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EFFECT OF ADDING GUAR SEED FLOUR OR ITS PROTEIN ISOLATE ON THE CHEMICAL, BIOLOGICAL AND ORGANOLEPTIC PROPERTIES OF BREAD AND BISCUITS

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ABSTRACT

The chemical, biological and organoleptic properties of bread and biscuits supplemented with guar seed flour or its protein isolate were studied.

Bread was prepared using 5%, 10% and 15% Guar seed flour (GSF) as wheat replacer. The results revealed that increasing percentage of (GSF) increased its protein, calcium, and iron contents. It was obvious that bread containing 10% (GSF) was the most acceptable whereas bread containing 15% (GSF) was the least.

Biscuits were fortified with 5%, 10% and 15% (GSF) or 3%, 5% and 7% of guar protein isolate (GPI). The addition of increasing percentage of (GSF) or (GPI) mainly increased their protein, calcium and iron contents, and decreased biscuit's thickness, diameter, and water loss while weight slightly increased. Biscuits containing (GSF) had lower quality than the control but still were accepted, while biscuits fortified with (GPI) had better quality compared with the control.

Bread and biscuits with and without enrichment with (GSF) or (GPI) were biologically evaluated in feeding trials using albino rats. It was found that protein efficiency ratio (PER), true digestibility (TD), and biological value (BV) of bread and biscuits supplemented with 5% and 10% (GSF) were compared with the control samples, while biscuits enriched with 5% (GPI) in preparing high protein biscuits and 10% (GSF) in bread making are highly recommended.

INTRODUCTION

One of the purpose of the supplementation of low quality and quantity protein is to avoid the unbalanced, monoton nutrition, first of all by most vulnerable groups of population e.g. children, pregnant and lactating women. Wheat is considered as one of the most important cereal crop used in making bread. The gradual increase in the population of Egypt as well as the bread consumption, substantial in Egyptian diet imposed to import large amounts of wheat Hussein *et al*., (1977).

The protein supplementation of meals results in a better physiological effect which in turn should hardly be predicted from experiments with individual protein sources because of the complementary patterns of amino acids Linder, (1983).

In Egypt biscuit is one of the major delicate and delicious food. Wheat flour used in biscuits production contains only 7.8 - 8.7% protein Wasfy, (1986). Utilization of some protein sources to improve the nutritive value of biscuit products is described by Rajor *et al*., (1989). Beech *et al*. (1989) reported that guar seeds which are the edible portion are highly nutritive because of their relatively high protein content. Guar has been added to

dough to retard dry out. It is useful in cake and biscuit dough. In pie fillings guar thicken and prevent shrinking and cracking of the filling Horace, (1977), Venkateswara Rao *et al*. (1985) studied the effect of adding various levels of guar on dough properties and bread making quality from milled wheat flour. They found that water absorption of the flour increased with higher levels of guar.

The aim of this investigation is to:

1. Substitute of some part of wheat flour with GSF or GPI which would reduce the production cost of bread and biscuits and to produce such products with high protein content.
2. Evaluate bread and biscuits fortified with GSF or GPI chemically, nutritionally, and organoleptically.

MATERIALS AND METHODS

Materials:

1. Wheat flour (72%) obtained from the local market of flour imported from France by the Egypt Ministry of supply.
2. Guar seeds were obtained from Legume Research Section, Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. They were cleaned and ground to a fine powder in an electric mill, then packed in polyethylene bags and stored in a refrigerator until used.
3. Guar protein isolate was prepared from guar flour.
4. Additives which used in preparing bread and biscuits such as diastatic malt, malt syrup, yeast, shortening, sodium bicarbonate and sugar (for biscuits), salt (for bread) were obtained from local market.

Methods:

Preparation of protein isolate:

Protein isolate was prepared from guar seed flour as described in details by Khalil, Mona (2000).

I- Preparation of special bread:

The bread making formula was as follows: 500 gm wheat flour or wheat flour mixtures with (5%, 10% and 15% GSF), 2% salt, 2% dry yeast and water.

The dough was mixed according to the straight dough method, AACC (1965).

