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PROXIMATE CONSTITUENTS OF GERMINATED BROWN RICE BASED GLUTEN FREE COOKIES

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Abstract

Gluten-free food products are becoming popular due to increased consumers awareness on celiac disease. The present investigation was undertaken to develop gluten free cookies from composite flour consisting of germinated brown rice and oat flour with better nutritional and sensory characteristics. Cookies were prepared using germinated brown rice and oats flour to make different treatment combinations. The developed products were packed in aluminium laminates and stored under ambient conditions for a period of 90 days. The proximate analysis of cookies revealed that among proximate constituents, highest mean crude protein of 8.58% was recorded in T_7 With the progression of storage period crude fibre content decreased from 1.59 to 1.26%.

Brown rice is an un-milled whole grain, containing the bran layer and germ. It is rich in essential nutritional components, such as fiber, iron, calcium, vitamins, minerals, and in bioactive components (Matsuo *et al*. 2012). Brown rice has not become a staple grain mainly because of its requirement of prolonged cooking time and the rough mouth feeling. To overcome these inferior characteristics, germination has been introduced. It increases the rate of water absorption and softens the cooked kernels, improving eating quality. Moreover, it activates residual enzymes, thus inducing the formation of various metabolic components having bioactive functions.

Oats are a good source of phenolic acid, phytic acid, and antioxidant vitamin E and they have also been connected to the health benefits of using β-glucans (Ahmed *et al*. 2014). Consumption of oat products has been associated with a reduced serum cholesterol level, a lower risk of cardiovascular disease and a lower risk of obesity, hypertension, cancer, diabetes, and gastrointestinal disorders. Several novel products using oats could be developed. Consumers' interest for gluten free cookies is increasing due to awareness on gluten allergy. In order to increase the nutritive value of cookies, and provide healthy alternative to gluten based cookies many researchers are now focusing on either partial substitution (Kaur *et al*. 2017) or total replacement of wheat flour (Bolarinwa *et al*. 2016) with gluten-free flour in value added product preparation. Considering the above, the aim of the present study was development of a cookie's formulation containing germinated brown rice and oat flour that contribute to the gluten-free cookies production - as a functional food - and evaluate its effect on proximate and sensory characteristics of the cookies.

Brown rice (Pusa basmati 1121) was procured from M/S Jatinder Rice Mill, R.S. Pura, Jammu. The rice grains were then washed and soaked in water for 12 hrs at 28 ± 2ºC, followed by incubation at 28 ± 2ºC for time interval of about 48 hrs. After that, the germinated brown rice samples were dried in a tray dryer at 50 ± 3ºC until the moisture content drops below 12% (AOAC 2012). The germinated samples were then milled by using laboratory flour mill followed by sieving using 80 - 100 mesh sieves. The sieved sample was packed in airtight containers till

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further use. For development of gluten free cookies, brown rice and oats were mixed in different proportions as per the treatment combinations : T_1(100% Germinated brown rice), T_2 (95:5:: Germinated brown rice: Oats), T_3 (90:10:: Germinated brown rice: Oats),T_4 (85:15:: Germinated brown rice: Oats), T_5 (80:20:: Germinated brown rice: Oats), T_6 (75:25:: Germinated brown rice: Oats), T_7 (70:30:: Germinated brown rice: Oats).Treatments were standardized using varying concentrations of germinated brown rice flour and oat flour along with other basic ingredients like shortening vegetable fat sugar, baking powder, milk powder and water. The powdered sugar and fat were creamed with flat beater for five minutes. The milk powder was made into a suspension in water and transferred to the cream. The contents were mixed and sieved flours were added to the cream and kneaded to form dough. The dough was then sheeted to a thickness of 3.5 mm and cut into cookies with the help of a circular mould (51 mm diameter). It was then baked at 180ºC for 15 minutes on a greased tray. After baking, cookies were cooled at room temperature and were wrapped tightly in laminated pouches, sealed and stored under ambient conditions (32±2°C) for a period of 90 days (Soni *et al*. 2018).The fresh as well as stored samples were analyzed periodically at an interval of 0, 30, 60 and 90 days of storage for proximate constituents.

