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EFFECT OF ADDING OF GERMINATED BROWN RICE ON THE QUALITY ASPECTS OF PAN BREAD

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ABSTRACT: *This study was performed to investigate the possibility of using the brown or germinated brown rice flour at different substitution levels of wheat flour for soft bread (Pan) making, evaluate the quality of produced bread and identify the optimal substitution levels for producing high quality bread. Chemical composition, some nutrients and amino acids contents of wheat flour 72%, ungerminated and germinated brown rice flours were determined. Pasting characteristics of starch and farinograph of dough were measured. In addition, sensory characteristics of prepared bread were evaluated. The obtained results indicated that ungerminated and germinated brown rice contain lipids, crude fiber, ash and reducing sugars higher than those of wheat flour. They contain higher contents of potassium and iron but lower contents of sodium and magnesium than those of wheat flour. In addition, they contain all essential and non-essential amino acids. Total essential amino acids of ungerminated brown rice (41.51%) and germinated brown rice (42.49%) were very higher than that of wheat flour 72% (26.93%). Pasting characteristics measurements showed that wheat flour starch had a lower gelatinization temperature and viscosity at 95 ^{o}C but it has setback higher than ungerminated and germinated brown rice starches. Germinated brown rice starch has The highest values of pasting properties compared with ungerminated brown rice. The results of farinograph indicated that substitution ungerminated or germinated brown rice with wheat flour decreased the development and stability time but increased the weakness of the dough, especially for ungerminated brown rice. Sensory characteristics of produced bread revealed that the effect of ungerminated or germinated brown rice on the flavor and texture (crump and crust) was very little, while its effect on the color (crump and crust) and mouth satisfaction was somewhat remarkable but all changes were in the acceptable limits. Germination process of brown rice improved its nutritional value and quality attributes of bread therefore, the using of germinated brown rice is more suitable for making of bread (Pan) than ungerminated brown rice.*

Key words: *Brown rice flour,* Germinated brown rice*, Rheological characteristics, Pan breed*

INTRODUCTION

Rice is the most important cereal in the developing world and is a staple food of over three billion people, constituting over half the world's population (Ebuehi and Oyewole, 2008). Rice flour is one of the most valuable cereal flours from a nutritional viewpoint due to its hypoallergenic proteins and low calcium content, moreover the absence of gluten (Gujral and Rosell, 2004).

Brown rice is the whole grain rice obtained from unpolished rice. It is an excellent source of nutrients such as protein, dietary fibre, fat, minerals and vitamins (Ohtsubo *et al.,* 2005). Moreover, brown rice contains the phytochemicals such as tocopherol, tocotrienol, oryzanol and ferulic acid (Miller and Engel, 2006 and Lai *et al*., 2009).

In the last decade, the use of brown rice (BR) has increased in both standard diets and in those diets catered to people with celiac disease or allergies to other cereals.In addition, the germination of BR grains provides higher nutritional and functional values since they are associated with the quality and quantity of their nutrients, biologically active compounds and antioxidant potential. Currently consumers demand natural foods, and sprout products have become increasingly popular among people interested in improving and maintaining their health by changing dietary habits. In this scenario, sprouted BR grains are excellent examples of functional food, because besides their nutritive value they lower the risk of various diseases and/or exert health promoting effects. (Cornejo, *et al .,* 2015)

Bakery foods are the major cereal products available to consumers and bread has been the principal food in over half of the countries around the world (Chung and Pomeranz, 1983). Bread is a staple food in many parts of the world providing most calories in the diet. Bread is mostly prepared from wheat flour, which makes it unsuitable for people suffering from celiac disease patients, which is a lifelong disorder with a prevalence of 1% of the world population . Accordingly, developing bread based on GBR with desirable nutritional quality and providing bioactive compounds is worthy of investigation. To date, experimental GBR breads have been characterised with adequate instrumental and sensory attributes (Cornejo, *et al .,* 2015).

On the other side, when substituting wheat flour with other flours, the amount of gluten is reduced and there will be a lack of gluten net work to capture the carbon dioxide formed during fermentation. The rice flour is far from the ideal as the structural component of leavened bread rolls or loaves, and the rice grain contains none of the gluten which gives wheat flour its unique ability to form highly expanded, tender, white and flavorful yeast leavened or chemically leavened baked products (Matz, 1996).

The aim of the present study is to evaluate the quality, physical and sensorial properties of bread prepared using different levels of brown or germinated brown rice flour as substitute of wheat flour and know the optimal substitution levels of brown or germinated brown rice flour to produce the bread with good quality and nutritional attributes.

