Chemical and Sensory Properties of Black Rice Compared with Giza 177 Rice Cultivar

Ayman M. Abouel-Yazeed1, Mohamed A.A.Nassar2, Ragab A.Ebaid 3and Mona A.M. Hassan4

ABSTRACT

The present work was carried out to evaluate the chemical and technological characteristic of Egyptian Giza 177 rice and black rice (BR) as well as to investigate the possibility of using black rice flour as substitution materials of wheat flour in preparing enriched biscuits. The obtained results revealed that black rice (BR) variety had a higher level of crude protein, ether extract, ash, fiber content than Giza 177 rice variety. Gel consistency was significantly higher in Giza 177 than (BR). BR contained higher amylose content than Giza 177. From the obtained results, BR could be considered as a good source of fatty acids, anthocyanin, total phenol and minerals compared with Giza 177. Regards to sensory evaluation of cooked rice, black rice was lower acceptance than Giza 177. Results of the organoleptic evaluation indicated that biscuit samples prepared using black rice flour (2.5 and 5%) to wheat flour were acceptable. Also, biscuit samples prepared using mushroom flour with black rice flour as substitutions instead of wheat flour (2.5%) were acceptable. The present study could be a guide in using black rice and mushroom flours to increase protein and other nutrients contents in some food products, as well as preparation of some functional foods. Also, gluten-free bakery products are advantageous to persons who suffer from celiac disease.

Keywords: Black rice, chemically, technologically, biscuits, mushroom flour, black rice flour, gluten-free.

INTRODUCTION

Rice (Oryza sativa) is the second main crop besides major nourishment of half of the total populace in terms of global production 740.96 million tons of rough rice in 2014 (FAO/UN, 2016). 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 used in many foods such as bread, cakes and noodles. Rice starch is also used in many food applications. Rice flour is mainly used for making desserts, noodles, and sweets and as a thickener for custards, gluten free bread, salad dressing, tortillas besides sauces (Chandra and Samsher, 2013).

A few rice varieties have unique characteristics in terms of their chemical composition, color and aroma. BR is rich in carbohydrates and micronutrients. It is also a good source of antioxidants, including phenolic compounds, which protect against diseases (Saenkod et al., 2013) such as cardiovascular diseases and cancer (Sompong et al., 2011).

BR is applied as a component in confectionery besides crackers. It is considered to be a functional food since it has a phenolic combination, particularly anthocyanins. Due to black rice value as a health foodstuff besides organic foodstuff color, its demand is increasing fast in United State and European Union. BR extract enhanced the plasma profile. BR has a quantity of nourishing benefits over common rice as higher protein besides minerals. It has low fat content, protein with excellent biological value, also, it is a decent source of vitamins besides insoluble fiber (Oko et al., 2012, American Culinary Federation Education Foundation 2016).

The gluten-free food remainder till nowadays the lone management for celiac disease. The gluten-free diet has assistances such as the recovery of the villi of the small intestine besides hazard decrease of malignant complications (Hussein et al., 2012). According to the definition free gluten foods it contain no more than 20 ppm of gluten.

Mushrooms is evaluated as decent possible basis of therapeutic bioactive compounds as essential amino acids, lipopolysaccharides, polysaccharides, besides many essential nutrients. Agaricus bisporus is the greatest vital trading cultured mushroom in the world, it belongs to Basidiomycetes family. Nutrients like proteins, minerals, vitamins, fibers, lipids and carbohydrates are present in this mushroom as known healthy foodstuff (Atila et al., 2017).

Food fortification is very important process, defined as the addition of one or more nutrients rich ingredients together aimed to improve nutritional composition of foodstuff. Usual goal of food fortification is to control nutrient deficiency problems. In this line, present study is designed and aimed to evaluate the chemical and sensory properties of black rice compared with Giza 177 rice cultivar and use black rice flour, mushroom flour with wheat flour to increase protein and other nutrient content in biscuits.

