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BIOLOGICAL EVALUATION OF RICE BRAN AND BARLEY RADICLE ON PLASMA LIPIDS PROFILE IN EXPERIMENTAL RATS

Foda, F.F.A.*, Saad, S.M.M.* and Sohair Abozied, A.A.M.**

* *Agric. Biochem. Dept., Fac. of Agric., Benha Univ., Egypt.*

** *Food Technol. Res. Institute., Agric. Res. Center, Giza, Egypt.*

ABSTRACT

This study was conducted on some by-products i.e. rice bran and radicle from rice and barley to evaluate their chemical and biological effects. Rice bran was added relatively 25% and radicle 10% for making Mary biscuit.

The obtained results indicated that rice bran and barley radicle are rich in protein, it amounted to 16.50% and 22.24%, respectively. While, rice bran contained 17.68% total lipids which higher than that of radicle (2.82%). On the other hand, biscuit supplemented with 25% rice bran contained 10.39% protein, 12.64% fat, 2.30% ash, 1.88% crude fiber and 72.79% total carbohydrate. However, manufactured biscuit fortified with 10% radicle contained 9.97% protein, 11.61% fat, 1.40% ash, 1.35% crude fiber and 75.67% total carbohydrate.

A nutritional experiment was performed on rats to evaluate the effect of feeding biscuits fortified with 25% rice bran or 10% radicle and rice bran or radicle powder on hypercholesterolemic rats. The results indicated that all groups, which were fed on these products had a significant increment in food consumption and body weight gain compared with hypercholesterolemic rats. A significant decrement was observed in serum total cholesterol, triglycerides and LDL-cholesterol levels but HDL-cholesterol was significantly increased. The activities of serum alkaline phosphatase (ALP), aspartate and alanine amino-transferase enzymes (AST and ALT) values were significantly decreased in groups fed on different diets relative to values of group fed on hypercholesterolemic diet. From the obtained

results, rice bran and barley radicle could be used as fortified material in bakery products for hypercholesterolemic patients.

Key word: Rice bran - Barley radicle - Hypercholesterolemic - Biological evaluation - Mary biscuit.

INTRODUCTION

Cereal brans are considered desirable for human consumption due to its health benefits. Rice bran as a by-product of rice milling, which amounted to 10% of rice grain weight. It is considered as a good source of protein and fat in food material (Prakash, 1996).

Orthoefer (1996) reported that rice bran composition amounted to 15% protein, 18% oil, 7% ash, 46% carbohydrates and 7% crude fiber.

Kahlon and Chow (1997) found that oat, rice and barley fibres contribute significantly to reducing total plasma cholesterol in a variety of animal species and in hypercholesterolemic human subjects.

Gerhardt and Gallo (1998) compared full-fat rice with oat bran and rice starch in hyperlipidemic humans. They found that serum cholesterol decreased significantly by 8.3±2.4% and 13.0±1.8% in the rice bran and oat bran groups, respectively, but there was no change in the rice starch group.

Kahlon *et al.* (1999) cited that diets containing rice bran, oat bran, or soy protein significantly reduced the development of aetherosclerosis in hypercholesterolemic hamsters.

Kalra and Jood (2000) studied the effect of dietary beta-glucan on cholesterol and lipoprotein in rats. They found that diet containing barley flours caused significant reduction in levels of total cholesterol (39%), LDL cholesterol (34%) in serum compared with casein diet.

Wilson *et al.* (2002) evaluated lipidemic and antiatherogenic activities of whole-fat rice bran using an animal model. They found that all experimental diets significantly reduced total cholesterol, very low density lipoprotein cholesterol and low density lipoprotein cholesterol levels in plasma compared with the control diet, but did not affect high density lipoprotein (HDL) cholesterol concentration.

Kahlon and Smith (2004) found that stabilized rice bran has been showed to possess cholesterol-lowering activity in hypercholesterolemic animals and human subjects. The active components of rice bran are contained in the unsaponifiable matter of its oil and other fractions of this cereal bran.

