J. of Food and Dairy Sci., Mansoura Univ., Vol.15 (8):115 - 121 , 2024

Journal of Food and Dairy Sciences

Journal homepage & Available online at: www.jfds.journals.ekb.eg

Physicochemical Characteristics and Grain Quality of Novel Egyptian Rice Cultivars

Mansour, A. R.[1*]; Rania E. Elgammal[2]; M. M. Rabie[2] and M. A. El Bana[1]

[1]Food Technology Research institute, Agriculture Research Center, Al-Giza, Egypt.
[2]Food Industries, Dept., Fac. of Agric., Mansoura Univ., Egypt.

ABSTRACT

This study evaluated new Egyptian rice varieties: Sakha Super 300, Sakha Super 301, Sakha Super 302, Sakha 108, Basmati Giza 201, and Giza 181, focusing on their physicochemical, nutritional properties, milling characteristics, and eating quality for both brown and milled rice. Data showed variations in physical characteristics, with Basmati Giza 201 being the longest and having the lowest width and percentage of white and head rice. White rice absorbs more water than brown rice in all studied rice varieties. Basmati Giza 201 brown rice required the longest cooking time (35.70 minutes), while Sakha Super 302 white rice, cooking time (18.10 minutes). Variations in gel consistency(GC) were observed, with Sakha 108 having the highest GC in both milled and brown rice, followed by Giza 181 and Sakha Super 302. The alkali spreading value (GT) for brown rice was lower than for white rice, with Basmati Giza 201 and Giza 181 white rice showing the highest gelatinization temperatures(7.00%). Milled rice had higher elongation percentages, with Sakha Super 300 showing a high rate(44.40%)and Basmati Giza 201 the lowest (30.60%). Basmati Giza 201 white rice had the highest amylose content (26.40%), while Sakha 108 and Giza 181 brown rice had the lowest (17.20%). Compared to white rice, brown rice had a lower carbohydrate content but higher protein, ether extract, and ash levels among the varieties. Brown rice also contains more minerals, so Increased cultivation of Basmati Giza 201 and Sakha Super 301 is recommended due to their favorable physical, chemical, and eating quality traits.

***Keywords*:** rice, grain quality, eating quality

INTRODUCTION

The rice plant, *Oryza sativa L.,* is essential to maintaining food security worldwide. The majority, exceeding 90% of rice cultivation and consumption takes place in Asian nations, notably in China and India. However, there's a noticeable uptick in rice consumption across regions like Africa, Latin America, and the Caribbean. Rice is an essential food staple that contributes to food security, especially in Asia where it is a key source of nourishment (Bandumula et al., 2018 and Bashir and Aggarwal, 2019). Forecasts indicate a rise in global rice prices as production declines, a consequence of climate change (Chen et al., 2012). Studies suggest that for every 1°C rise in temperature, rice production may decline by 8-10% (Song et al., 2022). Rice is the second most important cereal crop in Egypt, behind wheat. It is grown on an area of 1.074 million feddans and produced around 4.5 million tons in the 2020 season, according to FAOSTAT (2020). This substantial production is attributed to the crop's considerable water requirements compared to other crops. Consequently, significant endeavors are underway to breed new rice varieties resilient to drought stress, as severe drought conditions can result in crop losses of up to 40%. (Fukagawa and Ziska, 2019). With its high content of carbohydrates, lipids, proteins, minerals, fiber, and vitamins, rice is an important source of nutrients. It is regularly taken in many forms, including parboiled rice, noodles, and bread (Swasdisevi et al., 2010). To produce rice kernels edible eating, the paddy goes through a procedure that includes dehulling to remove the outer covering and milling to remove germ layers and bran. These processes have a substantial effect on the physicochemical and cooking properties of the rice (Jinorose et al., 2014). The physicochemical attributes encompass parameters such as grain length (L), grain width (W), L/W ratio, hulling %, and milling % are included in the physicochemical properties. Meanwhile, Numerous parameters, such as the amount of amylose, the alkali spreading value, the amount of water absorbed, the kernel elongation % and the volume expansion % affects properties of cooked rice. According to Siddiqui et al. (2007), state that grain quality is made up of a variety of characteristics that are either indirectly or directly associated with quality aspects. Rice is subject to processing and marketed as milled whole grain following polishing. Yet, a discernible trend has emerged in consumer preferences favoring brown rice, especially evident among affluent demographics and those attentive to health, spurred by an increased recognition of its nutritional advantages. Brown rice comprises the endosperm, embryo, and the outer bran layer (Abd El-Sattar et al., 2016 and Meera et al., 2019). The key quality characteristic for rice varieties is their consistency in shape and size. According to Ahuja et al. (1995), milled rice is classified into 4 categories based on the average kernel length: Short (≤5.50 mm), Medium (5.51 - 6.60 mm), Long (6.61 - 7.50 mm) and Extra-long (>7.50 mm).

The quality of rice is influenced by various factors including the variety, preharvest and postharvest practices, as well as processing techniques. Consumer choice and their

* **Corresponding author.**
E-mail address: ahmedramadan5160@gmail.com
DOI: 10.21608/jfds.2024.303782.1161

readiness to invest in rice are influenced by factors such as its appearance, sensory attributes, and perceived nutritional value (Akoa-Etoa et al., 2016). Moreover, consumers seek rice varieties that boast higher nutrient content, quicker cooking times, a high-volume expansion % when cooked, slender grains, and a "medium to soft" texture, coupled with a natural "popcorn" aroma post-cooking (Demont et al., 2017).

