Study of some cooking and eating quality characters on some Egyptian rice genotypes

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SUMMARY

Some Egyptian rice genotypes [i.e. Japonica (Sakha 104), Japonica/Indica (Egyptian hybrid) and Indica (Giza 182)] were investigated to evaluate the cooking and eating quality characters. High significant differences in grain shape were observed among rice genotypes. Hulling, milling and head rice percentage were higher in Sakha 104 than other rice genotypes, while Indica type (Giza 182) recorded the lowest values in milling and physical characters. No significant differences were found in chemical composition of the three genotypes of rice was recorded, but Giza 182 had the highest protein content. All Egyptian rice genotypes were low in gelatinization temperature and soft in gel consistency. Japonica and Indica rice varieties were low in amylose content, while Japonica/Indica rice variety was intermediate. The use of RVA is considered a good index for palatability evaluation for milled rice flour and starch. The Indica and Japonica/Indica types are low in breakdown viscosity, but higher in cooked pasta than Japonica type. Japonica type recorded the best score in panel test, followed by Indica type, while Indica/Japonica rice variety was the least accepted by Egyptian consumer.

Keywords: rice, genotype, protein content, breakdown viscosity

INTRODUCTION

Cereal grains and legumes are the main source of dietary energy as well as a source of proteins and vitamins. For example, rice is widely consumed as a staple food in world (Byun et al., 2010). Rice is typically consumed as cooked rice, although a small amount is used as an ingredient in processed foods. Grain shape, a typical complex quantitative trait, is closely associated with grain weight and usually measured by grain length, width, thickness and length-to-width ratio (Yoon et al., 2006). Length-to-width is considered an important measure of rice appearance quality since people’s preferences are rather different in the rice-producing areas of the world (Wang et al., 2008). 1000-grain weight is an important agronomic trait of rice. Grain weight not only has close correlations with grain number per panicle and yield but also affects apparent and processing qualities of grains, such as percentage of chalky grain, brown rice, milled rice, and head rice (Li et al. 2008). Brown rice is a rice kernel dehulled from rough rice and consists of embryo (2–3%), endosperm (92%), and bran (5–6%). Milling yield, is milled rice after milling processing “Head rice recovery”; is defined as the percentage of whole milled rice kernel obtained from rough rice (paddy rice) after milling. Milling yield is an economically important trait of commercial rice because the price of rice for whole grains is typically twice that of broken grains (Childs, 2006). Each milling component may be affected by multiple traits (sub-components) such as kernel dimension, kernel hardness, and bran thickness, as well as other factors. Many of the sub-component traits of milling yield are under the control of numerous genes, and therefore milling yield and its sub-components are quantitatively inherited. Breeding for improved milling yield is, therefore, difficult because the trait exhibits complex inheritance. Amylose content was considered one of the most important characteristics for cooking behavior. For instance, cooked rice with low amylose content was generally soft and sticky, while rice with high amylose content was relatively firm and fluffy (Rani and Bhattacharya, 1989). The texture of cooked rice is related to its amylose content and the fine structure of amylopectin. The intra and/or inter-molecular interactions of starch with other components in rice such as proteins, lipids and non-starch polysaccharides affect rice’s texture (Prasert and Suwananaporn, 2009). Gelatinization, retrogradation and pasting properties of rice starch and flour, as well as the texture of cooked rice, are related to the fine structure
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content and total carbohydrate content according to the
(n X 5.95), lipids content, ash content, crude fibbers
method described by A.o.A.C. (1990). Cooking and
Adair (1952). Flour was analyzed for the following
eating quality characters i.e. gelatinization temperature,
were estimated according to the methods reported by
Derycke et al., 2005). The particle size distribution of rice flour is known to
effects on eating and cooking quality. Recently, the
Brabender Visco Amylograph and the Rapid Visco
analyzers (RVA) were used to study the effect of protein
on the pasting properties of rice flour. Viscosity decreased
along all the points of the curve, when rice flour was
remaining with a protease. The addition of DTT to rice
cooking water increased stickiness and decreased the
hardness of almost all cooked rice (Dereke et al., 2005).
The particle size distribution of rice flour is known to
play an important role in its functional properties and the
quality of end products. Some unique functional
properties of rice make it a suitable grain to be used in
value-added products. Rice flour has soft taste, colorless,
non-allergic properties, low levels of sodium and easy
digestible carbohydrates. Because of these properties,
rice flour is the most suitable cereal to make gluten free
products (Lopez et al., 2004). The object of this study are
to evaluate the physical, chemical, cooking and eating
quality of some Egyptian rice genotypes characters.

