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EFFECT OF SUPPLEMENTING BALADY BREAD WITH RICE BRAN ON THE HIGH BLOOD GLUCOSE AND CHOLESTEROL LEVELS

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ABSTRACT

There is an increasing interest with rice bran due to its natural phytochemicals content such as phenolic acids and Vit E which have been reported as strong antioxidants. The purpose of this study was to produce and study the effect of supplementing Balady bread with rice bran on blood glucose and cholesterol levels in diabetic rats. Chemical composition shows that rice bran is good source of protein, minerals, dietary fiber and antioxidants such as phenolic acids and vitamin E. Balady bread was supplemented with 5%, 10%, 15% and 20% of rice bran. Supplementation of Balady bread with rice bran up to 15% increased dietary fibers, phenolic acids and vitamin E content of the bread without negative effects on sensory properties of produced bread. Balady bread Supplemented with 15% and 20% rice bran recorded the highest treating effect on serum glucose and cholesterol levels in diabetic rats. It reduced glucose and cholesterol levels by 40%and 18.4%, respectively, comparing with diabetic rats group (control +ve). The results ascertain the possibility of producing Balady bread supplemented with rice bran as a functional food with high nutritive values and technological qualities for diabetes and hypercholesterolemic people.

INTRODUCTION

Cereal bran is known to have substantial concentrations of important nutrients such as soluble and insoluble fiber (Hoseney, 1994 and Chronakis, *et al.*, 2004), minerals, vitamins, proteins and lipids (Murtaugh *et al.*, 2003). Rice bran is the outer layer of brown rice, obtained as a by-product of the rice milling industry. However, most of them are discarded, except for using in feeds (Harada, *et al.*, 2008). Due to the abundance of some functional compounds, rice bran has drawn the attention of chemists and pharmacologists recently (Azizah and Yu, 2000; Gurpreet and Sogi, 2007; Juan *et al.*, 2006). Among the functional compounds, many biological active polysaccharides extracted from rice bran appeared to elicit excellent physiological properties in maintaining health and preventing diseases such as anti-tumor (Takeshita *et al.*, 1992), enhancing the immune function (Tzianabos, 2000) and increasing the peripheral blood lymphocytes (Takenaka and Itoyama, 1993).

Phenolic compounds have attracted the attention of food and medical scientists due to their strength in vitro and in vivo antioxidant activities and their ability to scavenge free radicals, break radical chain reactions and scavenging metals. The consumption of phenolics has been connected with a reduced risk of cardiovascular diseases and cancer (Zhao and Moghadasian, 2008).

At the molecular and cellular levels, antioxidants serve to deactivate certain particles called free radicals. Free radicals are the natural by-products of many oxidative metabolic processes within the cells. Vitamin E is thought to be the most effective antioxidant due to its abundance in the body. Oryzanol found in rice bran oil is also a potent antioxidant. One test- tube study indicated that oryzanol was more than four times as effective in stopping tissue oxidation as vitamin E. Oryzanol is a mixture of sterol esters of ferulic acid (Hiramitsu and Armstrong, 1991).

The nutritional functional of oryznol components may be related to their antioxidant property because of the ferulic acid structure. Ferulic acid is a phenolic acid antioxidant (Marinova and Yanishlieveva, 1992).

Ferulic acid is found in all parts of the grain, especially the aleurone layer, such as wheat bran (Mandalari *et al.*, 2005). It is known as a potential antioxidant, antimicrobial and anti-inflammatory agent. The oxidative cross-linking properties of ferulic acid have been exploited in developing the gel matrix of wound dressings (Kennedy *et al.*, 1999). In the food industry, it is used as a natural food preservative for its ability to inhibit peroxidation of fatty acids and it may acts as a source of natural vanillin for fungal conversion (Thibault *et al.*, 1998). Phenolic acids, such as ferulic and p-coumaric acid are esterified to arabinofuranosyl residues (Chanliaud *et al.*, 1995).

Rice bran contains a significant amount of natural phytochemicals such as oryzanols, tocopherols and tocotrienols that have been reported as the strongest antioxidants in rice bran (Godber and Juliano, 2004 and Orthoefer and Eastman, 2004).

