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Physiochemical, Sensory and Biological Properties of Wheat- Rice Bran Composite Biscuits, Crackers and Pasta.

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ABSTRACT

Stabilized whole rice bran (WRB) of Egyptian short grain variety (Sakha 101) and its oil were used for preparation of functional foods such as biscuits, crackers and pasta. Rice bran oil was added in some of the previous products. Crackers containing defatted rice bran (DRB) as 60, 70, 80 and 90% replacements of wheat flour were prepared. Rheological properties of dough and colour quality of biscuits and crackers were studied. Food products were subjected to analysis of proximate composition and sensory evaluation. Biological evaluation of pasta (20% rice bran), fortified biscuits and crackers (90% DRB) was carried out to determine their food and protein efficiency ratio and safety concerning liver and kidney functions. Results clarified that there was no significant difference between sensory parameters of different types of crackers and between 10% and 20% WRB containing biscuits. Pasta containing 20% WRB was far superior compared to that of 30% in respect to sensory attributes. The presence of WRB and DRB affected both rheological and colour properties. Protein contents of 20% WRB biscuits without fortification by rich protein sources was 10.2%, while that of the fortified was 13.13%. Pasta containing 20% WRB and crackers of 90% DRB showed percentage protein to be 10.71 and 16.03, respectively. Biological evaluation showed pasta diet to have the highest food and protein efficiency ratio. All food products showed safety towards liver and kidney function. We concluded that the products containing different rice bran products showed successful results suggesting the possible marketing of such functional foods.

Keywords: Rice bran, biscuits, pasta, crackers.

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INTRODUCTION

Rice is one of the widely used crops in the world for human consumption. Paddy rice is milled to separate the rice kernel from the hull and bran. Human consumption of rice bran, a by-product of milled rice, has been limited primarily because of the rapid onset of rancidity, but methods to stabilize rice bran and to extract its oil have been developed. The oil content in rice bran is about 20%, it has been used in Asian countries as cooking oil [Orthoefer, 1996]. Egypt is one of the largest rice producers thereby, rice bran is accumulated in huge amount annually during pearling and polishing, and it is used as livestock and poultry feed. However, most of the rice bran is still discarded, despite its high content of bioactive constituents.

Rice bran and its oil are rich in nutrients and bioactive constituents that make them important materials to be incorporated into food products [Orthoefer, 1996]. Rice bran oil contains relatively high unsaponifiable fractions, such as plant sterols; stanols, oryzanol, tocopherols, tocotrienols and policosanol. Rice bran oil contains 20% saturated fatty acids [Rukmini & Raghuram, 1991] ~ 43.8% oleic acid and ~ 39.3% linoleic acid [Edwards & Radcliffe, 1994]. The oil constituents have potent antioxidant activity that may exert protection towards chronic diseases [Xu et al., 2001]. The oil and its bioactive constituents have been reported to possess different health benefits as preventive and/or nutraceutical effects towards cancer, hyperlipidemia, fatty liver, heart disease and inhibition of platelet aggregation [Cicero & Gaddi , 2001; Jariwalla, 2001]. Moreover, rice bran contains flavonoids that have been reported to reduce the risk of certain types of cancer and possess anti-inflammatory activity [Hudson et al., 2000]. Supplementation of 30.6% insoluble and 11.7% soluble fibers from rice bran per day showed reduced mean fasting and postprandial serum glucose levels in diabetic patients [Rodrigues et al., 2005]. Previous literature dealt with incorporation of rice bran into food products showed conflicting results [Lebesi & Tzia, 2011; Oghbaei & Prakash, 2011]. The aim of the present study is implementation of WRB, DRB, and rice bran oil into different suitable functional food products and studying both sensory and physical attributes of such products and the rheological properties of dough. Proximate composition and biological evaluation of the promising food products were carried out.

MATERIALS AND METHODS

Materials

-Stabilized rice bran (Sakha 101, short grain rice variety, Egypt) was supplemented by Dr Amr M. Helal, International Trade & Marketing.
- Wheat flour (72% extraction), oil, sugar, salt, vanilla, cinnamon, eggs, skimmed milk, roasted chick pea, curcumin and baking powder were obtained from the local market, Cairo, Egypt. Wheat flour used in the study contains 0.82% ash, 11.65 % protein, 9.5% dry gluten and 30% wet gluten.
-Gum acacia, gluten and improver were amongst the materials used in the present study.

Methods

Rice bran preparation

Stabilized rice bran was sieved through a 20 –mesh sieve and stored within tight poly ethylene bags in a deep freeze until used. On preparation of food products, rice bran was ground to obtain very fine powder to increase hydration capacity and remove grittiness by decreasing mean particle size and producing a desirable mono-modal size distribution.