Moisture content in the samples was determined by following the oven drying method as the loss in weight due to evaporation from sample at a temperature of 105±1°C (AOAC 2012).The crude protein content of the cookies was determined by micro Kjeldahl method, using the factor 5.95 for converting nitrogen content into crude protein. The crude fat content was determined by the Soxhlet extraction technique. The crude fibre and ash content was determined by the method given by AOAC (2012). The carbohydrate content was estimated by the difference method given by AOAC (2012). The results obtained were statistically analyzed using completely randomized design (CRD) and CRD factorial for interpretation of the results through analysis of variance using OPSTAT software. The experiment was repeated twice, with three replications for each treatment.

Table 1. Effects of blending and storage on moisture and crude protein (%) of germinated brown rice: oat flour blended cookies.

Blends (Germinated brown rice: Oat flour)	Moisture (%)				Mean	Crude protein (%)				Mean
	Storage period(days)					Storage period (days)				
	0	30	60	90		0	30	60	90	
T_1(100:00)	2.73	2.80	2.89	3.00	2.86	7.86	7.78	7.67	7.56	7.72
T_2(95:05)	2.62	2.69	2.78	2.87	2.74	8.02	7.95	7.86	7.77	7.90
T_3(90:10)	2.51	2.58	2.67	2.75	2.63	8.14	8.06	7.97	7.85	8.01
T_4(85:15)	2.38	2.45	2.54	2.67	2.51	8.31	8.22	8.13	8.05	8.18
T_5(80:20)	2.26	2.34	2.43	2.56	2.40	8.45	8.36	8.27	8.16	8.31
T_6(75:25)	2.14	2.25	2.35	2.44	2.30	8.58	8.49	8.40	8.29	8.44
T_7(70:30)	2.03	2.16	2.24	2.34	2.19	8.73	8.62	8.53	8.44	8.58
Mean	2.38	2.47	2.56	2.66		8.30	8.21	8.12	8.02	
Effects	$CD_{(p\leq0.05)}$					$CD_{(p\leq0.05)}$				
Blends (B)	0.03					0.04				
Storage (S)	0.02					0.03				
B×S	0.05					0.07				

The highest mean moisture content was recorded in T_1 as 2.86% and the lowest mean moisture value of 2.19% was recorded in T_7. The storage period of 90 days resulted in an increase in mean moisture content of gluten free cookies from 2.38 to 2.66%. The highest mean crude protein content of 8.58% was recorded in T_7, whereas the lowest mean crude protein content of 7.72% was recorded in T_1 (Table 1). The supplementation of oat flour increased crude protein content which might be due to high amount of protein present in oat flour compared to germinated brown rice flour. A significant decrease in crude protein content from 8.30 to 8.02% was observed during 90 days of storage period. The decrease in crude protein content during storage might be attributed to Maillard's reaction involving reaction between amino acids and sugars along with the disorganized protein structure resulting from moisture gain during storage which further led to the degradation of proteins during.

Table 2. Effects of blending and storage on crude fat and crude fibre (%) of germinated brown rice: oat flour blended cookies.

Blends (Germinated brown rice: Oat flour)	Crude fat (%)				Mean	Crude fibre (%)				Mean
	Storage period(days)					Storage period (days)				
	0	30	60	90		0	30	60	90	
T_1(100:00)	27.23	27.15	27.06	26.95	27.10	1.82	1.74	1.62	1.53	1.68
T_2(95:05)	27.42	27.34	27.25	27.14	27.29	1.75	1.63	1.54	1.42	1.59
T_3(90:10)	27.57	27.48	27.39	27.29	27.43	1.68	1.56	1.45	1.34	1.51
T_4(85:15)	27.71	27.64	27.55	27.45	27.59	1.59	1.47	1.36	1.23	1.41
T_5(80:20)	27.90	27.81	27.73	27.61	27.76	1.50	1.39	1.27	1.16	1.33
T_6(75:25)	28.08	27.99	27.87	27.76	27.93	1.43	1.32	1.21	1.09	1.26
T_7(70:30)	28.24	28.17	28.06	27.94	28.10	1.36	1.24	1.11	1.02	1.18
Mean	27.74	27.65	27.56	27.45		1.59	1.48	1.37	1.26	
Effects		$CD_{(p \le 0.05)}$			$CD_{(p \le 0.05)}$					
Blends (B)		0.03			0.03					
Storage (S)		0.02			0.02					
B×S		0.05			0.06					