MATERIAL AND METHODS

Fresh harvested grains of 14% moisture content of
three rice genotypes i.e Sakha 104 (Japonica type),
Egyptian hybrid 1 (Indica /Japonica) and Giza 182
(Indica type) produced from planting at 5th May during
summer seasons 2012 were used to investigate the
grain quality and chemical compositions of milled rice
Characters. About 150 grams (three replication) of rough
rice for all samples were taken, mixed and cleaned.
Grain shape and physical characters were determined as
described by Khush et al. (1979). Milling recovery
characters i.e. Hulling, milling and head rice percentage
were estimated according to the methods reported by
Adair (1952). Flour was analyzed for the following
chemical composition moisture content, protein content
(N x 5.95), lipids content, ash content, crude fibers
content and total carbohydrate content according to
the method described by A.O.A.C. (1990). Cooking and
eating quality characters i.e. gelatinization temperature,
amylose content and gel consistency test were estimated
for milled rice samples following the methods of Little
et al. (1958). Juliano (1971) and Cagampang et al.
(1973) respectively. Rapid Viso Analyzer (RVA) was used
to investigate the amylase gelatinization
viscosity characteristic for the three Egyptian milled
rice flour genotypes following the method reported by
El-Kady (1999). Milled rice samples (1 kg) were cooked
and were served to a panel of 10 Judges for evaluation.
The judges were instructed to sip water before and after
tasting each sample. The samples were evaluated before
cooking for three rice varieties. Water ratios, grain length,
shape and translucency, after cooking they evaluated
for cooking time, kernel expansion, whiteness, odor,
stickiness and taste according to Peryam and Shapiro
(1955). The samples were evaluated using ten points
scale for each character with maximum scores of 80
and a limit of acceptability of 60 scores. Treatments
means were compared by Duncan’s multiple range test
(Duncan, 1955).

RESULTS AND DISCUSSION

Data in Table 1 show the characters of three rice
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Figure 1: The effect of cooking water pH on the
pasting properties of rice flour. Viscosity decreased
along all the points of the curve, when rice flour was
remaining with a protease. The addition of DTT to rice
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RESULTS AND DISCUSSION

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Grain length was highly significant affected for the three rice varieties. Giza182 had the tallest grain length
(6.62) but there was no significant difference between
Egyptian hybrid1 and Sakha 104. This may be due to its
parents. While the shortest was Sakha 104 (5.50 mm).
The lowest in Grain Width was Giza182 (1.86 mm), but
there was no significant difference between Egyptian
hybrid1 rice and Sakha 104 in grain width. Grain shape
expressed as the ratio between grain length and width.

Data in Table 1 show that there was high significant
difference in grain shape due to rice genotypes; Giza182
recorded the maximum grain shape (3.54). While the
minimum value was found for Sakha 104 and Egyptian
hybrid rice (2.14 and 2.33, respectively).

Milling characters are shown in Table 2. Milling
percentage is the measure of rough rice performance
during milling process. It is the total quantity of head
and broken grains recovered from unit of rough rice.
Hulling involves removing the husk from the paddy with
a minimum damage to the grain and separating the husk
from the paddy to produce brown rice. Generally, hull
percentage in difference varieties varies from 16–24%.

Rice variety Sakha 104 have the highest brown rice
percentage (81.48%), while Giza 182 recorded the
lowest value (78.04%). Whereas no significant difference
between the varieties Sakha 104 and Egyptian hybrid1
in this respect. The process of removing the embryo
and the outer bran layer from the brown rice is termed
as whitening or milling. Results in Table 2 show that
there was a significant difference among the tested
genotypes in milling trait. Sakha 104 showed the highest
milled rice percentage (69.10%) comparing with the
Giza 182 which produced the lowest value (62.70%).
The data also in Table 2 indicated that no significant
differences between Sakha 104 and Egyptian hybrid1
in milled rice percentage. Also, it indicated that there
was significant difference between Sakha 104 and
Egyptian hybrid1 in head rice percentage. Sakha 104
surpassed significantly both two varieties under study
(62.2%), while Giza 182 had the lowest (51.7%).
Hulling, milling and head rice percentage were higher in
Sakha 104 than the other verities under study. Head
rice out-turns proportion of whole grain in milled rice.
It depends on varietal characters and drying condition.
Data presented in Table 3 show that there were significant differences among rice genotypes for whitening. The highest value (54.80%) was found by Egyptian hybrid1. While, the lowest one was Sakha 104 (43.50%). Also, data tabulated in the Table 3 reveal that cracks were highly significantly affected by rice genotypes. The highest cracks were recorded by Giza 182 (Indica) rice. Long grain (13.00), however the lowest was observed by Sakha 104 (short grain) and Egyptian hybrid1 (Medium grain). These two characters are mainly depending on the drying method of grains during ripening and methods of processing during milling.