Extraction of rice bran oil (RBO) and preparation of defatted rice bran

Stabilized rice bran was placed in a continuous extraction apparatus (Soxhlet) and extracted with n-hexane (60-70°C) in dark room till complete extraction. The solvent was removed by evaporation under reduced pressure. Residual traces of solvents were removed by flushing with nitrogen**.** The obtained oil was placed in amber brown glass container and kept into deep freeze until used. Defatted rice bran (oil cake) that result from hexane extraction was heated in hot air oven at 40 ºC to remove residual solvent.

Preparation of flour mixtures

Wheat flour (72% extraction) was partially replaced by WRB to obtain flour mixtures containing 10, 20, and 30g. rice bran/100 g. wheat flour for manufacture of biscuits. Also, 20% and 30% replacements of wheat flour were used for preparation of pasta. Wheat flour was partially replaced by 60, 70, 80, and 90% DRB for manufacturing of crackers.

Preparation and evaluation of baking quality and sensory attributes of biscuits

The basic formula of biscuit and that containing different levels of rice bran are shown in table, 1. Biscuits were prepared by mixing wheat flour (72%) with other ingredients; 14.7 ml of sucrose solution (5.93%) and the suitable amount of water were added according to AACC [2000]. The formulas were baked in an oven at 200 °C for about 15 minutes. Weight, volume, specific volume, diameter, thickness (height) and spread ratio of biscuits were recorded, every parameter was measured in triplicate and the mean was calculated. Organoleptic (sensory) characteristics of biscuits were evaluated according to Hoojjat and Zabik [1984] where each formula was subjected to sensory analysis by 20 panelists. Each panelist was asked to assign scores 0-10 for color, flavor, taste, texture, appearance and overall acceptability. Based on these tests the promising biscuit was subjected to modification aiming at increasing protein value and contents through fortification with protein rich sources such as chick pea and excess skimmed milk (table, 1). The resulted modified products were again sensory and physically evaluated.

Table 1: Composition of mixtures used in manufacture of biscuits, crackers and pasta (g.)

Ingredients	Pasta formulas			Biscuit basic formula (1)	Biscuit formulas				Different formulas of crackers				
	Control	20% rice bran	30% rice bran		2	3	4	5	1	2	3	4	5
Wheat flour72%	100	80	70	100	90	80	70	60	10	20	30	40	50
Sucrose	-	-	-	50	35	35	35	35	-	-	-	-	-
Sunflower oil	10	-	-	28	15	15	15	--	-	-	-	-	-
Rice bran oil	-	5	10	--	--	--	--	10	-	-	-	-	-
Baking powder	-	-	-	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Salt	1	1	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Emulsifier	-	-	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Skimmed milk	-	-	-	10	10	10	10	20	-	-	-	-	-
Eggs	20	20	20	20	20	20	20	20	-	-	-	-	-
WRB	-	20	30	--	10	20	30	20	-	-	-	-	-
Chick pea	-	-	-	--	--	--	--	20	10	10	10	10	10
Vanilla	-	-	-	1	1	1	1	1	-	-	-	-	-
Cinnamon	-	-	-	---	--	--	--	2	--	--	--	--	2
DRB	-	-	-	-	-	-	-	-	90	80	70	60	50
Gluten	-	-	-	-	-	-	-	-	2	2	2	2	2
Improver	-	-	-	-	-	-	-	-	1	1	1	1	1
Curcumin	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-	-
Gum	-	-	-	-	-	-	-	-	1.5	1.5	1.5	1.5	1.5

Preparation and sensory evaluation of crackers

Crackers were prepared from the blends of wheat flour and DRB (table, 1). The different mixtures were mixed with water, sheeted, cut into rectangle shapes, baked in an oven at 250 °C for 5 minutes. The crackers were sensory evaluated for taste, aroma, mouth feeling, texture, crispness, color, appearance and overall acceptability by twenty trained panelists. Taste and aroma were scored 0- 20, the other items were scored from 0-10.

Preparation and sensory evaluation of frozen pasta

The ingredients of the three prepared pasta are shown in table, 1. Pastas were prepared, packed and stored in a deep freezer. Before sensory evaluation, the different prepared pastas were cooked separately for 2-3 minutes in boiling water. Water was decanted. Tomato sauce was prepared and added to different types of pasta. The evaluation was carried out by 8 panelists [Meiselman, 1978]. Each panelist was served a control pasta sample along with the test samples and was asked to assign scores on a ten-point scale for color, taste, odor, appearance, elasticity, texture, mouth feeling, mastication and overall acceptability. A sensory score of 5 or above was considered acceptable, and a sensory score below 5 was unacceptable.