Lipophilic antioxidant activity, tocotrienols have shown peculiar physiological potential including antitumor properties toward mammary cancer (Nasaretnam, 2005), reducing serum cholesterol effects (Qureshi, *et al.*, 2000), and anti-inflammation (Akihisa *et al.*, 2000).

Antioxidant activity tests reveal that polysaccharides extracted with hot-water from rice bran and precipitated with 40% ethanol showed good capability of scavenging superoxide radical, hydroxyl free radical and anti-lipid peroxidation at 1.0 mg/mL. The hypocholesterolemic effect of rice bran has been attributed to various fractions of the bran such as the neutral detergent fiber, hemicellulose, rice bran oil and its unsaponifiable matter (Visser *et al.,* 2000).

Phenolic acids are predominantly found in the outer bran layer of a wheat grain (Moore *et al.*, 2006). Phenolics in wheat can be subdivided into acids derived from either benzoic acid or cinnamic acid (Kim *et al.*, 2006). Vanillic and salicylic acids, for example, are derivatives of benzoic acid while ferulic acid, the dominant phenolic acid in a wheat grain, and caffeic acid are derivatives of cinnamic acid (Abdel-Aal *et al.*, 2001). Phenolic acids within the wheat grain are strong antioxidants and may alleviate oxidative stress by quenching or neutralising reactive species, thereby reducing cellular damage or death (Zhou and Yu, 2004). Besides acting as antioxidants, phenolics can be beneficial to health by chelating metal ions (Liyana-Pathirana and Shahidi, 2006), stimulating antioxidative (Moore *et al.*, 2006) and detoxifying enzymes (Yoshioka *et al.*,1995).

Rice bran and derived products appear as nutraceuticals potentially useful in the prevention of cardiovascular diseases (Cicero and Gaddi, 2001).

Rice bran contains many valuable substances such as fiber, proteins, and minerals required for human health (Watchararuji, 2008). The major component of dietary fiber in rice bran can lower the risk of cancer and coronary heart diseases (Choi, *et al.*, 2008), and can be used to reduce blood cholesterol levels and prevent obesity (Sera *et al.*, 2005).

Leonora *et al.*, (2006) reported that brown rice is more health beneficial food for diabetics and hyperglycemic individuals than milled rice due to the higher amounts of phytic acid, polyphenols, dietary fiber and oil in brown rice compared to milled rice.

Egypt is the largest rice producer in the Near East region, cultivating rice on about 1.6 Million feddan with average of 4.2 tons rice per feddan. The annual production is about 6,720,000 tons annually and rice bran is about 1,008,000 tons annually partially used as livestock and poultry feed as well as for cosmetic purposes (Helal, 2005).

The purpose of this study was to study the treating effect of supplemented Balady bread with 5%, 10%, 15% and 20% rice bran on serum glucose and cholesterol levels in diabetic rats.

MATERIALS AND METHODS

Materials:

Rice bran was obtained from Alshrkia Rice Mill Co., Zagazig Provence, as a by-product of the rice milling. Soft wheat (Sakha 69) was obtained from Agriculture Research Center. Yeast and salt were purchased from the local market.

Animals: Forty two male adults albino rats weighting (130 ±10) of Sprague Dawley strain, were purchased from the Animal House of the Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Alloxan was obtained from Sigma Co.

Basal diet content: Basal diet consisted of 497g starch, 20g casein, 50g corn oil, 100g salt mixture and 20g vitamins mixture. Choline and Sucrose contents were 3g and 100g, respectively as shown in Table (1) according to the National Research Council (1989).

Methods:

Preparation of rice bran: Rice bran was dried at 130°C for 60 min. Dried rice bran was then milled in laboratory mill (in hammer type mill, model 3100).
Preparation of wheat flour (82%): Wheat was cleaned, conditioned at 14% moisture. The conditioned wheat was milled using Qudrumat Senior Laboratory Mill. The extraction rate was adjusted to 82%.

