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Article

Comparison of the local black rice'srice's grinding quality to that of anber 33 Rice

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Abstract

The study aimed to evaluate the quality criteria of grinding local black rice rice and compare it with non-colored rice rice (Anber 33 variety). The physical traits of raw rice were studied, represented by the weight of 1000 grains, specific weight, bulk density, particle density, impurities percentage and their impact on the husking process and the extraction rate of husked rice (the hulls removed), the results indicated that the Anber 33 rice had higher values for these traits compared with local black rice rice. A manufacturing process (husking and grinding) was conducted for the two rice varieties. The quality criteria of the husking and grinding process, and knowing the percentages of brown rice, outer shell, bleached grain resulting from brown rice, whole grains, broken grains and bran, the results showed that the percentage of extracting of the total bleached grains and the percentage of whole grains for bleached rice (removed the hulls) in the rice Anber 33 rice was higher compared with local black rice. In contrast, the percentage of bran and broken grains was higher in local black rice compared with Anber 33 rice. Anber 33 rice recorded higher values of the whiteness degree and hardness degree, whereas the local black rice recorded higher percentages of protein, lipid, ash, and fiber. Removing the hulls for 25 seconds reduced the nutritional components of the two rice varieties, as the loss of components varies depending on the grinding period and the quality of the variety. The ground local black rice was distinguished by its retention of higher protein, lipid, fiber, and ash percentages of 6.4, 1.6, 1.8, and 1.1%, respectively. Regarding the sensory evaluation traits, ground black rice for 25 seconds recorded the highest degrees of taste, texture, and chewing, while raw black rice recorded the highest degree of flavor. Regarding the general acceptance degree and color, the Anber 33 rice model achieved the highest degree of these traits.

Keywords: Black rice, rice grinding, white rice, sensory evaluation.

Introduction

Rice (*Oryza sativa* L.) is one of the cereal crops and a vital food sources[1], and it comes in second place in production after wheat[2]. It is one of the most consumed

foods, especially in Asia, because it is a rich source of carbohydrates and a moderate source of proteins and lipids. It contains several vitamins, minerals necessary for nutrition, phenolics, and flavonoids[3]. White rice is the most common in the world. However, there are many particular varieties of rice known as "pigmented rice," which are genetic types that differ from the standard rice in the world. It is the rice of different colors ranging from red to purple or blue and then black. The color difference depends on the color of the outer layer of the rice grain. The difference in colors is due to the deposition of large amounts of anthocyanin pigment or proanthocyanin pigment in this layer[4] Among the colored varieties; black rice has received increasing attention due to its high nutritional properties and primarily due to its beneficial health properties[5] as it contains flavonoids, phenols, sterols, tool, oryzanol, essential amino acids and fatty acids. Anthocyanins are among the main functional components of rice rice, as phenolic compounds and bioactive phytochemicals perform many biological activities such as antioxidant, anti-inflammatory, anti-cancer, and blood-glycemic-regulatory activity[6] Ricerice is usually consumed after the processes of removing the husk and grinding (removing the hulls). The grinding process is considered the most crucial step in rice production because it determines the nutritional properties and improves the culinary and sensory traits of raw rice[7]. The main objective of rice's husking and grinding processes is to remove raw rice's outer shell, bran, and embryo with the lowest percentage of starchy endosperm breakage. The process of manufacturing and sound processing of rice produces several products, including rice kernel at a percentage of 70% of rice grains with a large number of rice byproducts, including rice bran (8-9%), rice embryo (1-2%) and rice outer shell[8] (20%)The grinding process has a significant impact on the nutritional components of rice rice, as the loss of nutrients as a result of the rice grinding process (removing the hulls) varies depending on the number of layers removed during grinding and the quality of the varieties[9] This study aims to evaluate the quality criteria of grinding local black rice and compare it with non-colored rice (Anber 33 variety) by adopting physical, chemical and manufacturing traits.

