EFFECT OF PARBOILING PROCESS ON MILLING QUALITY, PHYSICAL AND CHEMICAL PROPERTIES OF TWO RICE VARIETIES

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ABSTRACT: The present study was carried out to investigate the effect of parboiling process on physicochemical, nutritional properties, Milling quality and organoleptically of brown and white rice. The obtained results revealed that, physical properties of brown and white rice varied from one variety to another. Giza 182 rice variety was significantly the longest length among Giza 179 rice variety. In addition, parboiling process had no effect on the length and width of either brown or the white rice at P ≤ 0.05.The paddy rice of raw (Giza 179) had the highest percentage of broken grains and the lowest percentages of head rice and Brown rice as compared with (Giza 182) variety, where parboiling process led to decrease the percentage of broken rice from 32.40 to 4.28% for Giza 179 and from 16.50 to 5.50 for Giza 182.In addition, parboiling process help to increase the head rice and white rice percentages. Water uptake, sedimentation value of white rice were significantly higher than that of brown rice. white rice variety of Giza 179 had the lowest cooking time among all of the tested rice samples (17 min.). water uptake and sedimentation values decreased as a function of parboiling process but cooking time increased for all rice samples. Gel consistency (GC) varied significantly among varieties in both brown and white rice. Alkali spreading value in brown rice varieties showed lower values in comparing with white rice varieties. white rice variety of Giza 182 had the highest Alkali spreading value, Elongation and Amylose content among the other varieties. Moreover, it were decreased upon subjecting rice to parboiling process. Brown rice of two rice varieties had higher contents of crude protein, ether extract and ash but lower content of total carbohydrates than those of white rice. Parboiling process lowered the percentage of the crude protein and ether extract in both brown and white rice .whereas, it increased the ash and minerals content in white rice samples. The cooked white rice of Giza 182 variety had the highest mean scores for the palatability characteristics among all of the tested rice samples. In addition, parboiling process helped to decrease the mean score for the palatability characteristics but the values were still acceptable by the panelists.

Key words: Parboiling process, physical and chemical properties, milling quality, cooking quality, brown and white rice.

INTRODUCTION

Rice (*Oryza sativa, L.*) is one of the most important staple food crops of the world. More than two thirds of the world relies of nutritional benefit of rice. In Egypt, rice is considered as one of the most essential field crops, not only as a food crop, but also a land reclamation crop and for exportation. (Jing *et al.*, 2008).

Egypt is the largest producer of rice in Africa, In 2014, the production of rice in Egypt was 6.00 million tons. Egypt recorded the second yield in the world (3.86 tons/acre) per year during the years 2010–2014 (FAO/UN, 2016). Rice is considered as one of the major source of nutrients, consisting of carbohydrates, proteins, fats, fibers, minerals, vitamins,

etc. and is consumed daily in the form such as bread, noodles and parboiled rice (Heinemann *et al.*, 2005 and Swasdisevi *et al.*, 2010). Brown rice is the whole grain rice obtained from unpolished rice. It is an excellent source of nutrients such as protein, dietary fiber, fat, minerals and vitamins (Abd El-Sattar *et al.,* 2016). The physicochemical characteristics include grain length (L), grain breadth (B), L/B ratio, hulling and milling percentage. The cooking qualities are amylose content, alkali spreading value, water uptake, volume expansion ratio and kernel elongation ratio. Grain quality is a very wide area encompassing diverse characters that are directly or indirectly related to exhibit one quality type (Siddiqui *et al.,* 2007). The quality of milled parboiled rice is being assessed based on physical parameters like degree of milling, percentage head rice, broken grain, chalkiness, red streak grain, grain size, color, shape and 1000 grains weight (Abdelhady *et al.,* 2014). In order to obtain rice kernel suitable for consumption, paddy undergoes dehulling to shear off the hull and milling to remove the bran and germ. These activities affect the physicochemical and cooking quality of rice (Jinorose *et al.*, 2014). Milling quality has been evaluated on the basis of head rice turnout, total milling recovery and has been considered as important criteria from marketing point of view. Brokens produced during milling are generally the result of immature, chalky or fissured kernels, all of which are weak and typically break during milling due to the substantial forces imparted to kernels in order to remove bran (Siebenmorgen *et al.*, 2013). Pusa Basmati 1121 has gained popularity due to its extra long slender length (8.3mm), leading to higher breakage during milling operation and hence reduced milling yield (Kale *et*

*al.,*2015). It was hypothesised that such breakage can be reduced by following parboiling treatment to the paddy before milling operation to harden the rice kernel in order to increase head rice recovery. Parboiling process is involved the partial boiling of rice paddy following steaming the hydrated paddy for 25 min followed by drying to 14% moisture content before dehusking and polishing (Ndindeng *et al.,* 2015).During boiling, the gelatinization occurs only in the outer layers of aleurone part and seals the grain hence the head rice yield improved. (Boers *et al.*, 2015). Furthermore, Parboiling treatment has been reported to cause significant qualitative changes in the rice, affecting its physical, chemical characteristics and nutritional composition (Manful *et al.*, 2008 and Patindol *et al.*, 2008). The objectives of this study are to investigate the effect of parboiling process on physicochemical, nutritional properties, milling quality and cooking quality of brown and white rice.