Bitter and Flucher (2005) reported that barley is a nutritious cereal grain that offers consumers bioactive compounds that can help improve their health. Also, contains many bioactive compounds that have demonstrated biological activities, such as reducing total and LDL-cholesterol, postprandial glucose, cancer and cardiovascular risks..

The aim of the present work was to study the chemical composition and biological effects of manufactured biscuit fortified with 25% rice bran and 10% barley radicle (rootlets) on lipids profile, liver and kidney functions of hypercholesterolemic rats.

MATERIALS AND METHOD

Materials:

Rice (*Oryza sativa* L.) bran was obtained from El-Obour mill, Desouq, Kafr El-Sheikh Governorate. Radicle (by-product from barley) was obtained from Al-Ahram Company of Beverage and Beer Industry, Giza Governorate. Commercial wheat flour (72% ext.) was obtained from South Cairo Mills Company, Fysal, Giza Governorate.

Adult male albino rats (weighed 140 to 190 g) were obtained from experimental Animal House, Crops Technology Department, Food Technology Research Institute (FTRI), Giza, Egypt

Chemical analysis: Moisture, ash, crude fiber, total lipid and total nitrogen contents were determined according to A.O.A.C. (2000). Total carbohydrate were determined according to the method described by Bernfeld (1955) and Miller (1959). Total dietary fiber, soluble and insoluble dietary fiber were determined according to the method described by Prosky *et al.* (1984).

Biological experimental: A total of thirty adult male albino rats weighed 140 to 190 g were used in the present study. Rats were fed on normal diet according to Lane-peter and Pearson (1971) as shown in Table (1).

After feeding on basal diet for two weeks for adaptation. The rats were divided randomly into six groups contain each group five rats. The first group (control) was fed on basal diet. The second group was fed on hypercholesterolemic diet. The other groups were fed on hypercholesterolemic diet plus different experimental diets as shown in Table (1). Each rat was weighed every week and food intake was also daily recorded. At the end of experiment, animals were killed by

Table (1): Composition of different experimental diets (g/100 g).

Diet	Casein	Corn oil	Sheep tail fat	Salt mix.	Vitamin mix.	Cellulose	Cholest-erol	Bile salts	Starch	Biscuit	Rice bran	Radicle
Basal diet	10.00	10.00	-	4.00	1.00	5.00	-	-	70.00	-	-	-
Hypercholest-erolemic diet	10.00	-	10.00	4.00	1.00	5.00	1.00	0.25	68.75	-	-	-
Biscuit with 25% rice bran	0.01	-	-	1.79	1.00	3.20	1.00	0.25	-	92.75	-	-
Biscuit with 10% radicle	0.78	-	-	2.71	1.00	3.76	1.00	0.25	-	90.5	-	-
Rice bran powder	-	-	-	-	1.00	0.27	1.00	0.25	39.21	-	58.27	-
Radicle powder	-	8.74	-	1.14	1.00	-	1.00	0.25	45.48	-	-	42.39

decapitation after an overnight fast, and the blood of each rat was collected in tubes and centrifuged at 3000 rpm for 20 min to obtain the serum which was kept in the deep-freezer. The liver, kidney, heart, splin and brain organs were removed from each rat and weighed.

Determination of biological parameters: Serum total cholesterol was determined by using the enzymatic method of Einely (1978). Serum HDL-cholesterol was determined by the method of Lopez-Virella *et al.* (1977). Serum LDL-cholesterol was calculated according to the equation of Steinberg (1981). Serum triglycerides were determined according to the method of Fossati and Precipe (1982). The burite method was used for determination of total protein in serum according to Doumas (1975). Serum albumin was determined according to the method described by Doumas *et al.* (1971). Serum aspartate transferase (AST) and serum alanine transferase (ALT) activities were measured colorimetrically according to the method of Retiman and Frankel (1957). Uric acid in the serum was determined according to the method described by Haisman and Muller (1977). Urea in serum was determined according to Tabacco *et al.* (1979). Creatinine was determined according to the method of Henery *et al.* (1974).

