ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 44(3): 1037-1052, (2006).

BIOCHEMICAL EVALUATION OF RICE GERM
1- Lowering effects of manufactured biscuit containing rice germ powder diets on hypercholesterolemic rats

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ABSTRACT

With the increase of attention being paid today to the positive physiological benefits that may occure from consumption of special food products, the present study aims to evaluate the use of rice germ powder, as a by-product of the rice mashing to produce biscuit. Also, proximate analysis of raw material and biscuit, sensory evaluation and rheological properties were determined. In addition, the biological effects of these products on hypercholesterolemic rats were also studied.

The obtained results showed that rice germ is rich in crude protein (18.97%), total lipid (20.89%) and total carbohydrate (43.93) but crude fiber and ash amounted to 9.75 and 6.41%, respectively. However, manufactured biscuit fortified with 25% rice germ had a higher amount of crude protein (10.26%).

The reheological properties showed that the addition of 25% rice germ to wheat flour (72% ext.) lowered the stability and increased the weakening of the dough making it more suitable for biscuit production. The obtained results indicated that the fortified biscuit had good quality, high nutritive value and storage stability.

The results indicated that the rats which fed on biscuit diet containing rice germ powder had the highest values of body weight gain, food intake and feed efficiency when compared with rats fed hypercholesterolemic diets. Therefore, that the rats fed on the above diets had the highest significant decrease in total cholesterol, HDL-cholesterol and triglycerides when compared with the hypercholesterolemic rats.

Also, the results showed that improving of transaminase activity enzymes (aspartate and alanine transferase; AST and ALT) and kidney functions in rats fed on hypercholesterolemic diets.

INTRODUCTION

Rice is the main cereal crop of Asia and it is the basis of the diet of half world's population. All rice is milled before consumption, producing hull, bran and germ. Rice brain and rice germ are rich in protein, lipids, dietary fiber, vitamins and minerals. These qualities lead to a high demand for them as feed

(Barber and Benedito de Berber, 1985; Juliano, 1985 and Saunders, 1990). Cultivated area in Egypt averaged more than 1534000 feddan for grain rice produced 6375000 tons with an average 4.155 ton per feddan (Bulletin of Agriculture Economics, Ministry of Agriculture, Egypt, 2005).

Rice germ is produced as by-product of the rice and less abundant than rice bran. Rice germ is characteristically richer in proteins (17.3-26.4%) and fat (16.6-39.8%) but lower in fiber (1.98-15.10%) than bran (Luh *et al.*, 1991).

Rice germ produced has a significant cholesterol reduction in moderately hyperlipidemic subjects consuming their usual product diet, and the decline in cholesterol was entirely due to decrease of low density lipoprotein cholesterol (LDL-C) levels (Gerhardt and Gallo, 1989 and Nicolosi *et al.*, 1991).

El-Tanahy *et al.* (1990) indicated that rice germ contained 7.10% moisture, 31.50% protein, 20.80% fat, 9.6% ash, 5.10% fiber and 33.0% carbohydrate (on dry weight basis).

Also, Aly (1993) found that rice germ contained 11.30% moisture, 28.93% protein, 1.13% fat, 8.83% ash, 11.40% fiber and 49.71%, carbohydrate.

Bekheit (1993) found that rice germ contained 8.93% moisture, 25.12% protein, 17.24% ether extract, 33.91% carbohydrate, 7.63% ash and 7.27% fiber. Also, he added rice germ powder with amounts of 10, 20 and 40% (on dry weight basis) for the production of two types of biscuit (medium and high fat biscuit) to wheat flour (72% ext.). He found that addition of rice germ to wheat flour did not cause any deleterious effects on the organoleptic properties. The fortified biscuit maintained good quality, high nutritive value and good storage stability.

Slavin *et al.* (2000) stated that rice whole grains are rich in many components, including dietary fiber, starch, fat, antioxidant nutrients, minerals, vitamins, lignins and phenolic compounds, all of which have been linked to reduce risk of cancer and most of these components are found in the germ and bran which are removed in the refining process.

Dawoud *et al.* (2003) evaluated of high-fiber biscuit quality which produced by using different materials such as wheat bran, corn bran, rice hull, orange peel, pea hull, soybean hull and sugar beet pulp before and after modified. They found that biscuit formulated to contain all raw and modified high-fiber sources at 4 and 8% levels of replacement were nearly similar to control biscuit in all biscuit quality measurements.

Mostafa (2004) determined the chemical composition of rice germ and showed that it contained 13.2% moisture, 16.35% crude oil, 10.5% protein, 8.5% fiber, 13.15% ash and 51.5% carbohydrate.

This work aims to the evaluation of rice germ powder to produce biscuit, sensory and rheological properties were measured. Therefore, the biological parameters of these products on hypercholesterolemic rats were also determined.

MATERIALS AND METHODS

1. Materials:

Rice (*Oryza sativa*) germ was obtained from El-Obour Mill, Desoug, Kafr El-Sheikh, Egypt. Commercial wheat flour (72% ext.) was obtained from South Cairo Mills Comp., Fysal, Giza, Egypt.

