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Development of de-oiled pomegranate seed cake based fiber rich cookies

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Abstract
The present investigation was carried out to study the effect of pomegranate de-oiled seed cake powder (PSCP) on nutritional and sensory properties of cookies. Whole wheat flour was replaced by 0, 5, 7, 9, 11 and 13 percent (w/w) PSCP for preparation of cookies. The cookies were evaluated for the nutritional, textural and organoleptic attributes. The moisture content, ash, crude fat, crude protein and crude fiber content of cookies were increased from 3.3 0.40, 24.01, 9.57 and 3.18 percent to 4.4, 0.61, 25.48, 10.75 and 7.49 percent respectively. The treatment T_3 obtained higher scores for organoleptic attributes as compared to other treatments. Breaking force was increased with the increase in PSCP. However among all the treatments, T_3 (7% PSCP) was found better and mostly acceptable than other treatments. Thus (T_3) 7% PSCP can be incorporated in formulation of cookies without affecting their overall acceptability.

Keywords: Pomegranate de-oiled seed cake powder (PSCP), cookies, nutritional properties and texture profile

Introduction
In present day's economic scenario, emerging globalization and growing consumer have changed the perception of food. There are considerable changes taking place in the liking of consumers due to change in life style, modernization, urbanization, increased women employment, increased per capita income and new marketing strategies. Most of the consumers demands convenience food, ready to eat snacks which add to bulk and satisfy their appetite. The diet consumed by a vast majority of people is deficient in fiber, proteins, minerals etc. Therefore, one of great challenges today is to develop inexpensive foods that are nutritionally superior and at the same time highly by the consumers.

Baking industry is considered as one of the major segments of food processing in India. Baked products are gaining popularity because of their availability, ready to eat convenience and reasonably good shelf life. "Cookies" originates from a Dutch word *koekje*, which means "little cake" the sound of a cracker being eaten most likely led to the use of that name (Zydenbos *et al.*, 2004) [20]. Cookies represent the largest category of snack item among bakery products (Pratima & Yadave, 2000) [13] and hold an important position in snack food industry due to variety in taste, crispiness and digestibility as well as shelf life.

Cookies refer to a baked product generally containing three major ingredients flour, sugar and fat. These are mixed with an array of minor ingredients including spices, chocolates, butter, peanut butter, nuts or dried fruits in variety of style to form dough. Due to its appreciated rheological characteristics, wheat is principally used in bakery products. Wheat flour constitutes the basic ingredient for cookies production because of its high gluten protein which forms elastic dough during baking and gives high organoleptic quality to the finished product. (Ahmad and Ahmed, 2014) [2]. Cookies differ from other bakery products like bread and cakes because of having low moisture content, comparatively free from microbial spoilage and long shelf life product.

Fortification is done mainly to maintain the nutritional quality of the products, prevent specific nutritional deficiencies in the population, to increase the nutritional value of a product from a commercial view point and to provide certain technological functions in food processing. Attempts are being made in recent days to improve the nutritional qualities and functionalities of cookies, due to competition in the market for more healthy, natural and functional products.

Cookies are prepared from refined wheat flour (white flour) which low in fiber content. Deficiency of fiber content leads to alter the physiology,

high cholesterol level leading to heart diseases, high blood sugar level leading to diabetes, causes weight gain and obesity etc. Dietary fiber inserted into bakery products provides benefits on the health of the heart, gastrointestinal pain, reduce the risk of various cancers. Also, dietary fiber have the role of ensuring a good intestinal transit, preventing constipation, reducing fat absorption from the digestive tract, as well as favoring the absorption of toxins. (Gallagher and Schneeman, 2001) [9].

Increasing the fiber content in cookies, utilization of pomegranate de-oiled seed powder is the key aspect of this research. Reusing processed by-product, which is rich source of nutritional components will enhance the nutritional and functional properties of cookies which results to lowering the risk of diabetes, heart disease, some types of cancer and provide fibers, apart from the phytochemicals, which would help in diverse beneficial aspects like weight management, blood sugar control. For this reason interest in research has arisen to increase fiber content of human diet and also this investigation was designed to produce fortified cookies with de-oiled pomegranate seed powder, which is rich in fiber content and require minimum preparation efforts before using.

Material and Methods

Preparation of pomegranate seed powder

The de-oiled pomegranate seed cake (*cv*. Bhagawa) was obtained from Indian Council of Agricultural Research National Research Centre on Pomegranate, Solapur. The de-oiled seed cake was ground in hammer mill (Make- Kohinoor, model-Titanium) and passed through 80 micron sieve to make the pomegranate seed powder.