Biscuit making technique: Rolled Marie biscuits were prepared according to the method of Wade (1988). The wheat flour in the formula biscuits were supplemented with rice bran or radicle at levels of 25% and 10%, respectively.

Statistical analysis: Statistical analysis of the data was carried out according to Fisher (1970). Least squares difference (L.S.D.) test was used to compare the significant differences between means of treatments (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

1. Chemical composition of rice bran, barley radicle and biscuits:

Chemical composition of raw materials and biscuits manufactured are tabulated in Table (2). The obtained results indicated that rice bran and radicle from barley are rich in protein, it amounted to 16.50% and 22.24%, respectively. While, rice bran shows that the total lipid was 17.68% which higher than that of radicle (2.82%).

From the obtained results, it could be noticed that the rice bran components (on dry weight basis) were 11.18, 7.20, 7.81 and 50.81% of moisture, ash, crude fiber and total carbohydrate, respectively.

On the other hand, radicle from barley contained moisture (8.10%), ash (6.37%), crude fiber (14.03%) and total carbohydrate (54.54%). These results are in agreement with those reported by Orthoefer (1996).

Also, the chemical components of manufactured biscuits fortified with 25% rice bran or 10% radicle under investigation were determined. The obtained data are presented in Table (2). From these data it could be observed that values of crude protein, total lipid, ash, total carbohydrate and crude fiber contents were 10.39, 12.64, 2.30, 72.79 and 1.88%, respectively for biscuits manufacturing from rice bran.

Table (2): Chemical composition of rice bran, barley radicle (rootlets) and biscuits (g/100 g dry weight) (mean±S.D.).

Components (%)	Rice bran (R.B.)		Radicle	
	Raw material	Biscuit (25% R.B.)	Raw material	Biscuit (10% radicle)
Moisture	11.18 ±0.26	4.43 ±0.20	8.10 ±0.13	4.38 ±0.16
Crude protein	16.50 ±0.25	10.39 ±0.15	22.24 ±0.27	9.97 ±0.20
Total lipid	17.68 ±0.21	12.64 ±0.22	2.82 ±0.31	11.61 ±0.19
Ash	7.20 ±0.15	2.30 ±0.17	6.37 ±0.18	1.40 ±0.22
Total carbohydrate	50.81 ±0.20	72.79 ±0.25	54.54 ±0.23	75.67 ±0.14
Crude fiber	7.81 ±0.20	1.88 ±0.21	14.03 ±0.11	1.35 ±0.11

However, biscuits supplemented with radicle from barley contained protein (9.97%) less than biscuits that fortified with rice bran (10.39%). Also, the crude fiber content was 1.35%, ash amounted to 1.40% and total carbohydrate was 75.67%. These results are related with those reported by Salama *et al.* (1997).

2. Biological effects of fortified biscuits with rice bran or radicle on hypercholesterolemic rats:

2.1. Effect of experimental diets on body weight, food intake and feed efficiency ratio of hypercholesterolemic rats:

The obtained results in Table (3) show that rats fed normal basal diet had the highest mean value of body weight (234.20 g), while rats fed hypercholesterolemic diet had the lowest mean value of body weight (195.80 g). However, the mean values of body weight were 210.80, 228.40, 206.20 and 203.80 g in rats fed diet biscuits containing rice bran (25%), radicle (10%), rice bran and radicle powders, respectively.

From the obtained results, it could be observed that rats fed diets containing biscuits made using 25% rice bran or 10% radicle and rice bran or radicle powders had the highest values of body weight than that of rats fed hypercholesterolemic diet. But these values had slightly decrement as compared with rats fed basal diet. On the other hand, food intake in rats fed normal diet which recorded 479.92 g higher than that rats fed hypercholesterolemic diet (348.24 g) and rats fed biscuits with 25% rice bran (465.18 g). While, food intake in rats fed biscuits with 10% radicle, rice bran or radicle powders had the highest values (515.81, 533.25 and 514.12 g), respectively than that rats fed basal diet and hypercholesterolemic diet.