MATERIALS AND METHODS

Materials:

Rough rice of (*Oryza sativa L*.), cultivar Sakha 106 (a popular short grain Japonica cultivar for consumption in the Egypt) was obtained from Rice Research and Training Center (RRTC) at Sakha, Kafr El-Sheikh Governorate, Egypt during the season of 2014, under the recommended conditions for date of culture, fertilization, harvesting time and irrigation.

Wheat flour 72%, table sugar, table salt and yeast were purchased from a local market at Kafr El-Sheikh city, Egypt.

Methods:

Technological methods:

Preparation of germinated brown rice:

Rough rice was dehusked to obtain brown rice, and steeped in distilled water, at room temperature (28 ± 2 ^{o}C) for 12 h. The steeping water was changed every 4 h and drained at the end of soaking. The steeped rice kernels were distributed on double layers of cotton cloth and placed in plastic basket. This basket was then covered by double layers of cotton cloth. The germination took place at 28 ± 2 ^{o}C, for 72 h with 90–95% relative humidity, using an automatic sprinkler. The germinated seeds were dried at 50 ^{o}C, to (~ 12% of moisture).

All samples were finely grounded (40 mesh), prior to analysis. The samples were stored at -2 ^{o}C, until used (Sangsopha, 2008).

Breadmaking:

The breadmaking formula and procedures were conducted with a slight modification of Approved Method (A.A.C.C. 2000). In this study, 1.6% of yeast was used and 10, 20 and 30% of the wheat flour was replaced by ungerminated or germinated brown rice flours. The required amount of water for the flour was determined from water absorption ratio by farinograph mixing. These ingredients were mixed for 20 min and then the dough was subjected to the first fermentation at 30°C and 85% rh for 60 min, followed by punching. The punched dough was subjected to the second fermentation for 30 min at 30°C and 85% rh. Then the dough was divided into three pieces (130g/piece), rounded and molded and placed in a baking pan. The dough was proofed in the pan for 48 min at 38°C and 90% rh, followed by baking at 200°C for 20 min.

Dough farinograms were determined and pasting characteristics of wheat, brown and germinated brown rice flours were carried out using Brabender amylograph as described by A.A.C.C. (2000) procedures.

Determination of chemical composition:

Moisture, ash, crude protein (N x 5.95), total lipids and crude fiber contents were determined according to the methods of A.O.A.C. (2005). Total carbohydrates content was calculated by difference. Total sugars and reducing sugars were determined according to the procedure described by Sadasivam and Manickam (1992). Non-reducing sugar was calculated by subtracting the above mentioned two components. Potassium and sodium contents of rice samples were estimated using flame photometer. Calcium, iron and magnesium contents of rice samples were conducted using the atomic absorption spectrophotometer Perken Elmer Model 20180 following the method of Pearson (1976). Phytic acid in these samples was determined using the spectrophotometric method (Latta and Eskin 1980). Thiamine content of rice was determined according to the method of Erbas, *et al.*, (2005).

Amino acids were determined using Beackman amino acid analyzer according to the method of Sadasivam and Manickam (1992).

Specific volume of the bread was determined after one hour of baking process end using the formula: *Specific volume (cm3/g) = Volume of bread (cm3) / Dough weight (g)*.

After weighing, the volume of the sample was measured by the method of displacement of millet seeds (Lopez *et al.,* 2004)

Sensory evaluation:

Sensory analysis of bread preparations was performed to evaluate flavor, crumb color, crumb texture, crust color, crust texture and degree of mouth satisfaction. The bread samples were presented in identical containers. The samples were sliced and served with water. Ten untrained panel members were selected from students and staff members in Food Technology Research Institute, Agric. Res. Center, Egypt. to perform the evaluation using a hedonistic scale of 5 points (Table A) (Veluppillai *et al.,* 2010).

Statistical analysis:

Most of the received data were analyzed statistically using the analysis of variance and the means were further tested using the least significant difference test (LSD) as outlined by Steell and Torrie (1980).

Table (A): Scores assigned for the sensory evaluation of the breads.

Attribute	Character	Score	Attribute	Character	Score
Flavor	Sweet	1	**Crumb color**	Reddish	1
	Savor	2		Reddish brown	2
	Fermented	3		Brown	3
	Raw dough	4		Light brown	4
	Bitter	5		White	5
Crumb texture	Crumbling	1	**Crust color**	Reddish brown	1
	Buttery	2		brown	2
	Floury	3		Light brown	3
	Soft	4		Whitish brown	4
	Sticky	5		White	5
Crust texture	Brittle	1	**Mouth satisfaction**	Dislike very much	1
	Hard	2		Dislike	2
	Dry	3		Like nor Dislike	3
	Soft	4		Like	4
	Sticky	5		Like very much	5