Preparation of cookies

Cookies were prepared using AACC micro method (No 10-52) with slight modifications. The process for preparation of cookies is given in Fig 1. Various ingredients were weighed accurately. The hydrogenated fat (*dalda*), powdered sugar and salt were creamed until light and fluffy. The composite flour was slowly added to the cream. The traditional creaming method was used for the preparation of cookies. The dough was thoroughly kneaded by adding required amount of milk dissolved with sodium bicarbonate and ammonium bicarbonate. The cookie pats were prepared from dough by hands. The pats were then baked in microwave oven (make model) at 180-200 ^{O}C for 14 min (Rathod *et al*., 2015) [14]. The cookies after removing from the oven were allowed to cool and packed.

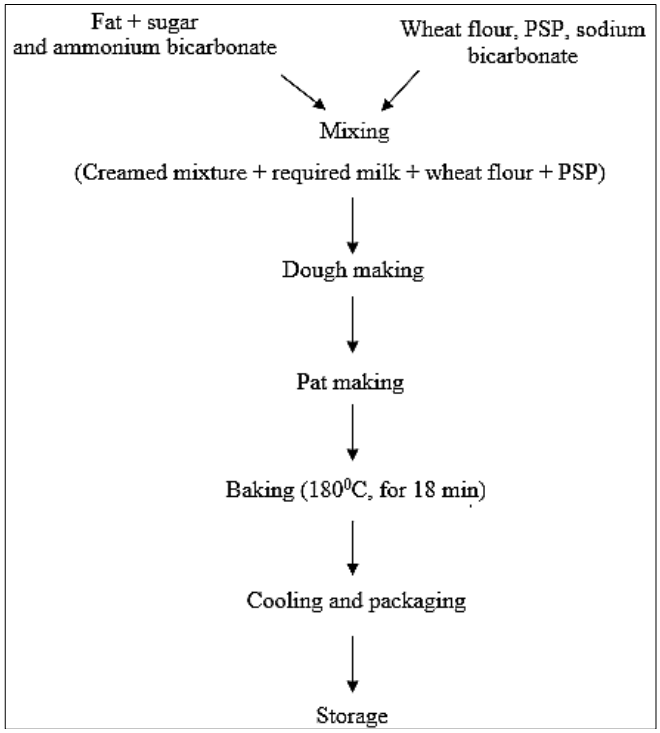


Fig 1: Process flow chart for preparation of cookies

Formulations of ingredients

The cookies were prepared using proportion of ingredients with blend of wheat flour and pomegranate seed powder at different level as shown in Table 1.

Table 1: Formulation of ingredients

Ingredients	Quantity in (g)					
	T_1	T_2	T_3	T_4	T_5	T_6
Wheat flour	100.00	95	93	91	89	87
Sugar	50.00	50.00	50.00	50.00	50.00	50.00
Shortening	50.00	50.00	50.00	50.00	50.00	50.00
Sodium bicarbonate	1.00	1.00	1.00	1.00	1.00	1.00
Ammonium bicarbonate	0.70	0.70	0.70	0.70	0.70	0.70
Pomegranate seed powder	0	5	7	9	11	13
Milk (ml)	20.00	20.00	20.00	20.00	20.00	20.00

Proximate composition
The raw ingredients used for preparation of cookies and prepared cookies samples were analyzed nutritionally by determining the moisture, protein, fat, fiber, ash and carbohydrate contents in treatments (AOAC, 2000) [7].

Color analysis
Color of the cookies prepared was evaluated by premier color scanning machine (Make: Premium color scan, Japan).

Textural analysis
The peak breaking forces (N) of prepared cookies were evaluated using universal testing machine (Make: Shimadzu, Model: AG-X). Each cookie was placed on loading cell and compressed. The three point bending test was used. Speed of the probe was maintained at 10 mm/sec up to the compression distance of 10 mm. It was expressed in terms of Newton (N) for force and for energy Joule (J). A force-time diagram was recorded for each test and plots were analyzed for peak breaking force (N).

Sensory evaluation of cookies
The cookies were evaluated for the sensory attributes using standard procedure reported by Amerine *et al.* (1965) [4], by a panel of 10 semi-trained judges. The cookies were evaluated for color, flavor, taste, texture and overall acceptability using a 9 point hedonic scale ranging from like extremely (9) to dislike extremely (1) for different parameters. The water at room temperature was provided to rinse the mouth between evaluations to ensure correct interpretations. The mean values of score for color, flavor, taste, texture and overall acceptability were calculated.

Statistical analysis
The obtained data was analyzed statistically through working out one-way analysis of variance (ANOVA) in order to determine the significant difference (p<0.05) between various treatments.