From the above-mentioned results, it could be observed that the addition of the powder of rice bran or barley radicle at different levels improved the body weight, food intake and feed efficiency relative to hypercholesterolemic rats. This is may be due to the good nutritional value of rice bran and barley radicle. These results are in agreement with those reported by Kalra and Jood (2000).

2.2. Effect of different experimental diets on organs weight of rats:

The weights of liver, kidney, heart, spleen and brain expressed as g/100 g of body weight for the different tested diet groups are presented in Table (4). From the obtained results, it could be observed that the liver, kidney, heart and brain of hypercholesterolemic rats had the lowest values than that of rats fed normal diet. While, rats fed biscuits with different levels of rice bran or radicle had similar mean values of liver weight except rats fed biscuits containing 10% radicle compared to control group. However, the weights of kidney and brain of rats fed different experimental diets had the lowest mean values

Table (3): Effect of experimental diets with rice bran and barley radicle on body weight gain, food intake and feed efficiency ratio in rats after 45 days.

Treatment	Initial body weight (g)	Final body weight (g)	Body weight gain (A) (g)	Daily food intake (g/rat)	Food intake (B) (g)	Feed efficiency A/B	F.E.R.
Basal diet	180.40 ±5.54	234.20 ±4.96	53.80 ±2.48	10.66 ±0.62	479.92 ±27.95	0.112 ±0.004	11.2
Hypercholesterolemic diet	176.40 ±4.50	195.80 ±5.35	19.40 ±1.51	7.73 ±0.44	348.24 ±19.87	0.055 ±0.005	5.5
Biscuit with rice bran (25%)	179.00 ±7.14	210.80 ±8.22	31.80 ±2.28	10.33 ±0.59	465.18 ±26.88	0.066 ±0.005	6.6
Biscuit with radicle (10%)	189.80 ±4.08	228.40 ±6.18	38.60 ±4.21	11.46 ±0.22	515.81 ±10.18	0.074 ±0.008	7.4
Rice bran powder	183.80 ±2.28	206.20 ±4.76	22.40 ±2.70	11.85 ±0.56	533.25 ±25.45	0.044 ±0.005	4.4
Radicle powder	190.40 ±3.84	203.80 ±5.80	13.40 ±4.82	11.42 ±0.64	514.12 ±29.03	0.026 ±0.008	2.6
L.S.D. at 0.05	6.173	7.304	4.536	0.526	23.697	0.0098	

Feed efficiency = Body weight gain/feed intake F.E.R. = Feed efficiency x 100

Table (4): Effect of fortified biscuits with different levels of rice bran and barley radicle on organs weight (g/100 g) of hypercholesterolemic rats at the end of experimental period (45 days).

Treatments	Final body weight (g)	Liver (g)	Kidney (g)	Heart (g)	Spleen (g)	Brain (g)
Basal diet	234.20 ±4.96	7.95 ±0.71	2.38 ±0.19	0.69 ±0.04	0.57 ±0.24	2.19 ±0.30
Hypercholesterolemic diet	195.80 ±5.35	7.02 ±1.09	1.56 ±0.21	0.55 ±0.11	0.70 ±0.10	1.83 ±0.20
Biscuit with rice bran (25%)	210.80 ±8.22	7.94 ±0.83	1.22 ±0.19	0.52 ±0.11	0.57 ±0.01	1.31 ±0.22
Biscuit with radicle (10%)	228.4 ±6.18	8.87 ±1.03	1.35 ±0.22	0.67 ±0.04	0.65 ±0.09	1.66 ±0.08
Rice bran powder	206.20 ±4.76	6.83 ±0.56	1.15 ±0.08	0.61 ±0.05	0.53 ±0.05	1.39 ±0.22
Radicle powder	203.80 ±5.80	6.03 ±0.42	1.47 ±0.22	0.60 ±0.03	0.59 ±0.10	1.97 ±0.21
L.S.D. at 0.05	7.304	1.534	0.244	0.103	0.160	0.269

than that of rats fed control basal diet. Also, the heart and spleen weights of rats fed hypercholesterolemic diet and different experimental diets had the same mean values with control group. Similar results were obtained by Kalra and Jood (2000) and Wilson *et al.* (2002).