Bread samples were baked for 20 min. at 210^{o}C in an electric oven, and after baking, the samples were subjected to the following determinations:

1. Loaf weight: loaves were weighted in grams one hour after baking.
2. Loaf volume: the volume in cm^3 was determined after one hour of cooling by seed displacement method using clover seeds.
3. Specific loaf volume: specific loaf volume was calculated as follows:

$$\text{Specific loaf volume} = \frac{\text{Volume (cm}^3\text{)}}{\text{weight (gm)}}$$

For chemical analysis of bread samples, three loaves were taken from each treatment, dried for 72 hrs., grounded in an electric mill, then packed in a polyethylene bags and stored in a refrigerator until use.

Preparation of biscuits:

Biscuits made from wheat flour and its mixtures with 5%, 10% and 15% GSF or 3%, 5% and 7% GPI were prepared according to the procedure described by Dovaldk and William (1975).

Biscuits were baked in oven at 230^{o}C for 10 - 15 min. biscuits samples were packed in polyethylene bags after cooling and then subjected to the following determinations according to the method described by Abdel-Magied (1991).

a) Thickness (average of 10 biscuits) cm.
b) Weight of 10 biscuits (gm)
c) Diameter (average of 10 biscuits) cm.

The diameter and thickness of biscuits were measured by planimeter to the nearest mm. The loss of water in the oven during baking was calculated according to the method described by Wade (1971).

Chemical analysis:

Moisture, crude protein, ash, crude fiber, crude were determined according to A.A.C.C (1983), while total carbohydrate were calculated by difference.

The levels of calcium (Ca) and iron (Fe) were determined using a shimadzu AA 630-2 atomic absorption spectrophotometer according to the method of A.O.A.C. (1980).

Amino acids were determined using a Mikrotechna AAA 881 automatic amino acid analyzer according to the method described by Moore and Stein (1963). Sulphur containing amino acids were determined after performic acid oxidation. Tryptophan was chemically determined by the method of Miller (1967).

Organoleptic evaluation:

I- Bread quality:

Shape, crust, roundness, texture and odor were evaluated by 10 panelists according to the method of Pyler (1952) and Matz (1960).

II- Biscuits quality:

Appearance, colour, thickness, crispiness, shrinkage taste and odor were evaluated by 10 panelists according to the method of Smith (1972).

Nutritional evaluation:

Twelve groups of male weanling rats of the Albino strain were secured from Faculty of Science, University of Mansoura were used in the study. Each group consisted of five males having an average initial body weight of 50 - 55 gm. One group served as control Winer (1971). Rats were housed individually in wire bottomed cages and maintained at room temperature with 12 hours light and 12 hours darkness. Water was supplied from special pipes

containing tap water Abd El-Rahim *et al*., (1995) and Al-Atteyah and Al-Othman (1995).

The composition of control diet was as follow according to Hegested *et al*., (1941).

Corn starch 80%, Oil any Kind 10%-Cellulose 5% salt mixture 4%, Vitamin mixture 1%. Protein was added by replacing part of corn starch with bread or biscuits samples to provide 10% protein diet for the experimental animals. All animals in different groups received their diets, and water ad libitum for 28 days. Daily food consumption and body weight were determined for each animals.

Nutritional indices:

Protein efficiency ratio (PER) was calculated as body weight gain per unit and crude protein (CP) intake along 28 days.

True digestibility (TD) and biological value (BV) were calculated according to the method described by Swaminathan (1981).

RESULTS AND DISCUSSION

The results given in Table (1) show that moisture and carbohydrate content of bread and biscuits gradually decreased as the percentage of GSF or GPI increased, except moisture content of biscuits enriched with different percentages of GPI which is little bit increased. On the other hand crude protein, ash, crude fat, crude fiber, calcium and iron contents of bread and biscuits gradually increased with the increasing percentage of both GSF and GPI, this is due to the high amount of these components in guar seeds. These results are in agreement with those reported by Korshom (1994).

Data shown in Table (2) indicate that all amino acids constituents gradually increased in all samples of bread and biscuits under study as the percentage of GSF or GPI added increased, such results gave the same attitude with those reported by Dako (1983) and (Khalil and El-Adawy 1994). They mentioned that legumes are limiting in sulphur containing amino acids and also concluded that as provided sufficient legumes are available, the traditional cereal legume diets provide adequate protein of good quality. The total amino acids of all samples under study increased with the increasing percentage of GSF or GPI added.

