COMPARATIVE STUDY ON THE UTILIZATION OF RICE IN PREPARING GLUTEN FREE FOOD PRODUCTS

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Abstract

This study evaluated agronomic and yield characters, proximate and mineral composition, and functional properties of some rice varieties [Black Rice (BR), Egyptian Yasmine Rice (EYR) and Egyptian Hybrid Rice1(EHR1)]. Results showed that yield attributes characters were significantly varied among the three varieties. There were highly significant differences among the mean values of all cultivars under study regarding all agronomic and yield characters under study in the two seasons. Rice cultivars were significantly differed in all grain quality and cooking characters in the two seasons. Rice varieties have amylose content ranged from 18.06 to 21.48%. Results showed that BR has the highest protein content among the tested rice varieties (10.5%). From results, it is clear that EYR, EHR1 and 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). Rice has good functional properties which enhance the nutritional quality of its products. Tortilla chips prepared from BR has the highest protein content (10.6%) while tortilla chips prepared from EHR1 has the lowest protein content (6.75%). In addition, EYR-tortilla chips have the highest overall acceptability score.

Key words: Rice varieties, yield characters, proximate & mineral composition, functional properties.

INTRODUCTION

Rice (*Oryza sativa L.*) is considered the most important cereal crop in the world. It is utilized as a staple food by more than a half of the world's population, especially in East and South Asia and the Middle East (Sharif *et al.*, 2014). According to USDA (2013), in the Middle East region, Egypt has been the largest rice producer, averaging rough rice production and milled rice production of about 6.812 and 4.850 million Tons, respectively.

To meet the new needs of consumers, researchers and rice breeders have developed rice cultivars with acceptable processing quality. The nutritional and commercial values of rice were affected by environment and genotype. Some rice

varieties have unique properties such as color, flavor, nutrition and chemical composition (Yang *et al*., 2010).

Grain quality of rice is important in consumer acceptability, it is the second as the major breeding objectives after yield. Aroma development is influenced by both environmental and genetic factors**.** All over the world, aromatic rice is preferred by consumers because of its flavor and palatability. It has a high amount of lysine (Subudhi *et al*., 2013), rich in carbohydrates, and is a source of the B vitamins.

A few varieties have unique characteristics in terms of their chemical composition, color and aroma. Black rice 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), and acts as an enhancer for some functions of spleen, liver, stomach and intestine**.**

Metwally *et al*., 2014 studied the agronomic characters as well as grain quality characters of black rice variety as compared to Egyptian Yasmine and Pusa Basmati 1 as aromatic varieties and Sakha105 as a high yielding variety. They reported that Black rice variety gave the highest values of grain width (mm), head rice (%), elongation (%) and protein content (%). On the other hand, black rice variety recorded the lowest values of plant height (cm), heading date (days), panicle length (cm), no. of panicles $hill^{-1}$, panicle weight (g), No. of filled grains $panicles^{-1}$, grain yield (t ha^{-1}) and grain length (mm).

Black rice is used as an ingredient in snacks and desserts. It is considered to be a functional food since it contains phenolic compounds, especially anthocyanins. Demand for black rice is growing fast in USA and EU due to its value as a health food and organic food color**.** Black rice extract improved the plasma lipid profile. Black rice has a number of nutritional advantages over common rice such as higher protein and minerals. It has low fat content, protein with excellent biological value, also, it is a good source of vitamins and insoluble fiber (Oko *et al*., 2012).

Rice is used in many foods such as bread, cakes and noodles. Rice starch is used in industries in many food applications. Rice flour is mainly used for making desserts, noodles, sweets and as a thickener for custards, sauces and gravies (Chandra and Samsher, 2013). It was also used in tortillas, processed meat, puddings, salad dressing and gluten free bread, for its unique functional properties.

This study was conducted to detect and shed more light on the quality and nutritional value of some rice varieties and encourage the utilization of rice to be incorporated in bakery products, taking in consideration people with celiac and kidney diseases.

MATERIALS AND METHODS

Materials:

Rice varieties [Egyptian Yasmine (EYR), Egyptian Hybrid Rice 1 (EHR1) and Black rice (BR)], also yield attributes characters were collected from the experimental farm of Rice Research and Training Center (RRTC), Sakha, Kafer El-Sheikh during 2013 and 2014. Samples were kept in polyethylene bags and stored at –22 ºC until used.

Corn flour and oil were obtained from the local market, of Kafr El-Sheikh, Egypt.

