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Development of high protein and sugar-free cookies fortified with pea (*Pisum sativum* L.) flour, soya bean (*Glycine max* L.) flour and oat (*Avena sativa* L.) flakes

[1*]Amin, T., [2]Bashir, A., [3]Dar, B. N. and [1]Naik, H. R.

[1]Divison of Post-Harvest Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir 191 121 India
[2]Jamia Hamdard University, Hamdard Nagar, New Delhi, Delhi 110 062 India
[3]Department of Food Technology, Islamic University of Science and Technology, Awantipora 1921 22, Jammu and Kashmir, India

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Abstract

High protein and sugar-free cookies fortified with different levels of pea flour, soya bean flour and oat flakes, were developed. Sucralose was used instead of sucrose with the intention to develop sugar-free cookies. Proximate composition, storage stability tests, microbiological analysis and sensory evaluation was carried out. The results of the proximate analysis showed that the moisture, ash, crude fat, protein and total dietary fiber of fortified samples were higher than the control. The carbohydrate content of the fortified products was found to be lower than the control. However, the energy value of the fortified cookies was found to be higher than the control. It was, therefore, contended from the results that the cookies were sugar-free and protein rich. The cookies were stable both in terms of peroxide and acid values during two months of storage period, as both the values were within the permissible limits prescribed by Bureau of Indian Standards (BIS). Microbial analysis of the cookies showed that there was not any microbial growth indicating the products are safe. Sensory evaluation of cookies showed that with regard to color, taste, flavor and texture, cookies with 5% to 10% pea flour and soya bean flour scored highest.

Introduction

Cookies have become one of the most desirable snacks for both young and elderly people due to their low manufacturing cost, more convenience, long shelf-life and ability to serve as a vehicle for important nutrients. Consumption of bakery products has been on an increase as a result of urbanization and increase in the number of working women. Food based industry can exploit this development by fabricating nutritious bakery foods (Akubor, 2003; Hooda and Jood, 2005). It represents the largest category of snack items among baked food products throughout the world (Pratima and Yadava, 2000). Cookies are not considered as staple food as is bread but may be feasible fiber carriers because of their longer shelf-life and thus enable their large scale production and widespread distribution (Vratania and Zabik, 1978). Townsend and Buchanan (1967) have developed high protein milk biscuits which had not only a longer shelf-life but also facilitated easy transport, storage and distribution, thereby leading to their use as an emergency food at the time of natural disasters (Nagi *et al.*, 2012). The protein content of cookies may be achieved through the incorporation of protein rich ingredients (McWatters, 1978).

Now-a-days, consumers are much more concerned about their health and demand the food products conferring health benefits with reduced calories, low sugar content, high protein and dietary fiber. Consumers also look for the products that are more natural-like. The low calorie products may be developed by adding bulking agents possessing high moisture absorption ability resulting in the reduction of calories by one-third (Nagi *et al.*, 2012). Due to the change in life-style, evidences of diseases such as high blood pressure, diabetes, cardiovascular diseases (CVDs) and similar other diseases is on the rise. Also the growing population with depleting sources of food resulted in malnutrition which is of great concern. Such people need sugar-free, high protein and low caloric diet which may be prepared by incorporating such ingredients into the diet which are low in sugar, high in protein and dietary fiber.

Bakery products are considered to be the better vehicles for fortification. Therefore, keeping in view the above factors, the present study was carried out to develop the high protein and sugar-free cookies fortified with Pea (*Pisum sativum* L.) flour, soya bean (*Glycine max* L.) flour and oat (*Avena sativa* L.) flakes

*Corresponding author.
Email: *tawheed.amin@gmail.com*

which would serve the functional food industry.

Materials and Methods

Raw material preparation

Soyabeans and dried peas were ground separately, by a grinder (LUMIX). The ground material was then sieved using 60 mesh size sieves to obtain uniform particle size. The ground and sieved material was kept in an airtight container for further use. Wheat flour was purchased from the local market and sieved.