2. Chemical analysis:

Moisture, ash, total lipid and crude fiber contents were determined according to A.O.A.C. (2000). Total nitrogen was measured by micro-Kjeldahl method (A.O.A.C., 2000). The crude protein was calculated by multiplying the total nitrogen by a factor of 5.9 for rice germ but 5.75 for biscuit. Total carbohydrate was determined by difference.

3. Technological characteristics:

The rheological properties of wheat flour (72% ext.), fortified with 25% rice germ doughs were carried out with farinograph and extensograph tests according to the methods outlined in A.A.C.C. (1995).

4. Biscuit manufacturing:

Rolled Marie biscuit was prepared according to the method described by Wade (1988). The ingredients of rolled Marie biscuit (Table 1) then the biscuit was baked at 180°C for 12 min, kept at room temperature for 75 min. The sensory characteristics of biscuit was evaluated according to the method of Monhar and Rao (1997) for taste, texture, colour, flavour and appearance (score 20 for each) by using 10 experienced panelists from the staff of the Foods Science, Fac. of Agric. Moshtohor, Benha Univ.

Table (1): Ingredients of rolled Marie biscuit made with different levels of rice germ powder.

Ingredients	Biscuit with rice germ		
Wheat flour	80%	75%	70%
Rice germ	20%	25%	30%
Sugar			34%
Corn oil			27%
Sodium carbonate			0.8%
Ammonium bicarbonate			1.43%
Skim milk powder			11.2%
Vanillia			0.2%

5. Biological experiment:

A total of twenty four male albino rats weighing 140-190 g were used. The rats were obtained from the Farm of Central Organization of Serum and Vaccine (Abasia Farm), Egypt. Rats were allowed to be acclimatized to laboratory condition for two weeks prior to the experiment and fed on basal diet. After the adaptation period, the rats were divided into four group. The first group (control) was fed on basal diet. The second, third and fourth groups were fed on hypercholesterolemic diet with different diets (Table, 2).

The actual weight of food intake was calculated and feed efficiency was determined. The rats were weighed weekly to determine body weight gain. After the end of experimental period (45 days), the blood samples were collected from orbital plexus with heparinized capillary glass tubes then centrifuged at 3000 rpm for 20 min to obtain the serum and kept frozen until analysis.

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

Diet	Casein	Corn oil	Sheep tail fat	Salt mix.	Vitamin mix.	Cellulose	Cholesterol	Bile salts	Starch	Biscuit	Rice germ
Basal diet	10.00	10.00	-	4.00	1.00	5.00	-	-	70.00	-	-
Hypercholesterolemic diet	10.00	-	10.00	4.00	1.00	5.00	1.00	0.25	68.75	-	-
Biscuit with rice germ powder	-	-	-	1.85	1.00	0.43	1.00	0.25	-	95.47	-
Rice germ powder	-	-	-	0.62	1.00	-	1.00	0.25	46.84	-	50.29

6. Determination of biological parameters:

Serum total cholesterol (Allain *et al.*, 1974) and total triglycerides (Fossati and Prencipe, 1982) were estimated by using total cholesterol kit and triglycerides kit, respectively. Serum HDL-cholesterol was determined by the method of Lopes-Virella *et al.* (1977), while LDL-cholesterol was calculated according to the equation of Steinberg (1981).

Enzymes activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined colorimetrically according to the method described by Reitman and Frankel (1957). Alkaline phosphatase (ALP) enzyme activity was determined according to Hausamen *et al.* (1967). Urea in the serum was determined according to Fawcett and Soctt (1960) and creatinine was estimated according to the method described by Bartles *et al.* (1972).

Uric acid in the serum was determined according to the method described by Haisman and Muller (1977).

Total protein and albumin in serum were determined according to the method described by Doumas *et al.* (1971), but serum globulin was calculated by subtracting the amount of albumin from total protein.

7. Statistical analysis:

Statistical analysis of the obtained data was done by using the procedure outlined by Gomez and Gomez (1984). The treatment means were compared using the least significant difference test (LSD) at the 5% level of probability as outline by Waller and Duncan (1969) using SAS institute program (SAS, 1996).

RESULTS AND DISCUSSION

Chemical composition of rice germ and fortified biscuit:

The results in Table (3) show the chemical composition of crude rice germ and biscuit by wheat flour (72% ext.) supplemented with 25% rice germ powder.

Rice germ is less abundant than that on bran. Since rice germ is characteristically richer in protein (18.97%) and fat (20.89%) but lower in fiber (9.75%). Also, the results indicated that, rice germ contained 11.13% moisture, 6.41% ash and 43.93% carbohydrate (on dry weight basis).

Also, biscuit of wheat flour (72% ext.) supplemented with 25% rice germ was determined for chemical components, (Table, 3). These results showed that the biscuit contained 4.02, 10.26, 12.8, 4.58, 2.16 and 70.02% for moisture, crude protein, total lipid, crude fiber, ash and total carbohydrate, respectively.

While, total dietary fiber content of rice germ was found to be 28.15% which contained 25.92% insoluble dietary fiber and 2.23% as soluble dietary fiber.