RESULTS AND DISCUSSION

The results of chemical composition of wheat flour (72%), ungerminated and germinated brown rice were recorded in Table (1). The obtained results indicated that, brown and germinated brown rice contain of lower protein than that of wheat flour 72% but they contain lipids, crude fiber, ash, reducing and total sugars significantly higher than that of wheat flour (72%).It could be also noted that , during the germination process, several enzymes are activated and some non-protein nitrogen substances, such as nucleic acids, are produced: therefore, these can cause protein levels to be increased. Furthermore, the germination process led to slightly decrease of lipids content of ungerminated brown rice. This related to the hydrolysis of lipids may be occurred to produce the necessary energy for biochemical reactions during germination. These results are in line with those found by Kennedy and Burlingame (2003) and Traore *et al.* (2004). On the other hand, the data indicate that germination of brown rice led to increase of reducing and non-reducing sugars. This may be due to starch degradation presumably occurs among the initial action of α amylase to produce the simple sugars from starch. During seed germination, the breakdown of seed reserves, carbohydrates and proteins takes place (Ruiz and Bressani, 1990 and Wu *et al.*; 2013). The action of invertase is the other hydrolysis probably assisted to produce reducing sugars such as glucose and fructose from sucrose according to Traore *et al.* (2004). It could be also noted that phytic acid and thiamine contents of ungerminated and germinated brown rice are higher than those of wheat flour(72%). Moongngarm and Saetung (2010) found that the brown rice contains thiamine content higher than that of wheat flour 72%.

Table (1): Chemical composition (on dry weight basis) of wheat, ungerminated and germinated brown rice flours

Parameter	Wheat flour (72%)	Ungerminated brown rice	Germinated brown rice
Moisture (%)	11.10^{a}	12.20^{a}	12.25^{a}
Crude protein (%)	10.11^{a}	8.48^{c}	9.30^{b}
Lipids (%)	1.01^{b}	2.14^{a}	2.10^{a}
Crude fiber (%)	0.62^{b}	1.35^{a}	1.39^{a}
Ash (%)	0.55^{b}	1.35^{a}	1.34^{a}
Reducing sugars (%)	0.45^{c}	0.55^{b}	0.86^{a}
Non-reducing sugars(%)	0.51c	0.60^{b}	0.90^{a}
Total sugars (%)	0.96^{c}	1.15^{b}	1.77^{a}
Total carbohydrates* (%)	88.33^{a}	88.03^{b}	87.26^{b}
Phytic acid (mg/100g)	50.0^{c}	80.12^{a}	58.11^{b}
Thiamine (mg/100g)	0.12^{c}	0.38^{a}	0.25^{b}

Values followed by the same letter in column are not significantly different $P \leq 0.05$.
* Total carbohydrates calculated by difference.

The content of thiamine in the ungerminated rice, was near to those reported by Deepa, *et al .* (2008), who found that the content of thiamine of (IR64) brown rice was 0.40 mg/100 g .The germination of the brown rice brought about a significant reduction of thiamine content (-47.8%) compared to that of Ungerminated brown rice, which may be due to the effect of soaking the de-hulled rice seed and changing the water, which led to a leaching out of water soluble vitamins, whereas there was no significant effect of soaking and water changing on the B vitamins in the rough rice, because it was protected by the hull. The results, in the same Table, show that the germination process has remarkable effect on nutrients of brown rice where it caused decrease in phytic acid. This may be attributed to the effect of soaking the rice and changing the water during germination which lead to leaching out the water soluble nutrients. The reduction in phytic acid content of brown rice during germination process may be due to decomposition the phytic acid to simple compounds as a result of enzymatic activity. These results are in agreement with those of (Liang *et al*., 2008 and Kim *et al*., 2012) found that the germination process reduced the phytic acid content of brown rice.

Minerals content of Wheat flour (72%), ungerminated and germinated brown rice flours:

Minerals or elements play an important role in human nutrition, some are essential for much component as hem for blood. magnesium and manganese for the activation of some enzymes and stimulation insuline activity, calcium and phosphorus are essential for bones. Potassium is very important for cardiovascular diseases and chromium, which improves the function of insuline and is used to treat both low and high blood sugars levels. (National Academy of Sciences, 2001). Minerals content of wheat flour 72%, ungerminated and germinated brown rice were determined and the data were recorded in Table (2). The results indicate that potassium is the major element but the iron is the minor element in wheat flour 72%, ungerminated and germinated brown rice. Ungerminated and germinated brown rice flours contain higher contents of potassium and iron; in contrast, they have lower contents of sodium and magnesium than those of wheat flour72%.

The low sodium content of ungerminated and germinated brown rice flour is an advantage and suitable for patients which have liver diseases.