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MATERIALS AND METHODS

Materials:
Two varieties of rice (Oryza sativa L.) namely Giza 177 and Black rice were employed in this study. These samples were obtained from Rice Research and Training Center (RRTC) at Sakha, Kafr El-Sheikh Governorate, Egypt during season 2016. The pedigree of these varieties are presented in Table (1).

Mushroom was obtained from the Cultivation and production of mushroom Unit; Agricultural Botany Department, Saba Basha Faculty, Alexandria university.

All ingredients used for biscuit preparation such as wheat flour, glucose syrup, shortening, salt, sodium bicarbonate, sucrose, dry milk and vanilla were obtained from the local market of Alexandria.

Chemicals and Reagents:-
Chemicals, reagents and Solvents were obtained from Sigma–Aldrich (Steinheim, Germany) and El-Gomhouria Company, Alexandria, Egypt. All chemicals and reagents used were of analytical grade.

Table 1. Pedigree, origin and type of two used rice varieties

<table>
<thead>
<tr>
<th>Rice cultivar</th>
<th>Origin</th>
<th>Type</th>
<th>Pedigree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 177</td>
<td>Egypt</td>
<td>Japonica</td>
<td>Cross bet. Giza 171/ - Yomji No.1</td>
</tr>
<tr>
<td>Black rice</td>
<td>China</td>
<td>Japonica</td>
<td>Jingu 96</td>
</tr>
</tbody>
</table>

Methods:

Preparation of white rice samples:-

Raw rice samples were dehulled and then milled to obtain the white rice. The white rice was kept in polyethylene bags and stored in freezer at -18 °C until further analysis. All grains quality test (grain technology and cooking characters) were conducted at Rice Technology Training Center, Laboratories, Hager El-Nawatia, Alexandria Governorate, while the chemical composition of rice grains was determined at Rice Research and Training Center, Agronomy Laboratories, Sakha, Kafr El- Sheikh, Egypt.

Preparation of cooked rice:-

Rice were thoroughly washed in tap water at ambient temperature in order to remove any dust particles, present, drained and then cooked in rice cooker as reported by Rewthong et al., (2011).

Preparation of rice and mushroom flours:-

Rice flour and mushroom flour were prepared as described by Okpala and Egwu (2015) and (Alemu et al., 2017), respectively.

Determination of milling properties :-

Hulling and milling percentages were estimated according to the methods reported by (Roberts, 1979).

Determination of cooking and eating quality:-

Amylose content, gel consistency and gelatinization temperature were determined according to Williams et al. (1958), Cagampang et al. (1973) and Little et al. (1958); respectively.

Chemical composition of raw materials:-

Moisture, ash, crude protein, ether extract and crude fiber contents of rice, wheat and mushroom were determined according to the methods of A.O.A.C. (2005). Total carbohydrates content was calculated by difference. Magnesium, potassium, iron, calcium and zinc were determined according to A.O.A.C. (2005) using Atomic Absorption Spectrophotometer, Perkin Elmer (Model 3300, USA).

Determination of antioxidants:-

Total anthocyanin pigment content of the rice grain was determined, according to Giusti and Wrolstad (2005) and Hosseinian et al. (2008). Total phenols were estimated with the Folin-Ciocalteu method as reported by Elfalleh et al. (2009).

Determination of fatty acids profile:-

Mixed (1g) ground rice grains with chloroform: methanol (2:1, v/v) to obtain the lipid extracts (Folch et al., 1957). The fatty acids composition of the lipid extracts was determined according to the method described by (Chung, 1991) by using GC-MS analysis. Concisely, the lipid extracts were saponified with 0.1 N potassium hydroxide in methanol at 70–75 °C and followed by methanolysis with 1.2 M hydrochloric acid in methanol at the same temperature. The methyl esters of fatty acids were extracted with n-hexane prior to GC-MS analysis. The gas chromatograph (6890 plus, Hewlett Packard, Co., USA) was equipped with a DB-225 capillary column (30 m × 0.25 mm × 0.25 µm) and coupled with a mass spectrometer (JMS700, Jeol, Japan). The column temperature was held at 140 °C for 1 min, then increased up to 200 °C at a rate of 1 °C /min, and finally increased to 230 °C at a rate of 10 °C /min and held for 10 min. Helium was used as the carrier gas and the flow rate was 1 mL/min. The amount of each fatty acid was calculated based on the peak area compared with that of the standards.

