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Preparation and Evaluation of Instant Rice

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Abstract: The aim of this study is to find a suitable method to prepare instant rice, which is, characterized with low rehydration time for two rice varieties, Giza 177 as short grain and Egyptian Jasmine as long grain. Instant rice was prepared by using boiling methods or cooking in electric cooker followed by refrigerating or freezing for 24 hours then drying. Physiochemical properties, solid loss %, cooking quality, rehydration quality and sensory properties of instant rice after drying and after rehydration were estimated. Results showed that Egyptian Jasmine rice characterized with higher amylose content compared to rice Giza177. Moreover, solid loss % was increased significantly in the rice, which prepared by using the boiling methods compared to the instant rice of electric cooker. Furthermore, agglomeration scores was increased in dried instant rice, which prepared by using the boiling method and its appearance was significantly decreased, leading to low overall acceptability and refusal. Water uptake ratio during cooking of home cooked rice (controls) was increased significantly compared to instant rice during rehydration. On other hand, the instant rice of electric cooker that followed by refrigerating was higher in rehydration ratio compared to instant rice of electric cooker that followed by freezing. Jasmine rice characterized with higher cooking time (25 min) in home cooked rice compared to Giza 177 (17 min), while rehydration time of instant rice declined to reach 6 and 5 min in Jasmine rice and Giza 177, respectively. Moreover, home cooked rice and instant rice of Jasmine rice characterized with higher grain elongation ratio, volume increase ratio and amylose content than Giza 177. Also the instant rice products for the two varieties which prepared by using electric cooker, followed by refrigerating were high in volume increase ratio and grain elongation ratio, while amylose content not affected significantly compared to an electric cooker that followed by freezing. Therefore, it could be recommended that the electric cooker that followed by refrigerating and drying is appropriate method to produce high quality instant rice in sensory properties, overall acceptability and can be rehydrated for consumption within few minutes.

Key words: Instant rice · Rehydration · Electric cooker · Boiling · Refrigerating and freezing

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important agricultural crops in the world and essential food in many countries, it is considered as a high value crop and second cereal crop after wheat in the world, where produce about 430 million ton of the world's production of rice [1]. Rice cultivation in Egypt in the 2018 season was reduced by one third to 724,000 feddans (304,000 hectares). As a result, productivity in Egypt 2018 was 6.1 million tones by reduction 4% year-on-year reduction [2].

Rice is not only the main source of energy, but also it is a source of protein, vitamin and other nutrients [3]. Also, rice is the only cereal crop which consumed as cooked and whole grains [4].

Life has changed dramatically, where many families have not had enough time to prepare food for them and their children, so they prefer to buy instant food products [5], leading to high demand for these products because consumers are looking for comfort. To meet consumer's needs, freezing and drying techniques was applied to rice [6].

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Instant rice is one of the favorite choices which becoming more common nowadays. Short rehydration times, cooking characteristics close to cooked ordinary rice are desirable properties of instant rice products, however the problem of long rehydration times and the quality is still facing instant rice [7].

Instant rice is defined as the dehydrated rice grain that can be prepared for consumption within 3-5 min by only following the addition of hot water, while raw rice requires about 20 min for cooking [8]. A general procedure for preparing instant rice involves the basic steps as soaking, cooking and drying. It was also observed that the processes of refrigerating and freezing had provided high quality instant rice [9], may be due to retard starch retrogradation [10]. Furthermore, fast cooling time can inhibit or slow down the starch retrogradation during refrigerated storage [11].

The economic importance of rice depends on its cooking quality, which can be measured by the water uptake ratio, solids loss in cooking water and cooking time [12].

Therefore, the aim of this research was to find a suitable method for preparing instant rice from two rice Egyptian varieties, Giza 177 as short grain and Egyptian Jasmin as long grain, to obtain high quality instant rice product with acceptable color, low solids loss %, low rehydration time and the more similar in the sensory properties to home cooked rice. Also, this product will be useful for families which seek to quick-cooking rice by reheating in boiling water or using a microwave oven.

MATERIALS AND METHODS

Materials: Two white rice varieties Giza 177 as short grain and Egyptian Jasmine as long grain were used to prepare instant rice. Both varieties were obtained from the Rice Research program, Field crops Research Institute, Agriculture Research Center, Sakha, Kafr El Sheikh, Egypt. The samples of rice were kept in polyethylene bags at refrigerator temperature (4± 1°C) till using.