Amino acids profile of wheat, ungerminated and germinated brown rice

Table (3) shows the amino acids composition of wheat flour 72%, ungerminated and germinated brown rice. It could be noticed that these flours contain most amino acids. Ungerminated and germinated brown rice contain high levels of all essential amino acids compared with those of wheat flour 72%. It can also show that glutamic and aspartic are the most predominant amino acids. The major essential amino acids in ungerminated and germinated brown rice flours are leucine, valine, isoleucine and phenylalanine, while the most predominant essential amino acids in wheat flour 72% protein are leucine, isoleucine and phenylalanine. Cysteine and methionine are the least abundant amino acids in ungerminated and germinated brown rice flours, while in wheat flour cysteine and methionine is the lowest amino acid. These results indicate that the protein of brown rice either ungerminated or germinated considers a good source of essential and nonessential amino acids but not for sulfur amino acids. From the results in the same Table, it could be observed that all essential amino acids values of ungerminated and germinated brown rice are higher than those of wheat flour 72%. In exception of glutamic, proline and serine, non-essential amino acids values of ungerminated and germinated brown rice are higher than those of wheat flour 72%. These results are in a harmony with those found by Moongngarm and Saetung (2010).

Total essential amino acids of ungerminated brown rice (41.51%) and germinated brown rice (42.49%) are more higher than that of wheat flour 72% (26.93%). This suggests that ungerminated and germinated brown rice protein will contribute to supply of essential amino acids in food products.

Table (2): Minerals content of Wheat flour (72%), ungerminated and germinated brown rice

Minerals content (mg/100g)	Wheat flour (72%)	Ungerminated brown rice	Germinated brown rice
Na	25.9	22.1	22.5
K	139	180	199
Ca	15	28	32
Mg	118	68	79
Fe	1.2	1.5	1.7
P	105	20	25

Table (3): Amino acids profile of wheat, brown and germinated brown rice flours

Amino acids (g/16g N)	Wheat flour (72%)	Ungerminated brown rice	Germinated brown rice
Essential amino acids			
Leucine	5.25	7.59	7.75
Isoleucine	4.33	5.83	6.12
Lysine	2.24	3.72	4.05
Cysteine	0.30	1.70	1.72
Valine	2.91	6.70	7.12
Methionine.	1.53	1.92	1.90
Phenylalanine	4.22	5.74	6.10
Threonine	3.51	4.91	4.10
Tyrosine	2.64	3.40	3.63
TEAA	26.93	41.51	42.49
Non essential amino acids			
Proline	8.62	4.95	5.30
Aspartic acid	10.95	11.81	10.84
Glutamic acid	27.99	13.95	13.05
Histidine	2.94	2.65	2.86
Glycine	5.12	5.71	6.15
Alanine	5.19	5.30	6.10
Arginine	4.88	8.50	8.70
Serine	4.99	4.11	3.90
TNEAA	70.68	56.98	56.90

TEAA: Total essential amino acids and TNEAA: Total non-essential amino acids.

It could be also noticed that most essential amino acids of brown rice flour increased as a result of germination process. Non-essential amino acids, \except glutamic, aspartic and serine, increased in germinated brown rice compared with those of ungerminated brown rice. The same trend was reported by Saman *et al*. (2008); Shu, *et al.* (2008) ; and Roohinejad *et al.* (2009) who reported that, during the germination process the hydrolytic enzymes activate and this lead to an increase of simple compounds such as sugars and amino acids of germinated rice.

Pasting properties of samples:

The pasting characteristics of wheat flour 72%, ungerminated and germinated brown rice flours were determined using amylography and the data are recorded in Table (4). The peak viscosity of ungerminated and germinated brown rice flour samples were high while the values of setback were low compared with those of wheat flour (72%). Germinated brown rice flours had a lower viscosity peak (540.0 BU) than the ungerminated brown rice flours (895.0 BU). Likewise, the breakdown viscosity, final viscosity and set back were also lower for germinated brown rice flours (GBRF) than ungerminated brown rice flours (UGBRF) . Similar changes in pasting profile by germination have been reported (Mohan *et al*., 2010; Watchararparpaiboon, *et al*., 2010 ; Wichamanee, and Teerarat, 2012 and Moongngarm, *et al*., 2014). A reduction in pasting viscosity of GBRF may be due to the endogenous enzymes such as α-amylase, β-amylase, limit dextrinase and α-glucosinase in rice are activated during germination and convert starch into smaller molecules (Mohan, *et al*., 2010 and Cornejo, *et al*., 2015). The breakdown viscosity is related to the rigidity of swollen granules to damage when the starch paste is heated and stirred. The low breakdown viscosity of GBRF indicated the instability of viscosity during the heat processing of starch. The setback and final viscosity are indicative of the retrogradation tendency that related to the structure of amylose and amylopectin. The low set back of GBRF may be attributed to the low value of amylose content during germination, where the hydrolysis of starch occurred. GBRF could be used to retard staling of bakery products, especially bread due to the low setback property (Watanabe *et al*., 2004).