Functional properties of rice varieties:-

Water uptake at 75 ± 2 °C and 80 ± 2 °C and cooking time of rice varieties were determined following to procedures of Simpson et al. (1965).

Preparation of biscuits:-

Biscuits prepared from wheat flour (72% extraction) was used as control sample. Substitution levels of 2.5, 5,
7.5 % black rice flour, mushroom flour were used to prepare the biscuit samples. The ingredients were mixed well, laminated sheeted, shaped and baked in oven at 215 °C for 12 min (Nnam and Nwokocha, 2003). The samples were removed and cooled on a rack for 5 min then served for the sensory evaluation.

**Sensory evaluation of cooked rice:**

Sensory evaluation of Cooked rice varieties were performed according to the characteristics of color, taste, odor, texture, over all acceptability were determined as described by (Ghufran et al., 2009).

**Sensory evaluation of biscuits:**

The prepared biscuit sensory evaluation of different organoleptic properties viz., color, appearance, texture, flavor and overall acceptability were carried by panel of 10 judges of different groups and food habits on basis of 9 point hedonic scale (More et al., 2013).

**Statistical analysis:**

All the analyses were carried out at least in triplicates and expressed as mean and standard deviation (SD). Data were statistically analyzed by analysis of variance (ANOVA) and significant differences were identified by Duncan’s Multiple Range test (P<0.05) (Steel and Torrie, 1980).

**RESULTS AND DISCUSSION**

**Chemical analysis of the two rice varieties:**

Black rice (BR) has a quantity of nourishing benefits over common rice, as it contain a higher contents of protein, vitamins besides phenolic (Lee et al., 2008). Data displayed in Table (2) showed, the moisture of rice varieties ranged between 10.9 to 11.3%. Amorim et al., (2004) reported that, moisture content plays a great role during the storage for rice. Black rice variety had higher content of crude protein (7.96%) as compared with Giza 177 rice.

There were significant differences (P≤0.05) in both ether extract and ash contents between the two varieties, the BR variety had higher of ether extract and ash content, where it was 1.32% and 1.17 %, respectively. Similar results had been reported by Amorim et al., (2004). Rice is a rich source of carbohydrate; starch is the main component. The data presented in the same table showed that, Giza 177 had higher carbohydrate content than black rice. Additionally, carbohydrates content of rice samples was increased as a result of milling. Process which remove some components such as embryo, aleurone and bran layers to obtain milled rice which poor in its content from fat, protein, fiber and ash. (Singh et al., 2000 and Suwansri and Meullenet, 2004). The bran layer of black rice is rich in anthocyanins, a plant compound that gives black rice its dark complexion. Anthocyanins act as antioxidants which play an important role to improve the memory function enhance vision and act as an anti-inflammatory (American Culinary Federation Education Foundation 2016). Additionally, anthocyanin dyes have been described to be very successful in decreasing cholesterol level in the human.

The phenolic complexes have been establish as a main effective constituent for antioxidation. The highest ingredient of phenolic combination in pigmented rice has been stated as anthocyanins (Iqbal et al., 2005, Zhang et al., 2006, Yawadio et al., 2007). These phytochemical compounds usually are accumulated in pericarp or bran of rice kernels (Sutharut and Sudarat, 2012).Polyphenols are the most effective antioxidative constituents in plant products consumed (Escrubano-Bailón et al., 2004). BR is more abundant in anthocyanin and other phenolic compounds compared to white rice (Rye et al., 1998, Zhang et al., 2006). From our results, it could be noticed that anthocyanins content in Giza 177 rice variety not detected. On the contrary, anthocyanin content in black rice was 305 mg / 100g. Also, Black rice had the highest values of total phenol compared with Giza 177 rice variety. Our results were in harmony with (Thomas et al., 2013, Metwally et al., 2014, Badawy and Mahgoub, 2015, Kushawa, 2016).