Methods

Preparation of Instant Rice: Five hundred gram of raw rice (Giza 177 and Egyptian Jasmine) were washed and soaked for 10 min at room temperature. Water to rice at ratio (1.5: 1 v/v). Preparation of instant rice were carried out in two ways according to Rewthong *et al*. [9]. The first way is the method of boiling and the second way is the method of using electric cooker (Panasonic Automatic jar cooker, Model SR-KA 22FA, 745 W). The cooking time of the two methods was 15 min., then simmering for 10 min. The obtained cooked rice of the two methods was washed with cool water to prevent rice agglomeration. The obtained cooked rice of the two varieties was cooled using refrigerating at 4°C for 24 hr. or using freezing at - 20°C for 24 hr. The obtained rice was dried at 60°C for 24 hr. The previous steps were illustrated in Figure (1). The home cooked rice was cooked using Tefal cooker as a control samples for the two rice varieties of short and long grain, cooking water was added at the rate of 1:1 (v.v) and 1.5:1 (v/v) for Giza 177 (HCS) and Egyptian Jasmine rice (HCL), respectively.

Physical Properties: Length and width of rice were measured using a caliper according to the method described by Khush *et al*. [13].

Length-Breadth Ratio: Length -breadth ratio (L/B) was determined by dividing the length by width of individual grains in 10 replications according to Wu *et al.* [14].

Grain Shape: Grains are classified as slender and short bold on the basis of length and length-breadth ratio according to Kuchekar and Yerigeri [15].

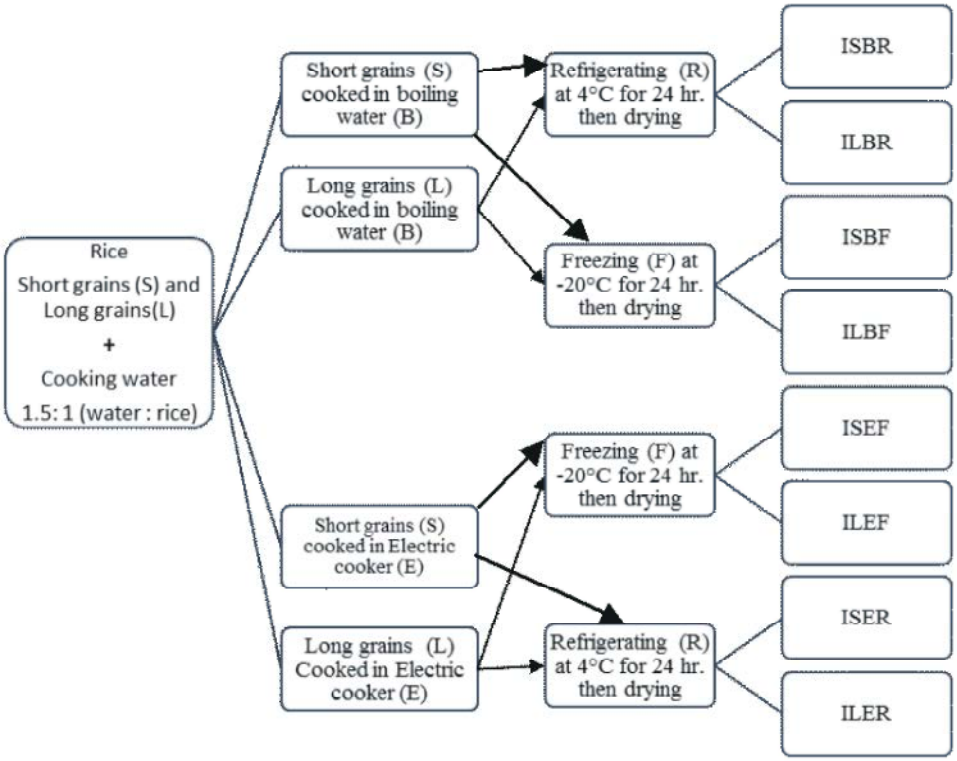
Bulk Density: Sample of rice was put in 100 ml cylinder, then the volume and weight were recorded. Bulk density was determined according to Wongsa *et al.* [8] as follows**:**

$$\text{Bulk density} = \frac{\text{Weight of rice (g)}}{\text{Volume of rice (cm}^3\text{)}}$$

Whiteness Index: Color was Measured based on the CIE-LAB system with color values of L^*, a* and b* display. Color was measured for raw rice, cooked rice and instant rice by using a handheld Chromameter (model CR-400, Konica Minolta, Japan). The whiteness index (WI) was determined according to Saricoban and Yilmaz [16] as follows:

$$WI = 100\sqrt{(100 - L^*)^2 + a^{*2} + b^{*2}}$$

Proximate Chemical Composition: Crude protein, crude fat, ash and crude fiber contents of raw rice were analyzed according to the procedures described in AOAC [17]. Total carbohydrates were calculated by difference.



ISBR = instant short rice + boiling + refrigerating, ILBR = instant long rice + boiling + refrigerating, ISBF = instant short rice + boiling + freezing, ILBF = instant long rice + boiling + freezing, ISEF = instant short rice + electric cooker + freezing, ILEF = instant long rice + electric cooker + freezing, ISER = instant short rice + electric cooker + refrigerating, ILER = instant long rice + electric cooker + refrigerating.