Materials and Methods

Rice models

The Al-Mishkhab Rice Research Station - Ministry of Agriculture / Iraq used the local black rice variety. It is an imported variety that was introduced to Iraq and was crossed and propagated in the station and registered as "Registered Black Rice ."Also, the Anber 33 rice variety, sourced from the Mashkhab station, was used and kept in polyethylene bags at 4°C.

Determination of the physical properties of raw rice rice

The physical examinations for both varieties of rice were carried out in the laboratory of the quality control department in Taji - General Company for Grain Trade - Ministry of Trade Iraqi, and these tests include:

1. Estimation of impurities percentage (%)

A sample of raw rice was taken for the two varieties; the sample was divided by an electric divider device (Divider) to obtain the required weight for examination, which amounted to 50 g of each variety. It was cleaned from impurities, dirt and gravel using sieves to remove impurities measuring 3/8 x 0.064 inches with longitudinal slots. The impurities percentage was calculated according to the following equation:

$$\text{Impurities percentage (\%)} = \frac{\text{Weight of raw rice after cleaning (g)}}{\text{Weight of raw rice befor cleaning (g)}} \times 100$$

2. Weight of 1000 grains (g)

The weight of 1,000 grains was calculated using a Contador seed counter to count 1000 grains of raw rice for each variety randomly and then weighed using a sensitive electronic scale[9].

3. Specific weight test

The specific weight of raw rice grains was estimated according to the AACC (2010)method, which numbered (10.01-55) using a Portable Hectoliter Test Weight Ki 250 with a volume of 250 ml.

4. Bulk density and particle density (g/cm^3)

The bulk density and the particle density were calculated according to the method. The bulk density was calculated according to the following equation:

$$\text{Bulk density} = \frac{\text{Sample Weight (g)}}{\text{Water equivalent volume weight (100 ml)}} \times 100$$

As for the particle density, the water is replaced with oil, and the particle density is recorded in the same equation above.

Rice manufacturing process

The rice manufacturing process (husking and grinding) for both rice varieties was conducted according to the organizational guide for the work of laboratories(1984) method, which was:

1. Husking process

100 g of raw rice grains were ground at the original moisture content of the grains, and the percentage of brown rice resulting from the grinding process was calculated according to the following equation[9]:

$$\text{Brown rice percentage (\%)} = \frac{\text{Weight of husked rice (g)}}{\text{weight of raw rice grains (g)}} \times 100$$

2. Grinding process (bleaching)

Anber 33 rice was bleached using a Japanese stone (Satake Grain Testing Mill), and 25 seconds was used to obtain a degree of bleaching 32. The bleached rice percentage was calculated according to the following equation:

$$\text{Bleached rice percentage (\%)} = \frac{\text{Weight of grinded rice (g)}}{\text{Weight of raw rice grains (g)}} \times 100$$

3. Percentage of whole and broken grains (%)

The bleached rice resulting from the bleaching process was placed in a cylindrical isolation device (Satake Rice Grader), and the operating time was set at 2 min and at an angle of 25ºin order to isolate the whole and broken grains of

different sizes with some manual isolation. The following equation calculated the percentage of whole grain percentage:

$$\text{Whole grain percentage (\%)} = \frac{\text{Weight of whole grain (g)}}{\text{Weight of raw rice model (g)}} \times 100$$

The percentage of broken grains percentage was calculated by the following equation:

$$\text{Broken grains percentage (\%)} = \frac{\text{Weight of broken grain (g)}}{\text{Weight of raw rice model (g)}} \times 100$$

Physical tests of ground rice

Some physical tests were carried out for the hulled rice grains of local black and Anber 33 rice varieties, which are:

1. Grain length, grain width and length/width ratio

The length and width of the rice grains were measured using an electronic vernier (Digital Grain Vernier SPA56)[10].

2. Hardness Test

A Hardness Tester device determined it according to the organizational guide for the work of laboratories (1984)method.

3. Whiteness test

It was measured using a C-600 Rice Whiteness Tester device, which measures the degree of whiteness of rice grains compared with the degree of whiteness of magnesium, amounting to 88.7, contained in a disc of the device.