**Table 2. Proximate chemical composition of the two rice varieties on dry weight basis**

<table>
<thead>
<tr>
<th>Rice variety</th>
<th>Moisture (%)</th>
<th>Crude protein (%)</th>
<th>Ether extract (%)</th>
<th>Ash (%)</th>
<th>Crude fiber (%)</th>
<th>Total carbohydrate (%)</th>
<th>Anthocyanin (mg /100 g)</th>
<th>Total phenol (mg / GAE /g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 177</td>
<td>11.3±0.85</td>
<td>6.33±0.79</td>
<td>0.77±0.61</td>
<td>0.53±0.02</td>
<td>0.83±0.02</td>
<td>89.24±0.90</td>
<td>0.00</td>
<td>18.3±0.2</td>
</tr>
<tr>
<td>Black rice</td>
<td>10.9±0.99</td>
<td>7.96±0.84</td>
<td>1.32±0.08</td>
<td>1.17±0.05</td>
<td>1.07±0.06</td>
<td>77.58±0.88</td>
<td>305±0.20</td>
<td>69±0.08</td>
</tr>
</tbody>
</table>

Each value is the mean± SD

Means within a column followed by different letters are significantly different at (P≤ 0.05)
Chemical analysis of the wheat and mushroom flours:-

Data presented in Table (3) showed that mushroom and wheat flour had moisture and carbohydrate contents of 9.45, 12.4 and 63.93m75.41 %, respectively. On the other hand mushroom had higher content in the rest of components. The previous data are in agreement with the data reported by Prodhant et al., (2015).

Hulling and milling properties of the two rice varieties:-

Hulling includes removing the husk from the paddy with the lowest loss to the grain to produce rice. Rita and Sarawgi (2008) reported that the hulling percentage ranged from 63 to 81%. Milling output is of the greatest vital standards of rice processing, storage, quality and also in trade. Degree of milling affects milling recovery and consumer acceptance (Childs 2006).

Data present in Table (4) indicated that the hulling percentage of raw paddy rice ranged between 75.05 % (Black rice) to 82.60 % (Giza 177). Milling percentage was significantly high in Giza 177 compared with black rice. However these data may be due to the genetic characters among tested rice varieties. The previous data are in agreement with the data reported by Kong and Lee (2010), Maisuthisakul and Changchub (2014), Paiva et al. (2014).

Minerals content of rice varieties: -

Minerals such as phosphorus and calcium as well as some traces of zinc, manganese, copper and iron (Verma and Srivastav 2017). Subudhi et al. (2013) mentioned that iron food content > 10.0 mg/kg is very good iron source. Black rice (BR) could be considered as good sources of Fe, Mg and Zn in relative to the recommended daily dietary allowances (for children aged 6-59 months) which amounted by 4.1 mg/24h for Fe, Mg and Zn; respectively. (WHO/WFP/UNICEF 2007).

Ash content of rice varieties was important to some extent, it contained the nutritionally important minerals. Some of these minerals are shown in Table (5). Black rice had a relatively high (P≤ 0.05) levels of iron (8.20), zinc (2.50), potassium (143.20), magnesium (79.1) and calcium (10.30mg / 100g) compared with Giza 177 variety. These results were in harmony with those stated by (FAO, 1993 and Abd El-Rassol et al., 2005, Badawy and Mahgoub 2015).

Fatty acids profile of two rice varieties:-

It could be noticed from the data in Table (6) the main fatty acids presence in black rice samples were oleic (C18:1) (39.2%), linoleic (C18:2) (37.4%), besides palmitic (C16:0) (17.75%) acids that represent more 90% of the total fatty acid contents in the samples. It is notable that the ratio of palmitic is high in Giza 177, these results were in harmony with that stated by (Lee et al., 2006, Kang et al., 2011, El-Refaei, et al., 2017).