Fig. 1: Preparation methods of instant rice

Amylose Content: Amylose content was determined by the colorimetric method according to Kumari *et al*. [18].

Solid Loss in Cooking Water: Solid loss was referred to the method of Gujral and Kumar [19] as follows**:** two grams of rice was put in an aluminum can containing 20 ml of distilled water. The rice was cooked. The cooking water was collected and transferred into a re-weighed aluminum can and dried at 105°C in hot air oven for 24 h to remove moisture. The aluminum can was cooled in a desiccator and weighed to determine the increase in weight of the can.

Increase in weight of can = Weight of can after drying - Weight of can empty

$$\text{Solid loss \%} = \frac{\text{Increase in weight of can}}{\text{Weight of rice before cooking}}$$

Evaluation of Cooked and Instant Rice

Cooking Time of Cooked Rice and Rehydration Time of Instant Rice: The cooking time was determined according to Singh *et al*. [20] by removing a few kernels at different time intervals during cooking and pressing them between two glass plates. When the starch is fully gelatinized, there is no white particle of the rice kernel is seen between the glass plates. Re-hydration time was determined according to Wongsa *et al.* [8] as follows**:** Twenty grams of the dried samples was rehydrated in 100 mL boiling water and the samples were removed every 30 sec (started from 3 min) and pressed by a glass plate. Rehydration time was the time that opaque white center of the instant rice was disappeared.

Water Uptake Ratio of Cooked Rice and Rehydration Ratio of Instant Rice: Water uptake was determined according to Sareepuang *et al*. [21] and the rehydration ratio was calculated according to Prasert and Suwannaporn, [7].

$$\text{Water uptake ratio} = \frac{\text{Weight cooked rice (g)}}{\text{Weight of uncooked rice (g)}}$$

$$\text{Rehydration ratio} = \frac{\text{Weight of instant rice after rehydration (g)}}{\text{Weight of dry instant rice before rehydration (g)}}$$

Volume Increase Ratio of Cooked and Instant Rice: Volume increase was determined according to Prasert and Suwannaporn [7] by measuring the volume of 20 g of rice before and after cooking or rehydration using graduated cylinders. The volume increase calculated as the volume of rice as follows:

$$\text{Volume increase ratio} = \frac{\text{Volume of rice after cooking or after rehydration (ml)}}{\text{Volume of rice before cooking or before rehydration (ml)}}$$

Grain Elongation of Cooked and Instant Rice: Length of rice before and after cooking and rehydration was measured using a caliper according to Kerdpiboon and Charoendee [22].

$$\text{Elongation} = \frac{\text{Length of cooked rice or rehydrated rice}}{\text{Length of raw rice or dried rice before rehydration}}$$

Sensory Evaluation: Sensory evaluation of dried instant rice was carried out using a hedonic test with a nine-point rating scale which rated from 1 (dislike very much) to 9 (like very much) for appearance, color, fluffy and overall acceptability. Moreover Sensory evaluation of home cooked rice and rehydrated instant rice was carried out for appearance, color, softness and stickiness, fluffy, taste, flavor and overall acceptability according to the method of Charutigon *et al.* [23]. The samples were evaluated by 10 panelists all have an experience in Food Technology Research Institute, Agricultural Research Center, Giza-Egypt.

Statistical Analysis: The obtained data were exposed to analysis of variance (ANOVA). Duncan is multiple range tests at ($P \leq 0.05$) level was used to compare between mean values [24].

RESULTS AND DISCUSSION

Physical Properties of Raw Rice: The physical properties of white rice for Giza 177 and Egyptian Jasmine are presented in Table (1). The obtained results showed that there were significant difference between the two varieties in length, width and length / breadth ratio (L/B), while there were no significant difference between them in bulk density. Whiteness index in Giza 177 was higher than Egyptian Jasmine rice (70.69 and 65.93, respectively). These results agreed with those reported by Abd-El Salam, [25]; Abd-El Salam, *et al*. [1] and Shimaa and Mahgoub [26]. On the other hand the shape grain of rice Giza 177 was short bold, while Egyptian Jasmine rice was long slender these results were similar with to Kuchekar and Yerigeri [15] who classified grain shape of rice on the basis of length and the L/B ratio to long slender grain shape, which had a length from 6.61 to 7.7 mm and L/B ratio over 3, while short bold grain shape which had length (6 or less) and L/B ratio (less than 2.5).