Another sensorial evaluation was conducted by a trained panel of three experts on pasta cooked to optimum cooking time as above. Stickiness, bulkiness, and firmness were evaluated by each expert on a scale of 10–100 according to Cubadda [1988]. Pasta with a total score of 40 was of poor quality; >40 to 50 was not completely satisfactory; >50 to 70 was fair; >70 to 80 was good; and >80 was excellent. Each cooking test was replicated three times in a laboratory under controlled temperature. Cooking quality of pasta was evaluated through observing material or solid lost during cooking and rinsing of drained cooked pasta.

Statistical analysis

The results of sensory evaluation were analysed statistically using one way analysis of variance ANOVA followed by the Duncan´s test, $p<0.05$ was used as the criterion of statistical significance.

Color quality of biscuits and crackers

The color of biscuits and crackers were measured by using a Spectro-Colorimeter (Tristimulus Color Machine) with CIF lab color scale (Hunter, Lab Scan XE, Germany). The assessed color quality includes, L= lightness (100= white; 0= black), a= redness (+100) to green (-80), b= yellowness (70) to blue (-80) and $E = (L^2 + a^2 + b^2)^{1/2}$.

Evaluation of nutrients contents of prepared food products

Proximate composition of food products was determined according to the official methods of analysis [AOAC, 2000]. The determined parameters were moisture, protein, crude fiber, fat, ash and carbohydrates.

Rheological properties of dough

Farinograph parameters

Blends of 0, 10, 20 and 30 % whole rice bran and 90, 80, 70, 60 and 50% defatted rice bran substituted wheat flour were subjected to dough rheology using Farinograph [Model Type No: 81010 (31, 50 and 63 r.p.m), ©Brabender ® OHG, Duisburg, 1979 Germany] as described in AACC [2000].

Pasting properties of dough and falling number

Blends of 0, 10, 20 and 30 % whole rice bran substituted wheat flour and 90, and 60 % defatted rice bran substituted wheat flour were measured using an amylograph (Brabender amylograph, Duisburg Nr. 940053, type 680022) according to AACC [2000]. Falling number was measured according to AACC [2000].

Biological evaluation of food products

Animals

Male and female Sprague Dawley rats of average body weight of 50.21 ± 3.718g (Mean ± SD) were used in the study. The animals were kept individually in wire bottomed stainless steel cages at room temperature. Water and food were given ad-libitum.

Preparation of diets

Crackers containing 90% defatted rice bran, pasta containing 20% rice bran + rice bran oil and fortified biscuits (formula No 5) were dried separately in hot air oven at 40C° and reduced into fine powder.

Different experimental diets appeared in table 2 were used in the present study. An appropriate amount of different dried food products that contain 10g protein was added to the different diets and their contents of fat, fibers and carbohydrates were calculated and completed with corn oil, cellulose, and starch-sucrose mixture, respectively so as each diet would contain 10% protein, 10% fat, 3% fiber, 1% vitamin mixture [Morcos, 1967]. 3.5% salt mixture [Briggs and Williams, 1963] and completed to 100% by starch and sucrose. Oil soluble vitamins were given orally in a dose of 0.1 ml/rat per week.

Table 2: Composition of different experimental diets (g per 100 g).

Ingredients	Balanced diet	Crackers Diet	Pasta diet	Biscuits Diet
Casein	11.9[1]	-	-	-
Methionine	0.6	-	-	-
Corn oil	10	8.92	2.05	4.26
Sucrose	23.5	7.82	7.68	5.05
Starch	46.5	15.65	15.36	10.09
Salt mix.	3.5	3.5	3.5	3.5
Vit. mix.	1	1	1	1
Cellulose	3	3	3	3
Crackers	-	60.11	-	-
Pasta	-	-	67.41	-
Biscuits	-	-	-	73.1

[1] 11.9 g casein was determined to contain 10 g protein (AOAC, 2000)

Design of experimental study

Twenty four rats were divided into four groups, each comprised of 6 rats. Group one served as control where rats fed on balanced. Rats of group 2, 3 and 4 were fed on crackers, pasta and biscuits diets, respectively as shown in table 3. The experiment continued for 4 weeks. During the experiment, rats body weights and food intake were recorded weekly. At the end of the experiment; total food intake, total protein intake, body weight gain, food efficiency ratio (FER) (body weight gain/total food intake) and protein efficiency ratio (body weight gain/ total protein intake) were calculated. After elapse of experimental period, rats were fasted 16 h, anesthetized and blood samples were withdrawn from eye vein on heparin for separation of plasma. Plasma activity of alanine transaminase (ALT) and aspartate transaminase (AST) were determined as indicator of liver function according to Reitman and Frankel (1957). Plasma creatinine (Houot, 1985) and urea [Fawcett & Scott, 1960] were assessed as representative of kidney function. The results obtained were expressed as the mean $\pm$ SE. Rats of test groups were compared with control rats. The significance of values was analyzed by Student's t-test. Animal experiment was carried out according to the Medical Research Ethics Committee, National Research Centre, Cairo, Egypt.