MATERIALS AND METHODS

Materials:

Two varieties of Egyptian rice (*Oryza sativa L.*) namely Giza 179 (short grain Indica/Japonica) and Giza 182 (long grain Indica) were employed in this study, These samples were obtained from Rice Research and Training Center (RRTC) at Sakha, Kafr El-Sheikh Governorate, Egypt during the season of 2019, under the recommended conditions for date of culture, fertilization, harvesting time and irrigation.

Methods :

Preparation of parboiled paddy rice :

Parboiled rice were prepared by using Giza 179 and Giza 182 varieties following the procedure of Singh *et al.* (1999) and modified by boiling the samples at 100 ^{o}C

for 20 minutes, then steaming under pressure (1.5 kg/cm2) at 121 °C for 15 minutes. Parboiled rice was dried in an air oven at 55 °C until constant weight was reached.

Physical characteristics:

The grain physical attributes namely, grain dimension (length and width) , grain shape (grain length to width ratio) and grain index were measured. Grain dimensions (mm) were measured using a micrometer with accuracy of 0.001 mm where 10 uniform rice grains were randomly selected and their length and width were measured in duplicate (Suwansri and Meullenet, 2004). Grain shape of rice was carried out by dividing the grain length by width for ten grains that were taken randomly as reported by Ahuja *et al.* (1995). The 1000 grain from each variety of rice were counted randomly in triplicate, weighed separately and estimated as grain index (g|1000g) as reported by Khush *et al.* (1979). Bulk density of rice was deter-mined according to the method of Myklestad *et al.* (1968).

Milling Characteristics:

One hundred and fifty gram of cleaned rough rice varieties Giza 179 , Giza 182, parboiled Giza 179 and parboiled Giza 182 were taken randomly. They were de-hulled using Asatake Laboratory Dehuller. The total milled rice, brown rice, hulls, heads and broken percentages were calculated using the procedure of Khan and Wikramanayake (1971).

Water uptake, sedimentation values at 77°C and 82°C and cooking time:

Water uptake, sedimentation values and cooking time of brown, milled, parboiled brown, parboiled milled rice varieties were determined following to procedures of Simpson *et al.* (1965).

Determination of cooking and eating quality:

Alkali spreading value was determined according to the method described by Bhattacharya and Sowbhagya (1980). Gel consistency (GC) was determined according to the method described by Cagampang *et al.* (1973). Elongation percentage was measured using the method of Tomar (1985). Amylose content was measured according to Juliano *et al.* (1981) procedure.

Chemical composition of rice samples:

Moisture, crude protein, ether extract and ash contents were determined according to the methods of 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).

Determination of minerals:

Rice samples were prepared for mineral determination according to the method of the A.O.A.C. (2005). Total phosphorus (P) was determined by ascorbic acid technique using the colorimetric method that described by Murphy and Riley (1962). Potassium (K) and sodium (Na) contents of rice samples were estimated using flame photometer as given by Pearson (1976). Iron (Fe), Copper (Cu), Zinc (Zn) and Calcium (Ca)contents of rice samples were conducted using the atomic absorption spectrophotometer Perken Elmer Model 2180 and following the methods of Pearson (1976).

Organoleptic evaluation of rice samples :

Organoleptic evaluation of cooked raw, parboiled and quick cooking brown and white rice were subjected to their

organoleptic qualities. Samples were served to panel of 10 judges. The panelists were asked to evaluate colour, flavour, taste, texture and overall acceptability on a 1 to 10 hedomic scale as described by Farag *et al.* (1996). A score 1 being (dislike extremely) and 10 being (like extremely).

Statistical analysis :

Data of physical properties, chemical determination and organoleptic evaluation were subjected to analysis of variance and the means were further tested using the least significant difference test (LSD) as outlined by Stell and Torrie (1980).