Preparation of Balady bread: Rice bran flour was blended separately with wheat flour (82% extraction) at different levels 5%, 10%, 15% and 520 as illustrated in Table (1). The technological procedure used for preparing bread was carried out in Food Technology Research Institute according to (Sallam *et al.*, 1995).

Table (1): Formula used in supplementing Balady bread with rice bran.

Components	Balady bread Supplemented with:				
	Control	**5% rice bran**	**10% rice bran**	**15%rice bran**	**20%rice bran**
Wheat flour	100	95	90	85	80
Rice bran	0	5	10	15	20
Salt	3	3	3	3	3
Yeast	5	5	5	5	5
Water	100	100	100	100	100

Experimental Design: Rats were housed in individual wire-bottom cages and fed on basal diet prior to feeding the experimental diets for acclimatization for five days. Animals had been accessed to diets and water ad-libitum. After acclimatization period, Albino rats were weighted and divided into six groups (7 rats/ group). Group (1) was fed on the basal diet only (control -ve). The remainder rats, thirty five, were injected subcutaneous with a single dose of the alloxan (150 mg/ Kg body weight) to attack the rats with hyperglycemia (Buko, *et al.*, 1996). The rats were then divided into five diabetic groups (7 rats/ group) and fed on the following diets for 4 weeks as shown in Table (2): Group (2), diabetic control (+ve), was fed on basal diet only (non treated rats). Group (3), fed on basal diet plus Balady bread supplemented with 5% of rice bran. Group (4), fed on basal diet plus Balady bread supplemented with 10% of rice bran. Group (5), fed on basal diet plus Balady bread supplemented with 15% of rice bran. Group (6), fed on basal diet plus Balady bread supplemented with 20% of rice bran, as shown in Table (2).

Table (2) Composition of excremental diets:

Diet contents:	Control (-ve) Group (1)	Diabetic rats:				
		Control (+ve) Group (2)	**Group (3)**	**Group (4)**	**Group (5)**	**Group (6)**
Casein	200	200	200	200	200	200
Corn oil	50	50	50	50	50	50
Salad Mixture	100	100	100	100	100	100
Vitamin Mixture	20	20	20	20	20	20
Cellulose	30	30	30	30	30	30
Sucrose	100	100	100	100	100	100
Choline	3	3	3	3	3	3
Corn starch	497	497	0	0	0	0
Balady bread supplemented with:						
5% rice bran	0	0	497	0	0	0
10% rice bran	0	0	0	497	0	0
15% rice bran	0	0	0	0	497	0
20% rice bran	0	0	0	0	0	497

Blood collection: Rats were fasted for 12 hours, weighted at the end of the experiment and sacrificed under ether anesthesia. Blood samples were received from portal vein into clean dry centrifuge tubes and left to clot at room temperature. Then centrifuged for 10 min. at 3000 rpm to separate the serum. Then, serum was carefully aspirated and transferred into clean covet tubes and stored frozen at -20ºC for analysis (Asatoor and King, 1954).

Gross chemical composition: Moisture, crude protein, lipids, total dietary fiber, soluble and in soluble dietary fibers and ash contents of wheat flour (82% extraction), rice bran and produced bread were determined by the standard procedures described in the A.O.A.C. (1995). The carbohydrates were calculated by differences. Vitamin E content was determined according to Brubacher *et al.*, (1985).

Determination of Phenolic compounds: 0ne gram of each sample was homogenized with 40% methanol and stirred on a shaker. The extract was was filtered through a nylon filter and the solvent was evaporated under vacuum. The dried residue containing phenolic compounds was dissolved in a solution consisting of methanol: water: acetic acid (40: 59.3: 0.7, v: v: v) and stored in brown vials at 5°C for analysis. HPLC analysis is used to detect and determine the phenolic compounds as suggested by Christian (1990). The analysis of phenolic compounds was performed on HPLC model Hp 1050, equipped with UV detector. The separation and determination were performed on C 18 column (150 × 4.8 nm). The mobile phase consists of methanol: water: acetic acid (40: 59.3: 0.7, v: v: v). the wave length in the UV detector is 254 nm. The run time is 25 min with 1 ml./ min. of flow rate.