RESULTS AND DISCUSSION

It is of interest to incorporate rice bran back into our diet to make use of this healthy by-product. So, in the present research, different rice bran products (WRB, DRB and RBO) were used to produce functional foods.

Bakery products have proven to be good vehicles for incorporation of bran from cereals, and many of those products are also suitable for rice bran [Sharp & Kitchens, 1990]. Rice bran has the potential of adding a natural rich flavor to breads, breakfast cereals, cookies and other food products. The nutritional benefits of incorporating fiber into baked products are well documented [Chavan & Kadam, 1993] due to its effect as hypolipidemic, antidiabetic and reducing the risk of cancer. Also, rice bran oil has many reported healthy effects [Raghuram & Rukmini, 1995; Gerhardt & Gallo, 1998; Rajnarayana et al., 2001]. The food products prepared in the present research were biscuits, crackers and pasta. Food products were physically, chemically, sensory and biologically evaluated.

Effect of adding WRB or DRB to wheat flour (WF) (72% extraction) on rheological properties of dough:

Farinograph parameters

Effect of replacing wheat flour (WF) (72% extraction) with WRB or DRB on the farinograph parameters is presented in Table 3. Water absorption, arrival time, dough development time, dough stability time and mixing tolerance index of dough increased on addition of WRB compared with the control sample. Water absorption and stability time was also increased on addition of DRB. This increase may be due to high protein and fibers contents of WRB and DRB compared to WF. Protein and fibers tend to bind more water as fibers are characterized by their high water holding capacity. Proteins and fibers in WRB and DRB may interact with WF ingredients and added water thereby stability of dough increased. In this respect**,** Kim et al. [1997] reported that water absorption and stability of dough increased as rice fibers increased**.** Hussein et al. [2006] reported that increasing proportion of barley flour in the blend with white flour resulted in a progressive increase in water absorption and arrival time. Also, Sudha et al. [2007] pointed out that water absorption and arrival time increased as dried apple pomace level (rich in fibres) increased in dough. Sairam et al. [2011] stated that addition of Defatted rice bran to wheat flour had a marginal effect on the water absorption of flour, dough stability and dough development time. On the other hand, in the present study, Dough weakening was reduced by increasing the level of WRB or DRB. Concerning DRB, mixing tolerance index was the highest at 80% replacement (40 BU) and the lowest at 70% (20 BU) and intermediate at 50, 60 and 90 % (30 BU). Similar findings were observed by Doxastakis et al. [2002].

Table 3: Farinograph parameters of dough prepared from WF and WRB or DRB at different levels.

Samples	Water absorption (%)	Arrival time (min)	Dough development time (min)	Dough stability (min)	Dough Weakening (BU)	Mixing tolerance index (BU)
Wheat flour (WF)	57.5±0.23	1.5±0.20	2.0±0.01	3.0±0.05	90±2.0	30±2.5
WF+ 10%WRB	59.8±0.30	1.5±0.20	2.3±0.05	6.0±0.03	80±1.5	40±2.2
WF+ 20%WRB	60.5±0.69	2.5±0.10	3.0±0.06	5.0±0.02	80±2.1	50±1.5
WF+ 30%WRB	62.7±0.12	3.0±0.05	3.5±0.04	4.0±0.06	70±1.2	55±1.5
WF+ 90%DRB	83.0±0.17	3.0±0.08	4.5±0.06	12.0±0.04	60±1.5	30±2.5
WF+ 80%DRB	75.5±0.57	2.5±0.06	3.5±0.02	7.0±0.09	40±1.3	40±1.0
WF+ 70%DRB	69.2±0.55	1.5[c]±0.02	2.5±0.07	5.0±0.03	30±1.9	20±0.8
WF+ 60%DRB	63.5±0.16	1.2±0.09	2.0±0.01	4.0±0.02	25±2.1	30±1.2
WF+ 50%DRB	60.8±0.33	1.0±0.01	2.0±0.03	3.0±0.01	20±2.0	30±1.5

Amylograph parameters

Amylograph characteristics of WF, and different blends of WF with WRB flours (10, 20 and 30%) and DRB (90 and 60%) illustrated in table, 4. The obtained results indicated that, temperature of both transition and maximum viscosity increased on addition of WRB, while maximum viscosity decreased on addition of DRB and 20% and 30% WRB. Break down viscosity **a**nd setback viscosity decreased on addition of 10% and 20% WRB and 90% DRB compared to control (WF 100%). Such results were in agreement with those obtained by Yadav et al. [2011]**.** Reduction of DRB flour from 90 to 60% led to a decline in temperature of both transition and maximum viscosity and at the same time, maximum viscosity, break down viscosity **a**nd setback viscosity were increased. This change may be attributed to variation in composition of defatted and full fat bran. Defatted bran, which is high in crude fiber may increase shear force resulting in increased pressure. The increase may also be due to reduction in dough mass temperature with increased bran fiber. The increases in dough mass viscosity with decreases in dough mass temperature followed the power law model [Hu et al., 1993].