RESULTS AND DISCUSSION

Physical and Technological Properties of Rice Samples:

Uniformity in shape and size is considered the first quality characteristic. Milled rice has been classified into four categories on the basis of the average length (mm) of the kernels. Extra long (> 7.50), Long (6.61 - 7.50 mm), Medium (5.51 - 6.60 mm) and short (≤5.50 mm), Ahuja *et al.* (1995). Data presented in Table (1) indicated that the length of raw brown rice grains of the two different studied varieties (Giza 179 and Giza 182) were 5.73 and 7.47 mm, respectively. Whereas the length of raw white rice grains were 5.46 and 7.23 mm of the previous mentioned varieties . Giza 182 rice variety was significantly the longest among Giza 179 rice variety. The same Table show that, parboiling process had no effect on the length of either brown or the white rice at P ≤ 0.05. The width of raw brown rice in the two different varieties of rice (Giza 179 and Giza 182) were 2.62 and 2.31 mm, where in case of white rice grains were 2.46 and 2.13 mm, respectively, with no obvious changes in width as a result of parboiling process. Subjecting the previous results to

analysis of variance at P ≤ 0.05 support our findings. These results are in the same trend of those reported elsewhere (Otegbayo *et al.,* 2001; Abd El-Sattar *et al.,* 2016 and Gewaily *et al.,* 2019).

As for Grain shape of the two rice varieties (Giza 179 and Giza 182) for raw brown and white rice were given in Table (1). The recorded differences were significant at P ≤ 0.05. In addition, no pronounce affect was found upon subjecting different rice varieties to parboiling process. However, grain shape of rice depends on the ratio between length and width as reported by Ahuja *et al.* (1995). who classified the shape as Slender (> 3.0), Medium (2.1 - 3.0), Bold (1.1 - 2.0) and Round (≤1.0). The present results are in accordance with those of (Otegbayo *et al.,* 2001; Abd El-Sattar *et al.,* 2016 and Gewaily *et al.,* 2019).In addition, the data in the same Table revealed that, grain index (weight of 1000 grains) values of raw brown and white rice for the two rice varieties (Giza 179 and Giza 182) were (29.95 and 26.10 g) and (22.92 and 20.41 g), respectively. It is noteworthy from the same Tables that, parboiling process had no significant effect on grain index, neither for brown nor for white rice grains at P ≤ 0.05. Similar results were found elsewhere(Otegbayo *et al.,* 2001 and Gewaily *et al.,* 2018). In addition the data in the same Table revealed that, bulk density were higher in white rice samples than those of brown rice. . In addition, pronounce affect was found upon subjecting different rice varieties to parboiling process. Apparent also from the above mentioned data that, milling process led to a pronounced increase of bulk density, where a noticeable decrement in grain index values were recorded. Data in this respect were in agreement with the findings of numerous investigators. (Jiamyangyuen and Ooraikul, 2008 ; El-Bana *et al.,* 2010 and Abd El-Sattar *et al. ,* 2016).

Table (1): Some Physical properties of the tested rice varieties.

| Rice variety | Treatments | Grain dimension | | Grain shape | "Grain index (g) | Bulk density (g/cm3) |
		Length (mm)	Width (mm)			
Giza179	**Brown**	5.73[c]	2.62[a]	2.19[d]	29.95[a]	0.66[f]
	Parboiled Brown	5.70[c]	2.64[a]	2.16[d]	29.99[a]	0.69[e]
Giza179	**White**	5.46[d]	2.46[b]	2.22[c]	26.10[b]	0.74[d]
	Parboiled White	5.49[d]	2.49[b]	2.20[c]	26.31[b]	0.76[cd]
Giza182	**Brown**	7.47[a]	2.31[c]	3.23[b]	22.92[c]	0.76[bc]
	Parboiled Brown	7.50[a]	2.33[c]	3.22[b]	22.94[c]	0.78[b]
Giza182	**White**	7.23[b]	2.13[d]	3.39[a]	20.41[d]	0.81[ab]
	Parboiled White	7.24[b]	2.15[d]	3.37[a]	20.49[d]	0.84[a]

*Each value was an average of ten determinations .

+Values followed by the same letter in column are not significantly different at P < 0.05.

"Grain index = weight of 1000 grains.

Milling characteristics of some rice varieties:

Data presented in Table (2) indicated that the hulls percentage of the two rice varieties (Giza 179 and Giza 182) were 21.10 and 20.40%, respectively, while parboiling treatment decreased the hull percentage in both. Apparent also from the same Table that, the percentages of brown rice were (78.90 and 79.60 %) for the two studied rice varieties (Giza 179 and Giza 182), respectively. Parboiling treatment caused an increment in the previous mentioned percentages. These results may be related to the gelatinization and expansion of the grain during steaming step of the parboiling process. In addition, the return to grains natural state by drying are believed to cement the interior fissures or check of the kernels, thus enabling the grains to assume a greater hardness (Jagtap *et al.,* 2008).These results are in line with those of (Abd El-Rassol *et al.,*2005 ; Chavan *et al.*, 2018 and Gewaily *et al.,* 2019) . Apparent also from the same Table that, total milled rice of the two rice varieties revealed that, samples of Giza 179 showed an increasing in the previous mentioned parameter in comparing with that of Giza 182, while the percentage of the total milled rice increased as a function of parboiling process. This increment may be related to the adhesion between the outer layer of the grain (aleuron layer) and the endosperm. These results are in the same trend of those reported by (Abd El-Rassol *et al.,* 2005; Ayamdoo *et al.,* 2014 and Chavan *et al.*, 2018).