Chemicals used in this study were purchased from El-Gomhoria Company, Egypt.

Methods:

The tested yield attribute characters are plant height (cm), number of panicle per hill, panicle length (cm), number of filled grain per panicle, 100-grain weight (g), sterility (%), grain yield (t ha^{-1}).

Table 1. Parentage, type and origin of rice varieties.

No	Varieties	Parentage	Type	Origin
1	Black rice (BR)	Jingu 96	Japonica	China
2	E. Yasmine (EYR)	IR262/KDML105	Indica	Egypt
3	Egyptian Hybrid Rice 1 (EHR1)	IR 69625A/Giza 178	Japonica	Egypt

The grain quality and cooking characters include grain width (mm), grain length (mm), grain shape, hulling (%), milling (%), head rice, elongation (%), gelatinization temperature and amylose contents.

Grain length (mm) and Grain width (mm) were measured according to Chang and Bardenas (1965). Grain shape was expressed as the ratio between grain length and width. Hulling percentage, milling percentage and broken rice percentage, were the ratio of brown rice to rough rice, milled rice to rough rice and broken rice to milled rice on a weight basis.

Kernel elongation (%) was measured as follow:-

$$\text{Kernel Elongation \%} = \frac{\text{Grain Avg.length a.c.-Grain Avg.length b.c.}}{\text{Grain Avg.length b.c.}} \times 100$$

Whereas: b.c: Before cooking a.c: After cooking

Gelatinization temperature was determined according to (Little *et al.*, 1958). Amylose content was determined according to (Williams *et al.*, 1958). It was determined using a conversion factor and grouped on the basis of their amylose content.

Moisture, crude protein, ether extract, crude fiber and ash of tested materials were determined as described in AOAC (2000). Total carbohydrates were calculated

by differences. Calcium, zinc, iron and magnesium were determined according to the method described by AOAC (2000) using the Perkin Elmer 3300 (USA) atomic absorption. Oil absorption capacity (OAC%) and water absorption capacity (WAC%) were determined as described by Sosulski *et al*. (1976). Aroma determined according to (Anonymous, 2004), where the cooked rice was smelled by a random panel and rated as strongly scented (SS); mild scented (MS); non scented (NS). Water uptake, was determined according to Anonymous (2004)

Preparation of tortilla chips

Tortilla chips were prepared according to Serna-Saldivar *et al*. (1988). Different blends were prepared to obtained three formulas from rice varieties, [E. Yasmin rice (YR), black rice (BR) and Egyptian hybrid rice (HR)] and control (corn flour100%).

Sensory evaluation of tortilla chips

Sensory evaluation of fresh tortilla chips was evaluated for various quality attributes such as color, taste, odor, texture and appearance on a 1 to 20 hedonic scale as described by Serna-Saldivar *et al*. (1988).

Statistical analysis.

The collected data for traits were subjected to the analysis of variance according to the procedure outlined by Gomez and Gomez (1984). Differences among varieties means were compared using the Revised LSD at 5% levels of significance**,** and the data were statistically analyzed using the analysis of variance as outlined by Snedecor and Cochran, (1980).

RESULTS AND DISCUSSION

Agronomic and yield characters:

Yield attribute characters of different rice varieties

Table (2) illustrates yield attribute characters of different rice varieties [Black Rice (BR), Egyptian Yasmine Rice (EYR) and Egyptian Hybrid Rice1(EHR1)] in seasons at 2013 and 2014. Data in Table (2) showed that yield attributes characters values were significantly varied among the three varieties. BR recorded the highest values of plant height and 100-grain weight. The highest values of panicle weight and sterility percentage were observed in variety EYR. EHR1 recorded the highest values of number of panicles hill^{-1}, panicle length, panicle weight, number of filled grains panicle^{-1} and grain yield. There were highly significant differences among the mean values of all cultivars under study regarding all the agronomic and yield characters under study in the tested seasons. This may be attributed to their genetic makeup. The superiority of EHR1 in grain yield may be due to its number of panicles hill^{-1},

panicle length, panicle weight and number of filled grains panicle^{-1}. These results are in agreement with those obtained by Sedeek *et al*. (2009).

Table 2. Yield attribute characters of different rice varieties in 2013 and 2014.