Results pointed out that there were differences among the tested varieties in 1000-grain weight Sakha 104 and Egyptian hybrid1 were the heaviest 1000-grain weight (24.70 and 24.60 gm respectively). While the lightest one was recorded by Giza 182 which gave 22.80 gm. The studied rice genotypes could be ranked from heavier to lighter in 1000-grain weight as follows, Sakha 104 and Egyptian hybrid1 and Giza 182. It might be due to the big canopy or high leaf area which causes shading and decrease the light penetration consequently increased yields but grain filling was lower with increasing rates of fertilizer and fertile soils would have increased yields but grain filling was lower with increasing rates.

Data presented in Table 4 show that the moisture content of milled rice grains for the three tested rice varieties ranged between 14.10% and 14.30%. There were significant differences among cultivars in respect to chemical composition due to the genetic constitution of these genotypes.

### Table 1.

**Grain shape characters of some Egyptian rice genotypes**

| Rice varieties | Rice genotypes | Grain length (mm) | Grain width (mm) | Grain shape |
|----------------|---------------|-------------------|------------------|-------------|
| Sakha 104      | Japonica (Shr.) | 5.50b             | 2.58a            | 2.14b       |
| E. Hybrid 1    | Indica/Japo. (M)| 5.73b             | 2.46a            | 2.33b       |
| Giza 182       | Indica (L)     | 6.62a             | 1.86b            | 3.54a       |

F-test

* * *

Note: means designated by the same letter are not significantly different at the 5% level by DMR test. Shr: short, M: medium, L: long.

### Table 2.

**Milling of some Egyptian rice genotypes**

| Rice varieties | Rice genotypes | Hulling % | Milling % | Head Rice % |
|----------------|---------------|-----------|-----------|-------------|
| Sakha 104      | Japonica (Shr.) | 81.48a    | 69.10a    | 62.20a      |
| E. Hybrid 1    | Indica/Japo. (M)| 79.05ab  | 67.40ab   | 60.60a      |
| Giza 182       | Indica (L)     | 78.04b    | 62.70b    | 51.70b      |

F-test

* * *

Note: means designated by the same letter are not significantly different at the 5% level by DMR test. Shr: short, M: medium, L: long.
Some cooking and eating quality characters are affected greatly by different factors; others seem unaffected, depending on the degree of differences among genotypes. Data recorded in Table 5 show that Sakha 104 (Japonica type) had low amylose content (18.20%), low gelatinization temperature (6 ºC) and soft gel consistency (97.00%). Mostly Indica and Japonica/Indica rice genotypes had high amylose content and hard gel consistency, but the Egyptian rice varieties Giza 182 (Indica type) and E. hybrid (Japonica/Indica type) had soft gel consistency (83.00), (91.00) and low (19.70) and intermediate (21.00) amylose content respectively. All rice genotypes were low in gelatinization temperature. These results are due to that the Egyptian breeding program breed and select for these characters which accepted by the Egyptian consumers.

Data in Table 6 show cooking and processing characteristics for three different rice genotypes. The time required to peak viscosity in Japonica type is relatively less than the other two rice genotypes. Amylograms of Sakha 104 (Japonica type) show higher breakdown and much lower setback than the other two rice genotypes due to their lower amylose content. The Egyptian hybrid1 recorded the lowest peak viscosity, breakdown and setback due to their intermediate amylose content. Also, this may be attributed to their parents which they are Japonica/Indica hybrid although they are low in gelatinization temperature. The Indica and Japonica/Indica types are low in breakdown viscosity; but higher in cooked paste viscosity than Japonica type. This in terms of solids loss during processing is relatively bold. The use of RVA peak viscosity, break down, consistency, setback and time required to peak viscosity is considered as good index for palatability evaluation for milled rice flours and starch.