These results is in accordance with the findings of El-Tanahy *et al.* (1990), Bekheit (1993) and Mostafa (2004).

Table (3): Chemical composition of rice germ and biscuit produced from rice germ.

Components (%)	Crude rice germ	Biscuit with 25% rice germ
Moisture (%)	11.13	4.02
Crude protein (%)*	18.97	10.26
Total lipid (%)*	20.89	12.80
Crude fiber (%)*	9.75	4.58
Ash (%)*	6.41	2.16
Total carbohydrate (%)*	43.93	70.02
Total dietary fiber (%)*	28.15	-
Insoluble dietary fiber (%)*	25.92	-
Soluble dietary fiber (%)*	2.23	-

* on dry weight basis.

Effect of addition of rice germ powder on the rheological properties of biscuit manufacturing:

The rheological properties of biscuit dough made using wheat flour supplemented by 25% rice germ are presented in Table (4) and Figs. (1a, b).

The farinograph properties of biscuit dough indicated that, water absorption was increased from 53.7 with wheat flour to 62.1 with biscuit

containing 25% rice germ. Also, the arrival time, dough development time and dough weakening were increased of biscuit with rice germ when compared with wheat flour only but lowered dough stability from 7.0 to 6.0 min (Table, 4 and Fig., 1a).

From the above results, it can observed that the addition of rice germ powder to wheat flour (72% ext.) have a deleterious effects in dough quality because of its protein is not gluten and contains glutathione which acts as a strong reducing agent and can influence dough properties. (Bekheit, 1993).

On the other hand, the extensograph results of the tested samples are presented in Table (4) and Fig. (1b). The resistance to extension (R), dough extensibility (E), proportional number (R/E) and dough energy values of dough without rice germ were 595 B.U., 150 mm, 4.0 and 154 cm^2, respectively. These values for biscuit dough fortified with 25% rice germ were 360 B.U., 60 mm, 6.0 and 35 cm^2.

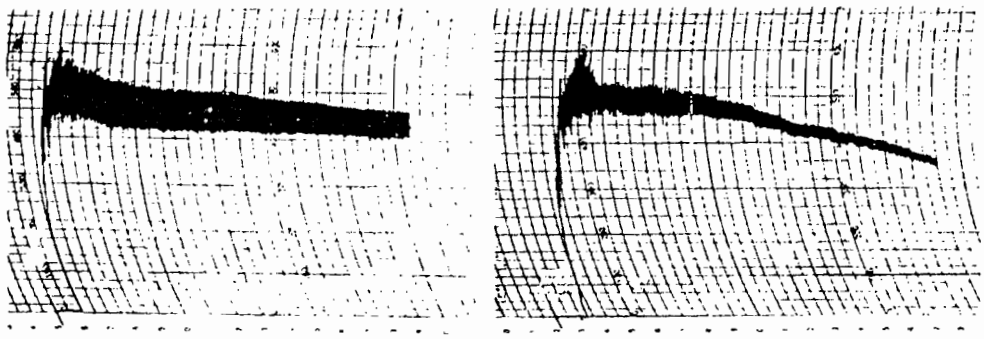
From the obtained results indicated that biscuit fortified with rice germ are recommendable food especially for children needing protein. Such results are in partial agreement with those reported by Bekheit (1993) and Dawoud *et al.* (2003).

Table (4): Effect of addition of rice germ powder to wheat flour (72% ext.) on the farinograph and extensograph tests.

Recipe mixture		Farinograph properties					Extensograph properties			
Wheat flour (72% ext.)	Rice germ (%)	Water absorption %	Arrival time (min)	Dough development time (min)	Dough stability (min)	Dough weaking 20 min (B.U.)	Resistance to extension R (B.U.)	Dough extensibility E (mm)	Proportional number R/E	Dough energy (cm^2)
100	-	53.7	0.5	1.0	7.0	60	595	150	4.0	154
75	25	62.1	1.5	2.0	6.0	110	360	60	6.0	35

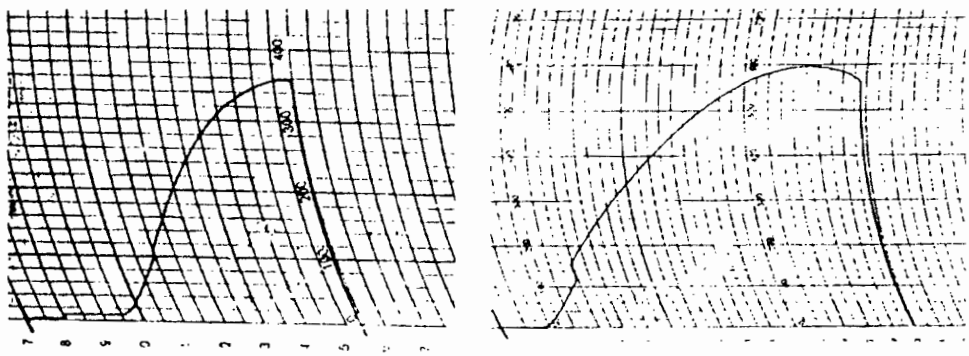
Sensory characteristics of biscuit supplemented with different levels of rice germ:

Sensory evaluation of biscuit prepared using wheat flour supplemented at different levels i.e. 20, 25 and 30% of rice germ were measured and the mean values are presented in Table (5). Samples of the produced biscuit were evaluated by ten experienced panelists working in Food Science, Faculty of Agriculture, Moshtohor. From the obtained results, total scores of color, texture, flavor, appearance and taste were 92.2, 93.3 and 89.0 with different levels of 20, 25 and 30% rice germ, respectively when compared with the control (93.9). Also, panelists described the biscuit with 25% rice germ was found to be very good for texture and taste and excellent for color, appearance and flavor.



