RESEARCH PAPER — FOOD SCIENCE RESEARCH JOURNAL
e ISSN-2230-9403 ■ Visit us : *www.researchjournal.co.in*
Volume 7 | Issue 1 | April, 2016 | 112-118
DOI : 10.15740/HAS/FSRJ/7.1/112-118

Development of protein enriched biscuit fortified with green gram flour

R.N. SHUKLA, ATUL ANAND MISHRA AND A.K. GAUTAM

Supplementation of food is of current interest because of increasing nutritional awareness among consumers. Supplementation with legumes is one way to meet the protein needs particularly with the help of baked foods. Supplementation of wheat flour with green gram flour was tried at 30, 40, 50, 60 per cent levels along with sugar, skimmed milk powder, fat and baking powder to improve the nutritional and sensory quality of biscuits. Results of baked biscuits revealed that the thickness (cm) was increased and diameter (cm) was decreased up to 60 per cent level of incorporation of green gram flour. Therefore spread ratio was decreased with increased the incorporation of green gram flour in formulation. However green gram dhal flour 30-60 per cent incorporation improved protein, fat and ash content of biscuits. The value of protein and fat content was decreased during storage but value of ash content was almost constant during storage. Moisture content of fortified biscuits was more than controlled biscuits and it was increased during storage. The sensory analysis of 50 per cent green gram dhal flour incorporated biscuit up to 30 days was accepted by panel judges on the basis of nine point hedonic scale. Thus supplementation of refined wheat flour with green gram flour 30- 60 per cent level, not only improve protein quality but also improved overall acceptability and sensory parameter in final product. Two types of packaging materials, high density polyethylene and low density polyethylene was used for packaging of biscuits in which high density polyethylene was more accepted because it was less permeable to gas and moisture as well as increased the storage period of biscuits.

Key Words : Green gram, Fortified biscuit, Packaging material, Protein, Moisture content

How to cite this article : Shukla, R.N., Mishra, Atul Anand and Gautam, A.K. (2016). Development of protein enriched biscuit fortified with green gram flour. *Food Sci. Res. J.*, **7**(1): 112-118.

INTRODUCTION

Fortification of foods is of current interest because of nutritional awareness of consumers. Supplementation with legumes is one way to meet the needs for protein foods, particularly baked foods. Biscuits are widely consumed that have relatively long shelf life and good eating qualities. Such qualities of food products make large scale production and distribution possible, in the shorted period. Biscuits can be easily fortified (Mishra *et al.*, 1991) with protein rich flours to provide convenient food in order to supplement protein in the diet.

Legumes are vital source of dietary protein for large sector of the world's population. The composition is predominant in countries where utilization of animal protein is limited owing to poverty, non availability, religious or cultural lifestyles (Boye *et al.*, 2001). Legumes are high in protein and complex hydrocarbons

MEMBERS OF RESEARCH FORUM

Author for correspondence :
R.N. SHUKLA, Department of Food Process Engineering, Vaugh School of Agricultural Engineering and Technology, Sam Hagginbottom Institute of Agriculture, Technology and Science, ALLAHABAD (U.P.) INDIA
Email : rama.shukla@shiats.edu.in

Associate Authors' :
ATUL ANAND MISHRA AND A.K. GAUTAM, Department of Food Process Engineering, Vaugh School of Agricultural Engineering and Technology, Sam Hagginbottom Institute of Agriculture, Technology and Science, ALLAHABAD (U.P.) INDIA