The results presented in Table (3) showed that the amount needed to cover the daily requirements of an adult male was however less for biscuits samples containing 7% GPI (550.0 gm) followed by biscuits containing 15% GSF (578.9 gm), the bread samples containing 15% GSF (611.1 gm), and biscuits samples enriched with 5% GPT (611.1 gm) compared with the other studied samples. Methionine was the limiting amino acid and therefore selected to determine daily requirements. So, from above mentioned results

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it can observed that different samples can cover the daily requirements of essential amino acids in the case it is the only source of these amino acids with different quantities. It can be also concluded that biscuits samples enriched with 7% or 5% GPI and bread samples containing 15% GSF can be considered as the best samples for making bread and biscuits taking in consideration the amino acids content.

The results in Table (4) show that the addition of GSF caused a variable decrease in specific volume of bread. In the same table, the data indicated that the increasing percentage of GSF or GPI added to biscuits caused a slight decrease in biscuit's weight before baking. The results also showed that the baking process caused an increase in thickness and diameter, while weight was decreased in all biscuits under study. Addition of increasing amounts of GSF or GPI to biscuits caused a slight decrease in baked biscuit's thickness, diameter, water loss and a slight increase in weight. This may be due to the increase of water absorption of the flour by adding increasing amounts of GSF or GPI. Venkateswara Rao *et al*., (1985).

Average sensory panel scores of appearance, colour, thickness, crispiness, shrinkage, taste and odor for biscuits, and shape, roundness, crust colour, texture, taste and odor for bread are summarized in Table (5). Data indicated that no obvious differences were obtained between bread (control) and bread enriched with 5% and 10% GSF. The average of the degree given by the selected panelists for biscuits made from wheat flour enriched with GSF or GPI indicated that the addition of 3% and 5% GPI followed by 5% GSF showed no significant differences in comparison with the control sample.

From results in Table (6) PER, TD and BV values varied in the range of 0.62 - 2.77, 0.80 - 0.90 and 0.69 - 0.87 respectively. The results compared well with that of casein (2.77, 0.91 and 0.88) as reported by Mandel *et al*. (1986).

So, it may be concluded that bread supplemented with 10% GSF and biscuits enriched with 5% GPI are highly recommended.

REFERENCES

A.A.C.C.(1983). American Association of Cereal Chemists. Cereal Laboratory Methods, St. Paul, Minnesota, USA.

A.A.C.C.(1965).American Association of Cereal Chemists. Cereal Laboratory methods published by AACC. Inc. St. Paul, Minnesota USA.

Abdel-Magied and Mona, M. (1991). Effect of dietary fiber of potato peel on the theological and organoleptic characteristics of biscuits. Egypt. J. Food Sci., Vol. 19, No. (3) pp. 293 - 300.

Abd El-Rahim, M.J.; El-Gaafry, M.N.; Tawfeek, M.I. and El-Kelawy, H.M. (1995). Effect of dietary supplementation with different levels of zinc on growth performance nutrients digestibility, minerals, metabolism blood constituents, organs, histopathology and reproductive efficiency in NZW rabbits. Egyptian J. of Rabbit Sciences, 5(1): 11 -31.

Al-Atteyah, Kh.A. and Al-Othman, A.A. (1995). Influence of dietary zinc on lipoprotein cholesterol and organ lipids and trace elements in rats. Annals Agric. Sci. Ain Shams Univ., Cairo, Egypt, 40(1): 269-278.

AOAC (1980). Official Methods of Analysis of the Association of Official Analytical Chemists Published by the Association of Official Analytical Chemists, INC. III North 19st Suite 210. Arlington, Virginia 22209, USA.

Beech, D.F.; Stutzel, H. and Charles-Edwards, D.A. (1989). Yield determinants of guar (*Cyamopsis tetragonoloba*) Grain and pod number. Field Crops Res., 21: 29-37.