Chemical Composition of Raw White Rice Samples: The chemical composition of the two white rice varieties (Giza 177 and Egyptian Jasmine) were analyzed and reported in Table (2). The results showed that there were no significant difference between Giza 177 and Egyptian

Table 1: Physical properties and color of raw white rice samples

Samples	Grain length (mm)	Grain width (mm)	Length / breadth ratio	Bulk density g/ml	Whiteness index	Grain shape
Giza 177	5.30^{b}±0.1	2.86^{a}±0.25	1.85^{b}±0.20	1.05^{a}±0.29	70.69^{a}±0.963	Short bold
Egyptian Jasmine	7.10^{a}±0.05	2.14^{b}±0.12	3.32^{a}±0.19	0.81^{a}±0.010	65.93^{b}± 1.577	Long slender

Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

Table 2: Chemical composition of raw white rice on dry weight basis (%)

Samples	Crude Fat	Crude Protein	Ash	Crude fiber	Total carbohydrates	Amylose
Giza 177	0.85^{a}±0.05	7.09^{a}±0.36	0.91^{b}±0.3	0.29^{a}±0.005	90.86^{a}±0.35	18.60^{b}±0.44
Egyptian Jasmine	0.89^{a}±0.01	7.56^{a}±0.15	1.02^{a}±0.05	0.32^{a}±0.03	90.21^{a}±0.20	22.0^{a}±0.65

Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

ISBR= instant short rice + boiling + refrigerating, ISBF= instant short rice + boiling + freezing , ISER = instant short rice + electric cooker + refrigerating , ISEF= instant short rice + electric cooker + freezing, ILBR = instant long rice + boiling + refrigerating , ILBF = instant long rice + boiling + freezing , ILER= instant long rice + electric cooker + refrigerating , ILEF= instant long rice + electric cooker + freezing

Fig. 2: Effect of preparing method of instant rice on the soild loss percentage

Jasmine in crude fat, crude protein, crude fiber and total carbohydrate contents, these results agreement with Abd-El Salam [25]; Shimaa and Mahgoub [26]; El-Bana *et al.* [27] and Abd-El Salam *et al*.[1]. While there were significant difference in the ash and amylose content, since Egyptian Jasmine had higher value for amylose and ash (22.0 and 1.02 %, respectively) and Giza 177 had lower values (18.60 and 0.91%, respectively). The differences in the amylose content are attributed to the characteristics of the varieties, the environmental conditions in which the crop is grown and particularly temperature [28]. Generally the long grain varieties have the highest amylose content [29].

Evaluation of Instant Rice Which Prepared with Different Methods

The Solid Loss During Prepare Instant Rice: Solid loss should not be high because the residual solid grain particles in boiling water is disposed after cooking [30]. In the current study the solid loss % ranged from 3.02 to 8.04 % (Figure 2). The results showed that the rice, which prepared by using boiling methods (ISBR, ISBF, ILBR and ILBF) had higher values of a solid loss % than the rice which prepared by electric cooker (ISER, ISEF, ILER and ILEF).

On the other hand the solid loss % was lower in Egyptian Jasmine rice which prepared by using boiling and electric cooker (ILBR, ILBF, ILER and ILEF) compared to rice Giza 177 (ISBR, ISBF, ISER and ISEF). The variation of solid loss % may be due to amylose content [31], product structure and cooking methods [32]. The decrease of solid loss % in Egyptian Jasmine rice can be attributed to its slender shape which have comparatively smaller surface area as mentioned by (Hirannaiah *et al.* [33].

Sensory Evaluation of Dried Instant Rice: Sensory evaluation is considered to be a valuable tool in solving problems relating to food acceptability. It is a useful in product improvement, quality protection and new product development [34].

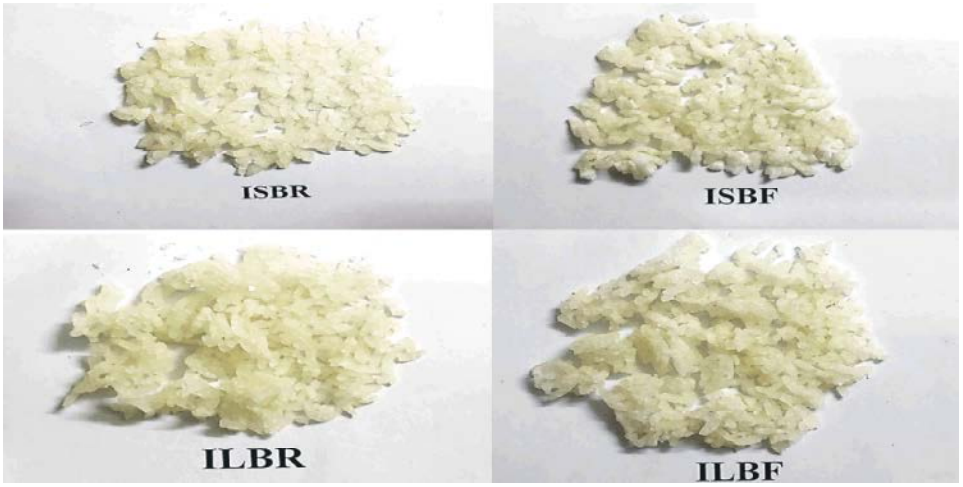
Sensory evaluation of dried instant rice by using different methods was carried out on the basis of 9-point hedonic scale. The mean scores of organoleptic characteristics are summarized in the Table (3). The dried instant rice (ILER, ILEF, ISER and ISEF) which prepared by using electric cooker recorded higher scores in appearance, color, fluffy and overall acceptability compared to the dried instant rice which prepared by using boiling methods (ISBR, ISBF, ILBR and ILBF).