Determination of chemical components of raw and ground rice rice

The percentage of moisture and protein was estimated using the Micro Kjeldhal method. In contrast, the percentage of lipids was estimated using the Soxhlet device, and the percentage of fibers and carbohydrates was estimated according to AACC (2010).

Sensory evaluation of cooked rice rice

A sensory evaluation was carried out for cooked rice, as four rice samples (T1 = raw black rice, T2 = ground black rice for 10 seconds, T3 = ground black rice for 25 seconds, and = ground Anber 33 rice for 25 seconds) were cooked. Cooking was carried out according to the method[11].

Results

Physical tests of raw rice grains

The results in Figure 1 show that were statistical differences ($P < 0.05$) in the physical traits of the raw rice, including impurities percentage (%)), the weight of 1000 grains (g), bulk density (g/cm^3), particle density (g/cm^3), a specific weight (Kg/hl) of raw rice for both varieties.

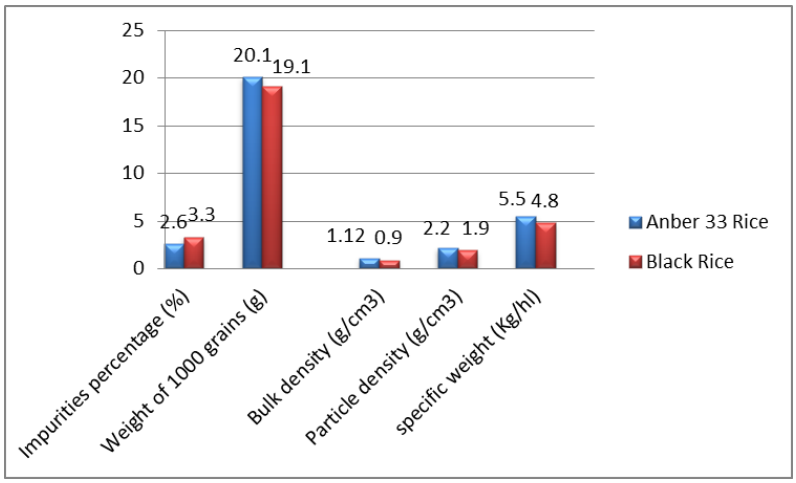


Figure 1: Physical tests (bulk density, particle density, specific weight).

The results in Figure 1 shows show that the impurities percentage in the Anber 33rice variety was 2.6% compared with the local black rice variety, which was 3.3%. Also, the results in Figure 1 reveal that the weight of 1000 raw rice grains for the local black rice variety was 19.1 g compared with an average of 33 rice varieties, which was 20.1 g. Figure (1) shows significant differences between rice varieties in the raw rice grains' bulk density, particle density, and specific weight. Anber 33 rice gave the highest means of these traits (1.12 g/cm^3, 2.2 g/cm^3, and 5.5 Kg/hl), respectively, compared with the local black rice variety, which gave the lowest means[9] (0.90 g/cm^3, 1.9 g/cm^3 and 4.8 Kg/hl) respectively. These results confirm that the bulk density of black rice rice is lower than that of non-colored sticky rice rice.

Raw rice manufacturing process

The results in Figure 2 indicate the properties of the remanufacturing process, which were hulled rice grains (%), shell (%), extraction of bleached grains (%), bran (%), whole grains (%), and broken grains (%)of raw rice for both varieties. The results in Figure 2 show a non-significant difference between rice varieties in the percentage of hulled rice grains, percentage of extraction of bleached grains, and shell percentage. Also, the results in Figure 2 reveal significant differences between rice rice.