Regarding the falling number, WF had a higher falling number (335 Sec) than blends containing WRB or DRB. This showed that addition of WRB or DRB to WF increased the amylolytic activity of the produced dough. Previously, low values of falling numbers imply a high α-amylase activity [Sergio et al., 2004].

Table 4: Viscoamylograph parameters and falling number of dough prepared for different formulas.

Samples[1]	Temp.of transition (°C)	Max. viscosity (BU)	Temp. of max. viscosity	Break down viscosity (BU)	Setback viscosity (BU)	Falling No. (Sec)
Wheat flour (WF)	60.0	500	82.5	210	640	335
WF+ 10%WRB	61.5	540	87.0	200	290	308
WF+ 20%WRB	64.5	440	90.0	180	260	307
WF+ 30%WRB	63.0	390	90.0	240	740	257
WF+ 90%DRB	67.5	200	75.0	160	520	82
WF+ 60%DRB	60.0	320	73.5	220	820	230

Baking quality of biscuit

Physical characteristics of biscuits are present in table, 5. The changes in diameter and height are reflected in spread ratio. The spread ratio of control was 4.77 while the value in case of formula 2, 3& 4 that contain 10, 20 and 30% whole rice bran replacement were 4.8, 4.64 & 4.83, respectively which showed no clear difference. Weight decreased while, volume and specific volume increased with the increasing level of WRB in blends. Previously it has been reported that the weight of supplemented biscuits increased, whereas diameter and spread ratio of biscuits decreased with the increasing level of rice bran-fenugreek blends, fenugreek flour and different bran blends [Sharma & Chauhan, 2002; Hooda & Jood, 2005 and Sudha et al., 2007] which partially agree with our results.

Table 5: Baking parameters of different biscuits formulas.

[1]Sample No	Diameter (cm)	Height (thickness) (cm)	Spread ratio (diam./ht)	Weight (g)	Volume (cc)	Specific volume (cc/g)
1	6.2±0.30	1.30±0.20	4.77 ±0.01	28.23±0.65	51.86±2.1	1.83±0.02
2	6.0±0.20	1.25±0.20	4.80±0.05	27.66±1.03	52.70±1.5	1.91±0.06
3	5.8±0.10	1.25±0.10	4.64±0.06	25.36±0.45	52.16±2.5	2.05±0.09
4	5.8±0.40	1.20±0.05	4.83±0.04	24.26±0.32	53.75±1.8	2.22±0.01
5	5.6±0.22	1.18±0.08	4.75±0.06	24.25±0.85	54.05±1.3	2.22±0.05

[1] The ingredients of samples No. 1, 2, 3, 4 and 5 of biscuits are present in table, 1.

Color quality attributes

Color attributes of biscuits and crackers as affected by adding WRB and DRB are shown in Tables, 6,7. It can be noticed that all biscuit samples supplemented with WRB were darker than control (formula, 1) where their L-values (lightness) were lower than control. Biscuits containing WRB decrease in b values (yellowness) when compared to control. The overall color quality (ΔE) of biscuits supplemented by WRB showed lower values than control. Lightness decreased with increasing the level of DRB in crackers from 60 to 90%, while degree of yellowness and redness did not show any correlation with the level of DRB in the product. Overall color quality was proportionally increased with the decreased level of defatted rice bran in the product from 90 to 60%. WRB and DRB are darker than wheat flour so, it was expected that darkness increased as a result of presence of WRB and DRB in food products. Such findings were also observed by Ramy et al. [2002]. Doubtless, addition of chick pea, skimmed milk and even flavoring agents (Cinnamon and vanilla) have interacted effect with rice bran (WRB & DRB) on color parameters.

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Table 6: Color quality of biscuits formulas.