Sample preparation

Eight different sample combinations were prepared using soya flour, pea flour and wheat flour in the proportions as given in Table 1.

Table 1. Different sample combinations for development of cookies

	Wheat flour (g)	Soya bean flour (g)	Pea Flour (g)
Sample 1	95	5	0
Sample 2	95	0	5
Sample 3	90	10	0
Sample 4	90	0	10
Sample 5	85	15	0
Sample 6	85	0	15
Sample 7	70	15	15
Sample 8 (CONTROL)	50	0	0

Formulation of recipe

Cookies were prepared as per AOAC method (2004) with some modifications. Instead of sucrose, sucralose (non-nutritive/zero calorie sweetener) procured from local market was used. The proportion of ingredients as per table 2, were used in preparation of cookies.

Preparation of a product

The dry ingredients (flour with various proportions of soya bean flour, pea flour, wheat flour, oat flakes, baking powder and salt) were weighed accurately and thoroughly mixed in a bowl by hand for 3 minutes. Then creaming of vegetable shortening (palmolein) and sucralose was done in a mixer till foaming occurred. The flour was added to the creamy mass and mixed for 3 minutes at medium speed in a laboratory mixer (LUMIX). The dough was then rested for 30 minutes followed by cutting the dough to a desired shape of uniform thickness. The dough was placed on baking trays leaving 25 mm space in between and baked at 175°C for 25 minutes in the baking oven. Following baking, the cookies were cooled to ambient temperature, packed in low density polyethylene bags and kept in airtight containers prior to subsequent analysis (nutritional analysis, microbial analysis and stability studies) and sensory evaluation.

Proximate composition

Proximate composition (moisture content, carbohydrate, ash, fat, protein, fiber content, total reducing sugars and sucrose) was determined by using different methods (AOAC, 2004; Amin & Thakur, 2014, Elinge *et al.*, 2012; Hassan *et al.*, 2008).

Shelf-life study

Shelf-life studies of cookies were also carried out by packing them in polyethylene pouches (100 g), stored in air tight containers at ambient temperature and analyzed at an interval of 1 month for stability studies by determination of peroxide value and acid value up to 2 months. Peroxide value and acid value was determined by following the methods of IS:548 (Part 1, 2010).

Microbiological analysis of cookies

Total Plate Count (TPC) of cookies was determined by the methods described by IS:5402 (2012). TPC was determined by pour plate method and spread plate method (Amin & Thakur, 2014). Yeast and mold count were determined by following the methods of IS:5403 (1999). Coliform of the samples were determined by following the methods of IS:5401 Part I (2012).

Sensory evaluation

Consumer acceptance test of the cookies was carried out by 10 semi-trained panelists using 9 point hedonic scale.

Results and Discussion

Proximate composition

Table 2 shows proximate composition of cookies. The nutritional analysis of cookies showed that the moisture content ranged from 3.52% to 4.11% as compared to the control with moisture content of 3.11%. The gradual increase in moisture content may be due to an increase in protein content by the addition of soya flour and pea flour in cookies as protein exhibits hygroscopic nature.

The ash content of cookie samples with different proportion of pea flour, soya bean flour and oat flakes ranging from 1.57% to 1.89% was higher than the control (1.45%) which may be attributed to the presence of more minerals in fortified cookies than