Dako, D.Y. (1983). Cereal utilization in West Africa. Proc. Int. Assoc. Cereal Chem. Symp. Amino Acid Compn. and Biol. Value of Cereal Proteins, Budapest, Hungary, Ed. Làsztity, R. and Hidvégi, M. Dovaldk, T. Ph.D. and William, J.S. (1975). Food Products Formulary, the Avi Publishing Company, Inc.

Hegested, H.D.; Bork, J.K. and Mosr, K.L. (1941). Nutrition of house animals Amer. J. Clin. Nutr. Washington, 92 - 1593.

Horace, D.C. (1977). Food Colloids. The AVI Pub. Co. INC. West, Port, Conn. USA.

Hussein, M.A.; Saleh, A. and Noaman, M. (1977). Effect of adding sorghum flour on the physical and chemical properties of Bread. Periodical Polytechnica-Chemical engineering - Vol. 21, No. 4.

Khalil, A.H. and El-Adawy, T.A. (1994).Chemical composition and nutritional quality of whey-white beans proteins corprecipitate Menofiya J. Agric. Res., 19(3): 1475 - 1494.

Khalil, Mona, M. (2000). Biochemical and Technological Studies on the production of guar protein isolate. Zagazig J. Agric. Res. Vol. (27), No. (1) 207 - 216.

Korshom, H.A. (1994). Some procedures to confirm that local guar gum is typical to the standard guar gum. Hydrocoll. in Food Proc. Ismailia, (1994) 101 - 113.

Linder, K. (1983). Fortification of wheat flour with potato protein. Proc. Int. Assoc. Cereal Chem. Symp. Amino Acid Compn. and Biol. Value of Cereal Proteins. Budapest, Hungary, Ed. Làsztity, R. and Hidvégi, M.

Mandal, B.; Ghosh Majumdar, S. and Matty, C.R. (1986). Isolation and evaluation of protein from processed karanja (*Pongamia glabra*) seed meal. Acta Alimentaria, Vol. 15(1), pp. 69 - 77.

Màtz, S.A. (1960). Bakery technology and engineering. Published by AVI Publishing Co. Inc., West Port, Conn.

Miller, E.L. (1967). Determination of tryptophan content in feeding stuffs with particular reference to cereals. J. Sci. Food Agric., 18, 381 - 6.

Moore, S. and Stein, W.H. (1963). Chromatographic determination of amino acids by the use of automatic recording equipment. In methods in Enzymology (Vol. 6) eds. S.P. Colowiek and N.O. Kaplan. Academic Press New York, USA, p. 819.

National Academy of Science (1959). Amino acids requirement by different categories of people. Research Council, Pub., 711, Washington.

Pyler, E.J. (1952). Baking Science and Technology. Vol. I and II published siobel publishing company, Chicago. Rajor, R.B.; Thompkinson, D.K. and Roa, B.R. (1989). Protein enrichment of biscuit and cookies Indian - Journal of Dairy Science. 42(3) 645 - 649.

Smith, W.H. (1972). Biscuits, crackers and cookies. Applied Science Published Ltd. London, England.

Swaminathan, M. (1981). Biochemistry. Geetha Book House Publishers, Mysore, India pp. 250 - 256.

Venkateswara Rao, G., Indrami, D. and Shurpalekar, S.R. (1985). Guar gum as an additive for improving the bread making quality of wheat flour. J. of Food Science and Technology India 22(2) 101.

Wade, P. (1971). Technological Aspects of the use of (S.M.S.) in the Manufacture of Semi-Sweet Biscuits Fd. Sci. Tech. Abstr. 3, 78784.

Wasfy, A.S.M. (1986). Relationship of mixture constituents to baking quality of biscuits. M.Sc. Thesis, Food Sci. and Tech. Dept., Faculty of Agric., Cairo Univ., Egypt.

Winer, B.J. (1971). In statistical Principles in Experimental Design. 2nd Ed. pp. 431 - 513. Mc. Graw-Hill, New York, N.Y. (1971).

