 24%. Egyptian rice cultivars belonging to the japonica group have the highest hulling recovery followed by Indica/Japonica group. Milling percentage of the tested cultivars significantly differed among each other (Table 5). Sakha106, Sakha104 and Sakha105 produced the maximum milling followed by Sakha101 cultivar, while both Giza 178 and 179 cultivars gave the lowest value in this respect in the two studied seasons. Data in the same Table clarified that Giza 179 produced the greatest head rice percentage followed by Sakha 105 and 106 rice cultivars, while the other cultivars under study gave nearly the same lowest head rice percentage in the two studied seasons. The cultivars which had high filling with maximum density of starchy indosperm of grain led to minimize the thickness and weight of hull consequently increase both hulling and milling percentage. Moreover, if the starchy indosperm in such rice cultivar has small spaces between the layers of starchy the broken rice will be increase consequently the head rice dramatically decrease. Also the moisture content in grain or the bad storage strongly increases the broken rice.

**Table 5:** Percentage of hulling, milling and head rice in some rice cultivars.

| Rice cultivar | Hulling (%) | | Milling (%) | | Head rice (%) | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Giza 178** | 79.67c$^{\pm 6.82}$ | 79.00c$^{\pm 7.59}$ | 69.67c$^{\pm 6.25}$ | 69.33c$^{\pm 6.77}$ | 48.33c$^{\pm 3.69}$ | 47.67c$^{\pm 3.88}$ |
| **Giza 179** | 80.00b$^{\pm 8.54}$ | 79.30c$^{\pm 8.11}$ | 68.00c$^{\pm 7.13}$ | 67.00c$^{\pm 6.84}$ | 63.00a$^{\pm 6.72}$ | 61.67a$^{\pm 5.76}$ |
| **Sakha 101** | 81.00ab$^{\pm 8.67}$ | 80.66b$^{\pm 9.16}$ | 70.67b$^{\pm 7.58}$ | 69.33c$^{\pm 7.18}$ | 47.23c$^{\pm 4.11}$ | 48.73c$^{\pm 5.12}$ |
| **Sakha 104** | 81.67a$^{\pm 9.21}$ | 81.76a$^{\pm 8.67}$ | 72.00a$^{\pm 7.69}$ | 71.33b$^{\pm 8.37}$ | 50.16b$^{\pm 4.97}$ | 49.43c$^{\pm 4.38}$ |
| **Sakha 105** | 81.00ab$^{\pm 8.4}$ | 81.33ab$^{\pm 7.69}$ | 71.00b$^{\pm 9.15}$ | 71.17b$^{\pm 7.64}$ | 52.33b$^{\pm 5.12}$ | 52.70b$^{\pm 5.14}$ |
| **Sakha 106** | 81.27ab$^{\pm 8.37}$ | 81.33ab$^{\pm 9.18}$ | 72.00a$^{\pm 37.7}$ | 72.33a$^{\pm 8.19}$ | 51.50b$^{\pm 3.94}$ | 52.16b$^{\pm 4.95}$ |
| **F Test** | * | * | ** | ** | ** | ** |

Each value represents the mean $\pm$ SD. Mean followed by different superscript letters in each column are significantly different ($p<0.05$).

**Chemical Composition**:

Chemical composition of studied cultivars is shown in Table (6). The moisture content significantly varied among the rice cultivars that ranged between 9.75 to 10.96% in the first season and from 9.87 to 10.77% in the second season. Sakha 106 had the highest moisture content, which was statistically similar with Sakha 104 and Sakha 105. The lowest moisture content was recorded with Sakha 101cultivar. These values were below 14% (optimal %) for bag storage of grains (Juliano and Villarreal, 1993). Low moisture content is known to enhance keeping quality of rice under storage.