Table 2. Proportion of ingredients used in different types of cookies

S. No.	Ingredients	SAMPLE							
		Control	5% Soya bean flour	5% Pea flour	10% Soya bean flour	10% Pea flour	15% Soya bean flour	15% Pea flour	15% Soya bean flour + 15% Pea flour
1.	Wheat flour	50g	95 g	95 g	90 g	90 g	85 g	85 g	
2.	Sugar	25 g	-	-	-	-	-	-	-
3.	Shortening	25 ml	-	-	-	-	-	-	-
4.	Sodium chloride	0.5 g	1 g	1 g	1 g	1 g	1 g	1 g	1 g
5.	Sodium bicarbonate	0.25 g	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g
6.	Water	Quantity Sufficient	Quantity Sufficient	Quantity Sufficient	Quantity Sufficient	Quantity Sufficient	Quantity Sufficient	Quantity Sufficient	Quantity Sufficient
7.	Oat flakes	-	5 g	5 g	5 g	5 g	5 g	5 g	5 g
8.	Palmolein Oil	-	50 ml	50 ml	55 ml	55 ml	50 ml	50 ml	50 ml
9.	Sucralose	-	5 g	5 g	5 g	5 g	5 g	5 g	5 g
10.	Soya bean or Pea flour	-	5 g (*SBF*)*	5 g (*PF*)**	5 g (*SBF*)*	5 g (*PF*)**	15 g (*SBF*)*	15 g (*PF*)**	15 g (*SBF*)*+ 15 g (*PF*)**

SBF*: Soya bean Flour
PF**:Pea Flour

Table 3. Proximate composition of different types of cookies

Sample	Moisture (Percentage)	Ash (Percentage)	Crude Fat (Percentage)	Protein (Percentage)	Carbohydrate (Percentage)	Total dietary fiber (Percentage)	Energy (Kcal/100g)
Control	3.10 ± 0.009	1.45 ± 0.04	28.99 ± 0.03	6.81 ± 0.01	59.62 ± 0.01	9.73 ± 0.03	526.63
5% SBF	3.52 ± 0.07	1.57 ± 0.04	32.06 ±0.03	7.46 ± 0.02	55.45 ± 0.01	10.09 ± 0.21	540.18
5% PF	3.91 ± 0.03	1.64 ± 0.05	31.3 ± 0.50	6.99 ± 0.02	56.16 ± 0.01	10.17 ± 0.34	534.3
10% SBF	3.60 ± 0.01	1.68 ± 0.02	32.7 ± 0.17	8.37 ± 0.02	53.69 ± 0.02	11.68 ± 0.64	542.54
10% PF	3.97 ± 0.04	1.70 ± 0.02	31.15 ±0.01	7.44 ± 0.02	55.81 ± 0.04	11.51 ± 0.72	533.35
15% SBF	3.70 ± 0.08	1.89 ± 0.04	32.26 ±0.02	9.43 ± 0.04	52.83 ± 0.02	13.28 v 0.71	545.38
15% PF	4.11± 0.07	1.78 ± 0.05	30.39 ± 0.01	8.09 ± 0.02	55.75 ± 0.02	13.71 ± 0.74	528.87
15% SBF + 15% PF	4.03 + 0.05	1.85 + 0.04	32.46 + 0.02	10.61 + 0.01	51.09 + 0.01	15.07 + 0.89	538.94

Results are expressed as Mean + SD
SBF: Soybean flour; PF: Pea flour

control. The increase in the ash content may be due to an incorporation of soya flour and pea flour containing higher proportion of ash.

Similarly, total fat content ranged from 31.30% to 32.46% in fortified cookies containing soya flour compared to 28.99% fat in control. Increase in fat content in fortified cookies may be due to an increased proportion of soya flour as soya flour contains higher percentage of fat (20-24%) (Reddy, 2004). Higher fat content improves the mouth feel and retains the flavor of cookies.

The protein content of fortified biscuits ranged from 6.99% to 10.61% higher than the control with 6.81% protein content. The significant increase in protein content may be due to the addition of soya flour and pea flour in the product as both are rich in proteins. One of the studies carried out by Ugwuona (2009) showed protein and fat content of biscuits increased with increasing soy fortifications.