Farinograph of wheat flour 72%, brown or germinated brown rice flour dough

Farinograph properties of Wheat flour 72% dough containing different levels (10, 20 and 30%) of brown or germinated brown rice flours as substitution were determined and the results were given in Table (5). The results show that the arrival time of dough containing brown rice was lower than that of wheat flour dough except for that containing 30% germinated brown rice has high value of arrival time. The arrival time of the dough containing brown rice gradually decreased along with increasing of substitution level. In contrast, there is a positively relationship between the arrival time and germinated brown rice level in the dough.

The results indicates also that the replacement of wheat flour by ungerminated or germinated brown rice flours decreased the development and stability time but increased the weakness of the dough especially with the higher substitution levels. The water absorption of dough containing ungerminated brown rice flour decreased along with the increase of ungerminated brown rice flour level. In contrast, it increased with increasing of germinated brown rice flour level. This tendency might be caused by the different treatments, especially heat treatment, between germinated and ungerminated brown rice. In brief, the starch in germinated brown rice has been gelatinized by the heat treatment, therefore gelatinized starch easily holds larger amounts of water during mixing when compared with brown rice without germination. This tendency coincided with previous reports that the water absorption of unpolished rice flour substitution for wheat flour became lower than that of the control wheat flour (Veluppillai *et al*., 2009). High water absorption capacity of germinated rice flour obtained in this study suggests that the flours can be used in preparation of bakery products where flour hydration is required.

Table (4): Pasting characteristics of Wheat flour 72%, ungerminated and germinated brown rice flours .

Samples	GT	Temp. at MV	MV (BU)	V 95 (BU)	V 50 (BU)	BD (BU)	SB (BU)
Wheat flour 72%	67.2	91.0	415	290	1100	125	685
Ungerminated brown rice	71.5	95.5	859	610	1200	249	341
Germinated brown rice	74.6	92.0	540	410	835	130	295

GT is Gelatinization temperature, V 50 and 95 are viscosity at 50 and 95 ^{o} C, (breakdown) = MV – V 95, SB (setback) = V 50 - MV and BU is Branbender Unit.

Table (5): Farinograph of wheat, ungerminated and germinated brown rice dough

Treatment	Arrival Time (min)	Development Time (min)	Stability Time (min)	Weakness (BU)	Water absorption %
Wheat flour 72%	1.5	20.10	24.90	10.0	60.0
UGBR 10%	1.3	10.80	20.0	10.0	59.0
UGBR 20%	1.1	9.30	17.40	24.20	57.10
UGBR 30%	1.0	4.30	12.80^{c}	26.70	56.50
GBR 10%	0.8	15.0	22.0	13.5	61.2
GBR 20%	1.0	9.8	15.20	26.80	63.80
GBR 30%	3.9	9.10	6.80	60.20	65.50

Values followed by the same letter in column are not significantly different P ≤ 0.05
UGBR = Ungerminated brown rice and GBR = Germinated brown rice

Sensory analysis of pan bread containing ungerminated or germinated brown rice

Sensory characteristics of pan bread containing different levels of ungerminated or germinated brown rice flours were evaluated and the mean scores were recorded in Table (6).

The results reveal that the effect of addition of ungerminated or germinated brown rice as substitution of wheat flour on the flavor and texture (crump and crust) was very little, while its effect on the color (crump and crust) and mouth satisfaction was somewhat remarkable, but all changes were in acceptable limits. This may be due to the rice flours (ungerminated or germinated) contains reducing sugars more than wheat flour that affect the product color as result of Millard reaction during baking process. It could be also noted that the increasing of substitution level of brown or germinated brown rice lead to gradual decreasing the scores of color (crump and crust) and mouth satisfaction. The highest decrement was noticed in crust color since, the color changed from whitish brown in control to light brown in bread containing brown or germinated brown rice flour. Kayahara *et al*. (2000) found that the pre-germination improved the flavor and nutritional quality of brown rice.

Specific volume and chemical composition of pan bread made by ungerminated and germinated brown rice at different substitution levels of wheat flour

Specific volume (cm^3/g) and chemical composition of bread contained ungerminated or germinated brown rice flours at different substitution levels (10, 20 and 30%) of wheat flour 72% were determined as in Table (7).

The results show that the specific volume of bread decreased with using the flour of brown rice either ungerminated or germinated. The decrement was gradual with increasing of replacement level and it was higher in case of germinated brown rice than that of ungerminated brown rice. These results are in agreement with those found by (Veluppillai *et al.,* 2010).

