Textural, Color and Sensory Attributes of High Fiber Cookies Supplemented with Oatmeal Flour

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ABSTRACT
High fiber cookies prepared by substituting refined wheat flour with oatmeal flour (0-30 %). Hardness of the control cookies was 57.05 N and it increases with addition of oatmeal flour progressively. Cookies with 30% oatmeal flour having hardness 107.82 N. The color (L*, a*, b*) values and sensory characteristics of the prepared cookies were evaluated and compared with control sample. Whiteness of the prepared cookies decreases significantly ($P<0.05$) with increase in the level of oatmeal flour. a* value increases from 5.48-14.27 and 8.04-15.13 whereas b* values from 29.23-33.54 and 30.41-34.87 for top and bottom surface, respectively. Sensory evaluation depicted that with increase in the levels of oatmeal flour (upto 10 %) improved overall acceptability. Further increase in the levels of oatmeal flour lowered the sensory score of the cookies.

Keywords
Oatmeal flour, fiber, cookies, hardness, color characteristics and sensory analysis.

1. INTRODUCTION
In recent years the interest for high fiber content in foods has greatly increased in India and other developing countries, therefore, brown flours or high extraction flours are being used as a substitute to refined flours. Traditionally wheat flour was used in the preparation of cookies. There is little record of rice being used in cookie type products. [1] prepared high dietary fiber cookies by substituting refined wheat flour with 6–24% of cereal by-products like corn bran, rice bran or barley husk. The use of oats in human nutrition has been increasing owing to the fact that they contain beneficial nutritional properties [2]. It was found that oat contains β-glucan, essential amino acids and phenolic compounds could be useful as a functional food [3,4,5,6]. In addition to its nutritional and antioxidant properties, phenolic compounds also influence multiple sensorial food properties, such as flavour, astringency, and colour. Phenolic compounds contribute to aroma and taste of numerous food products of plant origin [7].

Many studies have reported that chronic ailments such as cardiovascular diseases and high cholesterol, colon cancer, diabetes and obesity and constipation can be reduced by increasing the consumption of whole-grain or fiber- enriched products [8,9,10,11]. Considering the effect of oat bran on water absorption, protein weakening, stability of gelatinized starch, cookies can also be prepared by substituting oat bran with wheat flour [12].

Oatmeal flour was selected from cereals owing to high fiber content. It becomes an important ingredient that can be incorporated in several food formulations.

Commercially available biscuits are deficient in protein, minerals and especially dietary fiber [13]. In order to overcome this deficiency several researchers have successfully used wheat bran to enhance the nutritional quality of baked products such as cookies, cakes, yeast breads and muffins. Often, the addition of wheat bran affects the physical and sensory properties of the baked products. Wheat bran supplemented cookies had physical properties that differed from the control [14,15]. The objectives of the present investigation were to study the independent effects of oatmeal flour on hardness, color attributes and overall acceptability cookie.

2. MATERIALS AND METHODS
The experiments were conducted for the purpose to study and analyze the physical and sensory characteristics of cookies supplemented with oatmeal flour and compared with control.

2.1 Raw Material
Refined wheat flour and dried oats were purchased from the local market, Sirsa and dried oat seeds were further ground to pass through 40 mesh sieve. The other ingredients in the preparation of cookies included sugar powder, raising agents (ammonium bicarbonates), bakery fat, liquid glucose (dextrose), emulsifying agents (glycerol-monostrearate and lecithin) and skim milk powder. Cookies were prepared as per the [16].

Table 1: Recipe for the preparation of cookies

Constituents	Quantity
Refined wheat flour/ oatmeal flour	225 g
Powdered sugar	130 g
Salt	2.1 g
Shortening agent	64 g
Skim milk powder	5 g
Ammonium bicarbonate	2.5 g
Liquid glucose (5.93 % conc.)	33 ml

2.2 Analysis
The prepared cookies i.e. control (100% wheat flour) and supplemented with oatmeal flour (5-30%) were subjected to following analysis:-

2.2.1 Physical Properties
The cookies were analyzed for hardness and color (L*, a*, b*) values.

Hardness was determined in freshly prepared cookies with texture analyzer (TA-XT2, Stable Microsystems, Surrey, UK) using 50 kg load cell and 4 mm diameter cylinder probe following the method of [17].