Rice varieties	Plant height (cm)		No. of panicles hill^{-1}		Panicle length (cm)		Panicle weight (g)	
	2013	2014	2013	2014	2013	2014	2013	2014
BR	111.40	113.83	15.14	16.41	17.17	19.87	3.63	3.81
EYR	109.79	114.43	19.51	20.89	25.25	26.59	6.62	6.56
EHR1	110.50	111.01	23.39	24.01	26.91	26.90	4.14	4.34
LSD at 0.05	3.51	3.28	2.63	1.82	2.01	1.01	0.48	0.32
Rice varieties	No. of filled grains panicle^{-1}		100-grain weight (g)		Sterility %		Grain yield t ha^{-1}	
	2013	2014	2013	2014	2013	2014	2013	2014
BR	132.61	140.39	2.90	2.93	5.08	5.12	6.95	6.82
EYR	170.39	154.23	3.23	3.13	19.78	19.18	8.70	9.00
EHR1	197.66	202.28	2.43	2.56	12.80	10.66	10.54	10.66
LSD at 0.05	4.30	11.24	0.14	0.17	1.46	0.99	0.58	0.47

Black Rice (BR); Egyptian Yasmine Rice (EYR); Egyptian Hybrid Rice1(EHR1)

Grain quality and cooking characters of different rice varieties

Table (3) illustrate Grain quality and cooking characters of different rice varieties [Black Rice (BR), Egyptian Yasmine Rice (EYR) and Egyptian Hybrid Rice 1(EHR1)] in 2013 and 2014. As indicated in Table (3), rice cultivars were significantly differed in all grain quality and cooking characters in the two seasons. The results indicated that BR variety had significantly the widest grain compared with the other rice cultivars under study. EYR cultivar had significantly the longest grain compared with the other rice cultivars under this study. EYR recorded the highest shape compared with the other rice cultivars under this study. This was expected because this cultivar has the longest grain. EYR recorded the highest values of hulling (%) while, EHR1 cultivar recorded the highest mean values on milling and head rice percentage. On the other hand, BR cultivar recorded the lowest values of hulling, milling and head rice (%).

Kernel elongation is one of the major determinants of cooking and eating quality characters of rice. BR cultivar produced the highest values of kernel elongation while, the lowest values were recorded for EYR rice cultivar in the tested seasons. EHR1 rice cultivar gave the highest values of gelatinization temperature, while, BR cultivar showed the lowest one. It is worthy to mention that the low gelatinization temperature (GT), cultivars had soft cores and require less water and shortest time

for cooking. EYR produced the highest amylose content (AC) while the lowest values were obtained by EHR1 cultivar in the two seasons. Rachel *et al*. (2013) indicated that differences in the observed amylose content among different rice varieties can also affect the cooking properties. Data in Table (3) showed that the three rice varieties (EYR, EHR1 and BR), have an AC content ranged from 18.06 to 21.48%. Amylose and amylopectin determine the texture of cooked rice and consumers in Egypt prefer rice with intermediate AC. On the other hand, AC, amylopectin structure and protein composition explained the difference in cooking quality of rice, the AC is responsible for texture of cooked rice. Our results are in agreement with (Subudhi *et al*., 2013).

The highly significant differences among the mean values of all cultivars in case of grain quality and cooking characters under study in the tested seasons may be attributed to their genetic differences. These findings are in close agreement with those reported by (Metwally *et al*., 2014).

Table 3. Grain quality and cooking characters of different rice varieties in 2013 and 2014.

Rice varieties	Grain width mm		Grain length mm		Grain shape		Hulling%		Milling%	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
BR	2.92	2.99	5.56	5.44	1.92	1.84	76.58	77.48	67.77	67.27
EYR	2.37	2.31	7.25	7.13	3.09	3.11	80.08	81.28	63.37	64.27
EHR1	2.45	2.55	5.54	5.56	2.26	2.18	79.05	79.01	70.17	71.00
LSD at 0.05	0.10	0.08	0.19	0.08	0.07	0.58	2.00	1.50	1.30	1.90

Rice varieties	Head rice%		Elongation %		Gelatinization temperature		Amylose content %	
	2013	2014	2013	2014	2013	2014	2013	2014
BR	60.06	60.16	53.52	51.98	5.59	5.68	20.72	20.55
EYR	50.85	51.35	12.65	12.62	5.78	5.82	21.87	21.48
EHR1	61.06	61.26	38.42	38.44	6.16	6.01	18.28	18.06
LSD at 0.05	0.90	2.00	4.01	2.30	0.48	0.60	0.49	0.72

Black Rice (BR); Egyptian Yasmine Rice (EYR); Egyptian Hybrid Rice1(EHR1)

Chemical composition of some rice varieties.