Sensory evaluation of bread: Bread quality attributes were evaluated after cooling during 30 min for crust and crumb attribute determinations. Appearance (20), Layers separation (15), Crumb texture (15), Crust color (10), Taste (20), Oder (20) and Overall acceptability (100) were determined according to (Ronda *et al.*, 2005).

Analytical Methods: Glucose was determined in the serum according to the colorimetric method described by Wayne (1998). Total cholesterol (TC) was determined according to Allain *et al.*, (1974). Total protein (TP) was determined according to Henry (1957). Albumin was determined according to Doumas *et al.*, (1971). Triglycerides (TG) level was determined according to Lowell *et al.*, (1973). Low density lipoproteins (LDL-c) was determined according to the method described by Steinberg, (1981). High density lipoproteins (HDL-c) was determined according to the method described by Kostner, (1976). The activities of serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined according to the method of Moss and Henderson (1999).

Statistical Analysis: Data were statistically analyzed by the variance and least significant difference (L.S.D) at 0.05 level according to the method described by McClave, and Benson (1991).

RESULTS AND DISCUSSION

Chemical composition and energy content:

Chemical composition and energy content of wheat flour (82% extraction), rice bran and Balady bread supplemented with 5%, 10%, 15% and 20% of rice bran are shown in Table (3). Data show that wheat flour (82% extraction) contained protein, fat, ash, total dietary fiber (TDF), total carbohydrates and energy by 13.5%, 1.7%, 0.8%, 4.1%, 79.9% and 388.8

calories, respectively. Also, rice bran contained protein, fat, ash, total dietary fiber (TDF), total carbohydrates and energy by 18.3%, 20.3%, 10.0%, 20.4%, 31.0% and 379.9 calories, respectively. Data show also that rice bran contained the highest content of protein, oil, ash, TDF, soluble dietary fiber (SDF) and insoluble dietary fiber (IDF) compared to wheat flour (82% extraction). So, rice bran could be recognized as an excellent source of nutritional and healthy component in human food. Meanwhile wheat flour (82% extraction) contained high content of total carbohydrate and energy.

Data in Table (3) show also that supplementation of Balady bread with rice bran increased protein, fat, ash, TDF, SDF and ISD content of supplemented bread. In contrast, increasing of rice bran addition slightly decreased both total carbohydrates and energy content of produced bread compared with the control Balady bread. Cheruvanky (2003) reported that rice bran and its derivatives are good sources of protein, TDF, phyto-nutrients, vitamins and minerals.

Table (3): Chemical composition (%) and energy(Kcal/ 100g) content of wheat flour (82% extraction), rice bran and supplemented bread (on dry wt. basis):

Component / Samples	Protein	Fat	Ash	SDF[1]	IDF[2]	TDF[3]	Carbohy-drates	Energy
Wheat flour	13.5	1.7	0.8	2.8	1.3	4.1	79.9	388.9
Rice bran	18.3	20.3	10.0	3.1	17.3	20.4	31.0	379.9
Bread supplemented with:								
Control	12.7	1.5	1.0	1.4	2.0	3.4	81.0	391.5
5% rice bran	13.0	2.4	1.4	1.6	2.4	4.5	79.2	390.4
10% rice bran	13.2	3.3	1.9	1.7	3.1	4.8	76.8	389.7
15% rice bran	13.5	4.2	2.3	1.8	4.0	5.8	74.2	388.6
20% rice bran	13.9	5.3	2.8	1.9	4.8	6.7	71.3	388.5

[1] Soluble dietary fiber. [2] Insoluble dietary fiber. [3] Total dietary fiber.

Antioxidant content of wheat flour (82% extraction), rice bran and supplemented bread:

Antioxidant content of wheat flour (82% extraction), rice bran and supplemented bread are shown in Table (4). Data show that rice bran is an excellent source of Phenolic acids and vit E.

