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Study of Engineering, Physical, Quality and Cooking Properties of Some Rice Varieties Imported For Tripoli Market

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Abstract

Five imported rice varieties (Herba, Abo bent, Al Hana, Uncle Benz and Al-Osra rice) were collected from private suppliers from 15 April to 25 Dec. 2019. Experiments were conducted in the labs of the High and Medium Center for Agricultural Sciences - Al Ghiran - Libya. The results were as follows: The highest average of length was recorded in Herba rice (6.2 mm), and the length ratio for width was in Herba and Uncle Benz (4.42, 4.00 mm) respectively, whiles the shortest varieties were Hana Rice (2.85 mm). The rice of the Al-Osra was short, where the average grain length was less than (5.2 mm) and the average grain width (2.25 mm) and the ratio of the width of this variety (6 mm), Which shows that the shape of a round and broad grain. The highest average weight of 500 grains was recorded in Uncle Benz rice (31.94 g), while Herba rice grains were of medium weight (22.09 g), while in Al-Hanaa rice, Al-Osra rice and Abo-bent rice (21.47, 21.10 and 18.56gm) respectively. Al-Osra rice recorded the highest average size (8 cm^3), Uncle Benz rice recorded the highest density (6.38 g /cm^3) among the varieties, followed by Al-Hana rice Herba rice (6.03, 3.15 g /cm^3), Abo-bent rice, and Al-Osra rice (3.09, 2.63 g /cm^3). All degrees of absorbency were varied, in the Al-Osra rice, Uncle Benz and Abo-bent rice (6.36, 5.25, 5.29 ml) respectively, whiles in Al Hanaa rice and Herba rice the degree of absorbency (4.64, 4.37 g). Herba rice has the highest volume increase (5 cm^3) while the Uncle Benz rice has the lowest absorbency (2g). During the smell test conducted on the five varieties of rice under study, it was observed that Hana rice and Al-Osra rice resulted in a strong smell (strong) during cooking, while the smell of Herba rice was weak (Slight) and the rice was Uncle Benz was smell almost non-existent. The smell of Abo-bent rice was medium strength (Moderate). The results of the sensory evaluation showed that the rice varieties imported to the Libyan market are mostly good and characterized by good cooking properties. Their quality is graded in the following order: Uncle Benz, Al-Hana, Ab-obant, Herba and then Al-Osra rice.

INTRODUCTION

Rice is grown in more than one hundred countries, and it is the top three cereal crops: rice, wheat, and maize, and it is the staple food for about two-thirds of the world's population (EL-Hissewy and et al, 2002; Wynn, 2009 & Mccaskill). Rice (Oryza sativa *L.*) is one of the most important species that contributes to highly nutritious food crops to a quarter of the global per capita dietary energy production. There are many studies documenting the physical and specific properties of different types of rice grains especially from Southeast Asia, the main rice growing region (Hori, 2016; Kaur, Panisar and Bira, 2011; Mir et al., 2013; Tran et al., 2012). The most important countries cultivating this crop are Bangladesh, Thailand, the Philippines, Burma, and Japan (Duvick, 1996). Rice (Oryza sativa L.) is an important crop that feeds about half of the world's population and choosing the method of processing is an important factor in preserving its quality. Therefore, the method of boiling rice before processing is considered one of the ancient

