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THE POSSIBILITY OF USING UNGERMINATED AND GERMINATED BROWN RICE FLOURS AT DIFFERENT SUBSTITUTION LEVELS OF WHEAT FLOUR IN BREADMAKING

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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 (Toast) making, evaluate the quality of produced bread and know the optimal substitution levels for producing high quality bread. Chemical composition, some nutrients and amino acids 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 (39.81%) and germinated brown rice (40.99%) were very higher than that of wheat flour 72% (25.03%). Pasting characteristics measurements showed that wheat flour starch has gelatinization temperature and viscosity at 95 ^{o}C lower but it has setback higher than ungerminated and germinated brown rice starches. Germinated brown rice starch has low breakdown and high setback compared with ungerminated brown rice. The results of farinograph indicated that using ungerminated or germinated brown rice caused decreasing the development and stability time but increasing 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 (Toast) than ungerminated brown rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereal foodstuffs in the world and is naturally gluten-free, highly digestible and hypoallergenic. Additionally, brown rice contributes good nutritional properties as it contains considerably higher amounts of proteins and minerals than milled rice (Lamberts *et al.*, 2007).

As a result of industrial and technological developments, consumers do not have enough time to cook or provide a good nutritional balance. Therefore, consumers need convenient foods such as instant noodles, boil-in-the-bag foods, and frozen foods. Convenience stores and supermarkets sell a lot of processed foods and various kinds of ready-to-eat foods. Hence, eating habits have changed and processed foods have been blamed for poor or imbalanced nutrition, especially in Japan. Therefore, a germinated brown rice with a germ length of 0.5 to 1.0 mm was produced for consideration in healthy foods. Germinated brown rice contains more vitamins, minerals, fibers, and physiologically activated materials than ungerminated brown rice (Kayahara, 2001).

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).

Celiac disease and wheat allergies are quite serious health problems and a daily diet of bread supplemented with Germinated brown rice containing various functional materials may have benefits for health (Kayahara and Sugiura, 2001).

A part of wheat flour was substituted with rice flour at the levels of 50, 100, 150 and 200 g/kg for bread making and the overall acceptability of the product was the best when wheat flour was substituted with rice flour up to the 150 g/kg replacement (Noomhorm and Bandola, 1994). Another study revealed that the incorporation of rice, corn and soy flour in wheat up to a level of 10% produced the bread without any negative effect in quality attributes, while 30% and 50% substitution levels had very low scores for the acceptability (Sabanis and Tzia, 2009).

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).

However, it may be possible to use malted rice flour instead of raw rice flour in the preparation of bakery items since many changes occur in the grains during germination. During seed germination, the breakdown of seed reserves, carbohydrates and proteins takes place. Germination causes increase in several vitamins (Ruiz and Bressani, 1990).

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 attributies.

MATERIALS AND METHODS

Materials:

Rough rice of (Oryza sativa L.), cultivar Sakha 105 (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 2011, 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:

Germinated brown rice preparation

Rough rice was dehusked to obtain brown rice, and steeped in distilled water, at room temperature (28 ± 2 ºC) 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 ºC, for 72 h with 90–95% relative humidity, using an automatic sprinkler. The germinated seeds were dried at 50 ºC, to (~ 12% of moisture). All samples were finely grounded (40 mesh), prior to analysis. The samples were stored at -2 ºC, until used (Sangsopha, 2008).

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).

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.

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 Department, Fac. of Agric., Kafrelshiekh, to perform the evaluation using a hedonistic scale of 5 points (Table 1) (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 (1): 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 chemical composition of flour of wheat (72%), ungerminated and germinated brown rice was given in Table (1). The results revealed that brown and germinated brown rice contain protein content lower than that of wheat flour 72% but they contain lipids, crude fiber, ash, reducing and total sugars significantly higher than that of wheat flour.

It could be also noted that the germination process led to slightly decreasing 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 the germination process of brown rice led to increasing 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). 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).

Table 2: 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	11.30^{b}	12.54^{a}	12.60^{a}
Crude protein	10.20^{a}	7.62^{b}	7.90^{b}
Lipids	0.90^{b}	2.34^{a}	2.20^{a}
Crude fiber	0.80^{b}	1.50^{a}	1.56^{a}
Ash	0.52^{b}	1.30^{a}	1.31^{a}
Reducing sugars	0.49^{c}	0.60^{b}	0.80^{a}
Non-reducing sugars	0.61^{c}	0.72^{b}	1.10^{a}
Total sugars	1.10^{c}	1.32^{b}	1.90^{a}
Total carbohydrates*	88.38^{a}	88.74^{a}	88.39^{a}

Values followed by the same letter in column are not significantly different P ≤ 0.05
*** calculated by difference**

Some nutrients of wheat, ungerminated and germinated brown rice flours:

Minerals, phytic acid and thiamine contents of the flour of wheat, ungerminated and germinated brown rice were determined and the data were recorded in Table (3). The results indicate that potassium is the major element but the iron is the minor element in flour of wheat, 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 flour.