Wheat flour (72% ext.) 75% wheat flour + 25% rice germ

Fig. (1a): Farinograph characteristic of wheat flour (72% ext) and wheat flour mixed with rice germ powder (75 : 25)



Wheat flour (72% ext.) 75% wheat flour + 25% rice germ

Fig. (1b): Extensograph characteristic of wheat flour (72% ext) and wheat flour mixed with rice germ powder (75 : 25)

Table (5): Sensory characteristics of biscuit fortified with different levels of rice germ.

Product	Colour (20)	Taste (20)	Crust appearance (20)	Texture (20)	Flavour (20)	Overall acceptability (100)
Wheat flour 72% ext. (control)	18.6	19.7	18.3	18.5	19.3	93.9
Biscuit with 20% rice germ	18.8	17.7	18.5	18.6	18.6	92.2
Biscuit with 25% rice germ	18.7	18.6	18.7	18.4	18.9	93.3
Biscuit with 30% rice germ	18.3	17.4	17.1	17.8	18.4	89.0

From the above-mentioned results, it can be observed that, all types of the produced biscuit with different levels of rice germ have satisfactory grade for all sensory characteristics and similar results were obtained with those reported by Bekhit (1993) and Dawoud *et al.* (2003).

Biological effects of rice germ powder and manufactured biscuit using (25%) rice germ on hypercholesterolemic rats:

Effect on body weight gain, food intake and feed efficiency:

The produced biscuit with 25% rice germ powder and rice germ powder were incorporated in a diet for hypercholesterolemic rats. Table (6) shows the mean values of initial and final body weight, body weight gain, food intake and feed efficiency. The obtained data showed that rats fed normal basal diet had the highest body weight gain (53.80 g), while rats fed hypercholesterolemic diet had the lowest body weight (19.40 g). On the other hand, the body weight for rats diet containing made biscuit using 25% rice germ powder had the same value (30.40 g) when compared with rats diet rice germ powder (29.60 g).

From the same Table, it could be seen that rats fed normal diet had the highest mean values of food intake and feed efficiency (479.92 g and 0.112 gain/g feed) than that of rats fed hypercholesterolemic diet (348.24 and 0.055 g gain/g feed). The other group of rats fed diet containing biscuit fortified with 25% rice germ had the lowest mean values of food intake and feed efficiency than that rats fed basal diet. While, the last group of rats fed diet containing rice germ powder had the highest food intake (560.25 g) when compared with rats fed normal basal diet and hypercholesterolemic rats. From the above results, it could be concluded that the addition of 25% rice germ powder to wheat flour (72% ext.) improved the body weight, food intake and feed efficiency relative to hypercholesterolemic rats, but they still had lower values when compared with rats fed normal diet. This is may be due to the good nutritional value of rice germ. These results are in same manner with that reported by Nicolosi *et al.* (1991) and Slavin *et al.* (2000).

Table (6): Effect of experimental diets on body weight gain, food intake and feed efficiency ratio of hypercholesterolemic rats at the end of experimental period (45 days).

Treatments	Initial body weight (g)	Final body weight (g)	Body weight gain (A) (g)	Daily food intake (g)	Consumption food intake (B) (g)	Feed efficiency A/B	F.E.R.
Basal diet (control)	180.40^{bcd} ±5.54	234.20^{a} ±4.96	53.80^{a} ±2.48	10.66^{a} ±0.62	479.92^{a} ±27.95	0.112^{a} ±0.004	11.2
Hypercholesterolemic diet	176.40^{d} ±4.50	195.80^{d} ±5.35	19.40^{d} ±1.51	7.73^{d} ±0.44	348.24^{d} ±19.87	0.055^{a} ±0.005	5.5
Hypercholesterolemic + biscuit with rice germ powder	177.80^{cd} ±5.71	208.20^{bc} ±5.26	30.40^{c} ±2.07	10.25^{a} ±0.49	461.25^{c} ±22.30	0.065^{b} ±0.005	6.5
Hypercholesterolemic + rice germ powder	185.20^{ab} ±3.49	214.80^{b} ±3.7	29.60^{c} ±5.72	12.45^{a} ±0.48	560.25^{a} ±22.04	0.052^{c} ±0.013	5.2
L.S.D. at 0.05	6.173	7.304	4.536	0.526	23.697	0.0098	

Feed efficiency = Body weight gain/food intake F.E.R. = Feed efficiency x 100
a, b, c & d: There is no significant difference between any two means, with the same attribute, have the same letter (P > 0.05).