and widespread methods in large parts of the world, including countries in South and East Asia such as India, China and Thailand, as well as Africa, Europe and America (IRRI. 2010). By studying the natural and chemical properties by measuring the rate of water diffusion within the gelatinous zone and the activity of the components of rice grains in the water during cooking during the cooking period. Labensky et al. (2007) divided rice into three types based on seed size, which are long-grain, medium-grain, and short-grain rice, and long-grain rice is the most popular around the world. When cooked, the grains remain whole, not worn, smooth and separate, but if they are cooked too much, they become sticky, and shorter rice grains have more starch content and become sticky when cooked. Grain quality indicators such as rupture force and color are of great importance in the food industry. Varietal differentiation helps to improve consumer acceptance and popularity of certain types of rice, and knowledge of the physical properties of the grain material is also useful for designing machines suitable for grain handling processes such as sorting, drying, heating, and cooling and grinding, the improvement associated with each particular variety (Mir, Bosco, & Sunooj, 2013). Moraru and Kokini (2003) indicated that the reason for the increase in rice volume is that the starch grains consist of linear amylose and branched amylose, which affects the increase in the size of the grain. It leads to stiffness and a smaller increase as the linear amylose chains arrange themselves in fields and become difficult to rupture during the increase in size. Theanjumpol *et al*. (2007) show that the rise in the temperature of the rice affects the moisture content of the rice at a temperature of 60 ° C. The moisture content of the rice has decreased, and the hardness of the rice is affected by the increase in temperature. The different rice varieties showed significant effects on the physicochemical properties, morphology and cooking properties, The difference of rice varieties would affect the characteristics of cooked rice produced, Yadav et al (2007), but Putri (2012) stated that the starch content of rice was still the same, ie more than 80%. Cooking method also affected the characteristics of cooked rice. Cooking method also affected the characteristics of cooked rice. According to Han et al (2008), different cooking method would affect the hydrolysis of starch rice. Cooking the raw rice into the cooked rice could be done in various ways. Cooking rice with combination of boiling and steaming method had the highest average value of texture because at the time after water boiled at 100 ° C, the water was absorbed into the rice and then the fire was turned off. Furthermore, the rice cooled and occurred re-arrangement of amylose that leads to retro gradation process before entering the stage steaming, and consequently the texture of rice produced was louder, Winarno (2004). Amylose content was one of the important criteria in the classification system of rice. Allidawati and Bambang (1989), based on the amylose level, rice was grouped into very low amylose (< 10%), low (10% to 20%), moderate (20% to 24%) and high (> 25%). Higher amylose content in rice increased the occurrence of rearrangement of amylose after experiencing gelatinization leading to retro gradation process. Rice, which is high in amylose, does not make sticky rice, and it can expand and become hard when cool. Mild amylose rice was generally fluffy. Low-amylose rice produced sticky, shiny, not expanding rice that still curdled after a cold (Damardjati, 1995; Indrasari et al, 2009). According to Haryadi *et al* (2008) and Larasati (2012), protein contents of rice ranged from 7.3% to 10.2% and a maximum of 14.0%. According to Haryadi (2008), the rice containing higher protein needed more water and a longer cooking time. This related to the structure of rice grains. The starch granules enclosed in a protein, and hence the absorption of water was blocked by protein, which resulted in a longer time of cooking.

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Material and method:

According to AOAC (2000) Official Methods of Analysis

Sampling:

Five imported varieties of rice were collected by the Price Equalization Fund and suppliers from the private sector represented in Herba Rice, Abo-bent Rice, Al-Hana Rice, Uncle Benz Rice, and Al-Osra Rice, during the period from 15 April to 25 Dec.2019. The experiments were conducted in the laboratories of the High and Medium Center for Agricultural Sciences - Al-Ghiran -Libya.

Material:

These tests include a magnifying glass, a glass beaker, test tubes, a wire strainer ruler, a small spoon, a holder, filter papers, a flame-sensitive scale, and a test tube 250-ml.

Methods:

Engineering properties:

The dimensions and shape of the grain

It estimates both grain length (mm), average grain width (mm) and calculates the length / width ratio of rice:

- Extra-long: if the average of grain length is > 7.5 mm.
- Long grain: if the average long of grain ranged 6.61 - 7.5 mm.

Medium grain: if the average long of grain ranged from 5.2 - 6.6 mm.

- Short grain: if the average length of grain is < 5.2 mm.

The ratio of length / width that determines the shape of the grain of rice grains: -

Thin: if this percentage is > 3

Full (medium): if this percentage is from 2-3.

Round (wide): if this ratio is <2

Physical properties: -

The Weight:

The average weight of a thousand grains is estimated by finding the weight of 500 grains (twice), multiplying the result by (2), and then calculate the average.

The volume:

The volume is estimated for 500 grain by replacement using an organic solvent such as petroleum ether

The density:

Density is calculated by dividing:

Weight (g) / Volume (cm^3) w = Weight / Volume

If the grain weight is > 28g, it is considered a heavy grain.
If the weight of a thousand grains ranged between 22-28 grams, the grains are considered medium heavy.