Table 3. Chemical compositions of wheat and mushroom flours on dry weight basis

<table>
<thead>
<tr>
<th>Flour Samples</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Fiber (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>12.4±0.60</td>
<td>10.2±0.30</td>
<td>1.22±0.16</td>
<td>0.77±0.10</td>
<td>0.55±0.12</td>
<td>75.41±0.55</td>
</tr>
<tr>
<td>Mushroom</td>
<td>9.45±0.75</td>
<td>20.5±0.65</td>
<td>1.71±0.18</td>
<td>4.40±0.76</td>
<td>11.0±0.94</td>
<td>63.95±0.64</td>
</tr>
</tbody>
</table>

Each value is the mean± SD
Means within a column followed by different letters are significantly different at (P≤ 0.05)

Table 4. Milling characters of the two rice varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Hulling (%)</th>
<th>Milling (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 177</td>
<td>82.60±0.95</td>
<td>71.92±0.80</td>
</tr>
<tr>
<td>Black rice</td>
<td>75.05±0.88</td>
<td>66.85±0.65</td>
</tr>
</tbody>
</table>

Each value is the mean± SD
Means within a column followed by different letters are significantly different at (P≤ 0.05).

Table 5. Minerals content of the two rice varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Fe (mg / 100g)</th>
<th>Zn (mg / 100g)</th>
<th>K (mg / 100g)</th>
<th>Mg (mg / 100g)</th>
<th>Ca (mg / 100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 177</td>
<td>3.1±0.11</td>
<td>1.20±0.12</td>
<td>74.0±0.18</td>
<td>33.2±0.77</td>
<td>8.1±0.45</td>
</tr>
<tr>
<td>Black rice</td>
<td>8.20±0.13</td>
<td>2.50±0.14</td>
<td>143.20±0.66</td>
<td>79.1±0.65</td>
<td>10.30±0.33</td>
</tr>
</tbody>
</table>

Each value is the mean± SD
Means within a column followed by different letters are significantly different at (P≤ 0.05)
Table 6. Fatty acid composition of the two rice varieties (g / 100 g rice)

<table>
<thead>
<tr>
<th>Fatty acid (%)</th>
<th>Rice varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Giza 177</td>
</tr>
<tr>
<td>Palmitic (C_{16:0})</td>
<td>19.85±0.18</td>
</tr>
<tr>
<td>Palmitoleic (C_{16:1})</td>
<td>0.14±0.22</td>
</tr>
<tr>
<td>Stearic (C_{18:0})</td>
<td>3.5±0.40</td>
</tr>
<tr>
<td>Oleic (C_{18:1})</td>
<td>37.1±0.20</td>
</tr>
<tr>
<td>Linoleic (C_{18:2})</td>
<td>34.1±0.23</td>
</tr>
<tr>
<td>Linolenic (C_{18:3})</td>
<td>1.35±0.35</td>
</tr>
<tr>
<td>Arachidic (C_{20:0})</td>
<td>0.67±0.25</td>
</tr>
<tr>
<td>Saturated (SFA)</td>
<td>24.02±0.99</td>
</tr>
<tr>
<td>Unsaturated (MUFA+PUFA) fatty acid</td>
<td>72.49±0.55</td>
</tr>
</tbody>
</table>

Each value is the mean± SD
Means within a row followed by different letters are significantly different at (P≤ 0.05)

The fatty acid profile of rice bran oil is nearly comparable to that of peanut oil and slightly higher in saturation level than soybean oil (McCaskill and Zhang, 1999). The fatty acid profile of rice bran oil reveals approximately 19% saturated (palmitic acid), 42% monounsaturated (oleic acid) and 39% polyunsaturated (linoleic acid) (Mezouari. et al., 2006).

Cooking quality parameters of rice varieties:

There are different parameters could be applied to measure the cooking and eating quality of rice such as gelatinization temperature, gel consistency, water uptake ratio, amyllose content besides cooking time. Gel consistency (G C) means that the cooked rice changes to harden on cooking. G C is correlated to the eating quality of rice, higher the gel consistency the harder the rice (Kanlayakrit and Maweang, 2013).