تأثير إضافة دقيق حبوب الجوار أو مستخلصه البروتينى على الخواص الكيميائية والبيولوجية والحسية للخبز والبسكويت٠

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تم دراسة الخواص الكيميائية والبيولوجية والحسية للخبز والبسكويت المدعم بدقيق حبوب الجوار أو مستخلصه البروتينى - وقد تم إضافة دقيق حبوب الجوار بنسب ٥%، ١٠%، ١٥% إلى دقيق القمح فى صناعة الخبز وأوضحت النتائج زيادة نسبة البروتين والكالسيوم والحديد بزيادة نسبة دقيق حبوب الجوار المضافة٠ وأن اضافة ١٠% من دقيق حبوب الجوار فى صناعة الخبز كانت أكثرهم قبولاً٠

كما تم تدعيم البسكويت بإضافة ٥%، ١٠%، ١٥% من دقيق حبوب الجوار أو معزوله البروتينى بنسبة ٣%، ٥%، ٧%٠

وقد وجد أن إضافة نسب متزايدة من دقيق حبوب الجوار تؤدى إلى زيادة فى نسبة البروتين والكالسيوم والحديد، ونقص فى سمك وقطر وفقد الماء للبسكويت، بينما حدث زيادة طفيفة فى الوزن٠

كما بينت النتائج ان البسكويت المحتوى على دقيق حبوب الجوار كان أقل جودة من العينة المقارنة ولكنها تعتبر مقبولة حتى إضافة ١٠% من دقيق حبوب الجوار٠ بينما كان البسكويت المدعم بمعزول الجوار البروتينى أفضل من العينة المقارنة٠ وتشير النتائج إلى زيادة نسبة الكالسيوم والحديد فى جميع عينات الخبز والبسكويت المدعمة بإضافة نسب متزايدة من دقيق حبوب الجوار أو معزوله البروتينى٠

وقد تم دراسة كل من الخبز والبسكويت المدعمين سواء بدقيق حبوب الجوار أو معزوله البروتينى بيولوجيا بإستخدام فئران التجارب٠ وقد وجد أن كل من نسبة كفاءة البروتين والهضم الحقيقى والقيمة الحيوية للخبز والبسكويت المدعمين سواء بدقيق حبوب الجوار أو معزوله البروتينى ذات صفات جيدة مقارنة بالعينة المقارنة، بينما البسكويت المدعم بـ ٥% معزول الجوار البروتينى كانت أفضل٠

وعموما يمكن التوصية بإستخدام ٥% معزول الجوار البروتينى فى صناعة البسكويت، ١٠% دقيق حبوب الجوار فى صناعة الخبز٠

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Table (1): Chemical composition of bread and biscuits enriched with GSF or GPI.

Samples	Moisture %	Grude protein %	Ash %	Crude fat %	Crude fibre	Total carbohydrate %	Calcium mg/100 g	Iron mg/100 g
Bread (Control)	15.00	11.21	1.73	13.08	0.95	73.03	68.61	3.22
Bread + 5% GSF	14.85	12.69	1.90	13.33	1.57	70.51	68.73	3.49
Bread + 10% GSF	14.76	14.10	2.00	13.64	1.99	68.27	69.45	3.88
Bread + 15% GSF	14.69	16.89	2.28	13.89	2.55	64.39	70.11	4.27
Biscuits (Control)	3.39	12.19	1.70	11.00	0.60	74.51	72.03	2.31
Biscuits + 5% GSF	3.32	13.66	2.01	11.34	1.00	71.99	72.32	2.77
Biscuits + 10% GSF	3.26	14.92	2.73	11.59	1.63	69.13	72.64	3.24
Biscuits + 15% GSF	3.15	16.90	2.99	11.93	2.08	66.10	72.91	3.71
Biscuits + 3% GPI	3.40	13.09	1.78	10.88	0.62	73.63	72.09	2.44
Biscuits + 5% GPI	3.41	14.62	1.89	10.75	0.63	72.11	72.15	2.54
Biscuits + 7% GPI	3.41	15.88	1.96	10.66	0.65	70.85	72.21	2.63

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Table (2): Amino acids composition of bread and biscuits enriched with GSF or GPI (gm/100 gm).

