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Nutritional enhancement of crackers by incorporation of guar meal protein isolate

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Abstract
The aim of the study was to develop nutritionally rich cracker by incorporation of guar meal protein isolate. The physical properties of developed test crackers had weight between 13.12 to 13.40 g, highest spread ratio and puffiness was observed for sample C_0 *viz* 13. 92 and 3.43%. The proximate composition revealed a high protein content of 16.36% for C_3 sample, while texture analysis revealed a hardness of 17.12 kg for C_1. The C_2 test food cracker revealed highest food acceptability and was microbially safe for 90 days.

Keywords: nutritional enhancement, crackers, incorporation, guar meal protein isolate

Introduction
Guar (*Cyamopsis tetragonalobus*) a draught tolerant legume is widely cultivated in India and Pakistan. India is known as the biggest producer of guar bean by contributing around 90% of the total production. Guar meal is obtained after the mechanical separation of the endosperm from the hulls and germ of the ground seeds and contains about 35 to 45% protein. It had received substantial attention for animal feedstuff and is being considered as a relatively cheap concentrated source of protein (33 to 60% according to the type of fraction) (Salehpour *et al* 2012) [15]. According to Conner (2002) [4] germ meal could be produced as a secondary product from the manufacture of guar gum and it is combined germ and hull fraction that remains after guar gum is extracted from guar seed. Nutritional content of guar meal reveals that it contains moisture 12%; fat 4%; crude protein 45%; fiber 6% and ash 4.5% and also it a cheap source of well-balanced protein, rich in lysine and sulfur-amino acids (Ramakrishnan, 1957) [13]. However, anti-nutritional components like saponins and trypsin inhibitors limit the use of guar meal in animal diets. These anti-nutritional factors have been reported to depress growth of animals (Hussain *et al* 2012) [7]. The utilization of guar meal can be improved by reducing antinutrional factors by developing protein isolate . The present study was carried out to improve the nutritional value of crackers by incorporation of guar meal protein isolate.

Materials and Methods
Guar meal protein isolate was procured from Department of Food Chemistry and Nutrition, College of Food Technology, Parbhani. Whole wheat flour, maize, sugar, shortening, salt, milk and baking powder was purchased from local market of Parbhani. Crackers were prepared using the method of Mir (2015) [8] by incorporating guar meal protein isolate at varying concentrations with C_0 as control. Baking was done at 170 ^{0}C for a period of 10min, followed by cooling at ambient temperature. Cooled crackers were packed in plastic pouches and were stored at room temperature for further analysis.
Physical properties such as diameter and thickness were measured by using vernier calliper, spread ratio of crackers was calculated by dividing the average value of diameter by average value of thickness as per the method of Bose *et al*, 2010 [2] and percent puffiness was determined by adopting the method of Nammakuna *et al.* (2009) [10]. Yield of the cracker was determined based on initial weight of dough. Proximate parameters *viz* moisture, protein, fat, ash and fiber were determined according to the standard method of AOAC (2019) [1]. Carbohydrate content was estimated by difference method. The monadic or single-bowl test was used to test the palatability of gaur meal protein isolate supplemented /crackers for dogs.
Stable Micro System TA-XT plus Texture Analyzer was used for texture profile analysis (TPA) of guar meal protein isolate incorporated crackers as per the method adopted by Chung

et al., 2014 [3]. Stored samples were analyzed for bacterial growth by standard serial dilution plate count method using nutrient agar as a medium for growth.The data of the all experimental treatments were statistically analyzed by Completely Randomized Design (CRD) using analysis of variance (ANOVA). The analysis of variance revealed at the significance of S.E. and C.D. at 5 per cent level is mentioned wherever required (Panse and Shukhatame, 1967) [12].

Table 1: Formulation of crackers by incorporation of guar meal protein isolate

Ingredients	Quantity (g)			
	C_0	C_1	C_2	C_3
Whole wheat flour	80	70	65	60
Maize flour	20	20	20	20
Protein isolate	-	10	15	20
Sugar	10	10	10	10
Shortening	15	15	15	15
Salt	2	2	2	2
Milk	40	40	40	40
Baking Powder	1	1	1	1

Result and Discussion

Physical characteristics of GMPI incorporated crackers

Physical characteristics of guar meal protein isolate (GMPI) incorporated crackers namely weight, diameter, thickness, spread ratio, puffiness and yield are presented in table 2. Individual cracker weight ranged from 13.12 to 13.40 g and control cracker had weight of 13.29 g. Lightest cracker was C_3 also it contain highest amount of GMPI. Hoojat and Zebik (1984) [6] observed that replacement of wheat flour by 20% navy bean flour or 30% sesame seed flour in the preparation of cookies reduced the weight of whole-wheat flour cookies.