The colour characteristics of the cookies were measured according to the CIE L*a*b* method using a Minolta CR-200B Chromameter (Konica Minolta Sensing, Osaka, Japan). These values were carried out in triplicate. Cookies were placed on a white standard plate (L = 97.71, a = -0.17, and b = 2.40). Values for L* [lightness = 0 (black) - 100 (white)], a* [redness = -60 (green) ± 60 (red)], and b* [yellowness = -60 (blue) ± 60 (yellow)] were recorded. Hue angle (h°), chroma (C*), saturation (s), total color difference (ΔE), yellowness index (YI), and whiteness index (WI) were calculated as described by [18,19].

$$\text{Hue angle (h°)} = \tan^{-1}\frac{b^*}{a^*} \quad (1)$$

$$\text{Chroma (C}^*\text{)} = \sqrt{a^{*2} + b^{*2}} \quad (2)$$

$$\text{Saturation (s)} = \frac{C^*}{L^*} \quad (3)$$

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2} \quad (4)$$

$$YI = 142.86\frac{b^*}{L^*} \quad (5)$$

$$WI = 100 - \sqrt{(100 - L)^2 + a^2 + b^2} \quad (6)$$

Where, $\Delta L = L_{standard} - L^*_{sample}$; $\Delta a = a_{standard} - a^*_{sample}$; $\Delta b = b_{standard} - b^*_{sample}$.

2.2.2 Sensory evaluation

A semi-trained panel of 10 food technologists was selected for organoleptic analysis of different samples of cookies. The sealed samples were presented in a coded letters on white tray at brunch time and taste-neutral water was provided for rinsing. A 9-point hedonic scale from 1 = "dislike extremely", 5 = "neither like nor dislike" to 9 = "like extremely") was applied to evaluate the products for appearance, texture, taste, cooler and overall acceptability [20].

3. RESULTS AND DISCUSSION

3.1 Physical Properties

With increase in level of oatmeal flour from 0 to 30% in cookies, hardness increased from 57.05-107.82 N (Table 2), these results are further justified by instrumental texture analysis as represented in Figure 1. In the present study, increase in hardness may be due to higher amount of fiber in the oatmeal. Similar results were also reported by [17] for flexseed cookies. Significant increase in hardness in dough was observed due to increase in fiber content after addition of sweet potato [21].

Color plays an important role in consumer's acceptability of the product. Color attributes L*, a*, b*, Hue angle (h°), chroma (C*), saturation (s), total color difference (ΔE), yellowness index (YI), and whiteness index (WI) are shown in Table 3, where both top and bottom surface having different values. As the level of oatmeal increases from 0-30% darker cookies were obtained in comparison to control sample. L* values decreased whereas a* and b* values increases with increase in the level of oatmeal flour in the cookies, which may be due to difference in the whiteness of wheat flour and oatmeal flour. Darker color of the cookies with supplementation of oatmeal flour possibly due to maillard reaction.[22] investigated that flaxseed decreased bread crust and crumb color values due to maillard reactions among the flaxseed protein and phenolic compounds. Increase in darkness after addition of oat bran was also reported by [23].

The chroma indicates color intensity, of the surface of the cookies increased as a function of level of oatmeal flour. There was significant decrease in the hue angle ($P < 0.05$) with increase in the level of oatmeal flour in the cookies. Addition of oatmeal flour leads to increase in color saturation from 0.48-0.73 of fiber cookies. Incorporation of oatmeal flour in the cookies, a significant ($P < 0.05$) increase in ΔE (44.88-58.64) and YI (67.16-95.51), however a significant ($P < 0.05$) decrease in WI was observed. Above findings are consistent with other researchers [18,24].

3.2 Sensory Characteristics

Consumer acceptability based on sensory characteristics is represented in Table 2. Cookies prepared with 10% oatmeal flour and 90 % wheat flour was highly acceptable in comparison to other levels of oatmeal flour. The least acceptability was found with combination of 30% oatmeal flour and 70% wheat flour. This may be due to increase in the darkness and hardness of the prepared cookies with addition of higher levels of oatmeal flour, that effected texture and decreased the overall acceptability of prepared cookies. These results are in line with findings of [25].

4. CONCLUSION

In the present study it can be concluded that the cookies made by substituting 10% oatmeal flour having highest consumers acceptability and similar physical properties that of control sample. High protein content in the oatmeal flour resulted an increase in the hardness of the cookie. With increased in the level of oatmeal flour darker and browner cookies were obtained. The present demand for nutritious food can be met with incorporation of oat meal flour in cookies that can lead to increase in fiber and protein content of the cookies compared to the cookies prepared from wheat flour. However owing to acceptability level by taking into consideration the original color, texture, flavor and appearance of wheat flour cookies, incorporation of upto 10% level of oat meal flour is recommended in present study. Comparative analysis of nutrient contents with and without addition of oat meal flour can be considered for future studies.