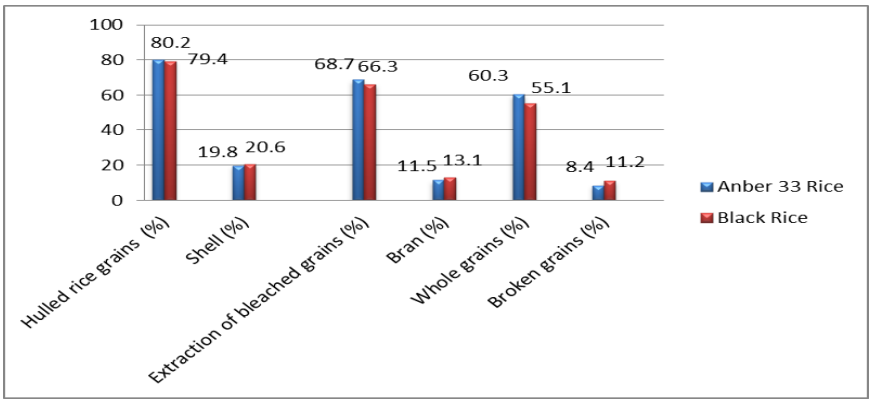


Figure 2: Property percentages (hulled rice grains, shell, extraction of bleached grains, bran, whole grains, broken grains).

Varieties in broken grains percentage resulting from the bleaching process, the local black rice variety achieved the highest mean (11.2%) compared with the Anber 33 rice variety, which achieved the lowest mean (8.4%).Regarding whole grains percentage, the results in Figure 2 show that there were significant differences between rice varieties in whole grains percentage resulting from the bleaching process; Anber 33 rice gave the highest mean (60.3%) compared with local black rice variety, which gave the lowest mean (55.1%). Regarding bran percentage, the results in Figure 2 reveal significant differences between rice varieties in bran percentage; the local black rice variety achieved the highest mean (13.1%) compared with the Anber 33 rice variety, which achieved the lowest mean (11.4%).

Physical tests of ground rice

The results in Figure 3 show the physical tests of ground rice, which were grain length(mm), grain width (mm), length: width, Hardness degree, and whiteness degree of ground rice for both varieties. The results in Figure 3 indicate significant differences between rice varieties in grain length; the local black rice variety achieved the highest mean (6.2 mm) compared with the Anber 33 rice variety, which achieved the lowest mean (5.6 mm). The results show that the local black rice rice and Anber 33 rice are in the medium grain category. On the other hand, the results in Figure 3 reveal a non-significant difference between rice varieties in the grain width (mm), length: width, and Hardness degree. Regarding whiteness degree, the results in Figure 3 show that there were significant differences between rice varieties in whiteness degree; Anber 33 rice gave the highest mean (32.5) compared with the local black rice variety, which gave the lowest mean (20.3), and increasing the grinding time lead to an increase the whiteness degree of the rice.