Table 2: Physical Properties of crackers prepared with different proportion of whole wheat flour and guar meal protein isolate

Sample	Weight (g)	Diameter (mm)	Thickness (mm)	Spread ratio (Diameter/Thickness)	Puffiness (%)	Yield (%)
C_0	13.29	69.22	4.97	13.92	3.43	78.62
C_1	13.40	69.15	4.92	14.05	2.68	79.43
C_2	13.25	69.10	4.98	13.87	2.74	79.42
C_3	13.12	69.00	5.02	13.74	2.96	79.56

The diameter and thickness were affected by increase in level of Guar meal protein isolate in the crackers. Addition of GMPI to cracker had resulted in reduced diameter to final product. The diameter for crackers ranged from 69.00 mm to 69.22 mm, least diameter was observed for C_3 sample. The thickest cracker was C_3 (5.02 mm) followed by C_2 and C_0 sample with a value 4.98 mm and 4.97mm respectively. Spread ratio is correlated with texture, grain fineness, bite and overall mouth feel and considered as one of the most important quality parameter of cracker (Nagi *et al.* 2012) [9]. High spread ratio is desirable in crackers. The spread ratio was between 13.74 to 14.05. Highest spread ratio was observed for C_1 followed by C_0 which was 14.05 and 13.92 respectively. Lowest spread ratio was showed by C_3sample (13.74). Results for decrease in spread ratio are in concordance with those reported earlier by Zlatica *et al.* 2011 and Tiwari *et al.* who recorded decrease in spread ratio for chickpea and pigeon pea flours substituted cookies or biscuits. Zucco *et al.* (2011) [20] described a decrease in spread with increased protein in cookies.

Puffiness is one of the most important attribute in crackers. The addition of guar meal protein isolate increased the puffiness of the crackers but these samples were less puffy as compared to the control sample, this might be directly correlated to the protein matrix formed in whole wheat crackers. Sample C_3 had highest puffiness of about 2.96% but it was less when compared to Control sample (3.43%). Faubion and Hoseney (1990) [5] reported that gluten matrix in wheat contains many inner layers that slows down the rate of gas diffusion and allow its retention before and after baking as well as determines the puffiness and crumb structure of wheat crackers. Yield of crackers was between 78.62 to 79.56%.

Proximate composition of GMPI incorporated crackers

The proximate composition of GMPI incorporated crackers are shown in table 3. The addition of protein isolate had increased the moisture content of the crackers. Significant variation was observed among moisture content of the control ($p \leq 0.05$) and treated sample, but among the protein isolate incorporated crackers significant variation for moisture content was not observed. Sample C_3 containing 20% GMPI had the highest moisture content among all samples and it was about 5.06%.

Replacement of whole wheat flour with guar meal protein isolate had increased protein content of the crackers and it varied between 12.35 to 16.36%. Protein content of treated cracker was significantly higher than the control sample. Highest protein content was observed in sample C_3 (16.36%). Fat concentration among the samples showed no significant variation and it was about 11.65 to 11.69 g/100g.

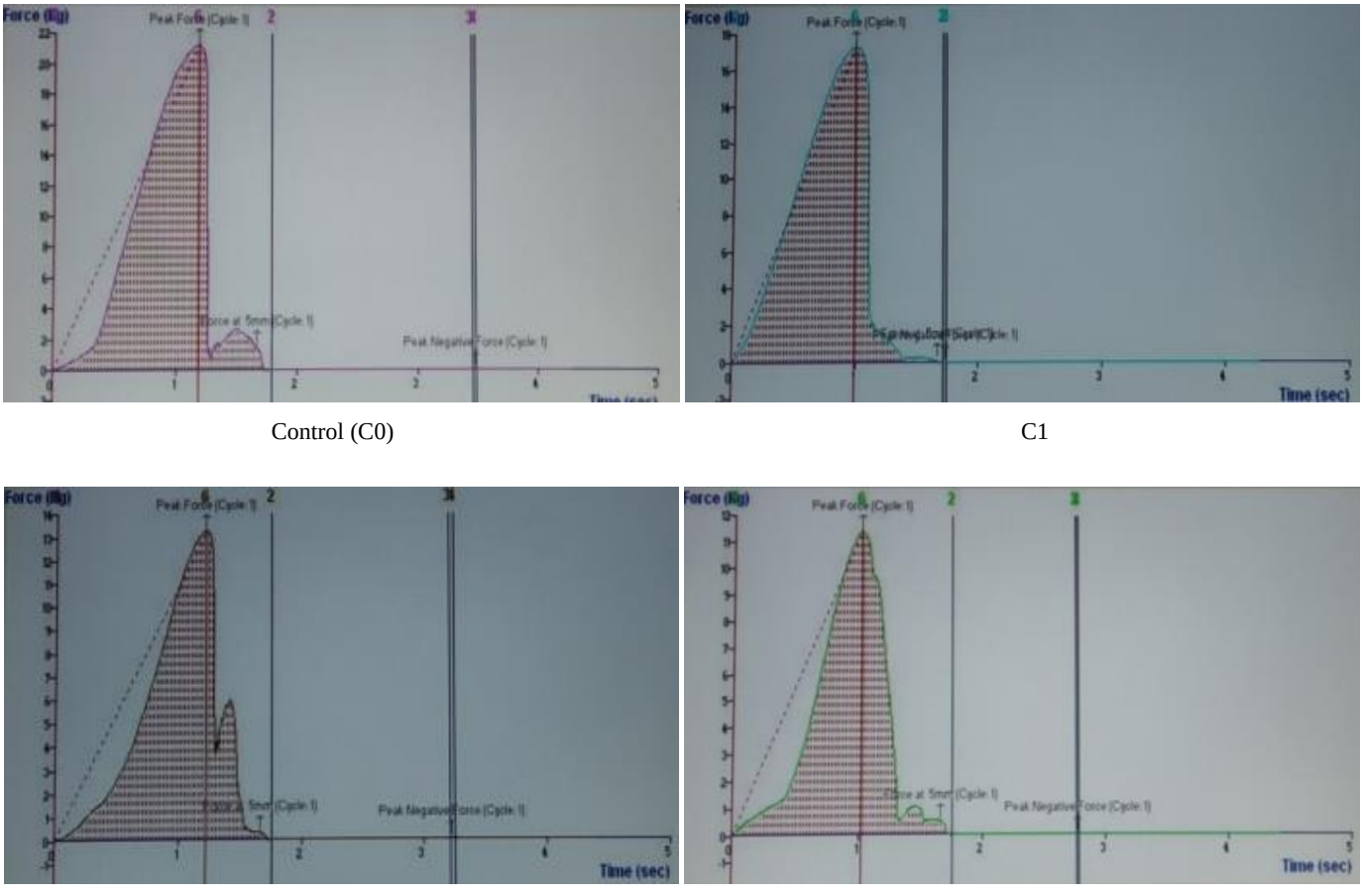
Table 3: Proximate composition of crackers prepared by incorporation of guar meal protein isolate.