along with presence of appreciable quantity of bioactive ingredients and minerals (Bazzano *et al.,* 2010; Rizkalla *et al.,* 2002; Anderson and Major, 2002; Bazzano *et al*., 2008). More ever, legumes posses some phytochemicals of interests including antioxidants, phytosterols and bioactive carbohydrates (Amarowicz and Pegg, 2008). Green gram is a protein rich staple food. It contains 25 per cent protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country. The biological value improves greatly, when wheat or rice is combined with green gram because of the complementary relationship of the essential amino acids. Green gram is a very nutritious food rich in high grade vitamin B1 and B2, iron and proteins. The country's population, which is currently more than 1.16 billion, is expected to reach 1.26 billion by March 2016. According to 2001 census, 35 per cent of the population is in the childhood age (0-14 years) (Chaudhary, 2007). The countrywide National Family Health Survey showed that more than 50 per cent of the children are undernourished. UNICEF has also reported that India has the largest number of malnourished children (Srilakshmi, 2003). Earlier the main cause of malnutrition among children was considered to be due to protein deficiency. However subsequent systematic study of the habitual diets of children indicated that concentration of protein in their diets was adequate, but they were suffering from energy or food inadequacy, since they were not eating enough of their habitual diet. As well as the prevalence of protein energy malnutrition, these children also suffer from other deficiencies like vitamin A, calcium, iron, riboflavin, etc. It may be wise policy to add these nutrients in supplementary food at sufficient concentrations, so as to make good the deficit in their habitual diets (Gopalan *et al.,* 1991). So, we have challenge now to feed properly to this 'India in childhood stage. Dietary supplements are being designed and produced to meet nutritional demand of children. Among ready-to-eat snacks, biscuits possess several attractive features including wider consumption base, relatively long shelf-life, more convenience and good eating quality (Tsen *et al.*, 1973; Akuborp, 2003; Hooda and Jood, 2004). Long shelf-life of biscuits makes large scale production and distribution possible. Good eating quality makes biscuits attractive for protein fortification and other nutritional improvements. Biscuits, which are categorized as miscellaneous food category products, consist of three major components; flour, sugar and fat. The biscuits are the soft wheat products. Cereal grains, including soft wheat flour are low in protein (7–14%) and are deficient in essential amino acids such as lysine and certain other amino acids (Claughton and Pearce, 1989). Legumes on the other hand, are higher in proteins (18–24%) than cereal grains and could be used to support certain amino acids such as lysine, tryptophan, or methionine (Potter, 1986).

METHODOLOGY

Materials:

Green gram dhal flour, wheat flour, sugar, fat, skimmed milk powder and baking powder were purchased from commercial stockers at Allahabad local market. All laboratory reagents used were of analytical quality and present work was carried out at department of Food Process Engineering, Vaugh School of Agricultural Engineering and Technology, SHIATS.

Method of development of biscuits :

The biscuits were prepared with the incorporation of green gram dhal flour in 30, 40, 50 and 60 per cent concentration with wheat flour and amount of sugar, fat, baking powder and skimmed milk powder kept constant to 50, 40, 1.2 and 10g, respectively on 100 g flour basis. Firstly all the ingredients e.g. all refined wheat flour, green gram dhal flour, milk powder, baking powder, fat, and sugar were weighed. Powdered sugar was added into fat mixed properly, this process is known as creaming.

Table A : Formulation of green gram fortified biscuits

Parameters	Ingredients	Level	Description (%)	Quality parameters
Variables	Wheat flour (g)	5	100, 70, 60,50,40	**Physico-chemical parameters**
	Green gram flour (g)	5	0, 30, 40,50,60	Spread ratio, Moisture content, Protein
	Sugar (g)	1	50	analysis, Fat analysis, Ash analysis
Invariables	Fat (g)	1	40	**Sensory evaluation**
	Baking powder (g)	1	1.2	Colour, Taste, Flavour, Texture, Appearance,
	Skim milk powder (g)	1	10	over all acceptability

Then slowly blended flour was added with baking powder and milk powder. All dry ingredients were mixed and little quantity of water was added for continuous mixing and then dough was produced by proper kneading with hands. When dough was ready it was kept for 10 to 50 minutes and then use for sheeting. Rolling ball of dough on wooden platform made sheets. Theses sheets were cut by hand operated metal die, kept for baking in baking oven at 175°C for 12-15 minutes. The baked biscuits were cooled at room temperature and then packed in low density polyethylene and high density polyethylene packaging material (Table A).

Physico-chemical analysis of green gram flour fortified biscuit :

Diameter of biscuits was measured with the help of a vernier calipers and then taking average value. Thickness was measured by vernier calipers and taking average thickness (cm). Spread ratio was calculated by dividing the average value of diameter by average value of thickness of biscuits.

Moisture and fat (solvent extraction) were determined by the AOAC (1975) methods. Protein (micro-Kjeldahl) and ash were determined by the Ranganna (1995) methods.