On the other hand, the moisture content of pan bread increased with using ungerminated or germinated brown rice flour. The increment was gradual with increasing of replacement level and it was higher in case of germinated brown rice than that of ungerminated brown rice. This may be due to the difference in chemical composition between wheat flour and ungerminated or germinated brown rice flours for example, the ungerminated and germinated brown rice flours contain crude fiber (1.35 and 1.39%) higher than that of wheat flour (0.62%) as shown in Table (1). In fact that, the high content of crude fiber causes an increase in the water holding capacity of the product. Addition of ungerminated or germinated brown rice flours as replacement of wheat flour causes increasing lipids, ash and crude fiber contents of resulted bread and their values gradually increased with increasing the substitution level. This may be attributed to the high contents of these constituents of ungerminated and germinated brown rice flours compared with wheat flour as shown in Table (1). These results are in agreement with those found by Kayahara (2001).

Table (6): Sensory evaluation of pan bread containing different levels of ungerminated or germinated brown rice flours as substitution of wheat flour 72%

Samples	Flavor	Crumb texture	Crust texture	Crump color	Crust color	Mouth satisfaction
Control	3.2^{NS}	4.2^{NS}	1.4^{NS}	5.0^{a}	4.3^{a}	4.5^{a}
UGBR 10%	3.1	4.1	1.3	4.4^{b}	3.8^{b}	3.9^{b}
UGBR 20%	3.1	4.0	1.2	4.2^{b}	3.5^{b}	4.0^{b}
UGBR 30%	3.0	3.9	1.2	3.9^{bc}	3.0^{c}	3.9^{b}
GBR 10%	3.2	4.0	1.3	3.7^{c}	3.9^{b}	4.1^{b}
GBR 20%	3.1	4.0	1.3	3.5^{c}	3.4^{bc}	4.1^{b}
GBR 30%	3.1	4.0	1.3	3.4^{c}	3.0^{c}	3.9^{b}

Values followed by the same letter in column are not significantly different $P \leq 0.05$
UGBR: Ungerminated brown rice, GBR: Germinated brown rice and NS: not significant

Table (7): Specific volume (cm^3/g) and chemical composition% on dry weight basis of pan bread made using different substitution levels of ungerminated or germinated brown rice flours

Samples	Specific volume	Moisture	Protein	Lipids	Ash	Crude fiber	Total carbohydrates
Control	4.10^{a}	30.51^{c}	12.48^{a}	1.14^{b}	0.61^{b}	0.83^{b}	85.77^{a}
UGBR 10%	4.0^{a}	30.99^{c}	12.14^{b}	1.29^{b}	0.70^{b}	0.90^{b}	85.87^{a}
UGBR 20%	3.71^{b}	32.21^{b}	11.81^{b}	1.47^{a}	0.80^{a}	1.01^{a}	85.92^{a}
UGBR 30%	3.30^{c}	33.30^{a}	11.62^{c}	1.64^{a}	0.91^{a}	1.13^{a}	85.83^{a}
GBR 10%	3.91^{a}	31.01^{c}	12.30^{a}	1.30^{b}	0.70^{b}	0.91^{b}	85.70^{a}
GBR 20%	3.70^{b}	32.32^{b}	11.99^{b}	1.42^{a}	0.81^{a}	1.01^{a}	85.78^{a}
GBR 30%	3.61^{b}	34.41^{a}	11.80^{b}	1.55^{a}	0.92^{a}	1.15^{a}	85.73^{a}

Values followed by the same letter in column are not significantly different $P \leq 0.05$
UGBR: Ungerminated brown rice and GBR: Germinated brown rice.

Finally, ungerminated or germinated brown rice flours until 30% substitution level of wheat flour can be used successfully to produce bread (pan) with high nutritional value and acceptable quality properties. This also contribute in solving the shortage problem in wheat production in Egypt.

REFERENCES

A.A.C.C. (2000). American Association of Cereal Chemists (2000). Approved Methods of the AACC, 10th Ed. Methods 10-10B, 22-10, and 54-21. The Association: St. Paul, MN.

A.O.A.C. (2005). Association of Official Analytical Chemists (2005). Official Methods of Analysis of the Association of Official Analytical Chemists. 18th Ed. Washington, DC, USA.

Chung, O. K. and Y. Pomeranz (1983). Recent trends in usage of fats and oils as functional ingredients in the baking industry. J . O. C. S., 60: 1848.

Cornejo, F., P.J. Caceres, C. Martnez-Villaluenga, C.M. Rosell and J. Frias (2015). Effects of germination on the nutritive value and bioactive compounds of brown rice breads. Food Chem., 173, 298–304.

Deepa, G., V. Singh and K.A. Naidu (2008). Nutrient composition and physicochemical properties of Indian medicinal rice – Njavara. Food Chemi., 106(1), 165–171.

Ebuehi, O. A.T. and A.C. Oyewole (2008). Effect of cooking and soaking on physical, nutrient composition and sensory evaluation of indigenous and foreign rice varieties in Nigeria. Nutrition and Food Sci., 38(1), 15–21.