Various factors contribute to determining the market price of rice, such as the milling percentage, head rice recovery percentage, physical appearance, eating and cooking characteristics and nutritional composition. These elements are pivotal in assessing the quality and appeal of rice across different consumer groups (Prom-u-thai and Reraise, 2020). In Egypt, cooking and eating quality issues have rarely been a concern, primarily because over 95% of rice cultivation is dedicated to Japonica varieties. These varieties are appreciated for their moisture content, tenderness, glossy appearance, and flavor. However, as the focus has shifted towards breeding long-grain Indica rice, concerns related to cooking and eating characteristics have emerged within breed programs (El-Hissewy and El-Kady, 1992).

The aims of this study were to assess several new Egyptian rice varieties (namely Sakha Super 300, Sakha Super 301, Sakha Super 302, and Basmati Giza 201) and contrast them with Sakha 108 and Giza 181 rice varieties, both in their brown and white rice. The evaluation encompassed an analysis of physicochemical and nutritional attributes, milling characteristics, as well as cooking and eating quality parameters.

MATERIALS AND METHODS

Materials:

Six commercial rice types *(Oryza sativa L.)* Basmati Giza 201, Sakha 108, Giza 181, Sakha Super 300, and Sakha Super 301. During the 2021 season), these samples obtained from the Rice Research and Training Center (RRTC) in Sakha, Kafr El-Sheikh Governorate, Egypt.

Methods:

Preparation of samples:

The first step in preparing the rice samples was to remove the hull to produce brown rice. The dehulled rice was then divided into two portions. One portion was kept as is, while the other underwent milling to create white rice. Until further examination, the samples of white and brown rice were both kept in polyethylene bags and frozen at -18°C.

Physical properties of rice varieties:

An assessment was conducted on the dimensions (length and width), shape (length to width ratio), and grain index of the rice grains. The measurements were taken in millimeters using a micrometer that has a precision of 0.001 millimeters. according to the method of Suwansri and Meullenet's (2004) , ten uniform grains were chosen at random to measure their length and width. The shape of the grains was calculated by dividing the length by the width for 10 randomly chosen kernels, as mentioned by Ahuja et al. (1995). To calculate the grain index (in grams per thousand grains), one thousand grains from each rice variety were randomly chosen in triplicate and individually weighed, using the method outlined by Khush et al. (1979). Bulk density was measured according to the procedure defined by Myklestad et al. (1968).

Rice variety milling properties:

150 grams of cleaned rough rice from each variety were chosen at random to assess the milling properties. A rice dehuller from Asatake Laboratory was used. At the Rice Research and Training Center (RRTC) in Sakha, Kafr El-Sheikh, Egypt, the resulting amounts of hulls, total white rice, brown rice, broken rice and head rice grains were quantified using the method by Khan and Wikramanayake (1971).

Water absorption and cooking durations of rice varieties:

The water absorption at temperatures of 77°C and 82°C, as well as the cooking times for both white and brown rice varieties were determined using the methods described by Simpson et al. (1965).

The eating quality parameters were assessed as follows:

The alkali spreading value (gelatinization temperature, (G.T.) was gauged following the method proposed by Bhattacharya and Sowbhagya (1980). The gel consistency (G.C.) was evaluated using the technique established by Cagampang et al. (1973). The elongation percentage was calculated using the method described by Tomar (1985). The amylose content (A.C.) was determined following the procedure outlined by Juliano et al. (1981).

Chemical analysis of rice samples:

The chemical analysis of different rice samples was analyzed using the procedures specified by **AOAC (2012)**. This analysis determined moisture, ether extract, ash content, crude protein, and crude fiber. Additionally, the total Carbohydrates were estimated by difference of follows:

Total carbohydrate = 100-(%protein + % fat + %Ash) .

Available carbohydrates= 100-(%protein + % fat + %Ash + %fibers) .

Mineral determination:

Techniques described by the AOAC (2012) were used to prepare the mineral content of rice samples. Using a colorimetric method as outlined by Murphy and Riley (1962), the ascorbic acid method was used to determine the amounts of total phosphorus (P). Using a flame photometer, the potassium (K) and sodium (Na) concentrations were determined in accordance with Pearson's (1976) technique. Using an atomic absorption spectrophotometer, namely the Perkin Elmer Model 2180, the contents of iron (Fe), copper (Cu), zinc (Zn), and calcium (Ca) were measured in compliance with Pearson's (1976) protocols.

Statistical analysis:

Data were analyzed according to Stell and Torrie (1980), the obtained data were statistically analyzed using the analysis of variance (ANOVA), and the mean values were further examined using the Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Physical characteristic of certain new Egyptian rice cultivars:

Table (1) data shows that brown rice grains ranged in length from 5.81 to 8.80 mm, while white rice grains were between 5.40 - 8.62-mm. Basmati Giza 201 rice emerged as the longest among all the rice varieties. The width of brown rice grains for six rice varieties (Sakha Super 300, Sakha Super 301, Sakha Super 302, Sakha 108, Basmati Giza 201, and Giza 181) was recorded as 3.20, 3.51, 3.57, 2.90, 2.22, and 2.36 mm, respectively. The corresponding width measurements for white rice grains were 2.97, 3.28, 3.39, 2.75, 2.07, and 2.18 mm, respectively.

Table (1) provides details on the grain shapes of six rice varieties for both brown and white rice, with statistically significant differences at $P \leq 0.05$. According to Ahuja et al. (1995), the length to width ratio determines the shape of the rice grains, which are then divided into four categories: round (≤1.0), bold (1.1 - 2.0), medium (2.1 - 3.0), and slender (>3.0).