Biscuits								
Samples No[1]	Face				Back			
	L	a	b	Δ E	L	a	b	Δ E
1	75.96	6.15	37.75	85.05	57.57	18.15	43.77	74.56
2	70.20	7.26	35.84	79.15	53.94	17.99	41.92	70.30
3	64.63	8.86	35.28	74.16	56.05	15.24	38.29	69.57
4	64.67	9.64	35.05	60.12	42.23	15.52	31.05	54.66
5	67.22	8.00	33.22	64.22	44.66	14.12	30.16	55.46

[1] The ingredients of samples No. 1, 2, 3, 4 and 5 of biscuits are present in table, 1.
L= lightness (100= white; 0= black), a= redness (+100) to green (-80)
b= yellowness (70) to blue (-80), $E = (L^2 + a^2 + b^2)^{1/2}$

Table 7: Color quality of crackers formulas.

Samples No[1]	crackers			
	L	a	b	Δ E
90% DRB(1)	28.07	3.29	13.65	31.39
80% DRB (2)	36.69	4.95	16.57	40.65
70% DRB (3)	48.17	3.03	15.43	50.57
60% DRB (4)	59.04	5.33	21.98	63.22
50% DRB (5)	46.77	3.22	19.66	50.83

[1] The ingredients of samples No. 1, 2, 3, 4 and 5 of crackers are present in table, 1.
L= lightness (100= white; 0= black), a= redness (+100) to green (-80)
b= yellowness (70) to blue (-80), $E = (L^2 + a^2 + b^2)^{1/2}$

Organoleptic evaluation

Supplementation of biscuit with WRB did not produced any significant change in all sensory attributes (data not shown) except for overall acceptability, in case of formula 4 (30% WRB) that showed significant decrease from control (1), (7.4 ±1.17 and 8.9 ±1.01, respectively). Adding different protein rich source in formula 5 did not produce any significant change in sensory attributes from original formula (3) that contain 20 %WRB.

Sensory attributes (data not shown) of prepared crackers (containing 90, 80, 70, 60 and 50% DRB as formula 1, 2, 3, 4 and 5, respectively) showed non significant changes when compared to each other. Adding cinnamon as flavoring agent in crackers containing 50% WRB (formula, 5) elevated most sensory scores none significantly when compared to other samples.

In a previous research, four cookie formulas were prepared by combining stabilized rice bran with flour of other locally produced cereals. Sensory evaluation of the products did not detect a significant change for any of the tested cookies. The formula containing 30% rice bran showed 100% acceptability when evaluated by children aged 4 to 7 years old [Sangronis and Sancio, 1990]. It was reported that muffins were acceptable by a sensory panel when rice bran was incorporated at levels up to 20% [Saunders et al., 1988]. However, James et al. [1989] found that muffins and biscuits containing 20% defatted stabilized rice bran were not as acceptable as controls because of grittiness or chalkiness and a bitter aftertaste. Pomeranz [1977] used fine bran to obtain good quality breads, even at 15% replacement levels.

Table 8 showed the sensory evaluation of different prepared cooked pastas. It could be noted that all the scores of sensory parameters decreased with increasing the level of WRB in pasta. Scores of sensory parameters of pasta containing 20% rice bran were higher than that of pasta containing 30% with significant difference concerning color, odor, texture and mouth feeling. Color, odor, elasticity, texture, mastication and mouth feeling scores of 20% WRB containing pasta did not differ significantly from the control. 30% WRB containing pasta showed significant lower scores of taste, odor, appearance, texture, mouth feeling and overall acceptability compared to control, however no significant change was noticed concerning elasticity and mastication.

Pasta consumers attribute fundamental importance to textural properties such as stickiness, firmness, and bulkiness are shown in table, 7. Stickiness and bulkiness are surface characteristics and together with firmness, which depends on the intrinsic structure of pasta, are considered the best predictors of consumer sensations when eating pasta. Therefore, sensory tests that incorporate those attributes are considered reliable tests to judge cooking quality. Moreover, in many cases, sensory tests are considered reference methods to assess the predictability of instrument-based methods. Sensory judgment is considered by Kovacs et al [1997] as useful tests to evaluate overall cooking quality. In the current study, sensory evaluation of stickiness, bulking, firmness of different prepared pastas by expertise showed significant reduction of the scores of the different sensory attributes when increasing WRB from 0 to 20 to 30% in the prepared pastas. In the present study, it was noticed that during cooking and rinsing pasta with tap water the lost solids were higher in case of control than WRB containing pasta which is supported by a previous study [Sangronis et al., 1997]. It is well documented that the smaller the amount of material lost during cooking, the better the pasta quality. Undesirable characteristics were given by rice bran such as color change and in case of 30% WRB supplemented pasta white spots were observed. However it has been reported by Sangronis et al. [1997] that sensory quality was affected because rice bran made pastas hard and dark but they were comparable to high fiber pasta existing in market. Sangronis and Rebolledo [1997] reported that it is possible to elaborate pastas with 20% as maximum of rice bran with high protein, ash and dietary fiber content.