If the weight of a thousand grains is less than 22 grams, the grains are considered rather heavy.

Cooking quality characteristics:

Rice Quality and Cooking Properties Tests:

1- Volume Expansion Test.
2- Water absorption.
3- Cooking time.
4- The aroma.

Water absorption:

Weigh 2 grams of rice and cook with 20 ml of hot water in a test tube by immersing it in a water bath at boiling point. After reaching the specified cooking time (20 minutes), cool the tube in a bath of cold water for 1 minute. The rice is collected on a wire strainer, and dried on the surface of the filter paper for 5 minutes; the weight gain is calculated based on the degree of water absorption.

Volume expansion test:

The volume of the previous rice is estimated by replacement of petroleum ether and is calculated as follows:
Size = volume of rice after cooking / volume of rice before cooking.

Cooking Time:

Repeat the same experiment for different cooking times 20, 30, 40 and 50 minutes for 5 varieties of rice, to find the time required for cooking, which is the minimum time required to reach an adequate cooking degree, and it can be judged to reach the cooking degree by taste.

Aroma:

The rice is tested for smell after cooking 2 gm. of rice for 10 minutes in 20 ml of water in a 50 ml sealed test tube, for strong, Moderate, Slight, or non-smell.

Statically analysis: Statistical analysis of the search results was carried out according to the statistical program spss version 2016 and version of Excel 201**0**

Results:

Physical properties:

Grain size and shape:

Figures (1 and 2) illustrate the results obtained for the dimension of a grain of rice represented in the length and width of the rice varieties selected for the study, where the average length of the rice of Herba, Al-Hana and Uncle Benz was (6.2, 5.07, 5.2 mm) respectively. This indicates that these varieties are medium grain. As the average grain, length is greater than 5.2 and less than 6.6 mm, The length to width ratio of Herba and Ankel Benz rice was (4.42, 4.00 mm), respectively, The shape of the grain was of a thin type, as the ratio of length to width increased in both varieties of (3 mm), while in Al-Hana rice (2.85 mm), and the shape of the grain was corpulent (medium), as shown in Figure (3). The results indicated that Al Osra rice is the shortest variety of rice goal of the study, and it is one of the short-grain varieties, as the average length of the grain was smaller than 5.2 mm, and the length of the grain for this variety was (3.6 mm) and the average grain width was (2.25 mm), while the ratio of length was The width of this variety (6 mm) indicates that the shape of the grains is round and broad. It was evident from the statistical results that there were high significant differences (P <0.001) in the average grain length among the types of rice under study, and the value was (L.S.D = 0.32).

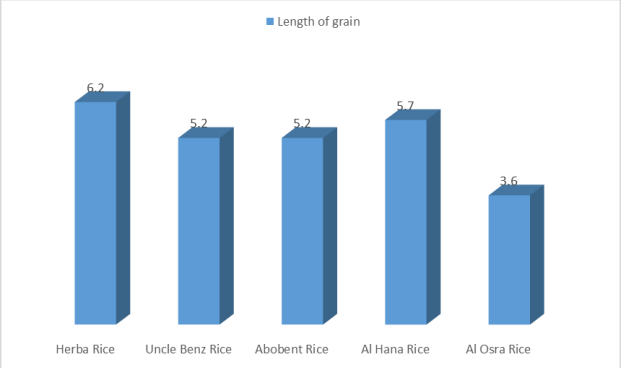

Fig (1): Average length of grain (mm)

These significant differences were found between the average length of the grain of Herba rice and all other types. These significant differences were also found between the average length of the grain of Uncle Benz rice and the other types of rice under study, with the exception of Abo-bent rice, where the differences between them were not statistically significant (Table 1). In addition, these significant differences appeared in the average grain length between Abo-bant rice, Al-Hana and Al-Osra rice (Table 1). The results showed that there were significant differences (P <0.001) in the average width of the grain between the types of rice under study, and the value of the lowest significant difference between the types of rice under study was (LSD = 0.26). These significant differences were evident in the average grain width between Herba rice and the other of the rice varieties with the exception of Uncle Benz rice, where the differences between them were not statistically significant. Likewise, significant differences were found in the mean grain width between Uncle Benz rice and all other types under study. These significant differences also appeared in the average width of the grain among the Hana rice, as shown in (Table 1).