5. REFERENCES

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Table 2 Hardness and sensory characteristics of the cookies

Wheat flour (%)	Oatmeal flour (%)	Sample Name	Force (N)	Flavor	Body & Texture	Colour & Appearance	Overall acceptability
100	0	C-1	57.05	7.5	7.6	8.3	7.5
95	5	C-2	58.14	6.3	6.3	6.6	6.6
90	10	C-3	62.96	7.6	7.6	8	7.3
85	15	C-4	76.73	7	7.1	7	6.8
80	20	C-5	90.17	7.3	6.6	6.6	6.6
75	25	C-6	92.53	6	6.3	6	6
70	30	C-7	107.82	5.8	5.3	5.33	5.5

Table 3 Color values of top and bottom surface of the cookies

Wheat flour (%)	Oatmeal flour (%)	Sample Name	L*	a*	b*	C*	h°	s	Δ E	YI	WI
Top Surface											
100	0	C-1	62.18	5.48	29.23	29.74	79.37	0.48	44.88	67.16	51.89
95	5	C-2	61.51	7.12	29.97	30.80	76.64	0.50	46.08	69.61	50.70
90	10	C-3	59.72	8.93	30.46	31.74	73.66	0.53	48.10	72.87	48.72
85	15	C-4	58.16	11.05	31.18	33.08	70.47	0.57	50.18	76.59	46.66
80	20	C-5	55.27	12.64	32.05	34.45	68.51	0.62	53.33	82.84	43.54
75	25	C-6	53.05	13.56	32.99	35.67	67.63	0.67	55.85	88.84	41.04

70	30	C-7	50.17	14.27	33.54	36.45	66.95	0.73	58.64	95.51	38.26
Bottom Surface											
100	0	C-1	59.45	8.04	30.41	31.45	75.18	0.53	48.12	73.08	48.68
95	5	C-2	58.17	9.87	31.27	32.79	72.49	0.56	49.98	76.80	46.85
90	10	C-3	56.39	10.24	32.09	33.68	72.28	0.60	51.93	81.30	44.90
85	15	C-4	53.86	12.79	32.78	35.19	68.66	0.65	54.90	86.95	41.97
80	20	C-5	50.32	13.45	33.39	36.00	68.04	0.72	58.24	94.80	38.65
75	25	C-6	48.28	14.32	34.24	37.11	67.30	0.77	60.56	101.32	36.34
70	30	C-7	46.89	15.13	34.87	38.01	66.50	0.81	62.22	106.24	34.69

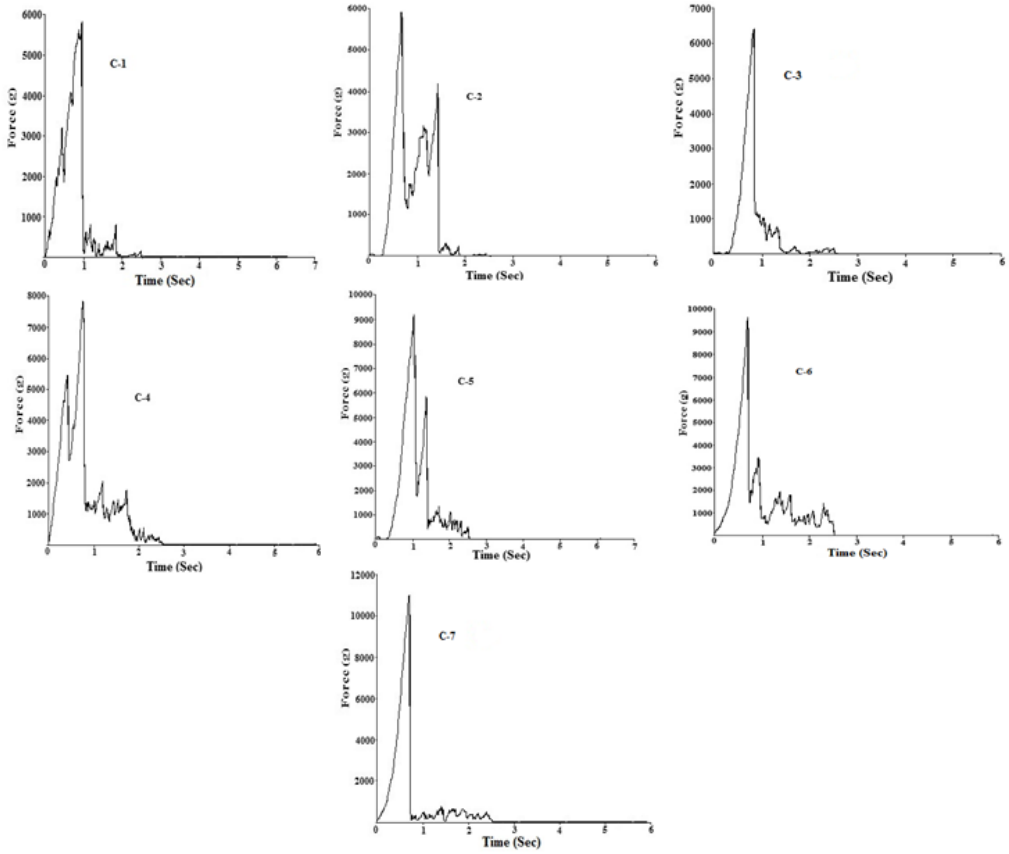

Fig. 1 Instrumental Texture Profile Analysis curve for hardness of different cookies