Table (2): Milling characteristics of some rice varieties.

Rice varieties	Treatments	Hulls%	Brown rice%	Total milled rice%	Head rice%	Broken rice%
Giza179	Raw	21.10[a]	78.90[d]	72.0[b]	39.60[d]	32.40[a]
Giza179	Parboiled	19.60[c]	80.40[b]	73.10[a]	68.82[a]	4.28[d]
Giza182	Raw	20.40[b]	79.60[c]	68.70[d]	52.20[c]	16.50[b]
Giza182	Parboiled	18.60[d]	81.40[a]	70.80[c]	65.30[b]	5.50[c]

*Each value was an average of three determinations.

+Values followed by the same letter in column are not significantly different at P < 0.05.

Head rice recovery of paddy is inversely proportional to broken percentage recovery as low broken percentage in the sample leads to high head rice recovery (Chavan *et al.,* 2016). The percentages of head and broken rice varied according to the length and width of the rice varieties as given in Table (2). The indica /Japonica rice variety (Giza 179) had higher percentages of broken rice than those of Indica rice variety (Giza 182). Parboiling process led to increase the percentage of the head rice regardless to the used rice varieties (Giza 179 and Giza 182). The head rice percentage increased from 39.60 to68.82 for Giza 179 and from 52.20 to 65.30% for Giza 182. Remarkable reduction was observed in broken rice percentage upon subjecting the tested rice varieties to parboiling treatment, especially in case of variety Giza 179. Such decline varied from 32.40 to 4.23% for Giza 179 and from 16.50 to 5.50 for Giza 182. reversible relationship was recorded between head rice percentage and percentage of broken rice. This may be attributed to the increase in hardness of the rice grain that occurred following parboiling process, which play an active rule in improving the head rice yields and hardness values. These results are in agreement with those found by (Abd El-Rassol *et al.,*2005; Ibukun, 2008 Abd El-Sattar *et al.,* 2016; Chavan *et al.,* 2018 and

Zohoun *et al.,* 2018). Furthermore, broken rice percentages have been used as means of detecting varietal differences in the varieties under investigation. Also this parameter may considered as an index for the quality of rice varieties.

Water uptake, sedimentation value, Cooking time and Cooking and eating quality of two tested rice varieties:

Results given in Table (3) show that, water uptake values of 77 $^{\text{O}}$C and 82 $^{\text{O}}$C were higher in white rice samples than those of brown rice ones. This may be related to the removal of protein, lipids and minerals in brown rice samples. Abd El-Sattar *et al.,* (2016) found that, water uptake could be easily bound by carbohydrate compared to lipid or protein. Apparent also from the same Table that, water uptake whether at 77 $^{\text{O}}$C or 82 $^{\text{O}}$C decreased as a function of parboiling process for all rice samples. Furthermore white rice variety of Giza 182 had relatively the highest water uptake value at 77 $^{\text{O}}$C and 82 $^{\text{O}}$C among all of the tested rice samples. The obtained results are in line with those reported by (Ayamdoo *et al.,* 2014; Abd El-Sattar *et al.,* 2016 ; Chavan *et al.,* 2018 and Gewaily *et al.,* 2019). Apparent also from the same Table Table (3) that, Sedimentation values at 77 $^{\text{O}}$C and 82 $^{\text{O}}$C

Table (3): Water uptake, sedimentation value, Cooking time and Cooking and eating quality of two tested rice varieties.