Sample	Chemical composition (g/100g)						Energy Value (kcal/100g)
	Moisture	Protein	Fat	Carbohydrate	Ash	Fiber	
C_0	4.23	7.89	11.69	73.66	1.21	1.26	431.41
C_1	4.91	12.35	11.65	68.79	1.11	1.13	429.45
C_2	4.98	14.24	11.67	66.98	1.05	1.07	429.92
C_3	5.06	16.36	11.68	64.84	1.01	1.02	429.92
SE±	0.012	0.014	0.011	0.015	0.014	0.006	0.005
CD @ 5%	0.038	0.043	0.035	0.046	0.042	0.018	0.016

The data in table 3 indicates that carbohydrate content in the prepared crackers differed significantly, highest content of carbohydrate was observed in control sample 73.66%. As concentration of protein isolate increased carbohydrate content of the crackers decreased. Among GMPI incorporated samples highest carbohydrate was obtained for sample C_1 followed by C_2 and C_3, 68.79, 66.98 and 64.84 g/100g respectively. Ash and fiber content was high in control sample. The ash content of the crackers decreased with increase in GMPI level. The fiber content of the crackers do not vary significantly, but it decreased with increase in GMPI content.

Texture Profile Analysis

Texture property is one of the major factors contributing to the eating quality of crackers. Hardness, which is the most important textural characteristics for crackers and is measured as peak force to snap the cracker. Addition of guar meal protein isolate decreased the peak force required to fracture the crackers when compared to the control. Fig 1 indicates that hardness of C_1 (17.12 kg) sample was close to the Control sample which depicted a value of 21.56 kg. GMPI incorporated samples had hardness less than the control and it was in ranged between 11.86 to 17.12 kg. This was due to the difference between GM protein and wheat gluten. GMPI added samples were more brittle and crispier. These results are in agreement with the findings of Sozer (2009) [16] who reported that addition of protein helps starch granules to adhere to one another and in water is more distributed through the system because of the polymeric structure of proteins (Sivaramakrishnan *et al.* 2004) [14].



Control (C0) C1

C2 C3

Fig 1: Texture analysis profile of Guar Meal Protein Isolate incorporated crackers

Microbial analysis

Data pertaining to microbial stability presented in table 4 indicated that TPC of the sample increased with increase in storage period from 1.2 x 10^2 to 55 x 10^2, this increase in TPC can be attributed to increase in moisture content during storage. Maximum TPC was obtained after 90 days of storage and it was about 55 x 10^2 and it was within the safe limit of 50,000 as prescribed by standard for high protein biscuits (Nagi *et al.* 2012) [9]. Results obtained for TPC are in close concession with findings of Tahiya *et al.* (2018) [17] who

reported a maximum TPC of (111.66 X 10^2) for wheat based crackers incorporated with brown rice flour and carboxymethyl cellulose (CMC).

Table 4: Microbiological analysis of GMPI incorporated crackers

Storage period (Days)	TPC (cfu/gX 10^2)
0	1.2
30	16
60	45
90	55

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