Table (3): Some nutrients of wheat, ungerminated and germinated brown rice

Nutrient (mg/100g)	Wheat flour (72%)	Ungerminated brown rice	Germinated brown rice
Na	119	22.9	22.3
K	136	182	199
Ca	30	31	36
Mg	121	79	69
Fe	1.2	1.6	1.7
Phytic acid	53.0	82.6	61.1
Thiamine	0.13	0.36	0.25

The low sodium content of ungerminated and germinated brown rice flour is an advantage and suitable for patients which have liver diseases. It could be also noted that phytic acid and thiamine contents of ungerminated and germinated brown rice are higher than those of wheat flour. Moongngarm and Saetung (2010) found that the brown rice contains thiamine content higher than that of wheat flour 72%. The results, in the same Table, show that the germination process has remarkable effect on nutrients of brown rice where it caused increase of potassium and calcium but highly 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. Liang *et al*. (2008) found that the germination process reduced the phytic acid content of brown rice.

Amino acids profile of wheat, ungerminated and germinated brown rice

Table (4) 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 comparing 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 is not found 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.

Table (4): 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	5.15	7.39	7.55
Isoleucine	4.13	5.63	5.72
Lysine	2.04	3.52	3.65
Cysteine	0.00	1.50	1.52
Valine	2.81	6.60	6.82
Methionine.	1.33	1.72	1.70
Phenylalanine	4.02	5.54	5.70
Threonine	3.11	4.71	4.90
Tyrosine	2.44	3.20	3.43
TEAA	25.03	39.81	40.99
Non essential amino acids			
Proline	8.42	4.95	5.30
Aspartic acid	10.65	10.51	9.54
Glutamic acid	27.79	13.85	12.95
Histidine	2.84	2.45	2.66
Glycine	4.92	5.51	5.95
Alanine	4.99	5.30	6.10
Arginine	4.88	8.30	8.50
Serine	4.79	3.91	3.70
TNEAA	69.28	54.88	54.70

TEAA: Total essential amino acids and TNEAA: Total non-essential 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 (39.81%) and germinated brown rice (40.99%) are more higher than that of wheat flour 72% (25.03%). This suggests that ungerminated and germinated brown rice protein will contribute to supply of essential amino acids in food products. It could be also noticed that all 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. Saman *et al*. (2008) 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 Characteristics 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 (5). The peak viscosities of ungerminated and germinated brown rice flour samples were significantly high, while the values of setback were low compared with those of wheat flour (72%). Rice flour samples suppressed retrogradation of starch.

The gelatinization temperature of ungerminated brown rice starch was significantly lower, but the breakdown was significantly larger than that of germinated brown rice. Ungerminated brown rice collapsed gas cells in dough samples during the baking process. In contrast, the pasting properties of germinated brown rice such as the low breakdown and high setback are considered suitable for breadmaking. The results indicate that the germinated brown rice is more suitable for the dough and bread qualities than ungerminated brown rice.

Table (5): Pasting parameters of wheat, 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%	68.1[c]	92.0[b]	410[b]	295[c]	1200[a]	115[b]	790[a]
Ungerminated brown rice	70.4[b]	91.5[b]	805[a]	399[b]	905[b]	406[a]	100[c]
Germinated brown rice	75.5[a]	97.6[a]	780[a]	695[a]	1215[a]	85[c]	435[b]

Values followed by the same letter in column are not significantly different P ≤ 0.05
GT is Gelatinization temperature, V 50 and 95 are viscosity at 50 and 95 °C, BD (breakdown) = MV – V 95, SB (setback) = V 50 - MV and BU is Branbender Unit.

Farinograph of wheat, brown or germinated brown rice flour dough

Farinograph properties of wheat flour dough containing different levels (10, 20 and 30%) of brown or germinated brown rice flours as substitution of wheat flour were determined and the results were given in

Table (6). 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.