Table (4): Antioxidant content of wheat flour (82% extraction), rice bran and supplemented bread (on dry wt. basis):

Component / Samples	Phenolic acids contents (mg/ 100g)					Vit. E (mg/ 100g)
	Ferulic	P. Coumaric	Vanilic	Proto catchuic	Total	
Wheat flour	2.8	1.2	0.6	0.4	5.0	0.6
Rice bran	175.5	77.8	33.4	28.3	315.0	8.6
Bread supplemented with:						
Control	2.6	1.1	0.5	0.4	4.6	0.5
5% rice bran	11.2	5.0	2.0	1.8	20.0	1.0
10% rice bran	19.4	8.8	4.0	3.4	35.6	1.4
15% rice bran	28.6	12.6	5.4	4.6	51.2	1.7
20% rice bran	36.5	16.2	6.9	5.9	65.5	2.1

Data obvious also that ferulic acid is the abundant acid in rice bran and wheat flour (82%). Data show also that Phenolic acids and vit. E content of Balady bread supplemented with rice bran increased with increasing rice bran levels. Eun Hee *et al.*, (2007) reported that rice bran contains ferulic acid and vit. E which possess antioxidant activities and show promising effects as preventive and therapeutic agents.

Sensory evaluation of produced Balady bread supplemented with rice bran:

Sensory evaluation of produced Balady bread supplemented with 5%, 10%, 15% and 20% of rice bran is shown in Table (5). Data show that increasing rice bran levels in supplemented Balady bread decreased sensory parameters. Also, supplementation of Balady bread up to 15% of rice bran caused no significant deterioration in sensory parameters. In contrast supplementation of Balady bread with 20% of rice bran caused significant deterioration in the sensory parameters. These results agree with those obtained by Delahaya *et al.*, (2009) and Saeed *et al.*, (2009).

Table (5): Sensory evaluation of produced Balady bread supplemented with rice bran:

Parameters / Samples	Appear-ance (20)	Layers separation (15)	Crumb texture (15)	Crust color (10)	Taste (20)	Oder (20)	Overall acceptability (100)
Control	19.0^{a}	15.0^{a}	14.6^{a}	10.0^{a}	18.6^{a}	19.0^{a}	96.2^{a}
5% rice bran	18.0^{ab}	15.0^{a}	14.6^{a}	10.0^{a}	18.6^{a}	19.0^{a}	95.2^{a}
10% rice bran	18.0^{ab}	14.6^{a}	14.3^{a}	9.0^{ab}	18.3^{a}	18.5^{a}	92.7^{a}
15% rice bran	17.6^{b}	14.5^{a}	14.1^{a}	8.0^{bc}	18.0^{a}	18.0^{a}	90.2^{a}
20% rice bran	12.3^{c}	12.3^{b}	12.5^{b}	7.0^{c}	13.0^{b}	14.0^{b}	71.3^{b}

Effect of supplementing Balady bread with rice bran on serum glucose levels of diabetic rats:

Effects of supplemented Balady bread with 5%, 10%, 15% an 20% of rice bran on serum glucose levels of the diabetic rats are shown in Table (6). The results show that serum glucose level increased from 107.33 mg/ dl. in control (-ve) to 396.42 mg/dl. in the control (+ve) due to alloxan treatment. Treating of the diabetic rats groups with Balady bread supplemented with 5%, 10%, 15% and 20% rice bran caused significant reduction in the serum glucose levels to 303.12, 275.34, 250.58 and 205.45 mg/ dl. of the diabetic rats after 4 weeks treating period, respectively.

From results presented in Table (6), it could be noticed also that serum glucose level of diabetic rats decreased with increasing both rice bran levels and treating period. Also, Balady bread supplemented with 20% rice bran recorded the lowest serum glucose the level in diabetic rats. It reduced serum glucose level by 40% comparing with control (+ve) group without significant differences with Balady bread supplemented with 15% rice bran. These results are in line with those obtained by Eun Hee *et al.*, (2007), who mentioned that rice bran contains ferulic acid which significantly decreased blood glucose level and increased plasma insulin levels of type 2 diabetes to regulate blood glucose levels by elevating glucokinase activity and production of glycogen in liver.

Table (6): Effect of supplementing Balady bread with rice bran on serum glucose levels (mg/dl.) of diabetic rats.