Effect on organ weights:

The weights of liver, kidney, heart, spleen and brain of rats fed basal diet, biscuit containing (25%) rice germ powder and rice germ powder are tabulated in Table (7). From these results, it could be observed that the weights of organ were 7.95, 2.88, 0.69, 0.57 and 2.19 g, respectively for rats fed basal diet. While, the mean values of these organ weights had highest values for liver and spleen with rats fed hypercholesterolemic diet and lowest values for kidney, heart and brain when compared with rats fed basal diet. On the other hand, rats fed biscuit fortified with (25%) rice germ and rice germ powder had lowest mean values of organ weights (except heart) than that of hypercholesterolemic rats and control group. The obtained results are in agreement with those reported by Nicolosi *et al.* (1991) and Slavin *et al.* (2000).

Effect of biscuit diets containing rice germ on total cholesterol levels of hypercholesterolemic rats:

Table (8) shows the total cholesterol levels at different periods i.e. 15, 30 and 45 days, of rats fed basal diet, hypercholesterolemic diet and biscuit diets containing 25% rice germ and rice germ powder. From these results, it could be found that the total cholesterol content in rats fed basal diet were 122.45, 125.81 and 125.60 mg/100 ml after 15, 30 and 45 days, respectively if compared with zero time (121.05 mg/100 ml). On the other hand, total cholesterol levels were (305.36, 301.26, 297.45 and 280.58 mg/100 ml), (290.90, 218.42, 204.50 and 186.58 mg/100 ml) and (280.14, 189.90, 186.50 and 176.84 mg/100 ml) in rats

fed hypercholesterolemic diet and biscuit with 25% rice germ and rice germ powder at zero time, 15, 30 and 45 days, respectively. These results indicated that the addition of different levels of rice germ to hypercholesterolemic rats improved the health of rats and decreased the total of cholesterol compared with hypercholesterolemic diet (Nicolosi *et al.*, 1991).

Table (7): Effect of biscuit containing rice germ on weight organs of hypercholesterolemic rats at the end of experimental period (45 days).

Treatments	Final body weight (g)	Liver	Kidney	Heart	Spleen	Brain
		g	g	g	g	g
Basal diet	234.2^{a} ±4.96	7.95^{abc} ±0.71	2.88^{a} ±0.19	0.69^{a} ±0.04	0.57^{a} ±0.24	2.19^{a} ±0.30
Hypercholesterolemic diet	195.8^{d} ±5.35	8.59^{ab} ±2.20	1.56^{b} ±0.21	0.55^{bc} ±0.11	0.70^{a} ±0.10	1.83^{bc} ±0.20
Hypercholesterolemic + biscuit with rice germ powder	208.4^{bc} ±5.26	7.02^{bcd} ±1.09	1.18^{d} ±0.18	0.67^{ab} ±0.07	0.58^{a} ±0.08	1.37^{d} ±0.15
Hypercholesterolemic + rice germ powder	214.8^{b} ±3.70	7.06^{bcd} ±1.60	1.30^{cd} ±0.14	0.67^{ab} ±0.10	0.67^{a} ±0.14	1.32^{d} ±0.19
L.S.D. at 0.05	7.304	1.534	0.244	0.103	0.160	0.269

a, b, c & d: There is no significant difference between any two means, with the same attribute, have the same letter ($P > 0.05$).

Table (8): Effect of biscuit containing rice germ on total cholesterol levels of hypercholesterolemic rats during the experimental period (45 days).

Treatments	Total cholesterol levels (mg/100 ml)			
	Zero time	After 15 days	After 30 days	After 45 days
Basal diet	121.05^{c} ±12.23	122.45^{e} ±12.72	125.81^{d} ±11.90	125.60^{e} ±7.49
Hypercholesterolemic diet	305.36^{a} ±12.00	301.26^{a} ±5.86	297.45^{a} ±10.07	280.58^{a} ±10.17
Hypercholesterolemic + biscuit with rice germ powder	290.9^{ab} ±12.49	218.42^{b} ±14.15	204.50^{b} ±10.17	186.58^{b} ±6.44
Hypercholesterolemic + rice germ powder	280.14^{b} ±12.06	189.90^{d} ±5.85	186.50^{b} ±14.50	176.84^{bc} ±6.93
L.S.D. at 0.05	17.845	13.935	17.287	12.770

Effect of biscuit containing rice germ on serum triglycerides, cholesterol and risk ratio:

The effect of feeding of rats on the diets containing biscuit made with rice germ on the levels of serum triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and risk ratio are presented in Table (9). From the obtained results it could be seen that the hypercholesterolemic rats had the highest mean values of triglycerides, total cholesterol, LDL-cholesterol and risk ratio (230.80, 280.58, 193.22 mg/100 ml and 5.60, respectively when compared with rats fed basal diet (120.26, 125.60, 29.90 mg/100 ml and 1.75). While, HDL-cholesterol was found to be lower value (41.18 mg/100 ml) as compared with that rats fed normal diet (71.64 mg/100 ml).