Protein content of the tested cultivars ranged from 6.53 to 8.27% in the first season and 6.60 to 8.31 in the second season. The highest protein content were produced from Giza 178, Giza 179 and Sakha 105 cultivars followed by the other tested cultivars which gave the same lowest values. The lowest protein content was estimated in Sakha 101 in the two studied seasons. Protein is the second highest component after starch in rice kernel. Protein is available in varying amounts in rice, mostly ranging from 6.5% to 8.7% with some exceptions, where it varies from the main range (Cao *et al.* 2004; Mir *et al.*2016). Ash residual is generally taken to be a measure of the mineral content of materials. High ash content in milled rice is an indication of a good quality of minerals (Dipti *et al.* 2003).

In both seasons, Giza 179 had the highest values of ash content followed by Sakha 106, while Sakha 101 had the lowest values for ash content. Amorim *et al.* (2004) found that, the ash content in the rice was 0.4%.It was reported that, the ash content indicated the amount of minerals. Significant differences were found among the tested cultivars in ether extract percentage. In both seasons, Giza 179 gave the highest percentage of ether extract followed by Sakha 101and Giza178 rice cultivar, while Sakha106 give the lowest percentage of ether extract. The fiber crude significantly varied among the rice cultivars that ranged between 1.30 to 1.82% in the first season and 1.38 to 1.81% in the second season. In both season Sakha 104 had the highest values of fiber crude followed by Sakha 106 cultivar. The lowest values of fiber crude were recorded with Sakha 101, which was statistically similar with Giza 179 cultivar. Data also showed that the rice cultivars significantly differed in respect of total carbohydrate percentage. In both season, Sakha 101 gave the highest values of total carbohydrate percentage (81.32 and 80.96% in 2015 and 2016 seasons, respectively). While Giza 179 followed by Sakha 104 cultivars had the lowest values of total carbohydrate percentage (78.44 and 78.30% in 2015 and 2016 seasons, respectively).

**Cooking quality in grain of rice cultivars:**

The rice cooking quality characteristics in milled grains of tested cultivars were evaluated included water uptake (ml $H_2O$/100g rice), volume expansion, cooking time (min.) and amylose percentage. Highly significant differences were observed for each of the previous characteristics among the tested cultivars (Table 7). Data demonstrated that Giza 178 cultivar gave the highest values for water uptake followed by Sakha 106 cultivar, while Sakha 104 cultivar gave the lowest values for water uptake. The other cultivars under study came in between. Similar results were observed in the two studied seasons. The water absorption by rice during cooking is considered as an economic quality parameter, because it gives the estimate of the volume increase during cooking. During