Gelatinization temperature determines the time it takes for a particular variety of rice to cook (Table 7). Higher gelatinization temperature is an indicator of a more crystalline structure and more resistance to water penetration and swelling of rice kernels (Yadav and Jindal, 2007). The varieties that have intermediate gelatinization temperature are either intermediate or high in amyllose content. (Cruz and Kush 2000).

Amylose content is considered to be one of the greatest vital standards of rice quality in cooking besides pasting properties (Adu-Kwarteng et al., 2003). Japonica/Indica rice variety of amyllose content was intermediate. Most consumers prefer rice with intermediate amyllose content ranged among 20-25% (Thomas et al., 2013). Rice types were categorized into five groups according to their amyllose content: waxy (1–2%), very low (2–9%), low (10–20%), intermediate (20–25%) and high (25–33%) (IRRI, 2009, Bassouy and El abed 2016). The differences in amyllose % are attributed to genetic background of the cultivars and in part to the differences in the environmental conditions in which the crop is grown (Anonymous, 1997, Hettiarachchy et al., 1997, Dipti et al., 2002 and Chukwuemeka et al., 2015).

Data presented in Table 7 showed the Giza 177 had higher GC than black rice. Generally, these varieties could be classified under soft rice which their GC ranged between 61-100 mm as described by (El-Bana et al., 2010). IRRI (2002) classified the gel consistency in grains as hard (40 mm or less), medium (41-60mm) and soft (>61mm). Cohesiveness, tenderness, color and gloss are differs greatly based on the gel consistency. Rani et al., (2006) stated that there are a great differences in gel consistency exist among varieties of similar amyllose content.

Table 7. Cooking and eating quality of rice varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Gel consistency (GC) (mm)</th>
<th>Gelatinization temperature (GT)</th>
<th>Amylose content (%)</th>
<th>Water uptake (ml H:O/100 g rice)</th>
<th>Cooking time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 177</td>
<td>95.19±0.99</td>
<td>5.00±0.85</td>
<td>17.27±0.75</td>
<td>245.20±0.98</td>
<td>19±0.38</td>
</tr>
<tr>
<td>Black rice</td>
<td>91±0.77</td>
<td>5.85±0.35</td>
<td>21.37±0.33</td>
<td>232.3±0.75</td>
<td>22±0.25</td>
</tr>
</tbody>
</table>

Gelatinization temperature (GT): Rating of 1-3= high GT (greater than 74°C), Rating of 4-5= intermediate (70-74°C) and Rating of 6-7= low GT (low 70°C); Gel consistency (GC) : Hard (27-40 mm), medium (41-60 mm) and soft (61-100 mm) (Diako et al., 2011).

Each value is the mean± SD
Means within a column followed by different letters are significantly different at (P≤ 0.05)
black rice higher gelatinization temperature than Giza 177. Milling process was considered as one of the major factors that affect the amylose content of the rice samples. Black rice contained higher amylose (21.37%) than Giza 177 (17.27%). The results of (Jane et al., 1999), Osman and Abd El-Galeel (2008), Subudhi et al., (2013), Abd-El Salam et al., (2016 and Lum, 2017) supported our findings.

Results in Table (7) show that, water uptake values at 75 ±2°C and 80±2°C were higher in Giza 177 rice than black rice, due to water uptake is more related to carbohydrate content it is higher in Giza 177 (89.24%) than black rice (77.58%). This results were agree with that reported by (Savita et al., 2004). (El-Bana et al., 2010), who stated that, faster rate of water uptake indicated a shorter cooking time.