Table (6): Farinograph of wheat, ungerminated and germinated brown rice dough

Treatment	Arrival Time (min)	Development Time (min)	Stability Time (min)	Weakness (BU)	Water absorption %
Control	1.6[b]	20.3[a]	25.1[a]	10.0[d]	60.0[b]
UGBR 10%	1.3[c]	11.0[c]	20.2[b]	10.0[d]	58.5[b]
UGBR 20%	1.1[d]	9.5[c]	17.6[b]	24.5[b]	56.7[c]
UGBR 30%	1.0[d]	4.5[d]	13.0[c]	27.0[b]	56.0[c]
GBR 10%	0.8[e]	15.2[b]	22.3[a]	13.5[c]	61.2[b]
GBR 20%	1.1[d]	10.0[c]	15.5[c]	27.0[b]	63.3[a]
GBR 30%	4.0[a]	9.3[c]	7.0[d]	60.3[a]	65.0[a]

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

The results indicate also that the replacement of wheat flour using ungerminated or germinated brown rice flours caused decrease in the development and stability time but increase in 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).

Sensory analysis of bread containing ungerminated or germinated brown rice

Sensory characteristics of bread containing different levels of ungerminated or germinated brown rice flours were evaluated and the mean scores were recorded in Table (7).

The results reveal that the effect 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.

Table (7): Sensory evaluation of 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	3.0^{NS}	4.0^{NS}	1.2^{NS}	5.0^{a}	4.1^{a}	4.5^{a}
UGBR 10%	2.9	3.8	1.1	4.2^{b}	3.6^{b}	3.9^{b}
UGBR 20%	2.9	3.8	1.0	4.0^{b}	3.3^{b}	3.9^{b}
UGBR 30%	2.8	3.7	1.0	3.7^{b}	2.9^{c}	3.8^{b}
GBR 10%	3.0	3.8	1.1	3.5^{c}	3.7^{b}	4.0^{b}
GBR 20%	2.9	3.8	1.1	3.3^{c}	3.2^{b}	4.0^{b}
GBR 30%	2.9	3.8	1.1	3.1^{c}	2.8^{c}	3.8^{b}

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

Specific volume and chemical composition of 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 (8).

Table (8): Specific volume (cm^3/g) and chemical composition% on dry weight basis of Toast 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	4.0^{a}	30.4^{c}	12.38^{a}	1.12^{b}	0.60^{b}	0.82^{b}	85.90
UGBR 10%	3.9^{a}	30.9^{c}	12.04^{a}	1.27^{b}	0.69^{b}	0.89^{b}	86.00
UGBR 20%	3.6^{b}	32.1^{b}	11.74^{a}	1.45^{a}	0.79^{a}	1.00^{a}	86.02
UGBR 30%	3.2^{c}	33.2^{a}	11.40^{b}	1.62^{a}	0.90^{a}	1.12^{a}	86.08
GBR 10%	3.8^{a}	31.2^{c}	12.19^{a}	1.28^{b}	0.69^{b}	0.90^{b}	85.84
GBR 20%	3.6^{b}	32.2^{b}	11.88^{a}	1.40^{a}	0.80^{a}	1.00^{a}	85.92
GBR 30%	3.5^{b}	34.5^{a}	11.73^{a}	1.53^{a}	0.91^{a}	1.14^{a}	85.83

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

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 agreement with those found by (Veluppillai *et al.,* 2010).

On the other hand, the moisture content of 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 (1.50 and 1.52%) higher than that of wheat flour (0.8%) as shown in Table (2). In fact that, the high content of crude fiber causes an increase in the water holding capacity of the product. Addition of brown 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 (2). The effect of this substitution on protein content, in general, was unremarkable. These results are in agreement with those found by Kayahara (2001).

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

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صناعة الخبز التوست بإستبدال جزء من دقيق القمح بدقيق الأرز قبل وبعد التنبيت

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تم إجراء هذه الدراسة لبحث إمكانية صناعة الخبز التوست بإستبدال نسب مختلفة (١٠, ٢٠, ٣٠%) من دقيق القمح (٧٢%) بدقيق الأرز قبل وبعد إجراء عملية تنبيت 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:

١- دقيق الأرز قبل وبعد التنبيت يحتوي علي قيم أعلي من الليبيدات والألياف والرماد والسكريات المختزلة مقارنة بدقيق القمح.
٢- دقيق الأرز يحتوي علي كل الأحماض الأمينية الأساسية وغير الأساسية ومحتواه الكلي من الأحماض الأمينية الأساسية أعلي بكثير مقارنة بدقيق القمح.
٣- 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.
٤- 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.
٥- نتائج التقييم الحسي للخبز أظهرت تشابه كبير في الرائحة والقوام للخبز في الكنترول والخبز الناتج من الإستبداللكن 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 لغاية نسبة ٣٠% 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.

قام بتحكيم البحث

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