The incorporation of soya flour and pea flour in

Table 4. Stability studies of cookies after 1 month and 2 months of storage

Sample	After 1 month		After 2 months	
	Peroxide value (meq/kg)	Acid value	Peroxide value (meq/kg)	Acid value
Control	5.68	0.33	6.11	0.39
5% SBF	6.01	0.43	6.29	0.48
5% PF	5.29	0.29	5.51	0.36
10% SBF	5.82	0.37	5.97	0.42
10% PF	6.00	0.39	6.21	0.47
15% SBF	5.68	0.35	5.47	0.39
15% PF	5.72	0.41	6.27	0.47
15% SBF + 15% PF	6.13	0.46	6.29	0.50

SBF: Soybean flour; PF: Pea flour

cookies resulted in a decrease in the carbohydrate content to 51.09% as compared to the control with 59.62% because both are rich in fiber. It is contented from the results that the energy value of these cookies also increased. Dietary fiber content in the fortified cookies was also found to be higher which may be due to the incorporation of oat flakes. In the present study, the percentage of dietary fiber increased from 10.09% to 15.07% as compared to the control with only 9.73% dietary fiber. Since the dietary fiber is higher in the high protein, sugar-free cookies, they might be recommended to alleviate constipation and serious alimentary tract disorders.

Shelf-life studies

Shelf-life studies carried out for high protein, sugar-free cookies in respect of peroxide value and acid value is shown in Table 4. It can be seen from Table 4, both the peroxide and acid values after 2 months of storage is higher than after only 1 month of storage. However, the cookies are stable as the peroxide value is less than 10 meq/kg (permissible limit for peroxide value is 10 meq/kg) and acid value is also less than 1.2. As per the BIS specification, the acidity of the extracted fat (% by mass), maximum limit for cookies is 1.2. Our findings were in accordance with the studies of Honda *et al.* (2012).

Microbiological analysis

Microbiological studies conducted for yeast, mold, total plate count and coliform revealed that no microbial growth was detected in fortified cookies except for control which recorded microbial load of 80 cfu/ml, much lower than the permissible limits. On the basis of these findings, it could be contended that the product is safe to consume due to the high heat treatment and proper hygienic considerations during preparation of high protein, sugar-free cookies.

Table 5. Sensory Evaluation of Sugar-Free Cookies (10% Pea and 10% Soya flour)

Color	Taste	Flavor	Texture	Overall Acceptability	Rank	Rancidity
8	8	6	9	8	8	Absent
9	9	7	8	9	7	Absent
9	7	6	9	8	8	Absent
8	8.5	6	9	8	8	Absent
9	9	7	8	7	6	Absent
8	8	8	9	8	7	Absent
9	7	7	9	8	8	Absent
9	9	6	8	9	8	Absent
8	8	7	9	7	9	Absent
9	8	6	9	8	8	Absent

Sensory evaluation

Acceptability of the product recorded significant effect of shortening on product quality. Taste is the primary factor in determining the acceptability of any product and has the highest impact in determining the market success of product. Firstly cookies were prepared by using butter but after sensory/textural evaluation, the cookies were found to be hard in texture. Due to this reason butter was replaced with palmolein oil. Textural studies showed that the cookies prepared by using palmolein oil were better in texture in all types of fortified cookies with different concentration of ingredients. The texture of cookies was crispy as compared to the cookies prepared by using butter. The incorporation of palmolein oil gave good results in terms of the texture. After that the cookies were prepared by incorporating soya flour and pea flour at different levels of 5%, 10% and 15%. Sensory score for cookies containing 5% soya and 5% pea flour were comparable to the control whereas cookies containing 15% each of soya flour and pea flour developed a beany flavor which was liked moderately by some panelists. While the beany flavor of the cookies was masked by adding chocolate flavor as masking agent. Overall acceptability scores were highest in cookies with 5% to 10% pea and soya flours (Table 5). Similar results were reported by Banureka and Mahendran (2009).

Conclusion

The cookies fortified were low in sugar, protein-rich and possessed high energy value, therefore, the cookies may be recommended for diabetic patients. The products may very well serve the functional food industry. The cookies were also microbiological stable since no microbial growth was found. The overall acceptance scored highest in cookies with 5%

to 10% pea and soya flours.

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