The data pertaining to crude fat content of gluten free cookies in Table 2 revealed that highest mean crude fat content of 28.10% was reported in T_7 whereas the lowest mean crude fat content of 27.10% was reported in T_1. During storage period of 90 days, the mean crude fat content decreased from 27.74 to 27.45% in gluten free cookies. The decrease in crude fat content might be due to the increase in relative humidity which stimulates the activity of lipase and causes breakdown of fat into fatty acid and glycerol. The highest mean crude fibre content of 1.68% was recorded in T_1 whereas treatment T_7 exhibited lowest mean crude fibre content of 1.18% (Table 2). With the advancement in storage period, the mean crude fibre content decreased significantly from 1.59 to 1.26% which might be attributed to the degradation of structural polysaccharides and hemicelluloses during storage. Among blends, T_7 recorded the highest mean ash content of 2.25%, whereas T_1 recorded the lowest mean ash content of 1.60% (Table 3). During 90 days of storage, the mean ash content of gluten free cookies decreased from 2.02 to 1.82% which might be due to the mineral losses from binding of minerals by Maillard reaction products during storage (Nadarajah and Mahendran 2015). The highest mean carbohydrate content of 60.73% was recorded in treatment T_1 whereas treatment T_7 exhibited lowest mean carbohydrate content of

58.88% (Table 3). The perusal of data also revealed that the mean carbohydrate content increased significantly from initial level of 59.57 to 60.05% during storage period of 90 days. This increase in carbohydrate is determined by calculation difference of other components (moisture, protein, fat and ash) which automatically increases the carbohydrate content. Based on the experiment it can be concluded that substitution of germinated brown rice and oat flour produced better quality cookies. The developed cookies can be stored for more than 90 days with minimum changes in nutritional quality. Thus, brown rice can be explored effectively and efficiently in the development of various nutritionally enriched value-added healthier products.

Table 3. Effects of blending and storage on ash and carbohydrate of germinated brown rice: oat flour blended cookies.

Blends (Germinated brown rice: Oat flour)	Ash (%)				Mean	Carbohydrate (%)				Mean
	Storage period(days)					Storage period (days)				
	0	30	60	90		0	30	60	90	
T_1(100:00)	1.68	1.63	1.58	1.51	1.60	60.50	60.64	60.80	60.98	60.73
T_2(95:05)	1.80	1.74	1.67	1.62	1.71	60.14	60.28	60.44	60.60	60.37
T_3(90:10)	1.91	1.85	1.78	1.70	1.81	59.87	60.03	60.19	60.41	60.13
T_4(85:15)	2.02	1.96	1.91	1.84	1.93	59.58	59.73	59.87	59.99	59.79
T_5(80:20)	2.14	2.08	2.00	1.93	2.04	59.25	59.41	59.57	59.74	59.49
T_6(75:25)	2.21	2.16	2.09	2.02	2.12	58.99	59.11	59.29	59.49	59.22
T_7(70:30)	2.35	2.29	2.21	2.14	2.25	58.65	58.76	58.96	59.14	58.88
Mean	2.02	1.96	1.89	1.82		59.57	59.71	59.87	60.05	
Effects	$CD_{(p\leq0.05)}$					$CD_{(p\leq0.05)}$				
Blends (B)	0.05					0.14				
Storage (S)	0.04					0.13				
B×S	NS					0.28				

References

Ahmed WS, Rouf ST, Bindu B, Khalid M and Pradyuman K 2014. Oats as a functional food. Univers. J. Pharm. **3**: 14-20.

AOAC 2012. Official Methods of Analysis. 19th edition, Association of Official Analytical Chemists, Washington, DC.

Bolarinwa IF, Abioye AO, Adeyanju JA and Kareem ZO 2016. Production and quality evaluation of biscuits produced from malted sorghum-soy flour blends. J. Adv. Food Sci Technol. **3**(3): 107-113.

Kaur M, Singh V and Kaur R 2017. Effect of partial replacement of wheat flour with varying levels of flaxseed flour on physicochemical, antioxidant and sensory characteristics of cookies. Bioact. Carbohydr. Diet. Fibre. **9**: 14-20.

Matsuo A, Sato K, Park EY, Nakamura Y and Ohtsuki K 2012. Control of amylase and protease activities in a phytase preparation by ampholyte-free preparative isoelectric focusing for unrefined cereal-containing bread. J. Funct. Food. **4**: 513-519.

Nadarajah S and Mahendran T 2015. Influence of storage conditions on the quality characteristics of wheat defatted coconut flour biscuits packed in metalized polypropylene. Int. J. Eng. Res. Technol. **4**: 948-951.

Soni N, Kulkarni AS and Patel L 2018. Studies on development of high protein cookies. Int. J. Chem. Stud. **6**(6): 439-444.

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