Sensory analysis :

Sensory analysis of biscuits Biscuit samples were analyzed for sensory characteristics. Sensory quality characteristics were evaluated by a panel of nine expert judges of different age group having different eating habit was selected and sample was serving to them using a 9-point Hedonic scale (Ranganna, 1995). The biscuits were evaluated for their colour, appearance, flavour, texture, taste and overall acceptability.

Statistical analysis :

Analysis of variance (ANOVA) was used in all the analysis for detection of significant differences ($p<0.05$) among samples. The data was statistically analyzed by using complete Randomized design (CRD) with seven treatments; the significance of study was tested at 5 per cent level (Panse and Sukhatme, 1967).

OBSERVATIONS AND ASSESSMENT

The product standardization was done by the panel of judges with the help of nine point hedonic scale. The data were summarized in following section. The four ratios of wheat flour and green Gram flour were taken in which best one was selected for further studies. The ratio were taken as 100:0 (T_0), 70:30 (T_1), 60:40 (T_2), 50:50 (T_3), 40:60 (T_4) and time interval during storage was 15 days (0 day, 15 day, 30 day, 45 day and 60 day). The sensory evaluation was done for general colour, taste, flavor, texture, appearance and overall acceptability.

The physical properties of biscuits prepared by different treatment of green gram flour and wheat flour are presented in Table 1. The diameter of biscuits made from 30, 40, 50 and 60 per cent green gram flour was found significantly lower than that of control biscuit. The thickness of biscuits ranged from 0.61 to 0.75 cm. It increased with the incorporation of green gram flour.

Table 1 : Diameter, spread ratio and thickness of green gram fortified biscuit

Sample/ physical parameters	Diameter (cm)	Spread ratio	Thickness (cm)
T_0	6.14	0.61	10.06
T_1	6.00	0.63	9.52
T_2	5.94	0.68	8.74
T_3	5.94	0.72	8.25
T_4	5.90	0.75	7.87

Table 2: Effect on moisture content of biscuits during storage in HDPE and LDPE packed biscuits respectively

Number of treatment	HDPE					Number of treatment	LDPE				
	Interval or storage days						Interval or storage days				
	0 days	15 days	30 days	45 days	60 days		0 days	15 days	30 days	45 days	60 days
T_0	2.90	2.92	2.94	2.956	2.98	T_0	2.90	2.93	2.96	2.98	3.0
T_1	3.25	3.27	3.28	3.31	3.35	T_1	3.25	3.27	3.28	3.35	3.39
T_2	2.61	2.62	2.63	2.635	2.70	T_2	2.62	2.64	2.65	2.68	2.70
T_3	2.47	2.47	2.473	2.48	2.5	T_3	2.41	2.44	2.47	2.48	2.52
T_4	2.47	2.47	2.475	2.5	2.52	T_4	2.47	2.48	2.48	2.53	2.54

Increase in thickness may be due to the decrease in diameter. The changes in diameter and thickness were reflected in spread ratio. The spread ratio of (10.06) for control sample and minimum (7.87) for that sample which was made by incorporation of 60 per cent green gram flour in wheat flour. Therefore Spread ratio decreased with the addition of green gram flour in formulation. Other research workers also reported reduction in spread ratio when soy flour and fenugreek flour were substituted for wheat flour (Singh *et al*., 1996; Hooda and Jood, 2004). the amount of water used for making dough was increased with increasing level of green gram dhal flour in the formulation. Reduced spread ratios of green gram flour fortified biscuits were attributed to the fact that composite flours apparently form aggregates with increased numbers of hydrophilic sites available that compete for the limited free water in biscuit dough (Watters, 1978). During storage it was observed that moisture content of control and treated biscuits were increased from zero to 60 days as presented in Table 2 but after comparing between high density polyethylene (HDPE) and low density polyethylene (LDPE) used as packaging material of biscuits the moisture content was slightly higher in low density polyethylene and the value of moisture was 3.35 per cent and 3.39 per cent in HDPE and LDPE packed biscuit, respectively.