2.3. Effect of different experimental diets on serum triglycerides, total cholesterol, HDL-, LDL-cholesterol, and risk ratio:

Table (5) shows the effect of biscuits containing rice bran or radicle on serum triglycerides, total cholesterol, HDL-chloesterol, LDL-chol. and risk ratio of hypercholesterolemic rats after 45 days of experimental period. From the obtained results, it could be seen that the rats fed high cholesterol diet had the highest mean values of triglycerides, total cholesterol and LDL-cholesterol (230.80, 280.58 and 193.22 mg/100 ml serum, respectively if compared with rats fed basal diet (120.26, 125.60 and 29.90 mg/100 ml serum, respectively). On the other hand, the mean values of triglycerides were lower (155.45, 161.32, 151.46 and 142.08 mg/100 ml serum) in rats fed biscuits with 25% rice bran, biscuits with 10% radicle, rice bran and radicle powders, respectively than that of rats fed hypercholesterolemic diet (230.80 mg/100 ml) but these values were higher than that of rats fed basal diet (120.26 mg/100 ml). However, total cholesterol levels of rats fed biscuits containing different concentrations of rice bran and radicle had the lowest values as compared with that high cholesterol group.

Risk ratios of hypercholesterolemic rats and rats fed biscuit containing different levels of rice bran and radicle were higher (6.81, 3.20, 3.32, 2.23 and 2.98, respectively) than that of rats fed basal diet (1.75).

The obtained results are in considered with that reported by Kahlon et al. (1999), Wilson et al. (2002) and Kahlon and Smith (2004).

2.4. Effect of experimental diets on total protein, albumin, globulin, alkaline phosphatase (ALP) and transaminase activities of hypercholesterolemic rats:

The mean values of serum total proteins, albumin, globulin, alkaline phosphatase (ALP) and aspartate, alanine transaminase (AST and ALT) activities are presented in Table (6). From the obtained results, it could be observed that the mean values of all the above-mentioned parameters had the highest values (7.27, 4.57, 2.70 g/100 ml), 124.78 U/L, 75.65 and 52.16 U/L) for rats fed hypercholesterolemic diet than

Table (5): Effect of experimental diets on serum triglycerides, total cholesterol, HDL- and LDL-cholesterol of hypercholesterolemic rats after 45 days.

Treatments	Triglycerides (mg/100 ml)	Total cholesterol (mg/100 ml)	HDL-chol. (mg/100 ml)	LDL-chol. (mg/100 ml)	Risk ratio TC/HDL-
Basal diet	120.26 ±5.93	125.60 ±7.49	71.64 ±5.60	29.90 ±10.31	1.75
Hypercholesterolemic diet	230.80 ±10.81	280.58 ±10.17	41.18 ±3.31	193.22 ±12.24	6.81
Biscuit with rice bran (25%)	155.45 ±6.96	164.50 ±13.00	51.36 ±3.95	82.04 ±14.45	3.20
Biscuit with radicle (10%)	161.32 ±4.21	186.11 ±12.54	56.12 ±3.52	97.83 ±11.88	3.32
Rice bran powder	151.46 ±4.21	148.91 ±8.56	66.72 ±2.36	51.89 ±9.90	2.23
Radicle powder	142.08 ±7.48	133.80 ±11.69	44.96 ±3.98	60.42 ±10.06	2.98
L.S.D. at 0.05	8.929	12.770	4.671	13.500	