Data in Table (4) illustrate values of crude protein, ether extract, crude fiber, ash, and total carbohydrates (on dry weight basis), for three rice varieties, [Black Rice (BR), Egyptian Yasmine Rice (EYR) and Egyptian Hybrid Rice1(EHR1)] and corn flour (CF). Data in Table (4) showed that EYR contained 7.02% and 3.2% crude protein and fat, respectively. On the other hand, it has 2.1% crude fiber and has low ash content (0.9%). EYR has high total carbohydrates, more than three quarters of its contents (86.78%). Our results are in agreement with (Subudhi *et al*., 2013). EHR1 showed low protein content (6.7%), and has 1% fat, 0.7% crude fiber, and 0.6%

ash. It has the highest total carbohydrates among the tested rice varieties (91%). Results are in agreement with (Oko *et al.*, 2012). Table (4) also showed that BR has the highest protein content among the tested rice varieties (10.5%). And also, it has 3.1%, 2% and 1.8% fat, crude fiber and ash contents, respectively. The rest being total carbohydrate (82.6%). Our results are in agreement with (Sompong *et al.*, 2011 and Metwally *et al.*, 2014). Corn flour showed 9.55% protein; 4.65% fat; 1.96% crude fiber and 1.6% ash, CF has total carbohydrates 82.24%.

Table 4. Chemical composition of some rice varieties, and corn flour (CF) (on dry weight basis).

Component %	EYR	EHR1	BR	CF
Crude protein	7.02	6.70	10.5	9.55
Ether extract	3.20	1.0	3.10	4.65
Crude fiber	2.10	0.7	2.00	1.96
Ash	0.90	0.6	1.80	1.6
Total carbohydrates*	86.78	91.0	82.6	82.24

Black Rice (BR); Egyptian Yasmine Rice (EYR); Egyptian Hybrid Rice1(EHR1)

*Carbohydrates were calculated by difference.

Minerals contents of some rice varieties, and corn flour (CF).

Table (5) showed the composition of elements i.e. iron (Fe), zinc (Zn), magnesium (Mg), potassium (K) and phosphor (P) in EYR, EHR1 and BR and CF on dry weight basis. Data listed in Table (5) reveals that the rice varieties in this study had K content in the range of 70.5-365 mg/100 g sample and P content in the range of 2.0-253 mg/100 g sample. Rice varieties in this study appear to be rich in Mg (85, 77 and 98 mg/100gm for EYR, EHR1 and BR, respectively) and contain considerable amounts of Fe (4, 2 and 17.3 mg /100 g for EYR, EHR1 and BR, respectively) and Zn (3.2, 3 and 3.6 mg /100 g for EYR, EHR1 and BR, respectively). Results are in agreement with (Subudhi *et al.*, 2013). Subudhi *et al.* (2013) mentioned that iron food content > 10.0 mg/kg is very good iron source. EYR, EHR1 and 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 10 mg/24h ; 76 mg/24h and 4.1 mg/24h for Fe, Mg and Zn respectively, (WHO/WFP/UNICEF 2007). Corn flour showed Fe and Zn contents lower than tested rice varieties.

Table 5. Minerals contents of some rice varieties, and corn flour (CF), (on dry weight basis).

Minerals (mg/100g)	EYR	EHR1	BR	CF
Fe	4.0	2.0	17.3	1.92
Zn	3.2	3.0	3.60	1.97
Mg	85	77	98	98.1
K	113	70.5	365	359
P	65	2.0	253	192

Black Rice (BR); Egyptian Yasmine Rice (EYR); Egyptian Hybrid Rice1(EHR1)

Physiochemical characteristics of some rice varieties

Physiochemical characteristics of rice are important indicators for grain quality. It is principally determined by the combinations of many physical and chemical characters. Quality evaluation of rice comprise the application of sensory tests and physicochemical determinations based on the chemical composition, cooking quality, and physical properties of cooked rice. The cooking quality of rice was determined on the basis of physicochemical properties and AC. Food functional properties would help in determining appropriateness in different methods of cooking and different aspects of handling. It is, also, considered apart from food nutritional value (Savita *et al*., 2004).