Table (1): Some characteristics of the rice types under study

Type of rice	Density gm/cm^3	Average volume of 500 grains (cm^3)	The average length of grain (mm)	The average width of grain (mm)	The average degree of water absorption (g)	The average weight of 500 grain after cooking (g)	The average weight of 500 grain before cooking (g)
Herba Rice	3.155 AB	7.00^{A}	6.20	1.40^{A}	4.737 A	26.827	22.0
Uncle Benz Rice	6.389	5.00^{B}	5.20^{A}	1.40^{A}	5.255 B	37.203	31.948
Abo-bent Rice	3.094 AC	6.00^{A} BC	5.20^{A}	2.30^{B}	5.296 B	23.862	18.566
Al-Hana Rice	3.067 BC	7.00^{A} CD	5.70	2.00^{C}	4.640 A	26.110	21.470
Al-Osra Rice	2.637	8.00^{D}	3.60	2.25^{B} C	6.360	27.463	21.103

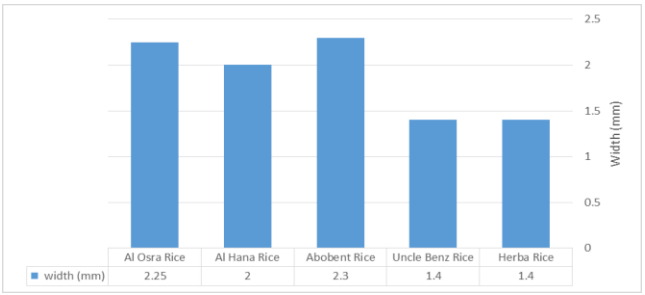

Fig (2): Average width of grain (mm)

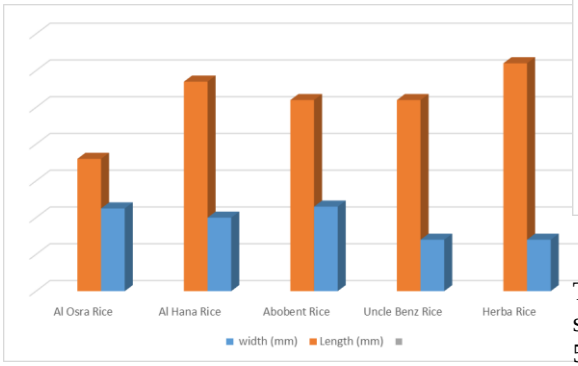

Fig (3): Shapes of the Grains

Weight, volume and density:

Weight:

The results indicated in Figure (4) that the average weight was high in Uncle Benz rice, which reaching (31.94 g), and the grain in this variety were heavy, while in Herba rice, the average weight was (22.09 g), while in Al Hana rice. Al-Osra and Abu Bint rice had an average weight of 500 grains (21.47, 21.10, and 18.56 g) respectively, and the grain in these varieties were considered rather heavy.

The statistical results showed that there were high significant differences in the average weight of 500 grains before cooking between the different types of rice under study. The lowest significant difference was found between them by (LSD = 0.11). Uncle benz rice and the other types, Abo-bent rice and other types of rice. The difference in the average weight of 500 grains before cooking the Al-Hana and Al-Osra rice was statistically significant (Table 1).

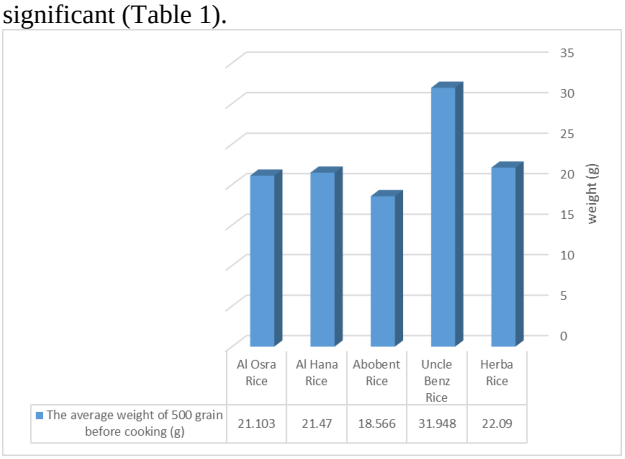

Fig (4): Average weight of 500 grain before cooking (g)

Volume:

The average volume of the Al-Osra rice was (8 cm3), while the rice of Herba and Al-Hana was (7 cm3), while it was in the rice of Abo-Bent (6 cm3) as shown in Figure (5).