Table (6): Effect of experimental diets on total protein, albumin, globulin, alkaline phosphatase (ALP) and transaminase activities of hypercholesterolemic rats after 45 days

Treatments	Total protein (g/100 ml)	Albumin (g/100 ml)	Globulin (g/100 ml)	ALP U/L	AST U/L	ALT U/L
Basal diet	5.99 ±0.77	3.59 ±0.19	2.40 ±0.72	82.32 ±4.85	54.71 ±2.26	24.50 ±1.90
Hypercholesterolemic diet	7.27 ±0.74	4.57 ±0.35	2.70 ±0.41	124.78 ±7.04	75.65 ±5.90	52.16 ±2.24
Biscuit with rice bran (25%)	5.72 ±0.73	3.72 ±0.23	2.00 ±0.62	94.88 ±3.60	64.60 ±3.18	31.48 ±2.17
Biscuit with radicle (10%)	6.62 ±0.80	3.74 ±0.15	2.88 ±0.76	89.68 ±6.45	55.42 ±3.47	33.08 ±4.90
Rice bran powder	5.57 ±0.76	3.64 ±0.19	1.93 ±0.33	93.84 ±8.36	61.42 ±5.17	24.46 ±3.79
Radicle powder	6.30 ±0.72	3.49 ±0.07	2.81 ±0.21	92.86 ±5.98	45.15 ±4.57	22.53 ±2.27
L.S.D. at 0.05	0.939	0.249	0.686	7.548	5.473	3.702

that rats fed basal diets (5.99, 3.59, 2.40 g/100 ml, 82.32 U/L, 54.71 and 24.50 U/L), respectively.

On the other hand, rats fed biscuits containing 25% rice bran, 10% radicle or rice bran and radicle powders had lower values of total protein, albumin and globulin than that of hypercholesterolemic and basal diet. While, rats fed on diets containing biscuits made using the different levels of rice bran and radicle powder had lower values of alkaline phosphatase (ALP), AST and ALT activities than that of rats fed hypercholesterolemic diet. From the above-mentioned results it could be concluded that the rats fed on biscuits containing rice bran and radicle had improvement in liver functions.

These results are in agreement with those reported by Kahlon and Chow (1997) and Bitter and Flucher (2005).

2.5. Effect of different experimental diets on Kidney functions of hypercholesterolemic rats:

Serum urea, uric acid and creatinine are determined as indicators of kidney functions. Since the increase in these components means that the kidney is less active or abnormal case (Table 7). The mean values of urea, uric acid and creatinine were 46.19, 3.51 and 0.86 mg/100 ml for rats fed basal diet while, the values in hypercholesterolemic rats were 60.08, 5.37 and 1.86 mg/100 ml, respectively. From these results, it could seen that kidney functions are less active in rats fed high cholesterol diet if compared with rats fed basal diet. However, urea contents of rats fed different levels of rice bran and radicle had the same manner mean values when compared with control group. While, uric acid levels were found to be higher than control group and lower than that rats fed high cholesterol diet. In the same line, rats fed diets containing different levels of rice bran and radicle had the lowest levels of creatinine than that of hypercholesterolemic rats. The results are in agreement with those reported by Wilson *et al.* (2002) and Kahlon and Smith (2004).

Table (7): Effect of experimental diets of rice bran and barley radicle on serum urea, uric acid and creatinine contents of hypercholesterolemic rats after 45 days.