The adverse effect of WRB was reflected in color attribute in all products except for biscuits. These effects may be due to high fiber content of WRB. Also, it has been reported that as aleuron flour level increased adverse effect regarding all tested sensory characteristics occurred [Hussein & Hegazy, 2007]. In this respect Zumbado et al. [1997] reported that sensory scores decreased with increasing level of rice bran. The deterioration in the crumb texture and crumb color of wheat bread due to such supplementations was observed by Carson et al. [2000]. On the contrary, other authors reported higher sensory scores with increasing rice bran level in bakery products [Sangronis & Sanico, 1990]. The fortified biscuit formula (5) in the present study is accepted and attracted by the consumers in addition of being of high nutritive and health value.

Table 8: Sensory attributes and textural properties of different prepared pasta samples.

Samples	Pasta from		
	Control (100%Wheat flour) (WF)	70%WF+ 30% Rice bran	80%WF+ 20% Rice bran
Sensory attributes			
Color	8.57^{a} ±0.42	6.86^{b} ±0.46	7.72^{a} ±0.36
Taste	9.43^{a} ±0.20	7.43^{b} ±0.57	8.00^{b} ±0.44
Odor	8.86^{a} ±0.34	7.57^{b} ±0.43	8.57^{a} ±0.30
Appearance	9.29^{a} ±0.18	6.71^{c} ±0.52	7.86^{c} ±0.34
Mastication	8.57^{a} ±0.40	7.86^{a} ±0.40	7.71^{a} ±0.42
Elasticity	8.71^{a} ±0.42	7.14^{a} ±0.63	7.43^{a} ± 0.48
Texture	8.86^{a} ±0.26	7.43^{b} ±0.57	8.14^{a} ±0.26
Mouth feeling	9.14^{a}±0.34	7.14^{b}±0.63	7.71^{a}±0.61
Overall acceptability	9.14^{a}±0.34	6.86^{b}±0.67	7.86^{b}±0.40
Textural properties			
Stickiness	96.7^{a} ±3.34	66.7^{c}±3.34	76.7^{b}±3.34
Bulkiness	93.3^{a}±3.34	65^{c}±2.89	76.7^{b}±3.34
Firmness	100^{a}±0.0	55^{c}±7.65	71.7^{b}±7.27

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Proximate composition of products

Proximate composition of biscuits containing 20% replacement of WRB and vanilla as flavoring agent (formula, 3) is shown in table, 8, percentage protein and fat in biscuit was 10.2 and 13.49, respectively. Moisture content in biscuits was 3.05%. This moisture level in the product is reasonable. Ash was 2.65% in biscuits and total calories were 442.61 Calorie. In the present study biscuit formula was modified (as can be seen in section, 2) to include high protein sources (chick pea and extra skimmed milk) to elevate both the level and values of the protein. Also, in addition sun-flour oil was replaced by rice bran oil. Fortified biscuit (5) was noticed to contain 13.13% protein, 7.53 %fat, 3.06% ash, 71.63% carbohydrates, 0.61% crude fibers and 4.04 % moisture. Calorific content in 100g biscuit was calculated to be 406.81. It can be noticed that fortification of biscuit with chickpea and increasing the level of skimmed milk elevated the percentage protein from 10.2 in formula 3 to 13.13 in formula 5. It is well documented that mixing cereals (represented here by wheat flour and rice bran) with legumes (represented here by chick pea) would complement and mutually reinforce each other nutritionally specially concerning amino acids profile. Addition of skimmed milk provides essential amino acids which is important especially for children.

Proximate analysis of crackers that contains 90%DRB replacement (formula1) (table 9) showed high percentage of protein (16.03) and ash (6.99) and low percentage of fat (1.73) compared to the previous food products which were supplemented by WRB. The moisture content was 3.65% which did not differ distinctly from the products supplemented by WRB. Total calories were 358.85 Calorie.

It can be noticed from table, 8 that increasing the level of WRB from 20% to 30% in pasta increased the percentage of protein, ash and crude fibers. Moisture was higher in 20% pasta than that of 30%. Sangronis and Rebolledo (1997) reported that protein content, ash and dietary fiber of pasta increased according to the percentage of rice bran added. In the present study, pasta containing 20%WRB was prepared by adding lower quantity of fat, approximately half the quantity added to the control and pasta containing 30%WRB. This may reflect the lower level of fat in 20%WRB containing pasta compared to other pasta samples, this resulted in decreased calorific content in this type of pasta. Pasta containing 30% WRB showed higher content of fat than the control; this is due to the oil content of WRB in addition to the added oil. Calorific contents of control and 30% WRB pastas was noticed to be similar.