Groups \ Variable	Treating time in weeks: 0	1	2	3	4
G1	107.33[a] ±4.04	105.00[a] ±4.58	103.33[a] ±4.32	100.69[a] ±3.93	102.44[a] ±2.91
G2	396.42[b] ±7.64	394.22[d] ±6.70	391.22[d] ±7.02	385.22[d] ±6.77	380.00[e] ±4.51
G3	395.34[b] ±5.00	336.42[c] ±5.7	318.32[c] ±4.84	313.32[c] ±6.70	303.12[cd] ±5.17
G4	394.54[b] ±6.35	330.11[c] ±5.36	314.31[b] ±2.91	308.51[c] ±3.93	275.34[c] ±4.33
G5	396.23[b] ±7.02	325.55[bc] ±7.53	310.42[b] ±2.19	302.11[c] ±4.32	250.58[bc] ±3.00
G6	392.54[b] ±10.00	314.60[b] ±7.35	300.32[b] ±5.36	285.11[b] ±2.60	205.45[b] ±2.19

Effect of supplementing Balady bread with rice bran on cholesterol profile and triglyceride level of diabetic rats:

The effects of supplementing Balady bread with rice bran on cholesterol profile and triglyceride level of diabetic rats are shown in Table (7). Data show that total cholesterol (TC), triglyceride and low density lipoprotein (LDLc) in control (+ve) group were higher than in control (+ve) group due to aloxan treatment. In the contrast, high density lipoprotein (HDLc) was higher in the control (-ve) group than in the control (+ve) group. Data show also that treating the diabetic rats with Balady bread supplemented with rice bran reduced TC, triglyceride and LDLc and increased HDLc compared with the control (+ve) group. Data show also that Balady bread supplemented with 15% and 20% rice bran recorded the highest treating effect with no significant differences with the control (-ve) group.

Table (7): Effects of supplementing Balady bread with rice bran on cholesterol profile and triglyceride level of diabetic rats (mg/ dl)

Groups \ Variables	Total cholesterol	Triglyceride	LDLc	HDLc
G1	97.30[a] ±3.71	125.67[b] ±2.96	50.00[a] ±1.53	67.83[a] ±1.76
G2	125.00[c] ±4.41	215.67[d] ±4.32	67.11[d] ±2.23	50.44[d] ±3.67
G3	120.25[c] ±4.67	178.64[c] ±4.26	65.11[cd] ±1.86	54.00[c] ±2.89
G4	116.30[bc] ±4.51	174.34[c] ±4.06	59.51[bc] ±1.86	59.31[b] ±2.60
G5	106.45[ab] ±3.71	101.00[a] ±4.51	54.67[ab] ±1.53	65.52[a] ±2.60
G6	102.00[a] ±3.00	131.00[b] ±4.16	50.10[a] ±1.53	67.37[a] ±2.33

The data obtained are in agreement with those obtained by Keser *et al.*, (2006), who reported that dietary fibers reduce blood cholesterol, glucose and insulin levels. Visser *et al.,* (2000) reported that the hypocholesterolemic effect of rice bran has been attributed to various fractions of the bran such as the neutral detergent fiber, hemicellulose, rice bran oil and its unsaponifiable matter. Also, Leonora *et al.*, (2006) reported that brown rice is more health beneficial food for diabetics and hyperglycemic individuals than milled rice due to the higher amounts of phytic acid, polyphenols, dietary fiber and oil in brown rice compared to the milled rice.