**Table 6:** Chemical composition of some rice cultivars on dry weight.

| **Rice cultivar** | **Moisture content** | | **Protein** | | **Ash content** | | **Ether extract** | | **Crude fiber** | | **T. carbohydrates** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** |
| **Giza 178** | 9.88c$^{\pm1,38}$ | 9.89b$^{\pm1.57}$ | 8.12a$^{\pm0.94}$ | 8.18a$^{\pm0.94}$ | 0.443c$^{\pm0.08}$ | 0.463d$^{\pm0.02}$ | 0.65b$^{\pm0.02}$ | 0.67b$^{\pm0.03}$ | 1.49c$^{\pm0.15}$ | 1.50c$^{\pm0.14}$ | 79.41b$^{\pm5.24}$ | 79.57bc$^{\pm6.28}$ |
| **Giza 179** | 10.44b$^{\pm2.11}$ | 10.23b$^{\pm2.38}$ | 8.27a$^{\pm0.83}$ | 8.31a$^{\pm0.82}$ | 0.680a$^{\pm0.04}$ | 0.683a$^{\pm0.05}$ | 0.72a$^{\pm0.04}$ | 0.72a$^{\pm0.02}$ | 1.35d$^{\pm0.12}$ | 1.38d$^{\pm0.13}$ | 78.44d$^{\pm4.38}$ | 78.30d$^{\pm5.46}$ |
| **Sakha 101** | 9.75c$^{\pm1.46}$ | 9.87b$^{\pm1.85}$ | 6.53b$^{\pm0.87}$ | 6.60b$^{\pm0.93}$ | 0.380d$^{\pm0.02}$ | 0.386e$^{\pm0.0}$ | 0.65b$^{\pm0.03}$ | 0.65b$^{\pm0.01}$ | 1.30d$^{\pm0.17}$ | 1.38d$^{\pm0.12}$ | 81.32a$^{\pm6.19}$ | 80.96a$^{\pm6.19}$ |
| **Sakha 104** | 10.57ab$^{\pm2.15}$ | 10.53ab$^{\pm1.97}$ | 6.73b$^{\pm0.56}$ | 6.80b$^{\pm0.79}$ | 0.470c$^{\pm0.01}$ | 0.453d$^{\pm0.01}$ | 0.64bc$^{\pm0.03}$ | 0.65b$^{\pm0.04}$ | 1.82a$^{\pm0.16}$ | 1.81a$^{\pm0.17}$ | 79.76b$^{\pm5.73}$ | 79.89b$^{\pm5.16}$ |
| **Sakha 105** | 10.44b$^{\pm2.18}$ | 10.26ab $^{\pm1.73}$ | 8.22a$^{\pm0.105}$ | 8.10a$^{\pm0.91}$ | 0.540b$^{\pm0.03}$ | 0.573c$^{\pm0.03}$ | 0.63bc$^{\pm0.02}$ | 0.67b$^{\pm0.04}$ | 1.70b$^{\pm0.19}$ | 1.71b$^{\pm0.15}$ | 78.77cd$^{\pm4.62}$ | 78.83cd$^{\pm4.97}$ |
| **Sakha 106** | 10.96a$^{\pm1.99}$ | 10.77a$^{\pm2.24}$ | 6.47b$^{\pm0.68}$ | 6.95b$^{\pm0.46}$ | 0.580b$^{\pm0.04}$ | 0.576b$^{\pm0.04}$ | 0.58c$^{\pm0.03}$ | 0.56c$^{\pm0.03}$ | 1.76ab$^{\pm0.13}$ | 1.73ab$^{\pm0.16}$ | 79.38bc$^{\pm6.17}$ | 79.53bc$^{\pm4.38}$ |
| **F. test** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |

Each value represents the mean $\pm$ SD. Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

**Table 7:** Water uptake, volume expansion, cooking time and amylose percentage of milled grain of some rice cultivars.

| **Rice cultivar** | **Water uptake (ml $H_2O$/100g rice)** | | **Volume Expansion** | | **Cooking Time (min.)** | | **Amylose (%)** | |
|---|---|---|---|---|---|---|---|---|
| | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** | **2015** | **2016** |
| **Giza 178** | 273.65a$^{\pm11.25}$ | 272.00a$^{\pm12.27}$ | 323.00b$^{\pm17.25}$ | 323.33b$^{\pm18.35}$ | 19.33a$^{\pm2.57}$ | 19.33a$^{\pm3.54}$ | 18.86a$^{\pm3.51}$ | 18.53a$^{\pm3.45}$ |
| **Giza 179** | 226.92d$^{\pm13.18}$ | 226.00d$^{\pm15.76}$ | 363.33a$^{\pm16.38}$ | 367.33a$^{\pm17.29}$ | 15.33b$^{\pm2.15}$ | 15.00b$^{\pm2.49}$ | 18.48b$^{\pm3.68}$ | 18.50a$^{\pm3.68}$ |
| **Sakha 101** | 244.76c$^{\pm15.38}$ | 243.33c$^{\pm14.38}$ | 291.67c$^{\pm14.39}$ | 292.00c$^{\pm16.28}$ | 19.67a$^{\pm3.86}$ | 19.67a$^{\pm3.84}$ | 18.74ab$^{\pm3.76}$ | 18.50a$^{\pm3.79}$ |
| **Sakha 104** | 213.82e$^{\pm14.51}$ | 217.67e$^{\pm16.29}$ | 286.67c$^{\pm15.27}$ | 286.67c$^{\pm16.37}$ | 14.67b$^{\pm2.64}$ | 14.67b$^{\pm2.81}$ | 17.89c$^{\pm2.87}$ | 17.73b$^{\pm2.88}$ |
| **Sakha 105** | 253.35b$^{\pm15.13}$ | 253.33b$^{\pm13.15}$ | 294.33c$^{\pm19.28}$ | 292.00d$^{\pm17.53}$ | 20.33a$^{\pm3.76}$ | 19.67a$^{\pm3.46}$ | 16.27e$^{\pm1.94}$ | 16.20c$^{\pm1.68}$ |
| **Sakha 106** | 254.44b$^{\pm14.28}$ | 253.33b$^{\pm16.24}$ | 295.33c$^{\pm17.64}$ | 296.33c$^{\pm17.61}$ | 19.67a$^{\pm2.81}$ | 19.67a$^{\pm3.94}$ | 16.69d$^{\pm1.86}$ | 16.40c$^{\pm1.39}$ |
| **F. test** | ** | ** | ** | ** | ** | ** | ** | ** |