The table indicates that, bulk density was higher in white rice samples compared to brown rice. The milling process resulted in a significant increase in bulk density alongside a notable decrease in grain index values. Moreover, it's evident from the data that, the grain index values for both white and brown rice of the six rice samples (Sakha Super 300, Sakha Super 301, Sakha Super 302, Sakha 108, Basmati Giza 201, and Giza 181) were documented as follows: for brown rice (23.96, 23.30, 23.10, 26.88, 22.96, and 20.81 g); and for white rice (21.66, 20.00, 21.66, 24.53, 21.60, and 18.50 g), respectively. These observations align with previous research findings conducted by El-Bana et al. (2010), Gewaily et al. (2018), and El-Bana et al. (2020), and Badawy et al. (2022).

Table 1. Physical properties of certain new Egyptian rice cultivars.

Rice varieties	Treatment	Grain dimension		Grain shape	Bulk density (g/cm3)	"Grain index (g)
		Length (mm)	Width (mm)			
Sakha Super 300	Brown rice	5.81±0.01[gh]	3.20±0.03[e]	1.81±0.02[f]	0.82±0.002[f]	23.96±0.58[bc]
	White rice	5.40± 0.03[i]	2.97±0.02[f]	1.81±0.02[f]	0.85±0.01[de]	21.66± 0.45[d]
Sakha Super 301	Brown rice	5.89±0.05[fg]	3.51±0.03[b]	1.67±0.03[g]	0.80±0.002[g]	23.30±0.17[bc]
	White rice	5.44± 0.05[i]	3.28±0.05[d]	1.65±0.02[g]	0.84±0.01[ef]	20.00±0.00[e]
Sakha Super 302	Brown rice	5.95±0.02[f]	3.57±0.0[a]	1.66±0.01[g]	0.74±0.00[h]	23.10±2.08[c]
	White rice	5.73±0.01[h]	3.39±0.0[c]	1.69±0.00[g]	0.83±0.00[f]	21.66±0.55[d]
Sakha 108	Brown rice	6.27±0.03[e]	2.90±0.0[g]	2.16±0.01[e]	0.86±0.01[cd]	26.88±0.04[a]
	White rice	5.97±0.02[f]	2.75±0.0[h]	2.17±0.01[e]	0.93±0.02[a]	24.53±0.55[b]
Basmati Giza 201	Brown rice	8.80±0.05[a]	2.22±0.0[j]	3.96±0.04[b]	0.74±0.00[h]	22.96±0.23[c]
	White rice	8.62±0.07[b]	2.07±0.0[k]	4.17±0.09[a]	0.82±0.01[f]	21.60±0.00[d]
Giza 181	Brown rice	7.06±0.10[c]	2.36±0.0[i]	2.99±0.01[d]	0.87±0.01[c]	20.81±0.43[de]
	White rice	6.82±0.03[d]	2.18±0.0[j]	3.12±0.01[c]	0.90±0.01[b]	18.50±0.55[f]

***Each value is an average of ten determinations± standard deviations. + Different lowercase letters within a column indicate significant differences at p ≤ 0.05.**

Milling properties of certain new Egyptian rice cultivars:

According to the information shown in Table (2), the hull % of the six rice varieties ranged from 19.26% to 21.50%. Additionally, significant differences in brown rice recovery were observed among the samples. Specifically, Sakha Super 300 rice exhibited the highest brown rice recovery rate at 80.74%, while Giza 181 rice had the lowest value at 78.50%. Regarding the white rice percentage, it's noteworthy that Super 301 samples demonstrated a notable increase in this parameter compared to other varieties. Additionally, it's important to highlight that the broken percentage recovery and the head rice recovery of the paddy are inversely correlated. This means that a lower broken percentage in the sample typically results in a higher head rice recovery, as Studied by Chavan et al. (2016)

Table 2. Milling properties of certain new Egyptian rice cultivars.

Rice varieties	Brown rice %	Hulls%	White rice %	Broken rice%	Head rice%
Sakha Super 300	80.74± 0.12[a]	19.26± 0.12[d]	70.35± 0.22[b]	7.84± 0.22[c]	62.51± 0.07[c]
Sakha Super 301	80.40± 0.04[b]	19.59± 0.04[c]	72.10± 0.31[a]	7.64± 0.14[c]	64.46± 0.17[b]
Sakha Super 302	80.17± 0.12[c]	19.83± 0.12[b]	69.77± 0.44[c]	8.17± 0.22[c]	61.60± 0.22[d]
Sakha 108	80.21±0.14[bc]	19.79± 0.14[bc]	72.53± 0.14[a]	6.42± 0.82[d]	66.11± 0.95[a]
Basmati Giza 201	80.33±0.10[bc]	19.67± 0.10[bc]	66.68± 0.01[d]	9.75± 0.25[b]	56.93± 0.24[f]
Giza 181	78.50± 0.11[d]	21.50± 0.10[a]	70.49± 0.11[b]	11.33± 0.05[a]	59.15± 0.15[e]

***Each value is an average of three determinations ± standard deviation.+ Different lowercase letters within a column indicate significant differences at p ≤ 0.05.**

Table (2) indicates that grain dimensions of the rice varieties correlated to changes in the proportions of head and broken rice. The Sakha 108 rice variety displayed lower percentages of broken rice compared to other varieties. These findings are consistent with previous studies conducted by Abd El-Rassol et al. (2005), and Badawy et al. (2022).

Water uptake, and cooking time of certain new Egyptian rice cultivars:

The presented in Table (3) indicate that white rice samples exhibited greater water uptake at temperatures of 77°C and 82°C compared to brown rice samples. This variation may be attributed to the procedure that removes minerals, lipids, and proteins from brown rice samples. According to Abd El-Sattar et al. (2016), carbohydrates tend to absorb water more readily than lipids or proteins. Additionally, among the tested rice samples, the Sakha super 301 white rice variety demonstrated the greatest water absorption values at 77°C and 82°C. These findings are consistent with previous studied by Jiamyangyuen and Ooraikul (2008), and Gewaily et al. (2019).