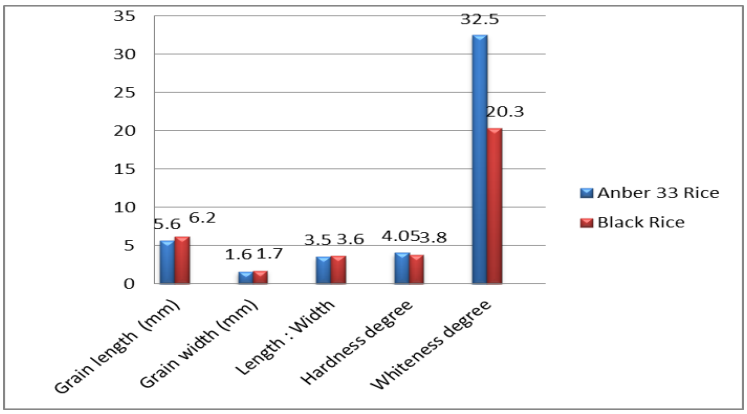
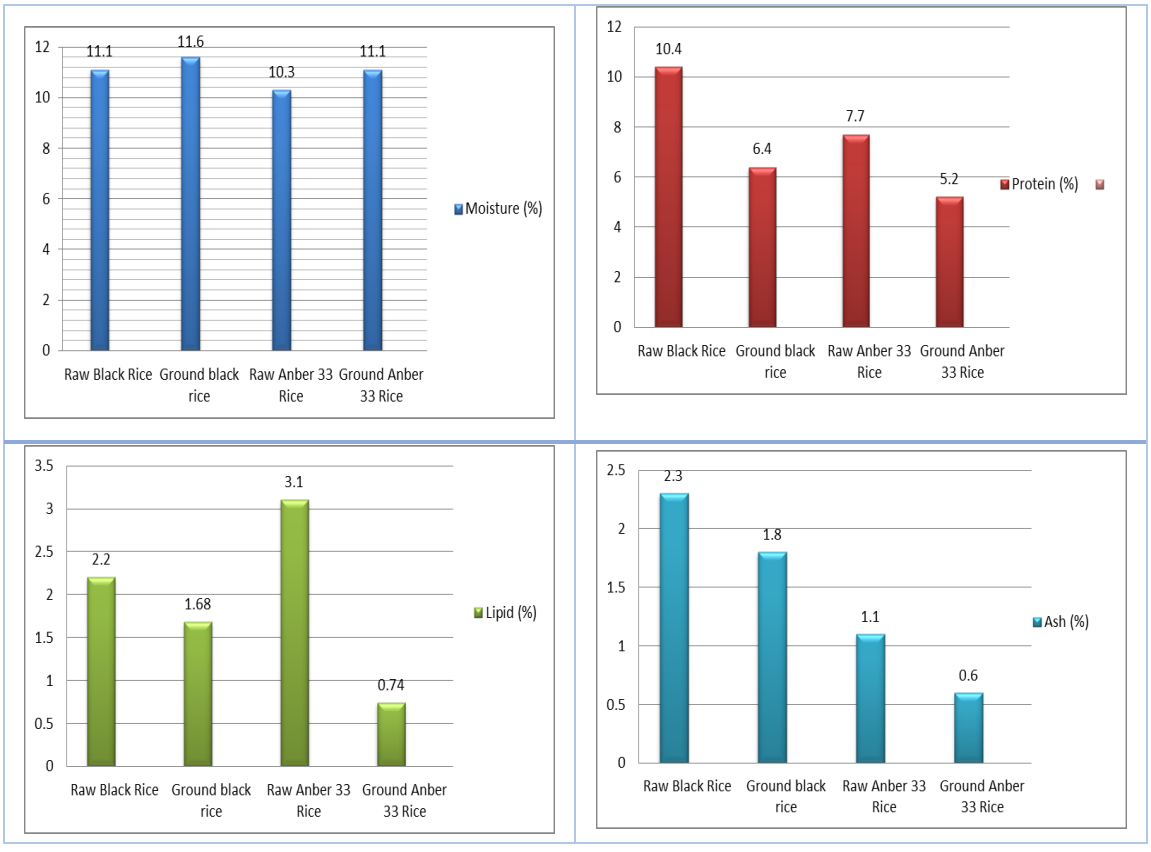


Figure 3: Physical tests (grain length, grain width, hardness degree, whiteness degree).

Chemical components of raw and ground rice rice

The results in Figure 4 show the percentages of moisture, protein, lipid, fiber, ash, and carbohydrates for each raw and ground Anber 33 rice and local black rice varieties. The results in Figure 4 reveal a non-significant difference between raw black rice, ground black rice, raw Anber 33 rice, and ground Anber 33 rice in the moisture percentage of rice grains. Regarding the protein percentage, there was a significant difference between raw black rice, ground black rice, raw Anber 33 rice, and ground Anber 33 rice in this trait (Figure 4); the means amounted to 10.4, 6.4, 7.7, and 5.2, respectively.