Data in Table (3) observed that the instant rice, which prepared by using boiling methods (ISBR, ISBF, ILBR and ILBF) recorded low scores in appearance and fluffy, leading to low overall acceptability. The methods of cooking influenced on the morphology of instant rice, where the rice, which prepared by using boiling was more agglomerate (less fluffy) than the instant rice, which prepared by using electric cooker. This corresponded with Fig (3), which showed the deformation in the case of the samples which prepared by using boiling methods. Ali *et al.* [3] reported that the instant rice, which prepared by using boiling had low scores in preference, color, flavor and overall acceptability.

Table 3: Sensory evaluation of dried instant rice samples

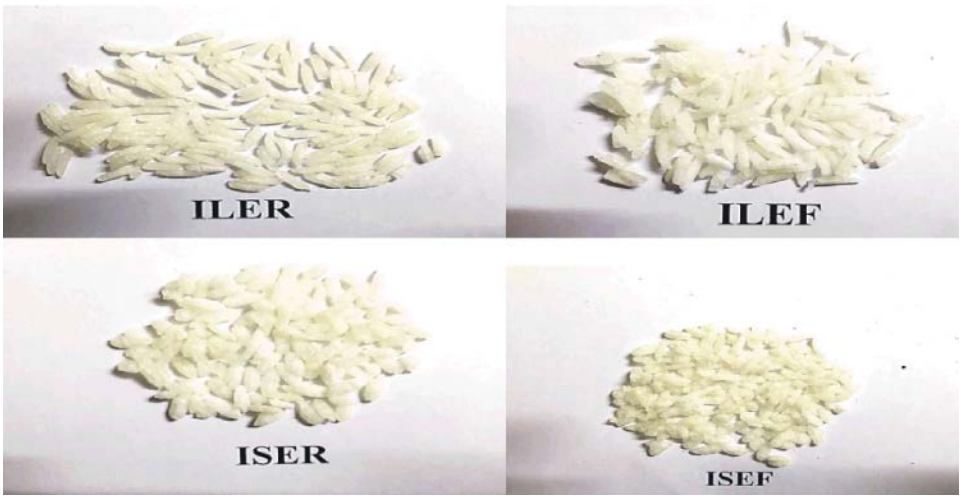
Treatment	Appearance	Color	Fluffy	Overall acceptability
ISBR	4.65^{c} ± 0.91	5.95^{c} ±1.64	5.75^{b} ±1.31	4.80^{b} ± 0.42
ISBF	4.75^{c} ± 1.06	5.85^{c} ±1.02	5.95^{b} ±1.0	4.55^{b} ± 0.83
ISER	7.90^{a} ± 0.51	8.30^{a} ±0.67	8.25^{a} ±0.63	8.10^{a} ± 0.73
ISEF	7.15^{b} ± 0.88	7.95^{ab} ±1.25	8.05^{a}±0.68	7.50^{a} ± 0.97
ILBR	4.85^{c} ± 0.85	5.85^{c} ±0.78	5.20^{b} ±1.39	4.80^{b} ± 1.25
ILBF	4.35^{c} ± 0.85	6.95^{b} ±1.25	5.50^{b} ±1.20	4.75^{b} ± 1.01
ILER	8.25^{a} ± 0.54	8.30^{a} ±0.82	8.40^{a} ±0.69	8.20^{a} ± 0.63
ILEF	8.25^{a} ± 0.92	8.20^{a} ±0.91	8.20^{a} ±0.78	8.20^{a} ± 1.03

ISBR= instant short rice + boiling + refrigerating, ISBF= instant short rice + boiling + freezing, ISER = instant short rice + electric cooker + refrigerating, ISEF= instant short rice + electric cooker + freezing, ILBR = instant long rice + boiling + refrigerating, ILBF = instant long rice + boiling + freezing, ILER= instant long rice + electric cooker + refrigerating, ILEF= instant long rice + electric cooker + freezing. Values are mean of ten replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 level



Dried Instant rice which prepared using boiling with refrigerating or freezing

ISBR= instant short rice + boiling + refrigerating, ISBF= instant short rice + boiling + freezing
ILBR = instant long rice + boiling + refrigerating, ILBF = instant long rice + boiling + freezing



Dried Instant rice which prepared using electric cooker with refrigerating or freezing

ILER= instant long rice + electric cooker + refrigerating, ILEF= instant long rice + electric cooker + freezing
ISER = instant short rice + electric cooker + refrigerating, ISEF= instant short rice + electric cooker + freezing

Fig. 3: Dried instant rice which prepared using boiling and electric cooker, followed by refrigerating or freezing.