The data from the same table indicates that brown rice generally required a longer cooking time compared to white rice. Specifically, the brown rice variety Basmati Giza 201 exhibited the highest cooking time among all tested rice samples, at 35.70 minutes. Conversely, the white rice variety Sakha Super 302 demonstrated the shortest cooking time among all samples, at 18.10 minutes. These findings are consistent with previous studied by Chavan et al. (2018), Gewaily et al. (2019), El-Bana et al. (2020), and Badawy, et al. (2022). which suggested that a faster rate of water uptake correlated with a shorter cooking time.

Table 3. Water uptake and cooking time of certain new Egyptian rice cultivars.

Rice varieties	Treatment	Water uptake (ml H2O/100 g rice) 77 ^{0}C	Water uptake (ml H2O/100 g rice) 82 ^{0}C	Cooking time (min.)
Sakha super 300	Brown rice	235.30±1.12^e	260.40±0.60^f	31.50±0.12^d
	White rice	247.50±1.02^b	280.55±0.92^{cd}	22.00±0.15^i
Sakha super 301	Brown rice	244.60±0.94^c	269.70±0.83^e	30.80±0.17^e
	White rice	273.25±0.62^a	299.81±1.13^a	20.10±0.18^j
Sakha super 302	Brown rice	223.40±1.46^g	251.35±1.43^h	32.70±0.14^b
	White rice	238.60±1.32^d	281.45±1.52^c	18.10±0.13^l
Sakha108	Brown rice	226.41±1.42^f	253.77±0.93^g	29.40±0.19^f
	White rice	247.65±1.11^b	279.30±0.75^d	22.50±0.21^h
Basmati Giza 201	Brown rice	219.65±1.53^h	251.40±0.63^h	35.70±0.17^a
	White rice	244.30±1.44^c	269.20±1.21^e	23.40±0.24^g
Giza 181	Brown rice	197.90±1.47^i	245.50±0.93^i	32.10±0.26^c
	White rice	218.10±1.32^h	286.50±0.82^b	19.10±0.15^k

***Each value is an average of three determinations ± standard deviation.+ Different lowercase letters within a column indicate significant differences at p ≤ 0.05.**

Eating quality of certain new Egyptian rice cultivars:

The data in table (4) reveals significant variations in gel consistency (G.C.) among different rice varieties, both in brown and White rice. Additionally, the gel consistency in brown rice demonstrated a notable decrease compared to that of White rice. The G.C. in brown rice exhibited a significant decrease compared to that of white rice. Among the rice varieties studied, Sakha 108 showed the highest GC in both brown and white rice, followed by Giza 181 and then Sakha Super 302 rice. Perez (1979) suggested that G.C. of milled rice or rice starch serves as a reliable indicator of gel viscosity, which, in turn, reflects the texture of cooked rice.

The alkali spreading value (GT) acts as a reverse indicator of the gelatinization temperature of rice starch granules. It reflects the temperature at which the starch granule initiates irreversible swelling in hot water, simultaneously losing crystallites in the amylopectin chain length (Irshad, 2001).

Table (4) presents the results of the alkali spreading value, revealing lower values in brown rice varieties compared to white rice varieties.

Table 4. Eating quality of certain new Egyptian rice cultivars.

Rice varieties	Treatment	Gel consistency (mm)	Alkali spreading value(GT)	Elongation %	Amylose %
Sakha super 300	Brown rice	54.40±1.20^f	5.50±0.10^d	18.19±0.29^g	18.20±0.17^g
	White rice	60.50±1.20^d	6.50±0.20^b	44.53±0.18^a	20.56±0.16^c
Sakha super 301	Brown rice	41.50±1.20^h	5.00±0.30^e	14.04±0.31^j	19.30±0.09^e
	White rice	46.03±1.05^g	6.00±0.10^c	40.00±0.20^d	20.23±0.15^d
Sakha super 302	Brown rice	56.16±1.04^{ef}	4.00±0.00^g	12.74±0.20^k	17.81±0.11^h
	White rice	61.00±2.00^d	5.00±0.00^e	38.54±0.20^e	18.80±0.10^f
Sakha108	Brown rice	83.00±0.30^b	4.50±0.20^f	15.04±0.20^i	17.21±0.10^i
	White rice	95.06±0.05^a	6.00±0.30^c	43.00±0.20^c	18.61±0.10^f
Basmati Giza 201	Brown rice	34.50±1.50^j	6.00±0.30^c	11.61±0.40^l	25.27±0.16^a
	White rice	38.06±3.00^i	7.00±0.00^a	30.60±0.30^f	26.40±0.20^b
Giza 181	Brown rice	58.50±1.10^{de}	5.50±0.30^d	17.54±0.40^h	17.20±0.20^i
	White rice	64.80±3.10^c	7.00±0.00^a	43.70±0.20^b	18.30±0.20^g

***Each value is an average of three determinations ± standard deviation.+ Different lowercase letters within a column indicate significant differences at p ≤ 0.05.**

Basmati Giza 201 and Giza 181 white rice varieties exhibited the highest gelatinization temperature levels at 7.00%. Elongation percentage is defined by El-Akary (1992) as the ratio of the length of cooked rice grain to the length of white rice grain. The cooked rice elongation % presented in Table (4) demonstrates higher values for white rice varieties compared to brown rice across all varieties. This outcome was anticipated due to the significant amount of water added during processing for white rice varieties. Notably, the white rice variety Sakha Super 300 exhibited a relatively high elongation value at 44.40%, while the white Basmati Giza 201 variety had the lowest at 30.60%. It's worth noting that amylose content plays a crucial role in determining the eating, cooking, and paste characteristics of rice, as highlighted by Asghar et al. (2012). According to the data presented in Table (4), milling emerged as a significant factor contributing to increased amylose content in rice varieties. Consequently, the amylose contents of milled rice surpassed those of brown rice across all varieties. Specifically, the white rice grains of Basmati Giza 201 exhibited the highest amylose content at 26.40%, whereas the brown rice of the Sakha 108 and Giza 181 varieties displayed the lowest value at 17.20%. These findings are consistent with prior research conducted by El-Bana et al. (2007), Gewaily et al. (2019) and Hussein and Abd El-Rahman (2021).