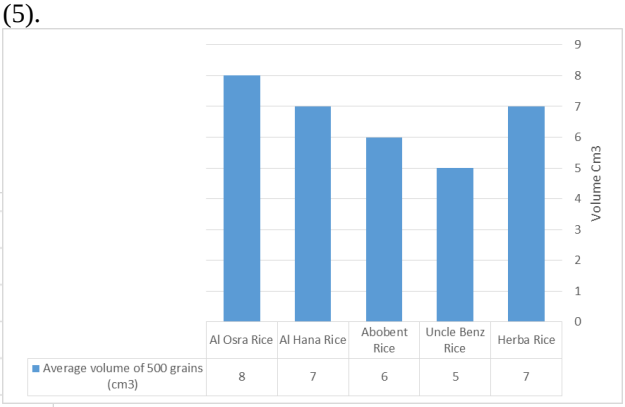

Fig (5): Average volume of 500 grains (cm3)

The statistical results indicated that there were high significant differences (P <0.001) in the average size of 500 grains. The value of the lowest significant difference between the types of rice under study was (LSD = 0.22). These significant differences appeared between the average size of 500 grains of Uncle Benz rice and all other types of rice except for Abobent rice, where the differences were in the average size of 500 grains between them. The differences were not significant, while the differences in the average size of 500 grains of the type Abobent rice and Al-osra rice were significant. (Table 1).

Density:

From the results obtained from the average weight and size, the density was calculated for the rice varieties, where the density of Uncle Benz rice was the highest (6.38 g / cm^3) among the varieties, followed by the Herba

rice (3.15 g / cm^3). As for Abo-bent and Al-Hana rice, a slight difference was found between them, where the density was in Abo-bant rice (3.09 g / cm^3), while in Al Hana rice (6.03 g / cm^3), the average density in Al-Osra rice decreased to (2.63 g / cm^3), as shown in Figure (6).

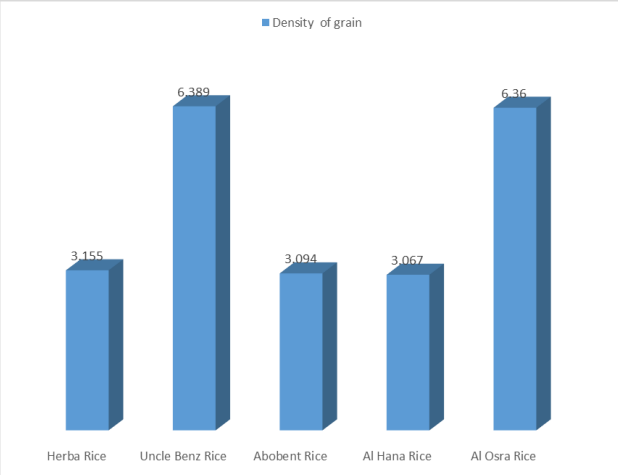

Fig (6): Average Density of grain

The statistical results showed that there were high significant differences (P <0.001) between the average density of the types of rice under study, and the value of the lowest significant difference was reached among the types of rice under study (LSD = 0.010) and all other types of rice. In addition, the significant differences were found in the average density between the Al-Osra rice and the other types of rice, while the differences in the average density between Herba rice and both Abo-Bent and Al-Hana rice were not significant. Besides, the difference in the mean density of Abo-Bent rice and Al-Hana rice was not significant (Table 1).