On the other hand, feeding rats on diet containing biscuit had lower values of serum triglycerides, total cholesterol and LDL-cholesterol amounted to 159.74, 186.58 and 90.89 mg/100 ml for biscuit supplemented with 25% rice germ powder, respectively. While, mean values for rice germ powder were 150.62, 176.84 and 87.13 mg/100 ml, but HDL-cholesterol levels of these group were 63.74 and 59.58 mg/100 ml, respectively. Also, risk ratios (total cholesterol/HDL-cholesterol) of hypercholesterolemic rats was higher (5.60) than that of rats fed diets containing biscuit with 25% rice germ powder or rice germ powder, where the ratios were 2.51 and 2.53, respectively.

From the above results, it can be observed that the rats feeding biscuit made with 25% rice germ or rice germ powder reduced triglycerides percentage from 191.92% to 132.83 and 125.25%, respectively. The relatively reduction values of total cholesterol were found to be 223.39, 148.55 and 142.39% in hypercholesterolemic rats and rats fed diets biscuit supplemented with 25% rice germ and rice germ powders, respectively.

These results are in agreement with those reported by Gerhardt and Gallo (1989) and Slavin *et al.* (2000).

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

The obtained data are tabulated in Table (10). Alanine transaminase (ALT) and aspartate transaminase (AST) enzymes most commonly indication to liver functions. From these results, it could be seen that the hypercholesterolemic rats had the highest mean values of total protein, albumin, globulin, ALP, AST and ALT than that of rats fed normal diet. While, rats fed biscuit with 25% or rice germ powder almost had the same values with rats in control group after 45 days. However, ALP, AST and ALT enzymes activity were (90.40 and 94.14 U/L), 57.34 and 64.13 U/L) and (28.26 and 21.42 U/L) for biscuit made containing 25% rice germ powder and rice germ powder, respectively when compared with hypercholesterolemic rats (124.78, 75.65 and 52.16 U/L), but the two enzymes (AST and ALT) almost gave the same mean values with rats fed on control diet.

Table (9): Effect of biscuit containing rice germ 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-chol.
Basal diet (control)	120.26^{e} ±5.93	125.60^{e} ±7.49	71.64^{a} ±5.60	29.90^{e} ±10.31	1.75
Relatively (%)	100.00	100.00	100.00	100.00	
Hypercholesterolemic diet	230.80^{a} ±10.81	280.58^{a} ±10.17	41.18^{f} ±3.31	193.22^{a} ±12.24	5.60
Relatively (%)	191.92	223.39	57.48	646.29	
Hypercholesterolemic + biscuit with rice germ powder	159.74^{bc} ±8.28	186.58^{b} ±6.44	63.74^{bc} ±2.24	90.89^{bc} ±4.33	2.51
Relatively (%)	132.83	148.55	88.97	303.98	
Hypercholesterolemic + rice germ powder	150.62^{cd} ±4.83	176.84^{bc} ±6.93	59.58^{cd} ±2.87	87.13^{bc} ±7.32	2.53
Relatively (%)	125.25	142.39	83.17	291.40	
L.S.D. at 0.05	8.929	12.770	4.671	13.500	

Table (10): Effect of experimental diets on total protein, albumin, globulin, alkaline phosphatase (ALP) and transaminase enzymes (AST and ALT) 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^{b} ±0.77	3.59^{b} ±0.19	2.40^{ab} ±0.72	82.32^{c} ±4.85	54.71^{d} ±2.26	24.50^{def} ±1.90
Hypercholesterolemic diet	7.27^{a} ±0.74	4.57^{a} ±0.35	2.70^{ab} ±0.41	124.78^{a} ±7.04	75.65^{a} ±5.90	52.16^{a} ±2.24
Hypercholesterolemic + biscuit with rice germ powder	5.60^{b} ±0.57	3.56^{bc} ±0.16	2.04^{b} ±0.58	90.40^{b} ±2.07	57.34^{cd} ±3.60	28.26^{cd} ±1.66
Hypercholesterolemic + rice germ powder	5.92^{b} ±0.69	3.30^{c} ±0.14	2.62^{ab} ±0.28	94.14^{b} ±6.07	64.13^{b} ±4.60	21.42^{f} ±2.39
L.S.D. at 0.05	0.939	0.249	0.686	7.548	5.473	3.702

The obtained results are in agreement with that reported by Nicolosi *et al.* (1991) and Slavin *et al.* (2000).

Effect on serum urea, uric acid creatinine:

Data of kidney functions (urea, uric acid creatinine, respectively), of hypercholesterolemic rats fed diet containing rice germ after 45 days of experimental period are presented in Table (11). The hypercholesterolemic rats had the highest values of these parameters (65.56, 6.24 and 1.75 mg/100 ml) than that of rats fed basal diet (46.10, 3.57 and 0.85 mg/100 ml) for last functions,

respectively. Also, rats fed diet biscuit containing (25%) rice germ had the lowest values of urea, uric acid and creatinine when compared with hypercholesterolemic rats.