Protein content of biscuit sample was found maximum 14.30 in T_4 sample for both HDPE and LDPE packed biscuit and minimum 7.32 in T_0 sample for HDPE packed biscuit and 7.30 in T_0 sample for LDPE packed biscuit as shown in Table 3. So protein content of LDPE packed biscuit was slightly less than HDPE packed biscuit. It was also observed that after 15 days of storage protein content of biscuits were decreased.

Fat content in experimental sample was found that the fat content of control and treatment decreased from zero to 60 days. Fat content of biscuit sample was found maximum 26.24 in T_4 sample for both HDPE and LDPE packed biscuit and minimum 23.11 in T_0 sample for HDPE packed biscuit and 23.10 in T_0 sample for LDPE

Table 3: Effect on protein content of biscuits during storage in HDPE and LDPE packed biscuits, respectively

Number of treatment	HDPE					Number of treatment	LDPE				
	Interval or storage days						Interval or storage days				
	0 days	15 days	30 days	45 days	60 days		0 days	15 days	30 days	45 days	60 days
T_0	7.44	7.42	7.40	7.38	7.32	T_0	7.44	7.42	7.39	7.35	7.30
T_1	10.41	10.4	10.39	10.35	10.31	T_1	10.41	10.40	10.39	10.34	10.28
T_2	12.58	12.57	12.55	12.50	12.49	T_2	12.58	12.56	12.53	12.50	12.46
T_3	14.25	14.24	14.23	14.15	14.11	T_3	14.24	14.22	14.20	14.12	14.11
T_4	14.30	14.29	14.27	14.22	14.13	T_4	14.30	14.28	14.25	14.18	14.13

Table 4: Effect on fat content of biscuits during storage in HDPE and LDPE packed biscuits, respectively

Number of treatment	HDPE					Number of treatment	LDPE				
	Interval or storage days						Interval or storage days				
	0 days	15 days	30 days	45 days	60 days		0 days	15 days	30 days	45 days	60 days
T_0	23.24	23.23	23.22	23.15	23.11	T_0	23.24	23.22	23.20	23.12	23.10
T_1	24.89	24.88	24.86	24.83	24.81	T_1	24.89	24.86	24.83	24.81	24.79
T_2	24.10	24.10	24.10	24.08	24.05	T_2	24.10	24.09	24.08	24.05	24.01
T_3	25.56	25.55	25.54	25.51	25.49	T_3	25.56	25.55	25.53	25.51	25.49
T_4	26.24	26.24	26.24	26.21	26.21	T_4	26.24	26.23	26.21	26.20	26.17

Table 5: Effect on ash content of biscuits during storage in HDPE and LDPE packed biscuits, respectively

Number of treatment	HDPE					Number of treatment	LDPE				
	Interval or storage days						Interval or storage days				
	0 days	15 days	30 days	45 days	60 days		0 days	15 days	30 days	45 days	60 days
T_0	1.29	1.29	1.29	1.29	1.29	T_0	1.29	1.29	1.28	1.29	1.29
T_1	1.87	1.87	1.87	1.87	1.85	T_1	1.87	1.87	1.87	1.88	1.85
T_2	2.23	2.22	2.21	2.21	2.21	T_2	2.23	2.22	2.21	2.21	2.20
T_3	2.62	2.62	2.62	2.60	2.60	T_3	2.62	2.62	2.62	2.60	2.60
T_4	2.91	2.91	2.91	2.91	2.90	T_4	2.91	2.91	2.91	2.90	2.90

packed biscuit as shown in shown in Table 4. So fat content in LDPE packed biscuit was slightly less than HDPE packed biscuit. It was also observed that after 15 days of storage fat content of biscuit was reduced.

Ash content in experimental sample was found minimum 1.29 per cent in T_0 sample for both HDPE and LDPE packed biscuit and maximum 2.90 per cent in T_4 sample for both HDPE and LDPE packed biscuit as shown in Table 5. It was also observed that after 15 days of storage ash content of biscuit was slightly reduced. Legumes have been reported to be good sources of ash (Pyke, 1981).