Samples	Lysine	Leucine + Isoleucine	Valine	Phenyl-alanine	Tyro-sine	Meth-ionine	Cyste-ine	Trypt-ophan	Threo-nine	Histi-dine	Argin-ine	Total
Bread (Control)	0.20	1.43	0.47	0.23	0.12	0.16	0.02	0.07	0.31	0.16	0.26	3.43
Bread + 5% GSF	0.71	2.49	0.81	0.74	0.43	0.16	0.05	0.08	0.67	0.41	1.33	7.88
Bread +10% GSF	1.72	3.54	1.16	1.24	0.73	0.17	0.07	0.09	1.03	0.67	2.31	12.73
Bread +15% GSF	1.73	4.60	1.50	1.75	1.04	0.18	0.09	0.11	1.39	0.92	3.48	16.79
Biscuits (Control)	0.31	0.51	0.32	0.37	0.18	0.16	0.03	0.08	0.24	1.00	0.88	4.08
Biscuits+5% GSF	0.81	1.66	0.68	0.86	0.48	0.16	0.06	0.09	0.61	1.17	1.89	8.47
Biscuits+10%GSF	1.31	2.81	1.04	1.36	0.78	0.17	0.08	0.10	0.97	1.34	2.90	12.86
Biscuits+15%GSF	1.81	3.96	1.39	1.85	1.09	0.19	0.10	0.12	1.34	1.51	3.92	17.28
Biscuits+ 3% GPI	1.46	0.84	0.43	0.52	0.27	0.16	0.08	0.10	0.35	1.05	1.18	6.44
Biscuits+ 5% GPI	1.56	1.07	0.49	0.62	0.32	0.18	0.09	0.11	0.51	1.09	1.39	7.43
Biscuits+ 7% GPI	1.65	1.29	0.56	0.71	0.37	0.20	0.11	0.13	0.69	1.12	1.59	8.42

Table (3): Daily requirements* of essential amino acids and amounts (gm) consumed of bread and biscuits enriched with GSF or GPI.

Samples	Lysine	Leucine + Isoleucine	Valine	Phenyl-alanine	Methionine	Tryptophane	Threonine
Daily requirement of man*	0.80	1.80	0.80	1.10	1.10	0.25	0.50
Bread (Control)	400.0	125.9	170.2	478.3	687.5	357.1	161.3
Bread + 5% GSF	112.6	72.3	98.8	148.6	687.5	312.5	74.6
Bread + 10% GSF	46.5	50.8	68.9	88.7	647.1	277.8	48.5
Bread + 15% GSF	46.2	39.1	53.3	62.9	611.1	227.3	35.9
Biscuits (Control)	258.1	352.9	250.0	297.3	687.5	312.5	208.3
Biscuits + 5% GSF	98.8	108.4	117.6	127.9	687.5	377.8	81.9
Biscuits + 10% GSF	61.1	64.1	67.9	80.9	647.1	250.0	51.5
Biscuits + 15% GSF	44.2	54.5	57.6	59.5	578.9	208.3	37.3
Biscuits + 3% GPI	54.8	214.2	186.0	211.5	687.5	250.0	142.9
Biscuits + 5% GPI	51.3	168.2	163.3	177.4	611.1	227.3	98.0
Biscuits + 7% GPI	48.5	139.5	142.9	154.9	550.0	192.3	72.5

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Table (4): Effect of adding GSF or GPI in different concentrations to bread and biscuits on some quality parameters.

Parameters	Bread samples				Parameters	Biscuits samples						
Baked bread	**Control**	**GSF 5%**	**GSF 10%**	**GSF 15%**	**Before baking**	**Control**	**GSF 5%**	**GSF 10%**	**GSF 15%**	**GPI 3%**	**GPI 5%**	**GPI 7%**
Weight (gm)	410	432	440	449	Thickness (cm)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
					Diameter (cm)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Volume (cm^3)	650	631	622	587	Weight (gm)	60.57	60.40	60.26	60.13	60.53	60.50	60.19
Specific	1.59	1.46	1.41	1.31								
Volume(cm^3/gm)					After baking							
					Thickness (cm)	0.575	0.563	0.550	0.531	0.570	0.568	0.565
					Increase of Thickness %	130.0	125.0	120.0	112.4	128.0	127.2	126.0
					Diameter (cm)	4.15	4.14	4.12	4.11	4.13	4.10	4.08
					Increase of diameter %	3.75	3.50	3.00	2.75	3.25	2.50	2.00
					Weight (gm)	51.34	51.64	51.75	51.90	51.28	51.37	51.52
					Water loss %	15.24	14.50	14.12	13.69	15.26	15.09	14.32

Table (5): Organoleptic properties of bread and biscuits enriched with GSF or GPI.