From this study, it concluded that the diets containing rice germ reduced serum triglycerides, total cholesterol and HDL-cholesterol in the hypercholesterolemic rats. Also, a significant reduction in serum alkaline phosphate (ALP), aspartate transaminase (AST) and alanine trensaminase (ALT) enzymes had been occurred. The obtained results indicated that there is improvement in liver and kidney functions.

The obtained above-mentioned results reveal that by incorporation of rice germ at suitable levels, it is possible to formulate biscuit that would cater to the therapeutic needs of various targeted population such as diabetics and persons suffering from coronary heart diseases. More studies should be carried out to confirm the obtained conclusions.

Table (11): Effect of experimental diets 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	46.10^{b} ±4.05	3.57^{c} ±0.53	0.85^{c} ±0.12
Hypercholesterolemic diet	65.56^{a} ±5.98	6.24^{a} ±0.97	1.75^{a} ±0.19
Hypercholesterolemic + biscuit with rice germ powder	52.38^{b} ±3.02	4.34^{bc} ±0.32	1.30^{b} ±0.13
Hypercholesterolemic + rice germ powder	50.80^{b} ±6.04	4.87^{b} ±0.55	1.25^{b} ±0.05
L.S.D. at 0.05	6.452	0.760	0.166

REFERENCES

A.A.C.C. (1995): American Association of Cereal Chemists. Cereal Laboratory Methods. 10th Ed., St. Paul. Minnesota, U.S.A.

Allain, C.C.; Poon, I.S.; Chan, C.S.; Richamand, W. and Fu, P.C. (1974): Enzymatic determination of total serum cholesterol. Clin. Chem., 20(4): 470.

Aly, M.H. (1993): Studies on rice germ: 1-Chemical evaluation of rice germ oil and evaluation of its unsaponifiable matter as natural occurring antioxidant. Egypt. J. Appl. Sci., 8(10): 356-368.

A.O.A.C. (2000): Official Methods of Analysis of the Association of Official Analytical Chemists 17th. Ed., Washington, D.C.

Barber, S. and Benedito de Barber, C. (1985): Rice bran: An underutilized raw material. United Nations Industrial Development Organization (UNIDO) Publication E, 84, II. B.3.

Bartles, H.; Bohemer, M. and Heirli, C. (1972): Colorimeteric kinetic method of creatinine. Clin. Chem. Acta, 32: 193.

Bekheit, M.A. (1993): Utilization of rice germ powder in biscuit manufacture. Egypt. J. Appl. Sci., 8(10): 342-355.

Dawoud, F.M.; El-Adawy, T.A. and Rabie, T.M. (2003): Production and evaluation of high-fiber biscuit. Minufiya J. Agric. Res., 28(3): 919-932.

Doumas, B.T.; Watson, W.A. and Biggs, H.G. (1971): Albumin standards and measurement of serum albumin with bromocresol green. Clin. Chim. Acta, 31: 87.

El-Tanahy, H.H.; Fouda, Z.M.A. and Ibrahim, A.A.M. (1990): Rice-wheat germ protein isolate as meat substitute in beef burgers. Annals of Agric. Sc., Moshtohor, 28(2): 1163-1172.

Fawcett, J.K. and Soctt, J.E. (1960): Enzymatic colorimetric method of urea. J. Cline. Path., 13: 156.

Fossati, P. and Prencipe, L. (1982): The determination of triglyceride using enzymatic methods. Clin. Chem., 28: 2077.

Gerhardt, A.L. and Gallo, N.B. (1989): Effect of a processed medium grain rice bran and germ on hypocholesterolemia. American Association of Cereal Chemists Annual Meeting, Washington, D.C. (Poster presentation).

Gomez, K.A. and Gomez, A.A. (1984): Statistical procedure for agricultural research. John Whily and Sons Inc., USA.

Haisman, P. and Muller, B.R. (1977): Glossary of clinical chemistry term. P. 126. Butterworth, London.

Hausamen, T.V.; Helger, R.; Rick, W. and Gross, W. (1967): Optimal conditions for the determination of serum alkaline phosphatase by a new kinetic method. Clin. Chem. Acta, 27: 241-245.

Juliano, B.O. (1985); Gross composition in "Rice Chemistry and Technology" published by the American Association of Cereal Chemists Inc., P. 44. St. Paul, Minnesota, USA.

Lopes-Virella, M.F.; Stone, S.; Ellis, S. and Collwel, J.A. (1977): Cholesterol determination in high density lipoproteins separated by three different methods. Clin. Chem., 23(5): 882.

Luh, B.S.; Barber, S. and Benedito de Barber, C. (1991): Rice bran chemistry and technology: Rice production and utilization, Vol. II: (B.S. Luh, ed), p. 313. Van Nostrand Reinhold, New York.

Monhar, R.S. and Rao, P.H. (1997): Effect of mixing period and additives on the rheological characteristics of dough and quality of biscuit. J. Cereal Sci., 25: 197-206.

Mostafa, D.M.M. (2004): Chemical evaluation of commercial rice germ oil. Minufiya J. Agric.Res., 29(1): 119-127.