Effect of supplementing Balady bread with rice bran on liver functions of hyperglycemic rats:

Effect of supplementing Balady bread with rice bran on liver functions of hyperglycemic rats are shown in Table (8). Data show that total protein (Tp) and albumin were significantly reduced from 6.40 and 2.13mg/dl., respectively, in the control (-ve) group to 4.03 and 1.67 mg/dl., respectively, in the control (+ve) group. Meanwhile AST and ALT significantly increased from 89.35 and 29.36 mg/dl., respectively, in the control (-ve) group to 152.00 and 49.35mg/dl., respectively, in the control (+ve) group. Also, treating hyperglycemic rats with bread supplemented with 5%, 10%, 15% and 20% rice bran increased both total protein and albumin levels. Also, Balady bread supplemented with 20% rice bran recorded the highest levels in TP and albumin levels of hyperglycemic rats. Data in Table (8), show also that AST and ALT increased in the control (+ve) group compared with the control (-ve) group due to aloxan treatment . Treating hyperglycemic rats groups with Balady bread supplemented with 5%, 10%, 15% and 20% rice bran caused significant reduction in AST and ALT of hyperglycemic rats, and 20% rice bran recorded the highest improvement without significant differences with the control (-ve) group. From data obtained in Table (8) it could be concluded that treating the hyperglycemic rats with wheat bread supplemented with 15% and 20% rice bran improved greatly the liver functions. Also, the present data are in line with those obtained by Panlasigui and Thompson (2006).

Table (8): Effect of the supplementing Balady bread with rice bran on liver functions of the hyperglycemic rats:

Variable / Groups	Total Protein (mg/ dl)	Albumin (mg/ dl)	AST (mg/ dl)	ALT (mg/ dl)
G1	6.40[a] ±0.87	2.13[a] ±0.03	89.35[a] ±2.60	29.36[a] ±1.45
G2	4.03[b] ±0.3	1.67[b] ±0.02	152.00[c] ±4.04	49.35[c] ±2.60
G3	4.20[b] ±0.43	1.70[b] ±0.06	142.34[c] ±4.10	47.67[c] ±2.52
G4	4.53[ab] ±0.64	1.75[b] ±0.09	117.00[b] ±3.60	42.35[b] ±2.29
G5	5.23[ab] ±0.72	1.83[b] ±0.14	108.00[b] ±3.51	35.00[a] ±1.89
G6	5.37[ab] ±0.63	1.87[b] ±0.10	95.67[a] ±2.89	30.33[a] ±1.62

Conclusion:

From the results obtained from this study, it could be suggested that it is possible to produce Balady bread supplemented with 15% and 20% rice bran with high nutritive value and technological quality and used it as functional food to satisfy the requirements of people suffering from hyperglycemia or coronary heart diseases. Also, rice bran by- product of rice milling can be utilize economically.

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تأثير الخبز البلدي المدعم بردة الأرز علي مستوي سكر وكولسترول الدم المرتفع

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يوجد اهتمام متزايد بردة الأرز لما تحتويه من مركبات مضادة للأكسدة مثل فيتامين E والأحماض الفينولية. يهدف هذا البحث إلي إنتاج خبز بلدي مدعم بردة الأرز ودراسة التأثير العلاجي لهذا الخبز علي مستوي السكر والكولسترول المرتفع في دم الفئران المصابة بداء السكري. أظهر التركيب الكيميائي أن ردة الأرز مصدر جيد للبروتينات، العناصر المعدنية، الألياف الغذائية ومضادات الأكسدة مثل الأحماض الفينولية وفيتامين E. تم تدعيم الخبز البلدي ب ٥%، ١٠%، ١٥% و ٢٠% ردة أرز. أدي تدعيم الخبز البلدي بردة الأرز حتى مستوي ١٥% إلي زيادة نسبة الألياف الغذائية، الأحماض الفينولية و فيتامين E بدون تدهور في الخواص الحسية للخبز الناتج. كما أظهرت النتائج المتحصل عليها أن تدعيم الخبز بنسبة ١٥% و٢٠% ردة أرز قد سجل أعلي تأثير علاجي علي مستوي السكر والكولسترول المرتفع في دم الفئران المصابة بداء السكري. وقد انخفض مستوي الجلوكوز والكولسترول بنسبة ٤٠% و ١٨،٤%، علي التوالي، مقارنةً بمجموعة الفئران المصابة بداء السكري الضابطة. يتضح من النتائج المتحصل عليها أنه يمكن إنتاج خبز بلدي مدعم بردة الأرز ذو قيمة غذائية وجودة تكنولوجية كغذاء وظيفي مفيد لمرض السكري والكولسترول المرتفع.

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