Cooking properties:

Water Absorption:

All the degrees of water absorption were different, as it reached in Al-Osra, Uncle Benz, and Abo bent rice (6.36), (5.25) and (5.29), respectively. The difference between them was slight, but in the Al-Hana rice the degree of water absorption reached (4.64) and in the Herba rice (4.37), they were close after they were represented graphically. As shown in Figure 7. The statistical results showed that there were high significant differences in the average degree of water absorption between the different types of rice under study, and the least significant difference was found between them by (LSD = 0.33). These significant differences were found to be valuable between the average degree of drinking Herba rice and the other grains, except for Al-Hana rice, as the difference between them is not significant. Significant differences were also found between Uncle Benz rice, Al Hana rice and Al Osra rice, as well as between Abu bent and Al Hana rice and Al Osra rice. In addition, significant differences appeared in the average degree of water absorption between Al-Hana and Al-Osra rice. On the contrary, the difference in the average degree of drinking Uncle Benz and Abo bent rice was not significant (Table 1).

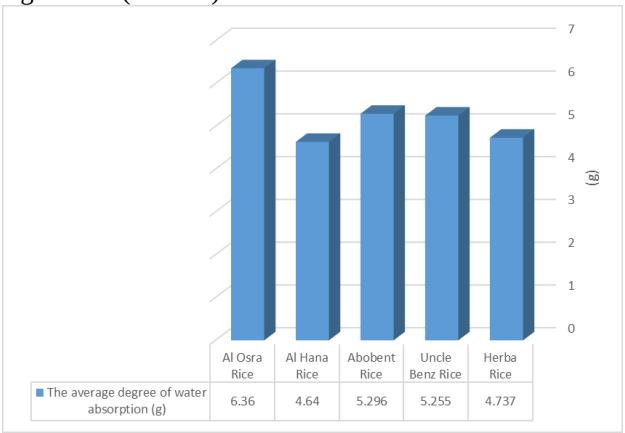

Fig. (7): Average degree of water absorption (g).

Volume Expansion test:

Through experiments, it was noticed that Herba rice obtained the highest degree of increase in volume (5 cm^3). As for Al-Hana rice and Abu Bent rice, the increase in volume was the same for both varieties, reaching (4 cm^3), while it was for the Al- Osra rice (2.77 cm^3) and for Uncle Benz (2 cm^3) as there is little difference between them.

High significant differences were found between the average weight of 500 grains after cooking for the different types of rice under study (P <0.001), and the lowest significant difference between them (LSD = 0.14). These significant differences were shown between Herba rice and the other rice types, as well as among Uncle Benz rice and the other types, and between abo bent rice and other types of rice. In addition, significant differences appeared in the average weight of 500 grains after cooking between Al-Hana and Al-Osra rice. As shown in Table (1).

Cooking Time:

During cooking process, the Hana rice and Herba rice for 20 minutes, and after tasting, the ripening process of the rice was not completed and there was a feeling of stiffness in the rice grains in the mouth, but when the time was increased to 30 minutes, we noticed the completion of the maturation process and the shape of the cooked rice was firm and not sticking together. When the shape of the grains changed, the time of exposure to heat increased to (40-50 minutes) and the grains became sticky with the appearance of a slight odor. As for Abo-bent rice, it needed a longer time to ripen. When we tasted the rice grains of this variety after cooking it for 20 minutes. It was noticed immaturity and the grains remained in a solid state, and with an increase in time for 30 minutes, the beginning of maturity was with the appearance of a slight odor, and the ripening process of this variety was completed after cooking it for a period of 40-50 Accurate, without defects.

Whereas, Al-Osra and Uncle Benz rice differed from the other rice varieties, as they reached the point of complete maturity after cooking them for 20 minutes. The sign of

deterioration has appeared after 30-minute cooking process, as their color changed and begin to clump and knead with the appearance of a strong smell with increasing time to 40-50 minutes.

Aroma Test:

Through the smell test that was conducted on the five varieties of rice under study. It was noticed that the Al-Hana rice and the Al Osra rice produced a strong (strong) smell during cooking. while the smell of Herba rice was weak (Slight) and the Uncle Benz rice had a smell of almost or little (Non), while the smell of Abo bent rice was of medium strength (Moderate), according to the tests conducted on these varieties.