	Bread samples					Biscuits samples						
Properties	**Control**	**GSF 5%**	**GSF 10%**	**GSF 15%**	**Properties**	**Control**	**GSF 5%**	**GSF 10%**	**GSF 15%**	**GPI 3%**	**GPI 5%**	**GPI 7%**
Shape (15.0)	13.0	13.0	13.0	10.0	Appearance (10.0)	9.0	8.0	8.0	7.5	9.0	8.5	7.5
Roundness (15.0)	14.0	13.0	14.0	12.0	Color (15.0)	14.0	13.0	12.0	12.5	14.0	14.0	13.5
Crust color (15.0)	14.0	14.0	13.0	11.0	Thickness (15.0)	13.0	12.0	12.0	13.0	12.0	12.0	11.5
Texture (20.0)	19.0	18.0	18.0	16.0	Crispiness (15.0)	13.0	11.5	13.0	12.5	12.0	11.0	11.5
Taste (20.0)	18.0	18.0	16.0	15.0	Shrinkage (15.0)	12.0	12.0	11.5	12.0	11.0	12.0	11.5
Odor (15.0)	12.0	13.0	12.0	11.0	Taste (15.0)	14.0	14.0	12.5	11.5	14.0	14.0	13.0
					Odor (15.0)	13.0	14.0	12.0	10.0	14.0	13.5	13.0
Total	90.0	89.0	86.0	75.0	Total	88.0	84.0	81.0	79.0	86.0	85.0	81.0

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Table (6): Nutritional and biological value of bread and biscuits enriched with GSF or GPI in different concentrations.

Samples	Body weight gain[a] g /28 days	CP[b] (N x 6.25) Intake g /28 days	PER[C]	TD[d]	Bv[e]
Casein	68.9 ± 2.0*	24.9 ± 1.5*	2.77 ± 0.10*	0.91 ± 0.00*	0.88 ± 0.00*
Bread (Control)	55.5 ± 2.1	24.9 ± 1.2	2.23 ± 0.21	0.86 ± 0.01	0.76 ± 0.02
Bread + 5% GSF	56.9 ± 1.6	24.8 ± 1.3	2.29 ± 0.18	0.87 ± 0.02	0.79 ± 0.01
Bread + 10% GSF	56.6 ± 1.4	24.6 ± 1.4	2.30 ± 0.16	0.88 ± 0.01	0.82 ± 0.03
Bread + 15% GSF	55.3 ± 1.5	24.7 ± 1.1	2.24 ± 0.17	0.81 ± 0.03	0.69 ± 0.05
Biscuits (Control)	55.8 ± 1.8	24.9 ± 1.2	2.24 ± 0.18	0.87 ± 0.04	0.73 ± 0.01
Biscuits + 5% GSF	57.0 ± 1.9	24.8 ± 1.5	2.29 ± 0.16	0.84 ± 0.03	0.79 ± 0.03
Biscuits + 10% GSF	56.5 ± 2.1	24.6 ± 1.4	2.29 ± 0.15	0.85 ± 0.01	0.80 ± 0.05
Biscuits + 15% GSF	56.4 ± 1.4	24.9 ± 1.6	2.22 ± 0.20	0.80 ± 0.03	0.77 ± 0.04
Biscuits + 3% GPI	57.6 ± 1.5	24.8 ± 1.4	2.32 ± 0.17	0.90 ± 0.04	0.85 ± 0.03
Biscuits + 5% GPI	58.2 ± 1.8	24.6 ± 1.2	2.36 ± 0.16	0.90 ± 0.02	0.87 ± 0.02
Biscuits + 7% GPI	58.0 ± 1.4	24.7 ± 1.5	2.35 ± 0.18	0.88 ± 0.01	0.86 ± 0.05

a: mean value from five rats ***± means standard deviation**
b: Crude protein **c : Protein efficiency ratio**
d: True digestibility **e : Biological value.**