Treatments	Urea (mg/100 ml)	Uric acid (mg/100 ml)	Creatinine (mg/100 ml)
Basal diet	46.19 ±6.05	3.51 ±0.64	0.86 ±0.05
Hypercholesterolemic diet	60.08 ±6.92	5.37 ±0.51	1.86 ±0.13
Biscuit with rice bran (25%)	49.84 ±6.50	4.48 ±0.46	1.35 ±0.08
Biscuit with radicle (10%)	50.82 ±6.11	4.46 ±0.43	1.52 ±0.06
Rice bran powder	47.34 ±6.97	4.70 ±0.63	1.21 ±0.08
Radicle powder	49.58 ±3.60	4.24 ±0.57	1.32 ±0.09
L.S.D. at 0.05	7.988	0.706	0.115

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التقييم البيولوجى لردة الأرز وراديسيل الشعير على مستوى دهون الدم فى فئران التجارب

فرحات فودة على فودة* – صلاح مصطفى محمود سعد* –
سهير عبدالله محمد أبوزيد**

* قسم الكيمياء الحيوية الزراعية – كلية الزراعة – جامعة بنها – مصر
** معهد تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة – مصر.

تهدف الدراسة إلى الاستفادة من بعض مخلفات الأرز والشعير وهى ردة الأرز وراديسيل الشعير كنواتج ثانوية لعمليات ضرب الأرز وتصنيع الشعير. حيث أجريت دراسة التركيب الكيميائى لمحتوى هذه المخلفات بإمكانية التدعيم مع دقيق القمح لصناعة البسكويت المضاف إليه مسحوق هذه المواد بنسب مختلفة. كما تم إجراء تجربة تغذية لمعرفة التأثيرات البيولوجية لمنتجات البسكويت على فئران التجارب المصابة (مرتفعة الكوليستيرول).

أظهرت النتائج المتحصل عليها أن التركيب الكيميائى لردة الأرز كانت ١٦,٥% بروتين، ١٧,٦٨% زيت، ٧,٢% رماد، ٧,٨١% ألياف، ٥٠,٨١% كربوهيدرات كلية، بينما كانت نسب هذه المكونات لراديسيل الشعير هى ٢٢,٢٤% بروتين، ٢,٨٢% زيت، ٦,٣٧% رماد، ١٤,٠٣% ألياف، ٥٤,٥٤% كربوهيدرات كلية.

ومن خلال التقييم الحسى للبسكويت المصنع وجد أن النسب المفضلة هى ٢٥% من ردة الأرز، ١٠% من الراديسيل حيث أعطت نتائج التحليل الكيميائى للبسكويت المضاف إليه ردة الأرز أن نسب كل من البروتين والزيت والرماد والألياف والكربوهيدرات الكلية هى: ١٠,٢٩، ١٢,٦٤، ٢,٣، ١,٨٨، ٧٢,٧٩% على التوالى، بينما للبسكويت المضاف إليه الراديسيل كانت ٩,٩٧، ١١,٦١، ١,٤، ١,٣٥، ٧٥,٦٧% على التوالى.

تم تغذية ذكور الفئران البيضاء على البسكويت المنتج والمضاف إليه ردة الأرز (٢٥%) والراديسيل (١٠%) وكذا المسحوق الخام من كل منهما. أوضحت النتائج المتحصل عليها أن التغذية بهذه المنتجات أدت إلى زيادة معنوية فى وزن الفئران وكذا وزن الأعضاء مقارنة بالمجموعة التى تغذت على عليقة مرتفعة الكوليستيرول. كما سجلت النتائج أيضا إنخفاض معنوى فى نسب الكوليستيرول الكلى، اللايبوبروتين منخفض الكثافة (LDL – كوليستيرول) والجليسريدات الثلاثية فى سيرم الدم مع تحسن فى نسبة اللايبوبروتين مرتفع الكثافة (HDL – كوليستيرول) وذلك فى كل المجاميع التى احتوت فى غذائها على البسكويت المنتج والمسحوق الخام عن الفئران المصابة. كما أعطت التغذية بهذه المنتجات إنخفاض معنوى فى نشاط إنزيمات الكبد ونسب كل من اليوريا والبوريك والكرياتينين فى سيرم دم الفئران مقارنة بالمجموعة مرتفعة الكوليستيرول. وبذلك فإنه يمكن التوصية باستخدام ردة الأرز وراديسيل الشعير كمواد مضافة لتدعيم دقيق القمح فى صناعة البسكويت وكخافض للكوليستيرول.

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