Sensory evaluation of cooked rice:-

During cooking, the structure of rice, physical properties, chemical composition and nutritional quality are changed (Mahadevamma and Tharanathan, 2007). Table (8) presented the means of the scores given by the panels to cooked rice. There were significant variations among the black rice that had the highest value of odor (8.7) than Giza 177 (8.1). Giza 177 had the best taste (8.7) followed by black rice (7.7). Also, Giza 177 rice had the highest score of color (9), texture (8.2) and overall acceptability (8.3) compared to black rice. The texture of the rice is a key indicator of cooked rice quality as it affects consumer acceptability (Bassuony et al., 2014). The black rice had the lowest acceptability than Giza 177 because its use is limited, unknown and the consumer Egyptians did not get used to it in food. Based on the results of sensory evaluation the current work aimed to use black rice flour in particular to prepare free gluten products such as biscuit to be as functional food product gluten-free. Additionally, it has high nutrients as protein, minerals (Ca, P, Fe, and Zn), anthocyanin besides dietary fiber compared to white rice. The present results are in harmony by (Abd-Kwarteng et al., 2003, Frei and Becker, 2003, Puspitowati and Driscoll, 2007, Asghar et al., 2012).

a-Sensory evaluation of biscuit prepared by substituting different levels of black rice flour with wheat flour:

The texture, flavor, and appearance of the biscuits are major attributes that affect biscuit acceptability (Torbica et al., 2012). Black rice flour (gluten-free) suitable to prepare products for celiac disease (Klunklin and Savage, 2018). There is a high demand to use natural antioxidants in foods to enhance the shelf life of biscuits. Hence replacing wheat flour with black rice flour in biscuit production was one scope of this study. Rice protein cannot generate a viscoelastic network like gluten in wheat, which retains carbon dioxide during biscuit dough fermentation (Sharma et al., 2016).

The results in Table (9) indicate that the samples contained 2.5% and 5% black rice flour gain higher scores for all characteristics. Significant differences in all characteristics for all biscuit samples. Samples contained 2.5% black rice flour had the highest values of color among the other biscuit samples. Furthermore, samples contained 7.5% black rice flour had the lowest scores for the color, appearance, taste and overall acceptability compared with the other biscuit samples.
Table 10. Sensory evaluation of biscuit prepared by substituting different levels of black rice and mushroom flours with wheat flour

<table>
<thead>
<tr>
<th>Sample</th>
<th>Color</th>
<th>Appearance</th>
<th>Taste</th>
<th>Crispiness</th>
<th>Over all acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>7.0±0.4</td>
<td>6.5±0.5</td>
<td>6.7±0.2</td>
<td>6.6±0.3</td>
<td>6.5±0.2</td>
</tr>
<tr>
<td>T2</td>
<td>8.6±0.2</td>
<td>8.5±0.2</td>
<td>8.4±0.1</td>
<td>8.7±0.5</td>
<td>8.5±0.3</td>
</tr>
<tr>
<td>T3</td>
<td>8.1±0.1</td>
<td>7.8±0.3</td>
<td>7.9±0.4</td>
<td>8.0±0.6</td>
<td>7.9±0.4</td>
</tr>
<tr>
<td>T4</td>
<td>7.7±0.3</td>
<td>7.5±0.4</td>
<td>7.6±0.5</td>
<td>7.6±0.3</td>
<td>7.5±0.6</td>
</tr>
<tr>
<td>T5</td>
<td>7.5±0.5</td>
<td>7.0±0.7</td>
<td>7.1±0.7</td>
<td>7.1±0.4</td>
<td>7.0±0.7</td>
</tr>
<tr>
<td>T6</td>
<td>6.7±0.6</td>
<td>6.1±0.2</td>
<td>6.2±0.6</td>
<td>6.2±0.2</td>
<td>6.0±0.4</td>
</tr>
<tr>
<td>T7</td>
<td>6.0±0.3</td>
<td>5.8±0.4</td>
<td>5.7±0.4</td>
<td>5.5±0.5</td>
<td>5.3±0.5</td>
</tr>
</tbody>
</table>

Each value is the mean± SD
Means within a column followed by different letters are significantly different at (P≤ 0.05)
T1 (100% wheat flour), T2 (96.5% wheat flour, 2.5% black rice flour, 1% mushroom)
T3 (95.5% wheat flour, 2.5% black rice flour, 2% mushroom), T4 (94.5% wheat flour, 2.5% black rice flour, 3% mushroom), T5 (94% wheat flour, 5% black rice flour, 1% mushroom), T6 (95% wheat flour, 5% black rice flour, 2% mushroom), T7 (92% wheat flour, 5% black rice flour, 3% mushroom)