Chemical composition of certain new Egyptian rice cultivars:

The moisture content analysis in Table (5) revealed a range of 12.77% to 11.18% for both brown and white rice varieties. Notably, the moisture content of brown rice varieties was found to be lower than that of white rice. These results align with the findings reported by Abd El-Sattar et al. (2016). It's important to note that moisture content plays a critical role in rice storage, as emphasized by Amorim et al. (2004).

The milling process led to a noticeable decrease in ether extract, crude protein, and ash content for the tested rice varieties, which can be attributed to the removal of the embryo and bran layers. Consequently, the levels of these nutrients found in these parts were reduced. From the data presented in the tables, it's evident that the crude protein content varied among the rice varieties, with the Giza 181 brown rice variety exhibiting the highest level at 9.16%, while the lowest value was recorded in the white rice of the Shakha108 variety at 6.92%. Furthermore, notable disparities in ether extract content were noted between brown and white rice of the same variety, as well as among different varieties. Brown rice of the Giza 181 variety exhibited a relatively high level of ether extract content at 2.78%, whereas white rice of the Sakha Super 302 variety displayed the lowest level at 0.51%. Pal et al. (1999) and Badawy, et al. (2022) noted an inverse relationship between surface fat content and the degree of milling. Additionally, ash content plays a crucial role in determining the mineral content of rice, as highlighted by Bhat and Sridhar (2008). There were significant differences in ash content observed among rice varieties, as well as between brown and white rice within the same variety.

Notably, the Sakha Super 300 variety exhibited the highest ash content at 1.66% for brown rice and 0.72% for white rice. Amorim et al. (2004) observed an ash content of 0.4% in rice, indicating its mineral content. Additionally, the data presented in the same table indicated that Basmati Giza 201 brown rice contained a relatively high crude fiber content at 1.65%, while Sakha Super 300 white rice exhibited the lowest crude fiber content at 0.39%.

Additionally, Shakha108 white rice exhibited the highest carbohydrate content compared to other samples, with carbohydrate content increasing post-milling. This rise is attributed to the removal of the layers and embryo bran leading to white rice with reduced crude protein, fat, ash, and fiber content. Consequently, white rice tends to have higher available carbohydrate levels compared to brown rice. These findings align with those reported by El-Bana and Abd El-Sattar (2016), Hussein and Abd El-Rahman (2021), and Badawy, et al. (2022).

Table 5. Chemical composition (%) of certain new Egyptian rice cultivars.

Rice varieties	Treatment	Moisture	Crude protein	Lipid	Ash	Crude fiber	T.C	A.C
Sakha Super 300	Brown rice	11.40 ± 0.14^{gh}	8.85 ± 0.11^{b}	2.20 ± 0.08^{d}	1.66 ± 0.01^{a}	0.91 ± 0.02^{e}	87.29 ± 0.21^{f}	86.38 ± 0.23^{f}
	White rice	11.81 ± 0.16^{def}	7.90 ± 0.11^{d}	0.60 ± 0.01^{gh}	0.72 ± 0.03^{e}	0.39 ± 0.01^{i}	90.78 ± 0.15^{bc}	90.39 ± 0.17^{c}
Sakha Super 301	Brown rice	11.72 ± 0.18^{efg}	8.11 ± 0 $.12^{cd}$	2.32 ± 0.03^{c}	1.33 ± 0.02^{c}	1.28 ± 0.03^{c}	88.24 ± 0.17^{d}	86.96 ± 0.21^{e}
	White rice	12.06 ± 0.11^{cd}	7.03 ± 0.12^{ef}	0.67 ± 0.01^{fg}	0.45 ± 0.10^{gh}	0.51 ± 0.01^{h}	91.84 ± 0.23^{a}	91.33 ± 0.24^{a}
Sakha Super 302	Brown rice	11.18 ± 0.21^{h}	8.77 ± 0.21^{b}	2.05 ± 0.03^{e}	1.44 ± 0.18^{bc}	1.18 ± 0.02^{d}	87.74 ± 0.41^{e}	86.56 ± 0.44^{ef}
	White rice	11.67 ± 0.22^{efg}	7.95 ± 0.23^{d}	0.51 ± 0.02^{i}	0.38 ± 0.04^{h}	0.45 ± 0.01^{i}	91.15 ± 0.30^{b}	90.70 ± 0.32^{bc}
Shakha108	Brown rice	12.31 ± 0.24^{bc}	7.89 ± 0.15^{d}	2.42 ± 0.03^{b}	1.50 ± 0.08^{b}	1.50 ± 0.03^{b}	88.19 ± 0.27^{d}	86.69 ± 0.31^{ef}
	White rice	12.77 ± 0.22^{a}	6.92 ± 0.16^{f}	0.65 ± 0.01^{gh}	0.63 ± 0.04^{ef}	0.71 ± 0.019^{f}	91.80 ± 0.22^{a}	91.09 ± 0.24^{ab}
Basmati G201	Brown rice	12.08 ± 0.13^{cd}	8.31 ± 0.13^{c}	2.50 ± 0.03^{b}	1.15 ± 0.01^{d}	1.65 ± 0.02^{a}	88.04 ± 0.18^{de}	86.39 ± 0.21^{f}
	White rice	12.51 ± 0.11^{ab}	7.26 ± 0.15^{e}	0.57 ± 0.01^{hi}	0.39 ± 0.01^{h}	0.66 ± 0.01^{g}	91.78 ± 0.19^{a}	91.12 ± 0.20^{ab}
Sakha Giza 181	Brown rice	11.59 ± 0.19^{fg}	9.16 ± 0.12^{a}	2.78 ± 0.08^{a}	1.54 ± 0.02^{ab}	1.15 ± 0.028^{d}	86.52 ± 0.22^{g}	85.37 ± 0.25^{g}
	White rice	11.95 ± 0.17^{de}	8.26 ± 0.13^{c}	0.75 ± 0.08^{f}	0.52 ± 0.06^{fg}	0.70 ± 0.02^{f}	90.46 ± 0.28^{c}	89.75 ± 0.30^{d}