Rice varieties	Treatments	Water uptake (ml H2O/100 g rice)		Sedimentation value ml sed./ 100 g rice)		Cooking time (min.)	Cooking and eating quality			
		77°C	82°C	77°C	82°C		Gel consistency (mm)	Alkali spreading	Elongation %	Amylose %
Giza179	Brown	206.45[g]	249.77[g]	2.10[cd]	2.40[c]	31[d]	89.50[c]	5.0[e]	55.21[e]	17.60[c]
	Parboiled Brown	195.50[h]	225.91[h]	1.02[e]	1.20[e]	41[b]	82.30[g]	3.71[g]	52.37[h]	16.50[d]
	White	232.70[c]	279.30[c]	3.80[b]	4.21[b]	17[g]	93.50[a]	6.59[b]	58.90[b]	18.61[b]
	Parboiled White	224.20[d]	264.80[d]	1.85[d]	2.03[d]	22[f]	88.30[d]	5.60[c]	54.61[f]	17.70[c]
Giza182	Brown	220.61[e]	271.11[e]	2.40[c]	2.64[c]	35[c]	85.75[f]	5.50[d]	57.22[c]	18.40[b]
	Parboiled Brown	213.90[f]	245.32[f]	1.22[e]	1.37[e]	45[a]	80.50[h]	4.20[f]	53.15[g]	17.37[c]
	White	252.50[a]	306.35[a]	4.20[a]	4.60[a]	20[fg]	90.22[b]	7.0[a]	62.10[a]	19.50[a]
	Parboiled White	243.10[b]	281.50[b]	2.13[cd]	2.35[cd]	27[e]	87.41[e]	5.60[c]	56.20[d]	18.40[b]

*Each value was an average of three determinations.
+Values followed by the same letter in column are not significantly different at P < 0.05.

were higher in white rice samples than those of brown rice. Furthermore, sedimentation values at 82 ^{O}C were higher than those of 77 ^{O}C for different rice varieties. Considerable reduction was recorded upon subjecting the different rice varieties to parboiling process and the reduction in sedimentation values that occurred at 82 ^{O}C was higher than that at 77 ^{O}C. However, (Soponronnarit *et al.,* 2006) found that, Decrease in the gruel solid loss was attributed to the stronger structure of rice imparted by gelatinization of starch. Moreover, parboiled brown rice variety of Giza 179 had the lowest sedimentation value among all of the tested rice varieties (1.02 and 1.20 ml sed./100 g rice) at 77oC and 82oC, respectively.. The obtained values are found to be in the range that reported elsewhere (Otegbayo *et al.,* 2001; Saeed *et al.,* 2001; Abd El-Sattar *et al.,* 2016 and Chavan *et al.,* 2018). The cooking time is the time needed to make the opaque central portion of the rice grain disappear completely during cooking (Itagi and Singh, 2015). The data in the same table revealed that, brown rice had cooking time higher than that of milled rice. In addition, cooking time increased as a function of parboiling process for all rice samples. Furthermore parboiled brown rice variety of Giza 182 had relatively the highest cooking time among all of the tested rice samples (45 min.)..While, white rice variety of Giza 179 had the lowest cooking time among all of the tested rice samples (17 min.). The obtained results were in line with those reported by (Abd El-Sattar *et al.,* 2016 ; Chavan *et al.,* 2018 ; Zohoun *et al.,* 2018 and Gewaily *et al.,* 2019).

Alkali spreading value is used as an inverse indicator of gelatinization temperature of rice starch granules. The gelatinization temperature is the temperature at which the starch granule begins to swell irreversibly in hot water with a simultaneous loss of crystallite (Irshad, 2001). Results of the alkali spreading value are given in Table (3). Alkali spreading value in brown rice of the two tested varieties showed lower values in comparing with white rice varieties. As for brown rice, it seems to require a longer time to cook. Moreover, the alkali spreading values decreased after subjecting the two mentioned rice varieties to parboiling process. These results may be due to the variation in terms of processing conditions for the rice varieties as clarified by (Takano, 1980) .Who reported that, The resistance of parboiled rice to disperse in the alkali test may be related to the hardness of the grain as a result of the retrogradation that take place in gelatinized starch. The white rice of the two tested varieties (Sakha 179 and Giza 182) had the highest values for alkali spreading values compared to the other rice samples. The obtained results are in agreement with those reported by (Derycke *et al.,* 2005; El-Bana *et al.,* 2007 and Zohoun *et al.,* 2018).

Gel consistency of rice are classified as hard (26 to 40 mm); medium (41 to 60 mm) and soft (61 to 100 mm) as reported by Cagampang *et al.* (1973). Data presented in Table (3) show that, gel consistency in brown rice decreased in comparing with white rice. Moreover, gel consistency content decreased after subjecting the brown and white rice to parboiling process. parboiled brown rice variety of Giza 179 had the lowest gel consistency content (82.30 mm) in comparing with the other rice samples. Generally, all varieties classified under soft rice which ranged between 61-100mm as described by Cagampang *et al.* (1973). Perez (1979) concluded that GC of milled rice or rice starch was a good measurement of gel viscosity which in turn was an index for the texture of cooked rice. Because of the relationship between gel viscosity and amylograph