Each value represents the mean $\pm$ SD. Mean followed by different superscript letters in each column are significantly different ($p<0.05$).

cooking, rice grains absorb sufficient water and increase in volume through increase in length and breadth. Lengthwise increase without increase in girth is desirable characteristic in high-quality rice (Shinde *et al*. 2014). Data also showed that Giza 179 cultivar gave the greatest values of volume expansion followed by Giza 178 cultivar, while Sakha 104 gave the lowest values in this respect**.** The other cultivars under study came in between. These results were holding true in the two studied seasons. In the same Table, data revealed that all the cultivars under study gave nearly the same values in cooking time (min) except both Sakha 104 and Giza 179 cultivars, which gave the least in the two seasons. Cooking time is an important parameter, which determines tenderness of cooked rice as well as its stickiness (Shinde *et al*. 2014). Concerning to amylose percentage of the tested rice cultivars data in the Table (7) indicated that Giza 178, Giza 179 and Sakha 101 cultivars gave nearly the same highest amylose percentage followed by Sakha 104 cultivar, while the other cultivars gave the lowest amylose percentage in the second season. In the first season, only Giza 178 cultivar gave the greatest amylose percentage followed by Sakha 101and Giza 179 cultivars, while the other tested cultivars gave the least. These results are in the same trend with those obtained by El-Abd *et al*. (2008). The differences in amylose % are attributed to genetic background of the cultivars and in part to the differences in the environmental conditions in which the crop is grown (Hettiarachchy *et al*., 1997 and Chukwuemeka *et al*., 2015). Amylose content higher than 25% gives non-sticky soft rice. Rice having 20-25% amylose gives soft and relatively sticky cooked rice (Anonymousm, 1997 and Dipti *et al.,* 2002).

## Conclusion

Form the previous results, it can be concluded that Giza 178 and Sakha 101 cultivars were the best in the yield and its attributes. Whereas, seed vigour, Sakha 101 cultivar gave the highest values of both 1000-seed weight and electrical conductivity, while Giza 178 cultivar gave the highest seed vigour index.

Seedling vigour characters were better with Sakha cultivars than Giza cultivars. Grain quality such as hilling and milling were better with Sakha cultivars than Giza cultivars, while Giza 179 gave the highest value in head rice percentage.

Regarding to cooking quality characteristics, Giza cultivars gave higher value in both water uptake and volume expansion than Sakha cultivars under study, while all the tested cultivars gave nearly the same cooking time except Giza 179 and Sakha 104 cultivars.

Amylose content was higher in the two Giza and Sakha 101 cultivars than the other tested cultivars. Chemical composition Giza cultivars surpassed Sakha cultivars and gave higher values in protein content, ash percentage and ether extract than Sakha cultivars, while most of Sakha cultivars produced more fiber crud percentage and carbohydrates content than Giza cultivars under study.

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