***Each value is an average of three determinations ± standard deviation.+ Different lowercase letters within a column indicate significant differences at $p \leq 0.05$.T.C.: Total carbohydrate. A.C: Available carbohydrate**

Minerals content:

Elements are essential for human nutrition, with some playing critical roles in vital bodily functions like hemoglobin production for blood (National Academy of Sciences, 2001). The ash content of rice varieties is nutritionally significant due to its inclusion of essential minerals, as illustrated in Table 6. Among the determined mineral contents, potassium content was found to be the highest element. Moreover, brown rice exhibited higher mineral contents compared to white rice among the tested samples. Specifically, the Super 301 rice variety displayed relatively high levels of P % contents in both brown and white rice compared to other varieties. These findings are consistent with previous studies conducted by Hussein and Abd El-Rahman (2021), and Badawy, et al. (2022). Showed variations in mineral content across rice varieties, with potassium ranging from 58 to 117 mg/100 g, calcium from 7.8 to 25 mg/100 g, sodium from 5.9 to 10.3 mg/100 g, iron from 0.2 to 2.7 mg/100 g, and zinc from 0.3 to 1.37 mg/100 g.

Table 6. Mineral compositions of certain new Egyptian rice cultivars.

Rice varieties	Treatment	P	(mg/100g)				
		%	Na	K	Ca	Zn	Fe
Sakha Super 300	Brown rice	0.33	11.70	181.30	9.40	1.70	1.70
	White rice	0.22	8.89	93.50	8.20	1.21	1.36
Sakha Super 301	Brown rice	0.36	13.50	147.20	12.50	1.83	1.53
	White rice	0.25	9.61	82.90	10.30	1.30	1.21
Sakha Super 302	Brown rice	0.26	11.22	170.10	13.40	2.00	1.35
	White rice	0.18	10.10	86.40	7.50	1.51	1.01
Sakha 108	Brown rice	0.31	10.59	173.25	10.90	2.10	1.85
	White rice	0.23	8.53	85.15	8.20	1.63	1.38
Basmati G201	Brown rice	0.21	8.14	195.33	13.10	1.60	1.41
	White rice	0.13	7.69	125.10	8.80	1.00	0.92
Giza 181	Brown rice	0.23	9.80	182.15	15.83	1.22	1.61
	White rice	0.15	8.72	78.90	10.25	0.82	1.11

CONCLUSION

Based on the findings presented in this study, it is advisable to expand the cultivated area of the Sakha Super 301 and Basmati G201 varieties, as they exhibit superior physical, chemical, and nutritional properties. Moreover, these new rice varieties, Sakha Super 301 and Basmati G201, demonstrate high productivity and resilience to drought and salinity, making them suitable for cultivation even in regions with limited freshwater resources, where seawater could potentially be utilized for cultivation purposes.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to El-Mowafi, H. F., of the Rice Research Department, Field Crops Research Institute, Agricultural Research Center, Kafrelsheikh, Egypt, for generously providing support with rice varieties (Oryza sativa L.).

REFERENCES

Abd El-Rassol, E.A., Sahar R. Abd El-Hady and El-Bana, M.A. (2005). Effect of parboiling and milling processing on chemical composition and some nutritional values of two rice varieties. J. Agric. Sci. Mansoura Univ., 30(12): 7781-7788.

A.O.A.C. (2012). Association of Official Analytical Chemists. Official Methods of Analysis (18th ed.). Washington D.C., USA.

Abd El-Sattar, A.S.; El-Bana, M.A. and Somaya M. Morsy (2016). Physical properties, chemical and technological evaluation of waxy and non waxy rice. Minufiya J. Agric. Res., 34(3):1119-1138.

Ahuja, S. C., Panwar, D. V., Ahuja, U. and Gupta, K. R. (1995). Basmati rice: The scented pearl (pp. 1-61). Hissar, Haryana, India: Directorate of Publications, CCS Haryana Agricultural University.

Akoa-Etoa, J.M.; Ndindeng, S.A.; Owusu, E.S.; Woin, N.; Bindzi, B. and Demont, M. (2016). Consumer evaluation of an improved parboiled technology: experimental evidence from Cameroon. Afr. J. Agric. and Res. Econ., 11 (1): 8–21.

Amorim, J.A., Eiziazrio, S.A., Gouveia, D.S. , Simoes, A.S. , Santos, J.C., Conceicao, M.M., Souza, A.G. and Trindade, M.F. (2004). Thermal analysis of rice and by-product. J. of thermal Analysis and Calorimetry, 75: 393-399.