Table 4: Whiteness index and bulk density of home cooked rice and rehydrated Instant rice.

Treatment	Whiteness index	Bulk density
	Home cooked rice (controls)	
HCS	71.78^{a} ±0.71	0.89^{a} ±0.005
HCL	67.68^{b} ±0.85	0.77^{b} ±0.006
	Rehydrated instant rice for short rice (IS)	
ISER	65.52^{c} ±1.01	0.73^{c} ±0.005
ISEF	66.07^{c}±0.33	0.72^{c} ±0.007
	Rehydrated instant rice for long rice (IL)	
ILER	63.57^{d} ±0.76	0.67^{d} ±0.01
ILEF	63.42^{d} ±1.08	0.66^{d} ±0.002

HCS= home cooked short rice as control, HCL= home cooked long rice as control, ISER = instant short rice + electric cooker + refrigerating, ISEF= instant short rice + electric cooker + freezing, ILER= instant long rice + electric cooker + refrigerating, ILEF= instant long rice + electric cooker + freezing, Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 level

Physical Properties of Instant Rice after Rehydration

Whiteness and Bulk Density: The color is considered the most important apparent attribute in the perception of the product quality, because it is evaluated by consumers and often is the basis for their selection or rejection [35]. Bulk density is the weight of a standard volume of grain; it is a generally accepted measure of grain quality. The whiteness index and bulk density are illustrated in Table (4). The whiteness and the bulk density were ranged from 63.42 to 71.78 and 0.66 to 0.89, respectively. The whiteness index and bulk density in the control sample (HCS) and instant rice (ISER and ISEF) for Giza 177 (short grain rice) were higher than (HCL) and instant rice (ILER and ILEF) for Egyptian Jasmine (long grain rice).

There were no significant differences between the instant rice (ISER and ISEF) as well as (ILER and ILEF). All instant rice had lower values for whiteness index and bulk density than home cooked rice (controls). These results agreed with Ponnappan *et al.* [36] who mentioned that bulk density was higher in short grain rice than the long grain rice. The color change during preparing instant rice may be due to the effect of heating process with hot air [37].

Quality Evaluation of Home Cooked Rice and Rehydrated Instant Rice: The water uptake ratio is an important parameter during cooking rice. [38], while rehydration is an important characteristic of many dried products before their consumption [39], it is mean wetting of dry material [40]. The results given in Table (5) showed that the water uptake ratio for home cooked rice (HCS and HCL) were higher values than the rehydration ratio of the instant rice (ISER, ISEF, ILER and ILEF).

Also water uptake ratio for home cooked rice (HCL) of long grain and a rehydration ratio of instant rice (ILER and ILEF) of long grain (Egyptian Jasmine) were high values, compared to HCS, ISER and ISEF for short grain rice (Giza 177). These results may refer to the amylose content EL-Hissewy *et al.* [41] who reported that the short grain varieties had lower amylose content and required less water uptake ratio and shorter in cooking time. Also, Danbaba *et al.* [42] found that the amylose content might be responsible for high water uptake ratio. Furthermore, Frei and Becker [43] stated that the rice of high amylose content tends to absorb more water during cooking.

Moreover, Table (5) showed that the instant rice, which prepared by using electric cooker, then refrigerating (ISER and ILER) had higher values in rehydration ratio compared with instant rice, which prepared by using electric cooker then freezing (ISEF and ILEF). The dried products which had a higher value of rehydration ratio were considered a good quality because the pores allow water to enter the cells [44].

Table 5: Cooking quality of home cooked rice and rehydration quality of instant rice samples.

Treatment	Water uptake ratio and rehydration ratio	Cooking time (min) and rehydration time (min)	Volume increase ratio	Grain elongation ratio	Amylose content %
		Home cooked rice (controls)			
HCS	3.03^{c} ±0.063	17^{b}	3.04^{b} ±0.036	1.53^{c} ± 0.015	16.47^{b} ±0.83
HCL	3.31^{a} ±0.056	25^{a}	4.25^{a} ±0.007	1.67^{a} ± 0.015	18.13^{a} ±1.31
		Rehydrated instant rice for short rice (IS)			
ISER	2.85^{d} ±0.01	5^{d}	2.25^{e} ±0.15	1.50^{cd} ± 0.015	13.43^{c} ±0.52
ISEF	2.62^{e} ±0.026	5^{d}	1.98^{f} ±0.005	1.48^{d} ± 0.26	14.01^{c} ±0.78
		Rehydrated instant rice for long rice (IL)			
ILER	3.26^{ab} ±0.015	6^{c}	2.76^{c} ±0.21	1.64^{ab} ± 0.025	15.71^{b} ±1.02
ILEF	3.21^{b} ±0.01	6^{c}	2.45^{d} ±0.015	1.63^{b} ± 0.017	15.70^{b} ±0.40