Data are given in Table (6) demonstrate values of oil absorption capacity (OAC%), water absorption capacity (WAC%), water uptake ratio (WU) and Aroma of some rice varieties [Black Rice (BR), Egyptian Yasmine Rice (EYR) and Egyptian Hybrid Rice1(EHR1)].

In tested rice varieties, WU ranged from 280-330 with the highest value in EHR1 and minimum in BR. The WU through the cooking process is commitment to the appearance of cooked rice. Our results are in agreement with (Subudhi *et al*., 2013).

WAC appear the ability of a product to combine with water under circumstances in which water is limited. The highest WAC of EHR1 could be attributed to the presence of higher amount of carbohydrates (starch). Water absorption capacity is a critical property in various food products such as doughs and baked products (Savita *et al*., 2004).

Table (6) reveals that the rice varieties in this study had OAC in the range of 112-121 with highest value in EHR1, it could be therefore being better to rice flour as flavor retainer. The OAC also enhance mouthfeel when rice flour used in food preparation because fat acts as a flavour retainer (Savita *et al*., 2004).

Aroma is an important characteristic, it has high demand in the global market. The studied rice varieties in this work showed that EYR has a strong aroma and mild aroma was detected in BR while, no aroma was detected in EHR1. Sellappan *et al*. (2009) explained that nutritional value, cooking characteristics and aroma are substantial for judging the quality and tendency of rice from one consumer to another.

From the above results, it can be concluded that the tested rice flour varieties has good functional properties which enhance the nutritional quality of its products. There is a trend in recent research, to use novel sources of nutrients for bakery products to diminishing the attribution of wheat flour by using locally available and nutritional sources. More recently, the main notion has become to use food as a wherewithal of promoting health while contraction the risk of disease. Therefore, these rice varieties could be developed in food applications as health products to add value to rice. (Saenkod *et al*., 2013)

Table 6. functional properties of some rice varieties, (on dry weight basis).

	EYR	EHR1	BR
OAC%	115	121	112
WAC%	175	187	170
Aroma	SS	NS	MS
WU	290	330	280

Black Rice (BR); Egyptian Yasmine Rice (EYR); Egyptian Hybrid Rice1(EHR1).
Oil absorption capacity (OAC%)
Water absorption capacity (WAC%); Water uptake ratio (WU)

Chemical composition of produced tortilla chips, (on dry weight basis).

It would be advantageous to manufacture rice and introduce a new rice product to the Egyptian market. Taking into consideration the growing of celiac disease in different areas in Egypt, its substantial to preparing gluten-free bakery products.

The chemical composition of rice tortilla chips and corn tortilla chips, as control (on dry weight basis) are shown in Table (7). From the data presented in Table (7), it could be noticed that tortilla chips prepared from BR has the highest protein content (10.6%), while tortilla chips prepared from EHR1 has the lowest protein content (6.75%). EHR1-tortilla chips showed the lowest fat (17.4%), fiber (2.03%) and ash (1.89%) contents. BR-tortilla chips showed the highest fiber (6.01%) and ash (4.15%) contents, this might be due to the high mineral and fiber contents of BR. On the other hand, EHR1-tortilla chips has the highest carbohydrate content (71.93%) while BR-tortilla chips has the lowest carbohydrate content (61.09%). Data also, showed that CF-tortilla chips has the highest fat content among all tested tortilla chips (19.69%). Protein content of BR-tortilla chips slightly increased compared to the control tortilla chips.

Table 7. Chemical composition of produced tortilla chips, (on dry weight basis).

Component %	EYR	EHR1	BR	CF
Crude protein	7.08	6.75	10.6	9.58
Ether extract	18.18	17.40	18.15	19.69
Crude fiber	5.95	2.03	6.01	5.91
Ash	3.65	1.89	4.15	3.72
Total carbohydrates*	65.14	71.93	61.09	61.1

*Carbohydrates were calculated by difference.

Organoleptic characteristics of produced tortilla chips

The organoleptic characteristics of rice-tortilla chips and corn- tortilla chips (as control), are given in Table (8). From data presented in Table (8) it could be observed that the differences in color, odor, texture and appearance among the three rice-tortilla chips were significant. On the contrary, no significant differences between EHR1-tortilla chips and BR-tortilla chips in taste. Also, Table (8) revealed that EYR-tortilla chips has the highest score for overall acceptability followed by control-tortilla chips while BR-tortilla chips has the lowest score. On the other hand, no significant differences between EYR-tortilla chips and CF-tortilla chips in color and texture.