Asghar, S.; Anjum, F.M.; Amir, M.R. and Khan, M.A. (2012). Cooking and eating characteristics of rice (*Oryza sativa* L.) A Rev. Pak. J. Food Sci., 22: 128-32.

Badawy, W. Z., El-Hady, A., Sahar, R., and Badr, M. R. (2022). Physicochemical and cooking quality characteristics of new Egyptian rice varieties. *sinai journal of applied sciences*, *11*(6), 1173-1184.

Bandumula, N. (2018). Rice production in Asia: Key to global food security. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 88, 1323-1328.

Bashir, K., and Aggarwal, M. (2019). Physicochemical, structural and functional properties of native and irradiated starch: A review. Journal of food science and technology, 56, 513-523.

Bhat, R. and Sridhar, K. R. (2008). Nutritional quality evaluation of electron beam-irradirated lotus (*Nelumbonucifera*) seeds. *Food Chem*., 107: 174-84.

Bhattacharya, K. R. and Sowbhagya, K. (1980). Size and shape classification of rice. Riso, 29, 181-185.

Chavan, P., Sharma, S. R., Mittal, T. C., Mahajan, G. and Gupta, S. K. (2016). Optimization of parboiling parameters to improve the quality characteristics of pusa Basmati 1509. *J Food Process Engg* doi:10.1111/jfpe.12454.

Chavan, P., Sharma, S. R., Mittal, T. C., Mahajan, G. and Gupta, S.K. (2018). Effect of parboiling technique on physico-chemical and nutritional characteristics of basmati rice. *Agric Res. J.,* 55 (3) : 490-499.

Chen, C. C., McCarl, B., and Chang, C. C. (2012). Climate change, sea level rise and rice: global market implications. Climatic change, 110(3), 543-560.

Demont, M.; Fiamohe, R. and Kinkpé, T. (2017). Comparative advantage in demand and the development of rice value chains in West Africa. World Dev., 96: 578–590.

El-Akary, M.O. (1992). Physicochemical Studies on Storage of Paddy Rice in Relation to Quality of the Parboiled Produced. Ph.D. Thesis, Food Sci. and Technol. Dept., Fac. Agric., Alex. Univ., Alexandria, Egypt.

El-Bana, M. A., Galal, W. K. and El-Hadidie, S.T. (2010). Physico- chemical and technological studies on some Egyption rice varieties. J. of Food and Dairy Sci., 1 (4): 161 -172.

El-Bana, M. A., Goma, R. A. and Abd El-Sattar, A. S. (2020). Effect of parboiling process on milling quality, physical and chemical properties of two rice varieties. Menoufia J. Food and Dairy Sci., 5: 35 – 51.

El-Bana, M.A. and Abd El-Sattar A.S. (2016). Effect of brown rice germination on quality of pan bread. Minufiya J. Agric. Res., 34(3):1119-1138.

El-Bana, M.A., Hanan A. Kassab, El-Deen, M.R. and Ghazi, A. (2007). Effect of some storage conditions on the physical and technological proprieties of raw, parboiled and quick cooking rice. J. Agric., sci. Mansoura Univ., 32 (4): 2673 – 2689.

El-Hissewy, A.A. and El-Kady, A.A. (1992). A study on the cooking and eating quality characters of some Egyptian rice varieties, Acta. Alimentaria, 21 (1): 23-30.

FAOSTAT (2020). Food and Agriculture Organization of United Nations Statistics Division. Food and Agric. Org. United Nations Sta. Div, 2020.

Fukagawa, N. K., and Ziska, L. H. (2019) Rice: Importance for global nutrition. Journal of nutritional science and vitaminology, 65(Supplement), S2-S3.

Gewaily, E.E., Abd El-Rahem, W. T.; Soheir T. El-Hadide and Maha M. Tawfik (2018). Chemical and technological evaluation of some Egyptian rice cultivars. Middle East J. Agric. Res., 7(3): 876-886.

Gewaily, E.E., Amera T. Mohammed and Abd El-Rahem, W.T. (2019). Effect of Different Irrigation Regimes on Productivity and Cooking Quality of Some Rice Varieties. World Journal of Agricultural Sciences 15 (5): 341-354.

Hussien, F.A. and Abd El-Rahman, S.N. (2021). Comparative studies of some agronomic and grain quality traits for three new developed rice varieties. *Menoufia Journal of Plant Production*, *6*(6), 315-326.

Irshad, A. (2001). Factors affecting rice grain quality. Cereal Chem., 78(4): 295-399.

Jiamyangyuen, S. and Ooraikul, B. (2008). The physico-chemical, eating and sensorial properties of germinated brown rice. J. of agric. and Environmental, 6(2): 119-124.

Jinorose, M., S. Prachayawarakorn and Soponronnarit, S. (2014). A novel image-analysis based approach to evaluate some physicochemical and cooking properties of rice kernels. J. Food Eng., 124: 184–90.

Khan, A. U. and Wikramanayake, V. E. A. (1971). A laboratory test tube miller, IRR. Agric. Eng. Dept. pp: 71-80. (Typescript).

Khush, G. S., Pauke, C. M. and Delacruz, N. M. (1979). Rice grain quality evaluation and improvement. In Proceedings of the Workshop on Chemical Aspects of Rice Grain Quality (p. 390). Los Banos, Philippines: IRRI.

Meera, K.; Smita, M. and Haripriya, S. (2019). Varietal distinctness in physical and engineering properties of paddy and brown rice from Southern India. J. Food Sci. Technol., 56: 1473-1483.