consistency, the last can be used as a tool for rapid screening of eating quality in a rice breeding program. These results are in accordance with those found by (El-Bana *et al.,*2007; Abd El-Sattar *et al.,* 2016 and Wafaa K. Galal *et al.,* 2019). Elongation percentages defined as the ratio of length of cooked rice grain to the length of milled rice grain (El-Kady, 1992). The elongation percentages of cooked rice presented in Table (3) show higher values for white rice than brown rice and long grain variety (Giza 182) than that of short grain variety (Giza 179) for all treatments. This was expected because of the large amount of water that added to long grain samples. Moreover, the elongation percentage of white rice of the Giza 182 variety was the highest among all of the studied rice samples. Moreover, it was decreased upon subjecting rice to parboiling process. Hardness of rice seems to correlated negatively with its elongation percentage. The results are in accordance with those of (El-Bana *et al.,* 2007; Gewaily *et al.,* 2019and Wafaa K. Galal *et al.,* 2019). Amylose content has an important role in determination of cooking, eating and pasting properties of rice (Asghar *et al.*, 2012). Data presented in Table (3) also indicated that, milling was considered one of the major factors that helped to increase the amylose content of rice varieties. Hence, white rice grains of Giza 182variety contained the highest amount of amylose content 19.5%. Where parboiled brown rice of Giza 179 variety had the lowest value 16.5%. On the other hand, parboiling process caused a reduction in amylose content of all samples. The obtained results are in agreement with those reported by (Kale *et al.,* 2015 and Yenrina *et al.,* 2017).

Chemical composition of some rice varieties:

Data presented in Table (4) showed that , the moisture content of brown and white rice varieties ranged between 11.93 to 12.83%. Furthermore, moisture content of brown rice grain for the two tested rice varieties were lower than those of white rice. These values are in line with those of (Abd El-Sattar *et al.,* 2016). Apparent also from the same Table that, slight increases, were occurred as a function of parboiling treatment in both brown and white rice varieties. Crude protein, Ether extract and ash tended to decrease with the milling for the two tested rice varieties this could be explained by the removal of the embryo and bran layers therefore crude protein, ether extract and ash found in this parts will be decreased. From the same Table, it could be observed that, crude protein content in brown rice Giza179 variety had the highest level of crude protein 9.83%, while the lowest value was recorded in parboiling white rice of Giza182 variety (7.80%). Parboiling process caused a reduction in crude protein content of different rice varieties. This could be related to the leaching out that take part of the non protein nitrogen , albumin and rupturing of molecules during steaming as reported by (Chavan *et al.,*2018).On the other hand, (Chukwu and Oseh, 2009)suggested that, the slight reduction of protein content is caused by dissolution of soluble nitrogenous compounds during the soaking step of parboiling process. Results of the same Table also revealed that, there were high significant differ in ether extract between brown and white rice of the same variety, also between the different varieties. Brown rice of Giza 182 variety contains a relatively high level of ether extract content (2.97%), while parboiling white rice of Giza 179 variety had the lowest level of ether extract content (0. 0.66 %). Parboiling process caused a reduction in the ether extract content in both brown and white rice varieties. These results

could be attributed to the effect of parboiling process whereas, the oil of the kernel travels to its surface, hence the bran will contain a higher percentage of oil and endosperm in turn will lose its oil (Abd El-Rassol *et al.,* 2005 and Ibukun*,* 2008). In addition to ,increased temperature and pressure during steaming can be implicated in leaching and breaking of oil globules (Heinemann *et al.,* 2005 ; Paiva *et al.,* 2015 and Chavan *et al.,*2018*).* Ash content has an important role in the determination of mineral content of rice (Bhat and Sridhar, 2008). High significant differences in ash content was recorded between the varieties as well as between brown and white rice in the same variety. Moreover Brown rice of Giza 179 variety had the highest level of ash content (1.64 %). Furthermore, an increment was recorded as a function of parboiling process of milled rice. In contrast ash content of parboiled brown rice was decreased. The increase in ash content of parboiled milled rice may be due to the water soluble mineral salts which penetrated

throughout the grain during soaking and steaming process (Ibukun,2008; Chukwu and Oseh 2009 Chavan *et al.,*2018 and Isnaini, *et al.,* 2019).

The data presented in the same Table showed that, the white rice variety of Giza 182 had the highest carbohydrates content in comparing with the other tested samples. In addition, carbohydrates content of rice samples was increased as a result of milling. These results may be due to the removal of the embryo and bran layer, to yield milled rice poor in fat, crude protein, fiber and ash. So, the level of available carbohydrates will be higher in milled rice than in brown rice (Moongngarm and Saetung 2010). On the other hand, parboiling process has effect on carbohydrate content of Brown rice. Results obtained were in agreement with (Abd El-Rassol *et al.,* 2005). Furthermore, (Thomas *et al.,* 2013 and Chavan *et al.,*2018) they reported that, parboiled rice can be considered as the good source of energy as higher carbohydrate content.