Table 9: Proximate analysis (g %) and Calories (Calorie %) of the studied formulas

Sample	Moisture	Protein	Fat	Ash	Crude fiber	Carbohy-drates	Calories
Biscuit (formula 3)	3.05±0.10	10.20±0.20	13.4±0.25	2.65±0.20	0.52±0.04	70.10±0.39	442.61±1.54
Biscuit (formula 5)	4.04±0.08	13.13±0.07	7.53±0.30	3.06±0.11	0.61±0.06	71.63±0.31	406.81±1.56
Crackers(formula 1)	3.65±0.08	16.03±0.05	1.73±0.06	6.99±0.15	1.81±0.08	69.80±0.14	358.85±0.51
Pasta Control	24.48±0.50	11.13±0.15	11.62±0.15	1.11±0.13	1.10±0.08	50.56±0.53	351.34±1.33
Pasta 30% WRB	24.85±0.20	12.20±0.15	13.73±0.15	3.02±0.1	1.52±0.13	44.68±0.19	351 .09±0.42
Pasta 20% WRB	27.8±0.25	10.71±0.10	8.52±0.10	1.24±0.15	1.40±0.10	50.33±0.04	320.84±0.16

Biological evaluation of food products

Results of nutritional parameters of different experimental groups are shown in Table (10). The results revealed that rats fed on pasta diet had higher significant values of total food intake, body weight gain, PER and FER than control group of rats fed on balanced diet containing casein. Rats fed on crackers or biscuits diet showed significant reduction in body weight gain, FER and PER compared to control. Rats fed on crackers diet showed the lowest values in body weight gain reflecting the possible use for loosing weight in obese subjects. The high PER of pasta might be due to presence of egg with higher percentage than in biscuit which has been reported to possess high quality protein [Sotelo & González, 2000] even than casein. On the other hand biscuit showed higher PER than crackers due to presence of chick pea, eggs and skimmed milk in biscuits. Milk as animal protein is of high protein value. Also the presence of legumes (chick pea) together with cereals (wheat flour and rice bran) and skimmed milk in biscuit complement each other and elevate the protein value [Milán-Carrillo et al, 2007] compared to crackers that contains only cereals. Doubtless, control diet which contains casein, an animal protein of high protein quality, was expected to possess high PER compared to crackers and biscuit diets.

The results of biochemical parameters (data not shown) clarified non significant change in all determined parameters that reflect liver and kidney functions compared to control group. These results revealed that feeding the studied rice bran products (That containing either defatted rice bran or whole rice bran with rice bran oil) are quite safe towards liver and kidney functions.

Previously, nutritional evaluation studies, carried out with 10 per cent rice bran oil (RBO) and 20 per cent protein indicated that growth; feed efficiency and mineral balance were comparable to ground nut fed animals. Toxicological studies had shown that there were no abnormalities in animals fed RBO. In addition, neither RBO nor the foods deep-fried in it showed any mutagenicity as judged by Ames test. In view of its safety and hypolipidaemic activity, RBO could be considered as an alternative source of edible oil as reported by Raghuram and Rukmini (1995).

Table 10: Nutritional parameters of different experimental groups.

Groups	Initial BW (g)	Final BW (g)	BWG (g)	Total food intake(g)	Total protein intake (g)	Food efficiency ratio	Protein efficiency ratio
Control	50.2±0.796	99.33±3.088	53±3.369	166.03±8.685	16.603±0.868	0.299±0.019	2.99±0.192
Crackers	50.5±2.469	69±3.915	18.5***±1.822	151.1±9.873	15.11±0.987	0.126***±0.015	1.266***±0.153
Pasta	50.2±0.863	124.5±3.977	74.3***±4.226	207.7**±10.235	20.722**±1.022	0.358*±0.007	3.581*±0.068
Biscuits	50±1.154	74.8±1.479	24.8***±1.816	126.7**±8.327	12.7**±0.833	0.199***±0.016	2.104***±0.159

Values significantly differ from control: *: p<0.010, **: p<0.005, ***: p<0.001

CONCLUSION

No significant changes were noticed in the sensory attributes of different prepared crackers and between 10% and 20% WRB containing biscuits. Inclusion of 20% WRB in pasta was superior to that of 30% concerning sensory properties. The rheological and color properties of food products were affected on addition of WRB and DRB. Protein level of 20% WRB biscuits was elevated on fortification by chick pea and higher percentage of skimmed milk. Crackers of 90% DRB showed 16.03% protein which is considered as high percentage that could be of health value for consumers. Food and protein efficiency ratio of pasta diet was the highest compared to crackers and biscuits. All food products showed safety towards liver and kidney function. Use of rice bran, defatted rice bran and rice bran oil with wheat flour for preparation of biscuits, crackers and pastas showed successful results suggesting the possible production of these functional foods in the markets.

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