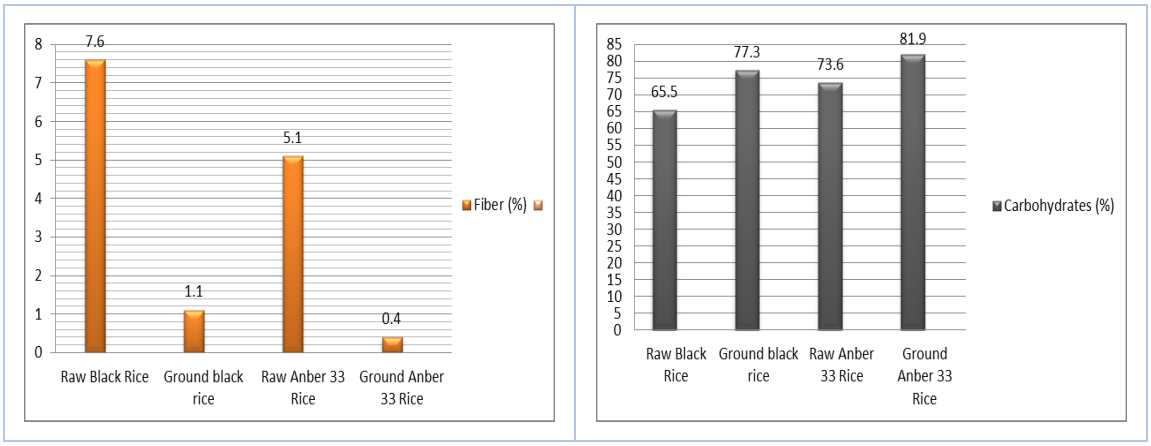


Figure 4: Chemical components (percentages of moisture, protein, lipid, fiber, ash, and carbohydrates).

The difference in the protein percentage may be due to the difference in genotypes, the location of cultivation, and the amount of fertilizer used, as it affects the total nitrogen percentage in the rice grains. As for lipid percentage, there was a significant difference between straw black rice, ground black rice, raw Anber 33 rice, and ground Anber 33 rice in this trait (Figure 4); the means amounted to 2.20, 1.68, 3.10, and 0.74%, respectively. The lipid content of rice grains varies due to the variation in the genetic structure of the varieties as well as the different extraction methods.

Regarding the ash percentage, there was a significant difference between straw black rice, ground black rice, raw Anber 33 rice, and ground Anber 33 rice in this trait(Figure 4); the means amounted to 2.3, 1.8, 1.1, and 0.6%, respectively.

As for fiber percentage, there was a significant difference between raw black rice, ground black rice, raw Anber 33 rice, and ground Anber 33 rice in this trait Figure 4; the means amounted to 7.6, 1.1, 5.1, and 0.4%, respectively. The fiber content affects the digestibility of rice rice, as the high fiber content in rice rice reduces its digestibility. So, the reason for the difference in the fiber percentage may be attributed to the difference in the genetic structure of rice varieties and grinding processes and in this regard[22], indicated that the fiber percentage in non-colored rice and Sri Lankan red basmati rice was lower than of Sri Lankan black rice.

Regarding the carbohydrates percentage, there was a significant difference between raw black rice, ground black rice, raw Anber 33 rice, and ground Anber 33 rice in this trait Figure 4, the ground Anber 33 rice gave the highest percentage (81.9%) compared with raw black rice (65.5%).

Sensory evaluation of cooked rice rice

The results in Figure 5 show the sensory evaluation traits of cooked rice (taste, flavor, general acceptability, color, texture, and chewing).

The results show that the ground black rice for the 25-second model (T3) was significantly superior and recorded the highest degrees of taste and texture compared with other models. This may be due to the effect of the grinding period in removing most of the hulls, which led to an increase in the percentage of

carbohydrates. In addition to the presence of phenols, anthocyanins, and flavonoids added to the rice a distinctive taste, the results in Figure (5) reveal that the raw black rice model (T1)was significantly superior and recorded the highest degree of this trait compared with Anber 33 rice variety model. The increase in flavor may be due to the concentration of flavor compounds in the grain hulls of the raw black rice model[27]. Mentioned that the distribution of flavor compounds is not evenly distributed in the grain, as its content is higher in the hull than in other parts. Also, the high amount of protein in the hulled rice rice contributed to the formation of flavor compounds, cyclic compounds formed during the roasting process of cooked rice rice (Mallard reactions).

Regarding the general acceptance degree and color, the Anber 33 rice model (T4) was significantly superior and achieved the highest degree compared with the raw black rice model (T1), which achieved the lowest degree for these traits. The total sensory evaluation degrees show that ground black rice had the highest degrees (69.8, 79.2, 84.7, 83.0%).