Table (4): Chemical composition (%) of some rice varieties.

Rice varieties	Treatments	Moisture	Crude protein	Ether extract	Ash	Total carbohydrate
Giza 179	Brown	11.93[e]	9.83[a]	2.75[c]	1.64[a]	85.78[f]
	Parboiled Brown	12.62[ab]	9.64[a]	2.63[d]	1.44[c]	86.29[e]
Giza 179	White	12.24[cd]	8.69[b]	0.75[g]	0.67[g]	89.89[b]
	Parboiled White	12.83[a]	8.52[b]	0.66[h]	0.84[e]	89.98[b]
Giza 182	Brown	12.01[de]	8.72[b]	2.97[a]	1.57[b]	86.74[d]
	Parboiled Brown	12.42[bc]	8.47[b]	2.85[b]	1.38[d]	87.30[c]
Giza 182	White	12.08[de]	8.02[c]	0.95[e]	o.58[h]	90.45[a]
	Parboiled White	12.22[cd]	7.80[c]	0.84[f]	0.78[f]	90.58[a]

Each value was an average of three determinations.

+Values followed by the same letter in column are not significantly different at P < 0.05.

Minerals content :

Minerals or elements play an important role in human nutrition, some are essential for much component as hem for blood.(National Academy of Sciences, 2001).The ash content of rice varieties was important to some extent, it contained the nutritionally the important minerals. Some of which are shown in Table (5). Potassium content was the highest element among all of the determined mineral contents. In addition, brown rice contained the high mineral contents of the tested rice samples. The results are in agreement with that reported by (Abd El- Rassol *et al.,* 2005 and Abd El-Sattar *et al.,* 2016), They reported that, brown rice had higher ash content than white rice due to high mineral content in its bran layer.

Whereas, parboiling process caused an increasing in most of minerals content of parboiled white rice. On contrast, parboiled brown rice samples seems to show a little decrease in their minerals content. These results are in accordance with those of (Abd El- Rassol *et al.,* 2005 ;

Ibukun, 2008 and Zohoun *et al.,* 2018).They reported that, mineral migrate from outer layers into endosperm during parboiling treatments.

Organoleptic Evaluation of Rice Samples :

Organoleptic evaluation of different varieties of brown and white rice samples are presented in Table (6). The data indicate that cooked white rice surpassed in colour when compared with cooked brown, parboiling cooked rice regardless to rice variety. Cooked white rice of Giza 182 and Giza 179 had the highest values of colour among all of the tested varieties. Generally, it should be noted that parboiling of paddy rice caused a decrement in the colour value of cooked brown and white rice. These results could be attributed to the effect of parboiling process on husk pigments, amylase activity during soaking of paddy rice and the accumulation of some fractions that result from starch degradation.

Table (5): Mineral contents of some rice varieties.

Rice variety	Treatment	P %	(mg/100g)					
			K	Na	Ca	Fe	Zn	Cu
Giza 179	Brown	0.26	183.22	23.22	27.9	1.87	1.50	0.75
	Parboiled Brown	0.23	183.10	23.01	27.5	1.75	1.51	0.71
Giza 179	White	0.15	90.21	9.51	13.7	1.20	1.11	0.56
	Parboiled White	0.21	94.58	10.00	16.8	1.41	1.10	0.58
Giza 182	Brown	0.21	174.80	24.40	26.31	1.50	1.12	0.58
	Parboiled Brown	0.19	174.61	24.15	26.0	1.45	1.11	0.84
Giza 182	White	0.12	85.54	8.50	12.60	1.22	0.80	0.39
	Parboiled White	0.17	89.65	8.99	15.70	1.35	0.77	0.45

Table (6): Effect of parboiling processing on the organoleptic properties of cooked brown and white rice varieties.

Rice varieties	Treatment	Colour	Flavour	Texture	Overall acceptability
Giza 179	Brown	7.8[cd]	7.6[bc]	8.5[ab]	7.97[bc]
	Parboiled Brown	7.5[d]	7.2[c]	8.2[ab]	7.63[c]
Giza 179	White	8.7[ab]	8.3[ab]	8.1[b]	8.36[ab]
	Parboiled White	8.1[bcd]	7.8[bc]	8.5[ab]	8.13[bc]
Giza 182	Brown	8.1[bcd]	7.9[bc]	8.2[ab]	8.06[bc]
	Parboiled Brown	7.8[cd]	7.6[bc]	8.4[ab]	7.93[bc]
Giza 182	White	9.2[a]	8.9[a]	8.4[ab]	8.83[a]
	Parboiled White	8.5[bc]	8.2[b]	8.8[a]	8.50[ab]

*Each value was an average of ten determinations .
+Values followed by the same letter in column are not significantly different at $P < 0.05$.