HCS= home cooked short rice as control, HCL= home cooked long rice as control, ISER = instant short rice + electric cooker + refrigerating, ISEF= instant short rice + electric cooker + freezing, ILER= instant long rice + electric cooker + refrigerating, ILEF= instant long rice + electric cooker + freezing ; Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 level

A suitable cooking time is usually obtained when an opaque center of a rice grain is no apparent by 90% of the starch in the grain [45]. While rehydration time is a major requirement for instant products, including instant rice [46]. Where very quick rehydration time with the appearance and texture close to normal cooked rice are considered the important properties of instant rice [8]. Table (5) showed that the cooking time was significant low in the home cooked rice (HCS) of short grain (Giza 177) compared to home cooked rice (HCL) for long grain Egyptian Jasmine (17 min and 25 min.), respectively. Also, the cooking time was the longest for home cooked rice (HCS and HCL) compared to rehydration time for instant rice (ISER, ISEF ILER and ILEF).

The rehydration time was significant low for instant rice (ISER and ISEF) of short grain rice Giza 177 compared with instant rice (ILER and ILEF) for long grain rice Egyptian Jasmine (5 min and 6 min, respectively). On the other hand, there was no significant difference in the rehydration time between instant rice (ISER) which prepared by electric cooker, then refrigerating and instant rice (ISEF) which prepared by electric cooker, then freezing as well as between instant rice (ILER) and (ILEF). The variation of cooking time and rehydration may be attributed to the amylose content [47]. Short grain varieties had lower amylose content and required less cooking time [41].

A volume increase of rice may be due to a rise in water vapor pressure inside the grain resulted to a rapid rise in the dimensions of grain and changes in their shape and produced a porous structure [8]. Data in Table (5) showed that the home cooked rice (HCL) and instant rice (ILER and ILEF) for long grain rice (Egyptian Jasmine) had a higher volume increase ratio compared to home cooked rice (HCS) and instant rice (ISER and ISEF) for short grain rice (Giza 177).

Also the control samples (HCS and HCL) contained the highest volume increase compared to the instant rice (ISER, ISEF, ILER and ILEF). From the obtained data of this Table, it was observed that the instant rice samples that prepared by using electric cooker, then refrigerating (ISER and ILER) were higher in volume increase compared to instant rice, which prepared by using electric cooker, then freezing. The volume increase of the rice depends on rice variety [48]. The high amylose content is correlated to the high volume increase ratio of rice [49].

Grain elongation indicates the extent of the grain length after cooking, it is one of the main characteristic and the best index for cooking quality and good rice, where the consumers preferred higher elongation ratio of the cooked rice than a lower elongation ratio and also it can be influenced by the amylose content [28, 42]. Rice absorbs water during cooking process, leading to its increases in length [30]. Table (5) showed that the grain elongation ratio ranged from 1.50 to 1.67. The samples HCS, ISER and ISEF for short grain rice (Giza177) were lower in grain elongation ratio compared to HCL, ILER and ILEF for long grain rice (Egyptian Jasmine). While the grain elongation ratio was higher for home cooked rice (HCL) compared to Instant rice (ILER and ILEF) as well as home cooked rice (HCS) compared to Instant rice (ISER and ISEF). Moreover the instant rice products which prepared by using electric cooker, then refrigerating (ISER and ILER) slightly increased in grain elongation compared to electric cooker, then freezing (ISEF and ILEF). Increasing in grain elongation after cooking may be due to absorb water, which leads to increased elongation of the cooked rice [22]. Also there was a strong positive correlation between amylose content and elongation of rice [12, 50].

Amylose content is the most important factors that determine textural properties. Table (5) showed that the amylose content ranged from 13.43 to 18.13%. The control sample (HCS) and instant rice (ISER and ISEF) for short grain rice (Giza177) were lower in amylose content compared to control (HCL) and instant rice (ILER and ILEF) for long grain rice (Egyptian Jasmine). EL-Hissewy *et al*. [41] reported that the short grain varieties had lower amylose content.

Regarding to the effect of the methods that were used in preparing the instant rice on amylose content, results observed that there was no significant difference in amylose content between the instant rice (ISER) which prepared by using electric cooker, then refrigerating and the instant rice (ISEF) which prepared by using electric cooker, then freezing as well as between (ILER) and (ILEF). The amylose content was higher in home cooked rice (HCS and HCL) compared to instant rice (ISER, ISEF, ILER and ILEF). This decrease in amylose content after cooking and after rehydration due to amylose solubility during heating and leaching in the cooking water [47], or attributed to the degree of gelatinization, which is inversely proportional to the amylose content [51]. Also, could be due to leach out of starch and amylose into the soaking water [52].