The sensory characteristics of control (T_0) and green gram fortified (T_1, T_2, T_3 and T_4) biscuit was analyzed on the basis of 9 point hedonic scale rating test as shown in Table 6. The green gram fortified biscuit were analyzed on zero days, 15 days, 30 days, 45 days and 60 days. From the data the sensory score of colour, taste, flavour, texture and appearance of biscuit was increased with the increase in level of green gram flour in the formulation, and it was slightly decreased during storage period. Biscuit with 60 per cent Green gram flour resulted in significantly decreased score for quality characteristics and this decreasing effect was more pronounced in the colour of the biscuits as the biscuits produced were much brown in colour. However the biscuits prepared by supplementation of refined wheat flour with 50 per cent green gram flour up to 30 days were more score for

Table 6 : Comparison on sensory characteristics of control (T_0) and experimental (T_1, T_2, T_3 and T_4) Green Gram flour fortified biscuit at different intervals during storage

Sensory characteristics	No. of treatments	Interval or storage days				
		0 days	15 days	30 days	45 days	60 days
Colour	T_0	7.6	7.6	7.6	7.5	7.5
	T_1	8.3	8.3	8.3	8.2	8.2
	T_2	8.2	8.2	8.2	8.2	8.2
	T_3	8.6	8.6	8.6	8.3	8.3
	T_4	7.7	7.7	7.7	7.6	7.4
Taste	T_0	7.5	7.5	7.5	7.5	7.5
	T_1	8.2	8.2	8.2	8.2	8.2
	T_2	8.3	8.3	8.3	8.3	8.3
	T_3	8.4	8.4	8.4	8.4	8.3
	T_4	7.8	7.8	7.8	7.8	7.8
Flavour	T_0	7.7	7.7	7.7	7.7	7.7
	T_1	8.4	8.3	8.3	8.3	8.3
	T_2	8.1	8.1	8.1	8.0	8.0
	T_3	8.4	8.4	8.4	8.4	8.4
	T_4	8.0	8.0	8.0	8.0	8.0
Texture	T_0	7.4	7.4	7.4	7.0	7.0
	T_1	8.1	8.1	8.1	8.1	8.1
	T_2	8.3	8.3	8.3	8.3	8.3
	T_3	8.4	8.4	8.4	8.3	8.3
	T_4	8.0	8.0	8.0	8.0	8.0
Appearance	T_0	7.8	7.8	7.8	7.7	7.7
	T_1	8.1	8.1	8.1	8.1	8.1
	T_2	8.3	8.3	8.3	8.3	8.2
	T_3	8.4	8.4	8.4	8.3	8.3
	T_4	8.1	8.1	8.1	8.0	8.0
O.A.A.	T_0	7.7	7.7	7.7	7.7	7.6
	T_1	8.2	8.2	8.2	8.1	8.1
	T_2	8.4	8.4	8.4	8.3	8.3
	T_3	8.6	8.6	8.6	8.5	8.5
	T_4	8.0	8.0	8.0	8.0	8.0

colour, taste, flavour, texture, appearance and overall acceptability.

Conclusion :

The present research work deals with the "Development of protein enriched Biscuits fortified with green gram dhal flour". Supplementation of wheat flour with green gram flour was tried at 30, 40, 50, and 60 per cent levels along with sugar, skimmed milk powder, fat and baking powder, to improve the nutritional and sensory quality of biscuit. The physicochemical analysis showed that the diameter of biscuits was decreased gradually with increased in level of green gram flour and thickness was increased in proportion. The spread ratio of biscuits was decreased significantly with increased the level of green gram flour. Moisture content of control biscuits was less than green gram flour fortified biscuits and it was increased during storage. Moisture content was higher at 60 days in 30 per cent treated biscuits but it was slightly higher in LDPE packed biscuits in comparison to HDPE biscuits and lower at zero days in 50 per cent green gram flour incorporated biscuits. Protein content of control biscuits was lower than green gram flour fortified biscuits decreased during storage and it was higher at zero days in 60 per cent treated biscuits. Fat content of green gram fortified biscuits was more than control biscuits. It was decreased during storage and it was higher at zero days in 60 per cent treated biscuits sample for both HDPE and LDPE packed biscuits. Ash content of green gram fortified biscuits was more than control biscuits and it was increased with incorporation of green gram flour. It was higher in 60 per cent treated biscuits for both HDPE and LDPE packed biscuits. The sensory analysis showed that the 50 per cent green gram dhal flour incorporated biscuits up to 30 days was accepted by panel judges on the basis of nine point hedonic scale rating test. High density polyethylene was accepted as packaging material because it was less permeable to the gas and moisture as well as increased the shelf life of green gram dhal flour fortified biscuits. So green gram dhal flour fortified biscuit can be recommended to the patients those are suffering from malnutrition.