Sensory evaluation:

Sensory evaluation was performed on the five varieties of rice under study by student evaluators. Aroma, color, taste, appearance, grain size, kneading and graininess were evaluated after cooking the rice for a period of (20, 30, 40 and 50 minutes). The total evaluation scores were 100 points distributed on the mentioned characteristics, and the following results were obtained:

Cooking for 20 minutes:

Uncle Benz rice gets the highest sensory evaluation when cooked for 20 minutes, with an average score of 87.21 / 100, although the degrees of color, appearance and grain size were not the highest compared to the other varieties. While, Al-Osra rice gets the lowest sensory evaluation score, with an average of 36.36 / 100, as shown in Table (2).

Cooking for 30 minutes:

Al Hana rice gets the highest sensory evaluation when cooked for 30 minutes, followed by Harba rice, where the average score for Al Hana rice was 87.62 and Herba rice was 87.28 out of 100, although the color, appearance and grain size of Al Hana rice were not the highest compared to other varieties. Whereas, Al-Osra rice gets the lowest scores of sensory evaluation with an average of 42.61 out of 100, as shown in Table (2).

Cook for 40 minutes:

The sensory evaluation of the rice varieties showed that when cooking for 40 minutes, Uncle Benz's rice was the best, getting 80.24 out of the total sensory rating score, while the Al- Osra rice was the worst, as this was expressed in results that did not exceed 11.13 as shown in table (2).

Cooking for 50 minutes:

The sensory evaluation of the rice varieties showed that when they were cooked for 50 minutes, Al-Hana rice was the best, as it got 85.73 of the total sensory evaluation scores, while the Al Osra rice was the worst, as it got the lowest sensory evaluation score, which did not exceed 19.48, as shown in Table (2).

It is evident from the results of the sensory evaluation that the rice varieties imported to the Libyan market are mostly good and have good cooking properties, and their quality was ranked in the following order: Uncle Benz, Al Hana, Abo-bent, Herba, and then Al-Osra.

Table (2): Degrees of sensory evaluation of the rice varieties after cooking for different periods (20, 30, 40 and 50 minutes)

Type	Color 15%	Taste 25%	Appearance 15%	Odor 15%	Grain Size 15%	Kneading and graininess 15%	Total 100 %
Cooking for 20 min.							
Herba	13.50	15.60	12.60	10.80	12.50	12.50	77.50
Uncle Benz	12.60	2012	13.12	13.75	13.50	14.12	87.21
Al-Hana	12.25	15.12	14.00	11.25	13.62	13.50	79.74
Abu-Bent	13.12	17.87	13.12	11.12	12.12	13.50	80.85
Al - Osra	11.73	8.00	3.12	8.62	3.25	2.00	36.36
Cooking for 30 min.							
Herba	13.00	20.80	11.87	6.62	12.37	11.62	87.28
Uncle Benz	13.62	18.87	13.25	13.25	13.87	13.00	85.87
Al-Hana	13.00	21.50	12.75	13.62	13.00	13.75	87.62
Abu-Bent	12.00	17.50	9.50	10.00	10.75	9.37	69.13
Al-Osra	10.12	10.00	4.37	10.12	5.00	3.00	42.61
Cooking for 40 min.							
Herba	13.12	18.75	12.62	11.62	11.37	9.12	76.60
Uncle Benz	13.75	15.25	12.50	11.87	11.87	12.25	80.24
Al-Hana	13.12	13.62	13.37	11.87	11.87	12.75	76.60
Abu-Bent	14.00	16.00	12.50	12.25	11.87	10.37	76.99
Al-Osra	3.87	1.37	0.87	4.75	0.15	0.12	11.13
Cooking for 50 min.							
Herba	13.37	16.75	11.75	12.87	11.12	8.12	73.98
Uncle Benz	12.12	16.50	12.20	12.25	13.25	12.12	78.44
Al-Hana	13.00	18.87	12.50	12.87	13.87	14.62	85.73
Abu Bent	13.00	11.37	11.25	12.50	12.25	10.50	70.87
Al-Osra	4.37	5.37	2.50	6.12	0.67	0.50	19.48

Conclusion:

It is evident from the study of some general characteristics of some varieties of rice imported to the Libyan market, which included the engineering characteristics represented in the dimensions and shape of the grains and the physical properties to identify the weight of the imported grains in addition to the characteristics. The quality and cooking of the targeted rice is mostly good and has good cooking properties. Its quality has been classified in the following order: Uncle Benz, Al Hana, Abobent, Herba, and then Al Osra.

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