Erbas, M., M. Certel and M.K. Uslu (2005). Some chemical properties of white lupin seeds (Lupinus albus L.). Food Chem., 89(3), 341–345.

Gujral, H. S. and C.M. Rosell (2004). Improvement of the breadmaking quality of rice flour by glucose oxidase. Food Research International, 37(1), 75–81.

Kayahara, H. (2001). Functional components of pre-germinated brown rice, and their health promotion and disease prevention and improvement. (In Japanese) Weekly Agric. Forest 1791:4-6.

Kayahara, H., K. Tsukahara and T. Tatai (2000). Flavor, health and nutritional quality of pre-germinated brown rice. In 10th international flavor conference (pp. 546–551). Paros, Greece.

Kennedy, G. and B. Burlingame (2003). Analysis of food composition data on rice from a plant genetic resources perspective. Food Chem., 80(4) 589–596.

Kim, H.Y., I. G. Hwang, T. M. Kim, K. S. Woo, D. S. Park and J.H. Kim (2012). Chemical and functional components in different parts of rough rice before and after germination. Food Chem., 134(1), 288–293.

Lai, P., K.Y. Li, S. Lu and H.H. Chen (2009). Phytochemicals and antioxidants properties of solvents extracts from Japonica rice bran. Food Chemistry 117(3): 538-544.

Latta, M. and M. Eskin (1980). A simple and rapid colorimetric method for phytate determination. J. Agric. Food Chem., 28:1313-1315.

Liang, J., B.Z. Han, M. J. R. Nout and R. J. Hamer (2008). Effects of soaking, germination and fermentation on phytic acid, total and in vitro soluble zinc in brown rice. Food Chem., 110(4), 821–828.

Lopez, A. C. B., A. J. G. Pereira and R G. Junqueira (2004). Flour mixture of rice flour, corn and cassava starch in the production of gluten free white bread. Bra Arch Biol Tech., 47(1): 63–70.

Matz, S A. (1996). Chemistry and Technology of Cereals as Food and Feed. 2nd edn. New Delhi: CBS Publishers and Distributors.

Miller, A. and A. Engel (2006) . Content of γ–oryzanol and composition of steryl ferulates in brown rice (Oryza sativa) of European origin. Journal of Agricultural and Food Chem., 54(21): 8127-8133.

Mohan, B.H., N.G. Malleshi and T. Koseki (2010) . Physico-chemical characteristics and non-starch polysaccharide contents of Indica and Japonica brown rice and their malts. LWT-Food Sci. and Tech., 43(5): 784-791.

Moongngarm, A., T. Moontree, P. Deedpinrum and K. Padtong (2014). Functional Properties of Brown Rice Flour as Affected by Germination . APCBEE Procedia (8) 41 – 46.

Moongngarm, A. and N. Saetung (2010). Comparison of chemical compositions and bioactive compounds of germinated rough rice and brown rice. Food Chem., 122, 782–788.

National Academies of Sciences, Institute of Medicine (2001). Fruits and vegetables yield less vitamin A than previously thought; upper limits set for daily intake of vitamin A and Nine Other Nutrients, Press Release Jan. 9.

Ohtsubo, K., K. Suzuki, Y. Yasui and T. Kasumi (2005). Bio-functional components in the processed pregerminated brown rice by a twin-screw extruder. Journal of Food Composition and Analysis 18(4): 303-316.

Pearson, D. (1976). The Chemical Analysis of Foods. 7th edn. Edinburgh, London: Churchill Livingstone.

Roohinejad, S., H. Mirhosseini, N. Saari, S. Mustafa, I. Alias and A. S. M. Hussin (2009). Evaluation of GABA, crude protein and amino acid composition from different varieties of Malaysian's brown rice. Australian J. of Crop Sci., 3(4), 184–190.

Ruiz, A. and R. Bressani (1990). Effect of germination on the chemical composition and nutritive value of amaranth grain. Cereal Chem., 67(6): 519–522.

Sabanis, D. and C. Tzia (2009). Effect of rice, corn and soy flour addition on characteristics of bread produced from different wheat cultivars. Food and Biop. Tech., 2(1):68–79.

Sadasivam, S. and A. Manickam (1992). Determination of total sugars, reducing sugars and amino acids, Agriculture Science, Wiley Eastern Limited, New Delhi, pp. 6 and 40, India.

Saman, P., J. A. Vázquez and S. Pandiella (2008). Controlled germination to enhance the functional properties of rice. Process Biochem., 43(12): 1377–1382.

Sangsopha, J. (2008). Study on chemical components, stability of bioactive compounds and its potential use as a functional food of rice bran extract using enzymatic. Food technology and nutrition, Vol. M.S. Mahasarakham, Thailand: Mahasarakham Univ., pp. 136).