Nicolosi, R.J.; Ausman, L.M. and Hegsted, D.M. (1991): Rice bran and germ lowers serum total and low density lipoprotein cholesterol levels in nonhuman primates. Atherosclerosis, 88: 133.

Reitman, S. and Frankel, S. (1957): Colorimetric method of glutamic oxaloacetic transaminase (GOT) or (AST) and glutamic pyruvic transaminase (GPT) or (ALT). Am. J. Clin. Path., 28: 56-63.

SAS (1996): Statistical Analysis System. SAS procedure guide. "Version 6.12 Ed." SAS Institute Inc., Cary, NC.

Saunders, R.M. (1990): The properties of rice bran as a foodstuff. Cereal Foods World, 35: 632-636.

Slavin, J.; Marquart, L. and Jacobs, D. (2000): Consumption of whole grain foods and decreased risk of cancer: Proposed mechanisms. Cereal Food World, 45(2): 54-58.

Steinberg, D. (1981): Metabolism of lipoproteins at the cellular level in relation to atherogenesis. In Lipoproteins. Atherosclerosis and Coronary Heart Disease, 1(2): 31-48.

Wade, P. (1988): Biscuit, cookies and crackers. Recipe of biscuit used during investigation. Vol. 1. Applied Science. Publisher, Ltd, London, UK.

Waller, W.M. and Duncan, D.B. (1969): A boys role for symmetric multiple composition problem. Am. State Assoc. J., 65: 1485-1503.

التقييم الكيميائى الحيوى لجنين الأرز
١- التأثير الخافض لعليقة البسكويت المدعومة بمسحوق جنين الأرز على فئران التجارب المصابة بمستوى عالى من الكوليستيرول.

فرحات فودة على فودة

قسم الكيمياء الحيوية الزراعية – كلية الزراعة – جامعة بنها

تهدف الدراسة إلى التقييم الكيميائى الحيوى لجنين الأرز كناتج ثانوى من عملية تبييض الأرز واستخدامه فى تدعيم بعض المنتجات مثل البسكويت الجاف وكذلك دراسة تأثيره كمادة منفردة أو مضافة إلى البسكويت على فئران التجارب المصابة بمستوى عالى من الكوليستيرول.

أوضحت نتائج التحليل الكيماوى لجنين الأرز أنه غنى فى كل من البروتين الخام (١٨,٩٧%) والدهون الكلية (٢٠,٨٩%) والكربوهيدرات الكلية (٤٣,٩٣%) منسوبا للوزن الجاف بينما كانت نسب كل من الألياف الخام والرماد هى ٩,٧٥، ٦,٤١% على التوالى. من ناحية أخرى كانت نسب هذه المكونات فى البسكويت المصنع مع ٢٥% جنين الأرز هى ١٠,٢٦، ١٢,٨٠، ٧٠,٠٢، ٤,٥٨، ٢,١٦% لكل من البروتينات الخام، الدهون الكلية، الكربوهيدرات الكلية، الألياف الخام والرماد على التوالى.

كما أظهرت الدراسات الريولوجية أن إضافة ٢٥% من جنين الأرز لتدعيم الدقيق استخلاص ٧٢% المستخدم فى صناعة البسكويت يقلل من ثبات العجين، ويزيد ضعف العجين مما يجعلها أكثر ملائمة لصناعة البسكويت. وأشارت نتائج التحكيم الحسى إلى أن البسكويت المصنع مع ٢٥% جنين الأرز ذات صفات جيدة وتشبه بسكويت الكنترول القياسى. بالإضافة إلى ذلك تم تقدير القياسات البيولوجية لفئران التجارب المصابة بمستوى عالى من الكوليستيرول والتى تم تغذيتها على البسكويت المضاف إليه ٢٥% مسحوق جنين الأرز وكذلك مسحوق جنين الأرز. وأظهرت النتائج المتحصل عليها إرتفاع فى زيادة وزن الجسم والغذاء المتناول وكفاءة الغذاء فى

الفئران المصابة المغذاة بهذه المنتجات عن الفئران المصابة بمستوى عالى من الكوليستيرول وهذا يعطى دلالة على القيمة الغذائية لجنين الأرز. كما سجلت النتائج إنخفاضا معنوى فى نسب كل من الكوليستيرول الكلى، الكوليستيرول المنخفض الكثافة (LDL) فى سيرم الدم مع تحسن فى نسبة الكوليستيرول العالى الكثافة (HDL) فى المجموعات المغذاة على البسكويت المضاف إليه ٢٥% مسحوق جنين الأرز وكذا مسحوق جنين الأرز بالمقارنة بالمجموعة ذات المستوى العالى من الكوليستيرول. كما أدت النتائج المتحصل عليها إلى تحسين فى وظائف الكبد والكليتين فى سيرم دم الفئران المصابة المغذاة على العليقة التى تحتوى على البسكويت المنتج ومسحوق جنين الأرز وذلك مقارنة بالفئران المصابة بمستوى عالى من الكوليستيرول. لذا يمكن التوصية بإجراء مزيد من الدراسات على إضافة مسحوق جنين الأرز إلى الدقيق المستخدم فى صناعة البسكويت لرفع القيمة الغذائية والصحية.