Considering the physical and sensorial properties, it would appear that rice tortilla chips are industrially feasible and acceptable by consumers. These data also provide opportunities to further increase the nutritional benefits of some food products from rice.

Table 8. Organoleptic characteristics of produced tortilla chips.

Rice varieties	Color (20)	Odor (20)	Taste (20)	Texture (20)	Appearance (20)	Overall acceptability
EYR	17^{b}	18^{a}	18^{a}	17^{a}	17^{a}	17.4
EHR1	18^{a}	15^{c}	17^{b}	16^{bc}	16^{b}	16.4
BR	13^{c}	16^{b}	17^{b}	15^{c}	13^{c}	14.8
CF	17.98^{a}	16.5^{b}	16^{c}	17^{a}	16.9^{ab}	16.88

Values followed by the same letter in same column are not significantly different at $p \leq 0.05$

Taking into consideration the growing of celiac disease in different areas in Egypt, its substantial to preparing gluten-free bakery products such as tortilla chips. In addition, being poor source of protein among the cereals (Subudhi *et al.,* 2013), EYR-tortilla chips and EHR1-tortilla chips are advantageous to persons who suffer from kidney disease or even to use as a wherewithal of promoting health while contraction the risk of disease. Therefore, these rice varieties could be developed in food applications as health products to add value to rice.

CONCLUSION

From the above results, it can be concluded that rice flour has good nutritious, chemical composition, and good functional properties which enhance the

nutritional quality of its products. The results could help food technologists and rice producers to encourage rice products consumption by increasing consumer consciousness of grains health benefits. In this regard, additional research will be addressed to the alteration of functional properties while food processing and will subsequently help to find recommended domains for their applications in food.

Rice-tortilla chips as gluten-free bakery products are advantageous to persons who suffer from celiac disease. Besids, being poor source of protein EYR-tortilla chips and EHR1-tortilla chips are advantageous to persons who suffer from kidney disease or even to use as a wherewithal of promoting health while contraction the risk of disease**.**

REFERENCES

1. Anonymous. 2004. Laboratory manual on rice grain quality procedure. Directorate of Rice Research, Rajendranagar, Hyderabad, India, pp. 1-20.
2. AOAC. 2000. Official methods of analysis of the association of official analytical chemists international 17th Ed. Published by the Association of Official Analytical Chemists International, Suite 400, 2200 Wilson Boulevard, Arlington, Virginia 22201-3301. USA.
3. Chandra, S. and Samsher. 2013. Assessment of functional properties of different flours. Afr. J. Agric. Res. 8(38):4849-4852.
4. Chang, T.T. and E. Bardenas. 1965. The morphology and varietal characteristics of the rice plant. IRRI Techn.Bull., Dec. 1965. Los Banos, Laguna, Philippines.
5. Gomez, K.A. and Gomez, A.A. 1984. Statistical procedure for agicultural research. 2nd Ed. Johin Wiley Sons. New yourk. USA.
6. Little, R.; G.Hilder and E.Dawson. 1958. Differential effect of dilute alkali of 25 varieties of milled white rice. Cereal Chem., 35: 111-126.
7. Metwally, T. F.; H.B.El-Habat; M.M. EL-Malky and A.S. Barakat. 2014. Comparative studies for grain yield, grain quality, cooking quality and nutrition value traits of black rice variety. J. Agric. Sci. Mansoura Univ., 5 (3): 401 – 414.
8. Oko, A.O.; Ubi, B.E.; Efisue, A.A. and Dambaba, N. 2012. Comparative Analysis of the Chemical Nutrient Composition of Selected Local and Newly Introduced Rice Varieties Grown in Ebonyi State of Nigeria. Int. J. of Agric. Forest. 2(2): 16-23
9. Rachel, T.; Wan, N.; Wan. N. and Rajeev, B. 2013. Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. Inter. Food Res. J. 20(3): 1345-1351.