LITERATURE CITED

Amarowicz, R. and Pegg, R.B. (2008). Legume as a source of natural antioxidants. *Eur. J. Lipid Sci. Technol*., **110** : 865-878.

Akuborp Peter I. (2003). Functional properties and performance of cowpea/ plantain/ wheat flour blends in biscuits, **58** : 1-8.+

Anderson, J.W. and Major, A.W. (2002). Pulses and lipaemia, short- and longterm effect: potential in the prevention of cardiovascular disease. *Br. J. Nutr.*, **88**: S263-S271.

AOAC method (1975). In official methods of analysis 14th Edn. Association of official and analytical chemistry chemist, Washington, D.C., U.S.A.

Bazzano, L.A., He, J., Ogden, L.G., Loria, C., Vuppuri, S. and Myers, L. (2010). Legume composition and risk of coronary heart disease in US men and women, NHANES I epidemiologic follow- up study. *Arch. Internal Med*., **161**: 2573-2578.

Bazzano, L.A., Tees, M.T. and Nnguyen, C.H. (2008). Effect of non so legume conjumption on cholesterol levels: A meta- analysis of randomized controlled trials. Abstract, 3272. Circ. Journal, Vol. 118: 1122.

Boye, J., Zare, F. and Pletch, A. (2001). Pulse protein process characterization, functional properties and application in food and feed. *Food Res. Internat.*, **43** : 414-431.

Choudhary, P. (2007). A study of childhood onset affective disorder, **13**:97-100.

Claughton, S.M. and Pearce, R.J. (1989). Protein enrichment of sugar-snap cookies with sunflower protein isolates. *J. Food Sci.*, **54** : 354- 356.

Gopalan, C., Ramasastri, B.V. and Balasubramanian, S.C., (1991). Nutritive value of Indian Foods. Hyderabad (A.P.) (INDIA).

Hooda, S. and Jood, S. (2004). Organoleptic and nutritional evaluation of wheat biscuit supplemented with untreated and treated fenugreek flour, **90**: 427-435.

Mishra, P., Usha, M.S. and Singh, S. (1991). Bengal gram flour-Wheat flour blends: chemical, archeological and baking characters. *J. Food Sci. Technol.*, **28** : 89.

Panse,V.G. and Sukhatme, P.V. (1967). *Statistical methods for agricultural workers*. 2nd Ed.. Indian Council of Agricultural Research, New Delhi: 381.

Potter, N.N. (1986). *Food science*, 4th Edn. Van Nostrand Reinhold, Inc., New York, U.S.A.

Pyke, M. (1981). *Classification of Wheat: Food Science and Technology*. 4th Ed.. John Murray Publishers Ltd, London, pp. 44-56.

Ranganna, S. (1995). "Hand book of analysis and quality control for fruit and vegetable products" Tata McGraw Hill Co. Ltd., New Delhi, India.

Rizkalla, S.W., Bellisle, F. and Slama, G. (2002). Health benefits of low glycaemic index foods. Such as pulses, in diabetic petients and health individuals. *Br. J. Nutr*., **88**: 255-262.

Singh, R., Singh, G. and Chauhan, G.S. (1996). Effect of incorporation of defatted soy flour on the quality of biscuits. *J. Food Sci. & Technol.*, **33**: 355-357.

Srilakshmi, B. (2003). *Food Science*, New Age International (P) Publishers Ltd., Chennai.

Tsen, C.C., Peters, E.M., Schaffer, T. and Hoover, W.J. (1973). High protein cookies effect of soy fortification and surfactants. *Bakers Digest*, **47**: 34–37.

Watters Mc, K.M. (1978). Cookie baking properties of defatted peanut, soybean and field pea flours in baking powder biscuits. *Cereal Chem.*, **55** : 853-863.

Received : *20.01.2016;* **Revised:** *09.03.2016;* **Accepted :** *24.03.2016*