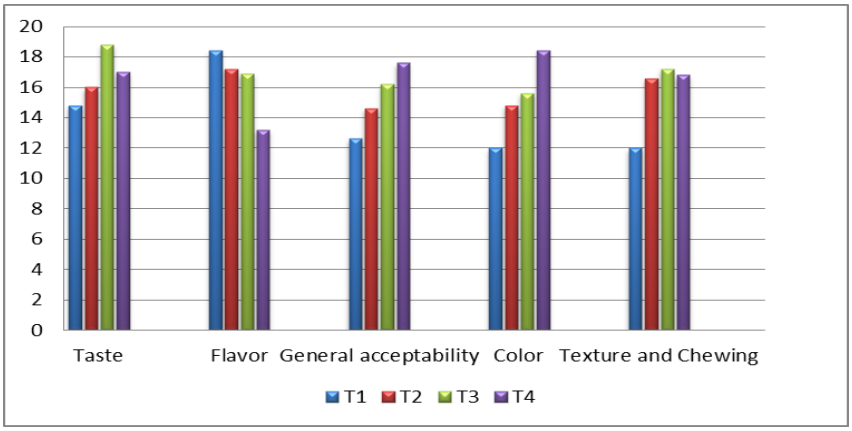


Figure 5: Sensory evaluation traits of cooked rice rice.

Discussion

The efficiency of the harvesting process, different agricultural practices, and the different environmental conditions significantly affect the percentage of impurities [12]. The weight of 1000 grains is one of the critical agricultural traits of raw rice rice. It refers to the maturity of the grain and its fullness with nutrients and has a relationship with harvest time [13]. The difference between the two rice varieties is the percentage of the whole grain to their difference in the grain the grand and the broken percentage of the broken grain husking stage [14]. This supports the results of [9] and [15], who indicated that the colored and non-colored rice varieties differed in this trait. Rice is classified according to grain length into very long (greater than 7.50 mm), long (6.61-7.50 mm), medium (5.51-6.60 mm) and short (less than 5.50 mm) [17], [18]. It reported that the grain length of light black rice ranged from 5.63-6.40 mm, while the grain length of dark black rice ranged from 5.59-5.69 mm, and the grain length of non-colored rice ranged from 5.52-6.03 mm. [16] indicated that the black rice contains a higher percentage of bran compared with red rice and non-colored rice.

Moreover, [19 and 20] reported that black rice's protein percentage was higher than red rice (Al-Hawizawi) and non-colored rice (Jasmine). Thomas mentioned that the percentage of ash in non-colored rice varieties ranged between 8.0-36.0%, and in black rice, it was [22] 0.9%. The percentage of ash in raw black rice was 1.64%, and in red basmati, [23] rice was 1.57%. Indicated that the ash content of rice is higher in brown rice, as it constitutes 61% of the total ash amount in rice, and that most of the ash percentage in black rice is in the brain), and the percentage of ash decreases with increasing grinding time. Also, he noticed a high percentage of ash loss in varieties characterized by a low length-to-width ratio. The fiber content affects the digestibility of rice, as the high fiber content in rice reduces its digestibility [24]. Also, raw rice's carbohydrate percentage was lower than in-ground rice. This may be because the grinding process increases the percentage of carbohydrates but reduces the other nutritional components (protein, lipid and fiber) [25]. The low degree of taste of the raw black rice model (T1) may be due to the presence of the bran, which caused the undesirable bitter taste [26] Regarding the flavor trait. , the lipid in the hulled rice contributed to the formation of other flavor compounds (Aldehyde), which made it more flavorful compared with bleached rice [28]. [29] indicated that most of the population prefers white rice for appearance, taste, ease of cooking, traditions, availability in the market, and palatability.

Conclusion

We conclude that the rice with higher values in physical traits, grain weight, bulk density, particle density, and specific weight had the highest extraction percentage of brown rice, whole grain, and chemical content (protein, lipid, fiber, ash). Also, the rice varieties differed in all the above traits, and local black rice was the best, in addition to its distinction in containing nutritional components, which was reflected in consumers' acceptance of cooked black rice, which increased the desire of people to eat black ground rice for its nutritional value and its distinctive sensory properties.

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