10. Saenkod, C.; Liu, Z.; Huang, J. and Gong, Y. 2013. Anti-oxidative biochemical properties of extracts from some Chinese and Thai rice varieties. Afr. J. Food Sci. 7(9): 300-305.
11. Savita, S.M; Sheela, K.; Sunanda, S.; Shankar, A.G. and Ramakrishna, P. 2004. *Stevia rebaudiana* -A functional component for food industry. J. of Hum. Ecol. 15(4): 261-264.
12. Sedeek, S.E.M.; S.A.A. Hammoud; M.H. Ammar and T.F. Metwally. 2009. Genetic variability, heritability, genetic advance and cluster analysis for some physiological traits and grain yield and its components in rice (*Oryza sativa l.*). J. Agric. Res. Kaferelsheikh Univ., 35 (3):858-878.
13. Sellappan, K.; Datta, K.; Parkhi, V. and Datta, S.K. 2009. Rice caryopsis structure in relation to distribution of micronutrients (iron, zinc, β-carotene) of rice cultivars including transgenic indica rice. Plant Sci. 177:557-562.
14. Sendecor, G.W. and Cochran, W.C. 1980. Statistical methods. Oxford and J.B.H. Publishing Com. 7th ed.
15. Serna-Saldivar, S.O.; Rooney, L.W. and Waniska, R.D. 1988. Wheat flour tortilla production. Cereal Foods World, 33:855-864.
16. Sharif, M.K.; Butt, M.S.; Anjum, F.M. and Khan, S.H. 2014. Rice bran: a novel functional ingredient. Crit Rev Food Sci Nutr. 54(6):807-16.
17. Sompong, R.; Siebenhandl-Ehn, S.; Linsberger-Martin, G. and Berghofer, E. 2011. Physicochemical and antioxidative properties of red and black rice varieties from Thailand, China and Sri Lanka. Food Chem., 124: 132–140.
18. Sosulski, F.W.; Garatt, M.O. and Slinkard, A.E. 1976. Functional properties of ten legume flours. Int. J. Food Sci. Technol., 9: 66-69.
19. Subudhi, H.; Meher, J.; Singh, O.N.; Sharma, S.G. and Das, S. 2013. Grain and food quality traits in some aromatic long and short grain rice varieties of India. J. Food Agric Env., 11(3&4): 1434-1436 .
20. USDA. 2013. United States Department of Agricultural, Economic and Statistics Sestem. Official Report, Apr. 4, 2013
21. WHO/WFP/UNICEF. 2007. Preventing and controlling micronutrient deficiencies in populations affected by an emergency Multiple vitamin and mineral supplements for pregnant and lactating women, and for children aged 6 to 59 months. World Health Organization.
22. Williams, V.R; W.T. Wle; H.Y. Tasi and H.G. Bates. 1958. Varietal differences in amylose content of rice starch. Agric. Food Chem., (6): 47-48.
23. Yang, D.S.; Lee, K.S. and Kays, S.J. 2010. Characterization and discrimination of premium quality, waxy, and black-pigmented rice based on odor-active compounds. J Sci. Food Agric., 90(15): 2595-2601.

دراسة مقارنة و الاستفادة من بعض أصناف الارز

فى تحضير منتجات غذائية خالية من الجلوتين

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تم في هذه الدراسة تقييم بعض الصفات الخضرية والمحصولية ومحتوى الحبوب من العناصر المعدنية المعدنية، والخصائص الوظيفية لبعض أصناف الأرز (الأرز الأسود، ياسمين مصري وهجين مصري ١). وأظهرت النتائج أن الصفات التى تم دراستها تختلف معنوياً بين الأصناف الثلاثة. كانت هناك اختلافات معنوية بين القيم المتوسطة من جميع الأصناف تحت الدراسة فيما يتعلق بجميع الصفات الخضرية والمحصولية قيد الدراسة في الموسمين. كما تباينت أصناف الأرز معنويا في كافة صفات جودة الحبوب والطبخ في الموسمين. وأظهرت النتائج أن صنف الارز الاسود سجل أعلى نسبة بروتين بين أصناف الأرز تحت الدراسة (١٠,٥٪). كما يتضح من النتائج ان الاصناف الثلاثة تحت الدراسة تعتبر مصدر جيد للحديد و الماغنيسيوم و الزنك طبقا للاحتياجات اليومية (للأطفال فى عمر ٦-٥٩ شهر). يمتلك الارز خصائص وظيفية جيدة تدعم القيمة الغذائية لمنتجاته. تم تصنيع مقرمشات مقلية خالية من الجلوتين للمرضى المصابين بالحساسية من جلوتين القمح. سجلت المقرمشات المعدة من الارز الاسود اعلى محتوى بروتين (١٠,٦%) بينما احتوت المقرمشات المعدة من الارز الهجين اقل نسبة بروتين (٦,٧٥%). و قد سجلت المقرمشات المعدة من ارز الياسمين المصرى اعلى درجة قبول كلى.