Sensory Evaluation of Home Cooked Rice and Rehydrated Instant Rice: Sensory evaluation provides information about products that are distinguished by the senses like appearance, color, softness, fluffy and flavor and helps consumer's choice the products [53].

Table 6: Sensory evaluation of home cooked rice and rehydrated instant rice

Treatment	Appearance	Color	Softness and stickiness	Fluffy	Taste	Flavor	Overall acceptability
Home cooked rice (controls)							
HCS	7.50^{b} ±1.35	8.65^{a}±0.66	8.20^{a} ±0.43	7.45^{b} ±0.95	7.90^{b} ±0.73	8.30^{ab} ±0.78	7.75^{a} ±1.31
HCL	8.75^{a} ±0.42	8.70^{a}±0.67	7.65^{ab} ±0.88	8.65^{a} ±0.47	8.75^{a} ±0.42	8.70^{a} ±0.48	8.40^{a} ±0.56
Rehydrated instant rice for short rice (IS)							
ISER	6.95^{b} ±0.76	7.90^{a} ±1.28	8.18^{a}± 0.33	7.20^{b} ±0.97	7.75^{b} ±1.03	8.10 ^{b} ±0.68	8.55^{a} ±0.12
ISEF	6.75^{b} ±0.97	7.60^{a} ±1.83	8.15^{a} ±0.33	6.85^{b} ±0.85	7.55^{b} ±0.68	8.0^{b} ±0.40	6.70^{b} ±1.08
Rehydrated instant rice for long rice (IL)							
ILER	8.70^{a} ±0.48	8.50^{a}±0.70	7.45^{ab} ±0.76	8.50^{a} ±0.577	8.60^{a} ±0.56	8.60^{ab} ±0.69	8.57^{a} ±0.51
ILEF	8.60^{a} ±0.51	7.95^{a}±1.30	7.15^{b} ± 0.88	8.40^{a} ±0.65	8.72^{a} ±0.48	8.50^{ab} ±0.57	6.75^{b} ±1.03

HCS= home cooked short rice as control, HCL= home cooked long rice as control, ISER = instant short rice + electric cooker + refrigerating, ISEF= instant short rice + electric cooker + freezing, ILER= instant long rice + electric cooker + refrigerating, ILEF= instant long rice + electric cooker + freezing.; Values are mean of ten replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 level.

The flavor is a combination of the taste and smell and it is the main criterion that makes the product to be liked or disliked, while tasting is the feeling that is distinguished by the taste buds and influenced by the flavor and it is one of the most essential factors of product acceptability [54]. The mean scores of organoleptic characteristics were summarized in the Table (6). The home cooked rice (HCL) and rehydrated instant rice (ILER and ILEF) for long grain rice (Egyptian Jasmine) had obtained higher scores in appearance, fluffy, taste and flavor than the control (HSC) and rehydrated instant rice samples for short grain rice (ISER and ISEF).

Moreover, there was no significant difference between all samples in the color. The home cooked rice (HCS) and rehydrated instant rice samples (ISER and ISEF) of short grain rice (Giza 177) recorded higher scores for softness and stickiness compared to the other samples for long grain rice (Egyptian Jasmine). From the data in this Table it was observed that the rehydrated instant rice, which prepared using electric cooker, then refrigerating (ISER and ILER) were contained higher scores in overall acceptability as their controls.

These results agree with Puspitowati and Driscoll [55] who reported that some of the amylose and amylopectin leach out of the rice kernels during cooking, leads to the stickiness of cooked rice. The rice varieties with high amylose content had a fluffy texture after cooking, while the rice varieties which had low amylose content become wet and sticky [43 and 49]. These results indicate that the Egyptian Jasmine rice which had high amylose content, therefore it is fluffy and less soft.

CONCLUSION

Nowadays, more active lifestyle leads to consumers' searching for high quality fast foods in the market. Instant rice is one of those fast foods which prepared by using simple techniques such as boiling and electric cooker, followed by refrigerating or freezing, then drying, some of these techniques effect on morphological and texture properties of the instant rice. From the results of this study it could be concluded the solid loss % was high in the instant rice which prepared by using the boiling method. Also the dried instant rice, which prepared by using this method was agglomerated and recorded the lowest score in appearance resulting in low overall acceptability and refuse it. While the dried instant rice, which prepared by using electric cooker, produces more acceptable products in terms of different sensory properties like appearance, color and overall acceptability before and after rehydration as well as flavor and taste after rehydration. Furthermore the instant rice, which prepared by using electric cooker, then refrigerating was high in rehydration ratio, volume increase ratio and grain elongation ratio and all these parameters are desirable to the consumer because it is characteristic of the quality for instant rice. Also Egyptian Jasmine rice showed good cooking and eating characteristics, based on its amylose content, grain elongation and solid loss % during cooking and rehydration.

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