Murphy, J. and Riley, J. P. (1962). A modified single solution method for determination of phosphate in natural waters. Analytica Chimica Acta, 27, 31-36.

Myklestad, O., Christie, E. M., Coate, G. G. and McDonald, D. J. (1968). Chemical, physical and organoleptic properties of 12 varieties of rice. Division of Food Preservation, Technical Paper, 33, 19. Commonwealth Scientific and Industrial Research Organization, Australia.

National Academies of Sciences, Institute of Medicine (2001). Fruits and vegetables yield less vitamin A than previously thought; upper limits set for daily intake of vitamin A and Nine Other Nutrients, Press Release Jan. 9.

Pal, V., Pandey, J.P. and Sah, P.C. (1999). Effect of degree of polish on proximate composition of milled rice. J. of Food Sci. and Tech. Myhsore, 36, 160-162.

Pearson, D. (1976). The Chemical Analysis of Food 7th Ed. Churchill, London, U.K.

Perez, C.M. (1979). Gel consistency and viscosity of rice, International Rice Research Institute (IRRI). pp. 292.

Prom-u-thai, C. and Rerkasem, B. (2020). Rice quality improvement. A review. Agron. Sustain. Dev. 40: 1-16.

Siddiqui, S.U., Kumamaru, T. and Satoh, H. (2007). Pakistan rice genetic resources I: Grain morphological diversity and its distribution. Pak. J. Bot., 39, 841-848.

Simpson, J. E., Adair, C. R., Kohler, G. R., Dawson, E. K., Deobald, H. J., Kester, E. B., Hogan, J. T., Batcher, O. M. and Halick, J. V. (1965). Quality evaluation studies of foreign and domestic rices. USDA Technological Bulletin, 133, 185.

Song, Y., Wang, C., Linderholm, H. W., Fu, Y., Cai, W., Xu, J., and Chen, D. (2022). The negative impact of increasing temperatures on rice yields in southern China. Science of the total Environment, 820, 153262.

Stell, R.G. and Torrie, J.H. (1980). Principles and Procedures of Statistics, 2nd Ed. McGraw-Hill, New York, USA.

Suwansri, S. and Meullenet's, J. (2004). Physicochemical characterization and consumer acceptance by Asian consumers of aromatic jasmine rice. Journal of Food Science, 69 (1), 30-37.

Swasdisevi, T., Sriariyakula, W., Tia, W. and Soponronnarit, S. (2010). Effect of pre-steaming on production of partially parboiled rice using hot-air fluidization technique. J. Food Eng., 96: 455-62.

الخصائص الفيزيائية والكيميائية وجودة الحبوب لأصناف الأرز المصرية الجديدة .

احمد رمضان منصور[١] ، رانيا ابراهيم الجمال[٢] ، محمد ممدوح ربيع[٢] و محمد احمد البنا[١]

[١]معهد بحوث تكنلوجيا الأغذية - مركز البحوث الزراعية -الجيزة -مصر
[٢]قسم الصناعات الغذائية - كلية الزراعة - جامعة المنصورة -مصر .

الملخص

تهدف هذه الدراسة إلى تقييم أصناف الأرز المصري الجديدة: سخا سوبر ٣٠٠، سخا سوبر ٣٠١، سخا سوبر ٣٠٢، سخا ١٠٨، بسمتي جيزة ٢٠١، وجيزة ١٨١، مع التركيز على خصائصها الفيزيائية والكيميائية والقيمة الغذائية وخصائص الطحن وجودة الطهي للأرز البني والأبيض. أظهرت البيانات اختلافات في الخصائص الفيزيائية بين الأصناف، و كان الصنف جيزة بسمتي ٢٠١ اكثر الاصناف في الطول و اقلهم في العرض. كما كان اقل الاصناف في كمية الارز الابيض و الارز السليم الناتج من التبييض و كذلك في خصائص الطهي، امتص الأرز الأبيض ماءً أكثر من الأرز البني. استغرق طهي أرز بسمتي جيزة ٢٠١ البني أطول وقت (٣٥,٧٠ دقيقة)، بينما كان أرز سخا سوبر ٣٠٢ الأبيض الأقل في زمن الطهي (١٨,١٠ دقيقة). لوحظت اختلافات في قوام الجل بين الأصناف، حيث أظهر سخا ١٠٨ أعلى قيمة في الأرز البني والأبيض، يليه جيزة ١٨١ وسخا سوبر ٣٠٢. كانت قيمة انتشار القلويات للأرز البني أقل من الأبيض في كل الاصناف ، حيث أظهر أرز بسمتي جيزة ٢٠١ وجيزة ١٨١ الأبيض هو الأعلي في دراجات الجلتنة (٧,٠٠). كانت نسبة الاستطالة في الأرز الأبيض أعلى، حيث أظهر سخا سوبر ٣٠٠ أعلى نسبة (٤٤,٤٠%)، بينما كانت أدنى نسبة في بسمتي جيزة ٢٠١ (٣٠,٦٠%). كان محتوى الأميلوز في أرز بسمتي جيزة ٢٠١ الأبيض هو الأعلى (٢٦,٤٠%)، بينما كان أدنى مستوى في أرز سخا ١٠٨ وجيزة ١٨١ البني (١٧,٢٠%). كان الأرز البني أقل في محتوى الكربوهيدرات وأعلى في البروتين، مستخلص الإيثر، والرماد مقارنة بالأرز الأبيض بين الأصناف. كما احتوى الأرز البني على كمية أكبر من المعادن. لذا يُوصى بزيادة زراعة بسمتي جيزة ٢٠١ وسخا سوبر ٣٠١ لتميزهما في الخصائص الفيزيائية والكيميائية وجودة الطهي.