The Flavour is a combination of the taste and smell and it is the main criterion that makes the product to be liked or disliked, while tasting is influenced by the flavor and it is one of the most essential factors of product acceptability (Durgrao, *et al.,* 2017). In addition, the same Table showed that, parboiled brown and white rice decline slightly in their flavour when compared with cooked brown and white rice. Furthermore, cooked white rice variety of Giza 182 had the highest values of flavour in comparing with all of the other rice samples.

As for texture of different cooked rice samples, it should be noted that, texture of parboiled brown and white rice were little bit better than those of cooked brown and white rice. white rice (Giza 179 variety) had the lowest texture value in comparing with all rice samples. parboiling leads to development of some unique aromatic and textural characteristics that are appealing to certain groups of consumers (Demont *et al.,* 2012). The mean scores of overall acceptability for cooked rice samples revealed that the acceptability of parboiled brown rice variety of Giza 179 had the lowest score among all of the cooked rice samples. These results were found to be true since, the raw cooked white rice had better properties (colour, flavour, texture and overall acceptability) in comparing with the other rice samples (brown, and parboiling rice).

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تأثير عملية الغلي على جودة الضرب والتبييض والخواص الطبيعية والكيماوية لصنفين من الأرز

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الملخص العربي

أجريت هذه الدراسة لمعرفة تأثير عملية الغلي على الصفات الطبيعية والكيميائية والغذائية وجودة عمليتى الضرب والتبييض والصفات العضوية الحسية للأرز البني والأبيض.

وأظهرت النتائج ما يلي:

وجد أن هناك اختلاف في الخواص الطبيعية للأرز البني والأبيض وذلك تبعا للصنف. كان صنف الأرز جيزة 182 أطول مقارنة بصنف الأرز جيزة 179. بالإضافة إلى ذلك ، لم يكن لعملية الغلي تأثير على طول وعرض الأرز البني أو الأبيض. الصنف جيزة 179 الخام أعطى أعلى نسبة من الحبوب المكسورة وأقل نسبة من الحبوب السليمة والأرز البني عند مقارنته بالصنف جيزة 182 . كما وجد أن عملية الغلي تقلل من نسبة الحبوب المكسورة كثيراً ، حيث وجد أنها تقل من (32.40 إلى 4.28%) ومن (16.50 إلى 5.50%) لأصناف الأرز جيزة 179 وجيزة 182 على التوالي ، كما وجد أن عملية الغلي تزيد من نسبة الحبوب السليمة والأرز الأبيض.قيم الماء الممتص والمواد الصلبة الغير ذائبة للأرز الأبيض أعلى بكثير من الأرز البني. صنف الأرز الأبيض في الجيزة 179 كان أقل وقت للطهي بين جميع عينات الأرز المختبرة (17 دقيقة). كما وجد أن عملية الغلي تقلل من نسبة الماء الممتص والمواد الصلبة الغير ذائبة ولكن وقت الطهي زاد لجميع عينات الأرز. اختلفت قيم تماسك الجيلى لحبوب الأرز البني والأبيض . أظهرت قيم الانتشار القلوي في عينات الأرز البني قيمًا أقل مقارنة بعينات الأرز الأبيض. صنف الأرز الأبيض جيزة 182 يحتوي على أعلى قيمة انتشار قلوي (GT) و استطالة الحبوب ومحتوى الأميلوز بين الأصناف الأخرى. علاوة على ذلك ، تم تقليل هذه النسب بعملية الغلي. الأرز البني لكل الأصناف احتوى على نسب اعلي من البروتين الخام والمستخلص الايثيرى والرماد و نسبة اقل من الكربوهيدرات الكلية مقارنة بالأرز الأبيض. أدت عملية الغلي إلى تقليل نسبة نسبة البروتين الخام و مستخلص الأثير في كل من الأرز البني والأبيض. ، بينما أدت هذه المعاملة على زيادة محتوى الرماد والمعادن في الأرز الأبيض . اختلفت الخواص العضوية الحسية للأرز المطبوخ تبعاً للصنف والمعاملة وكانت متوسطات قيم خواص تقبل الأرز المطبوخ فى الصنف جيزة 182 الأبيض أعلى من باقي العينات ، بينما أدت معاملة الغلي إلى تقليل متوسطات قيم خواص تقبل الأرز .