The mean scores of overall acceptability for biscuit samples revealed that biscuit contained 2.5% black rice flour had the highest score of overall acceptability than the other biscuit samples. It could be noticed that replacing wheat flour with 2.5% black rice flour in biscuit is acceptable. So, suggest that it is better for the consumer to add black rice flour in biscuit manufacture and the consumer will get more nutrient and bioactive components including anthocyanin, lipids, amino acids, phenolic compounds, and minerals. These data are in harmony by (More et al., 2013; Metwally et al., 2014; Cho and Lim, 2015; Klunklin and Savage, 2018).

b-Sensory evaluation of biscuit prepared by substituting different levels of black rice flour and mushroom A. bisporus flour with wheat flour:

Mushroom proteins contain essential amino acids which necessary to humans (Kakon et al., 2012, Muszyńska et al., 2013, Correa et al., 2016). Moreover, it is rich in protein besides carbohydrates (Ahlavat et al., 2016).

Results in Table (10) showed that the samples contained 2.5% black rice flour and 1%, 2%, 3% mushroom flour gain the highest scores for all characteristics. Moreover, the samples that contained 2.5% black rice flour and 1% mushroom flour had the highest values among of other biscuit samples. On the other hand, the samples contained 5% black rice flour, 3% mushroom flour had the least score of color, appearance, taste, crispiness and overall acceptability.

As a result of the mean scores of overall acceptability for biscuit, samples revealed that the acceptability of biscuit that contained 2.5% black rice flour and 1% mushroom flour had the highest score than the other biscuit samples. So, it could be noticed that replacing wheat flour with black rice flour and mushroom flour in biscuit production was acceptable for consumer and added more value because of the presence of nutrients and bioactive components including protein, amino acids, minerals, vitamins, antioxidant, anti-diabetic and antibacterial properties. These data are in agreement with (Atila et al., 2017 and Klunklin and Savage, 2018).

CONCLUSION

It can be concluded that black rice flour has good nutritional value and good functional properties which enhance the nutritional quality of the products. The results could help food technologists and rice producers to encourage rice product consumption by increasing consumer consciousness of grains health usefulness. In this regard, Gluten-free bakery products are advantageous to persons who suffer from celiac disease. Besides using black rice flour and mushroom flour increased protein and other nutrients contained in the products.

REFERENCES


الملخص العربي

الخصائص الكيميائية والحسية للأرز الأسود مقارنة بصنف الأرز جيزة 177

أيمن محمد أبو اليزيد، محمد أحمد عبد الجواد نصار، رجب عبد الغنى عبيد، منى علاء الدين محمد حسن

أجريت هذه الدراسة بهدف تقييم الأرز جيزة 177 والأرز الأسود من حيث الصفات الكيمائية والتكنولوجية وإمكانية الاستفادة من دقيق الأرز الأسود لحل محل دقيق القمح في صناعة بعض المنتجات المخبازة مثل البيسكويت لتغذية الأفراد ذوي الحساسية لجلوتين القمح.

وأوضحت النتائج ما يلي:

- أظهرت النتائج أن الأرز الأسود يحتوي على نسبة أعلى من البروتين ومحتوى الدهون والرماد والألبومين والفيونولات الكلية والعناصر المعدنية مقارنة بصنف جيزة 177.
- مختلفة قيم سيلول سجة الجل معنوية حيث أظهر صنف الأرز جيزة 177 على أعلى قيمة من سيلول سجة الجل مقارنة بالأرز الأسود.
- أحتوى الأرز الأسود على نسبة مرتفعة من الأميلوز مقارنة بالصنف جيزة 177.
- أظهرت النتائج بأن الأرز الأسود يعتبر مصدرًا جيدًا للبروتين والأحماض الدهنية والألوخانين والفيونولات الكلية والعناصر المعدنية مقارنة بصنف جيزة 177.