| Rice varieties | Rice Genotypes | Amylose (%) | Gel consistency (mm) | Gelatinization temperature (Cº) |
|----------------|----------------|-------------|----------------------|---------------------------------|
| Sakha 104      | Japonica (Shr.)| 18.20c      | 97.00a               | 6.00b                           |
| E. Hybrid 1    | Indica/Japo (M)| 21.00a      | 91.00b               | 6.00b                           |
| Giza 182       | Indica (L)      | 19.70b      | 83.00c               | 7.00c                           |

*Note: means designated by the same letter are not significantly different at the 5% level by DMR test. Shr: short, M: medium, L: long.*

| Rice varieties | Rice Genotypes | Time to peak (min) | Peak viscosity | Break down | Set back (50c) | Consistency (50c) | Set back (30c) | Consistency (30) |
|----------------|----------------|--------------------|---------------|-----------|----------------|-------------------|----------------|------------------|
| Sakha 104      | Japonica (Shr.)| 6.38               | 288           | 72        | +30            | 60                | +13            | 110              |
| E. Hybrid 1    | Indica/Japo (M)| 6.43               | 215           | 45        | +75            | 120               | +103           | 150              |
| Giza 182       | Indica (L)      | 6.40               | 225           | 67        | +87            | 155               | +130           | 190              |

*Note: Shr: short, M: medium, L: long.*

Panel test were determined commonly by breakage. Expansion, whiteness and some other attributes of cooked milled rice are shown in Table 7. Also, eating quality of milled rice determined mainly by its amylose/amylopectin ratio of the starch. Data in Table 7 show the cooking properties of three rice genotypes at different water ratios. The Egyptian consumer prefers short and medium translucent milled rice than long grains of milled rice as clear in the table before cooking. Cooking time largely depends on the properties of the starch and water ratio. The Japonica type Sakha 104 takes less time than the other two genotypes. Rice water ratio (1:2) needs less time for cooking than the other rice water ratios for the three different rice genotypes. Data presented in Table 7 show no big differences in odor and whiteness trait for all tested rice genotypes. The whiteness of milled rice after cooking was not affected at any water ratio, but it mainly depends on milling methods and ratios. Also, whiteness and odor depends on genetic factors of different rice genotypes. Water absorption and volume expansion during cooking are directly affected by amylose content while, Bhattacharya (2009) reported that water absorption and volume expansion are mainly the function of the surface area of milled rice. Giza 182
recorded the best volume expansion among the three rice genotypes, even under the three rice/water ratio. Whiteness of milled rice after cooking was not affected at any water ratio. The whiteness of milled rice depends mainly on milling methods and milling ratios, as well as, genetic factors. Therefore, the breeders select the new lines for whiteness in the early generations.

| Rice variety | Rice genotypes | Rice/water ratio | Whiteness | Stickiness | Taste | Total score | % |
|--------------|----------------|------------------|-----------|------------|-------|-------------|---|
| Sakha 104    | Japonica (Shr.) | 1:1              | 7         | 8          | 6     | 66          | 82.5 |
|              |                 | 1:1.5            | 7         | 7          | 8     | 63          | 78.8 |
|              |                 | 1:2              | 7         | 6          | 8     | 62          | 77.5 |
| E. Hybrid 1  | Indica/Japo (M) | 1:1              | 7         | 8          | 5     | 58          | 72.5 |
|              |                 | 1:1.5            | 7         | 7          | 8     | 61          | 76.3 |
|              |                 | 1:2              | 7         | 7          | 7     | 59          | 73.8 |
| Giza 182     | Indica (L)      | 1:1              | 6         | 9          | 8     | 61          | 76.3 |
|              |                 | 1:1.5            | 7         | 8          | 6     | 60          | 75.0 |
|              |                 | 1:2              | 7         | 7          | 9     | 63          | 78.8 |

Note: Shr: short, M: medium, L: long.

Stickiness is one of the most important properties of rice eating quality for consumers. Water ratio and hardness of milled grains affect stickiness, but the amylose content is the most important factor in this respect. At (1:1) rice/water ratio for the three genotypes, stickiness was better than the other ratios as shown in Table 7. The Egyptian consumers prefer short grain rice varieties, although there are long grain varieties which have a good taste such as Giza 182 at (1:2) rice/water ratio. Also the results recorded in Table 7 for Sakha 104 short grain variety with (1:1) rice/ water ratio. Japonica type rice variety Sakha 104 recorded the best total score followed by Indica type Giza 182 while. Indica/Japonica type rice variety was the least one accepted by the referees as shown in Table 7. These results may be attributed to the differences in size of starch granules in the different three rice genotype.

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