Shu, X. L., T. Frank, Q. Y. Shu and K. R. Engel (2008). Metabolite profiling of germinating rice seeds. J. of Agric. and Food Chem., 56(24), 11612–11620.

Steell, R.G. and J.H. Torrie (1980). Principles and procedures of statistics, 2nd Ed. (pp. 120). McGraw Hill, New York, USA.

Traore, T., C. Mouquet, C. Icard-Verniere, A. S. Traore and S. Treche (2004). Changes in nutrient composition, phytate and cyanide contents and alpha-amylase activity during cereal malting in small production units in Ouagadougou (Burkina Faso). Food Chem., 88(1) 105–114.

Veluppillai, S., K. Nithyanantharajah, S. Vasantharuba, S. Balakumar and V. Arasaratnam (2009). Biochemical changes associated with germinating rice grains and germination improvement. Rice Science, 16(3), 240–242.

Veluppillai, S., K. Nithyanantharajah, S. Vasantharuba, S. Balakumar and V. Arasaratnam (2010). Optimization of Bread Preparation from Wheat Flour and Malted Rice Flour. Rice Sci., 17(1): 51−59.

Watanabe, M., T. Maeda, K. Tsukahara, H. Kayahara and N. Morita (2004). Application of pregerminated brown rice for breadmaking. Cereal Chem., 81(4): 450-455.

Watchararparpaiboon, W., N. Laohakunjit and O. Kerdchochuen (2010). An improved process for high quality and nutrition of brown rice production. Food

Sci. and Tech. International 16(2): 147-158.
Wichamanee, Y. and I. Teerarat (2012). Production of germinated Red Jasmine brown rice and its physicochemical International Food Research Journal 19(4): 1649-1654 .
Wu, F., N. Yang, A. Touré, Z. Jin and X. Xu (2013). Germinated brown rice and its role in human health. Critical Reviews in Food Sci. and Nutrition, 53(5), 451–463.

تاثير اضافة الارز البنى المنبت على خواص جودة خبز القوالب

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الملخص العربي

تم إجراء هذه الدراسة لبحث إمكانية صناعة خبز القوالب بإستبدال نسب مختلفة (10, 20, 30%) من دقيق القمح (72%) بدقيق الأرز البنى قبل وبعد إجراء عملية تنبيت الارز وتقييم الخبز الناتج ومعرفة أنسب نسبة إستبدال للحصول علي خبز عالي الجودة. تم تقدير التركيب الكيماوي وبعض المركبات الهامة مثل الأملاح المعدنية والأحماض الأمينية لدقيق الأرز قبل وبعد التنبيت ومقارنتها بدقيق القمح. كذلك تم تقدير خواص النشا وتم قياس الفارينوجراف للعجينة. بالإضافة إلي ذلك تم تقييم الخواص الحسية للخبز الناتج.

ويمكن تلخيص النتائج المتحصل عليها في الآتي:

1- دقيق الأرز قبل وبعد التنبيت يحتوي علي قيم أعلي من الليبيدات والألياف والرماد والسكريات المختزلة مقارنة بدقيق القمح.

2- دقيق الأرز يحتوي علي كل الأحماض الأمينية الأساسية وغير الأساسية ومحتواه الكلي من الأحماض الأمينية الأساسية أعلي بكثير مقارنة بدقيق القمح.

3- يتفوق دقيق الأرز علي دقيق القمح في البوتاسيوم والكالسيوم والحديد والثيامين. ويتميز بإنخفاض الصوديوم مقارنة بدقيق القمح. لكنه يحتوي كمية أعلي من حمض الفيتيك التي تقل بعد التنبيت.

4- خواص نشا دقيق القمح أفضل قليلا من نشا دقيق الأرز ولكن عملية التنبيت حسنت بعض هذه الخواص. كذلك خواص العجينة تأثرت سلبا بعملية الإستبدال لكن عملية التنبيت أدت إلي تحسين بعض الصفات.

5- نتائج التقييم الحسي للخبز أظهرت تشابه كبير في الرائحة والقوام للخبز في الكنترول والخبز الناتج من الإستبدال لكن التغير في اللون والتذوق كان ملحوظا لحد ما وإنما هذا التغير لم يخرج خواص الناتج عن الحدود المقبولة.

خلاصة القول أنه يمكن إستبدال جزء من دقيق القمح بدقيق الأرز حتى نسبة 30% ويفضل إجراء عملية تنبيت للأرز قبل الإستبدال وبهذا يمكن تحسين القيمة الغذائية مع المحافظة علي صفات الجودة والخواص الحسية للخبز الناتج. كذلك يساهم في حل مشكلة نقص إنتاج القمح في مصر .