Results and Discussion
Proximate composition of raw ingredients
The chemical composition of raw material used for preparation of cookies are given in Table 2. Moisture content of the wheat flour was 8.02% (w.b.) whereas pomegranate de-oiled seed cake powder it was 9.50% (w.b.). Crude fat, crude protein, ash and carbohydrate content of the wheat flour and pomegranate seed powder were 1.02, 15.74, 1.04 and 71.79% and 12.48, 22.53, 2.59 and 11.15% respectively. The fiber content was found to 2.41% in wheat flour whereas it was 41.75% in the pomegranate de-oiled seed cake powder.

Table 2: Proximate composition of raw materials used for preparation of cookies

Ingredient	Moisture (%, w. b.)	Crude fat (%)	Crude protein (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)
Wheat flour	8.02	1.02	15.74	1.04	2.41	71.79
Pomegranate seed powder	9.50	12.48	22.53	2.59	41.75	11.15

Proximate composition of cookies

Table 3: Effect of different levels of PSCP on proximate composition of cookies

Treatments	Moisture (%, w.b.)	Crude fat (%)	Crude protein (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)
T_1	3.3±0.17	24.007±0.06	9.57±0.33	0.40±0.12	3.18±0.03	59.55±0.45
T_2	3.5±0.29	24.183±0.12	9.62±0.36	0.48±0.05	4.74±0.01	57.48±0.21
T_3	3.9±0.23	24.667±0.04	10.06±0.02	0.55±0.03	5.67±0.01	55.15±0.22
T_4	4.1±0.06	24.967±0.13	10.23±0.05	0.58±0.01	6.28±0.01	53.85±0.05
T5	4.3±0.17	25.220±0.18	10.40±0.03	0.59±0.03	7.00±0.05	52.49±0.13
T6	4.4±0.23	25.483±0.18	10.75±0.07	0.61±0.01	7.49±0.07	50.83±0.35
C.D. @ 5%	0.64	0.367	0.629	N/A	0.115	0.838
C.V.	9.087	0.824	3.463	17.678	1.098	0.849

The chemical composition of cookies is presented in Table 3. Moisture content of cookies was ranged between 3.3-4.4%. The highest moisture content (4.4%) was recorded for T_6 and lowest moisture content (3.3%) was recorded for T_1. It was observed that with increasing PSCP the moisture content was increased significantly. Uthumporn *et al.* (2014) [17] also found the increase in moisture content with increase in eggplant flour. The differences in moisture content were due to the high fiber content in egg plant. Ingale *et al.* (2017) [10] also observed the same trend in increment of moisture content with increase in concentration of beetroot powder and stated that this was due to the higher fiber content in beetroot powder. More hydroxyl groups of cellulose in fiber were able to bind with free water molecules through bonding and thus resulting in greater water holding capacity (Rosell *et al.*, 2001) [15]. Therefore higher the substitution of fiber increases the moisture content of cookies.
Crude fat of cookies was ranged between 24.01-25.48%. The highest crude fat (25.48%) was recorded for T6 and lowest crude fat was recorded for T1 i.e. (24.01%). Significant increase in crude fat content was observed with increasing PSCP. Bolanho (2012) [8] and Sharma *et al.* (2017) [16] also reported the increment of fat content. This might be due to the percentage of fat present in the pomegranate de-oiled seed cake powder which contributed to the fat content of the final product.
Crude protein of cookies was ranged between 9.57-10.75%. The highest crude protein (10.75%) was recorded for T_6 and lowest crude protein was recorded for T_1 i.e. (9.57%). The protein content was increased with increasing PSCP content. Significant difference was observed between all the treatments. Uthumporn *et al.* (2014) [17] observed the significant increase in crude protein with increase in concentration of eggplant flour. The incorporation of different eggplant flour greatly increases the crude protein. Thus high crude protein content of PSCP powder than the refined flour attributed to the high protein content of cookies.
Ash content of cookies was ranged between 0.40-0.61%. The highest ash content (0.61%) was recorded for T6 and lowest ash content was recorded for T1 i.e. (0.40%). It was observed that with increasing PSCP the ash content was increased. The increase in ash content was non-significant between all the treatments. Uthumporn *et al.* (2014) [17] found the same effect of increasing ash content with increase in eggplant flour and

stated that it was due to the high mineral content found in eggplant.

Crude fiber of cookies was ranged between 3.18-7.49%. The highest crude fiber (7.49%) was recorded for T6 and lowest crude fiber was recorded for T1 i.e. (3.18%). It was observed that with increasing PSCP the crude fiber content increased significantly. Alam *et al.* (2014) [3] also reported the same trend in increment of fiber content. Ingale *et al.* (2017) [10] observed increment in crude fibers with increase in concentration of beetroot powder and revealed that this was due to higher fiber content in beetroot. Uthumporn *et al.* (2014) [17] also found that the crude fiber for control cookies was low when compared to other samples substituted with eggplant flour and reported high fiber content in the cookies prepared with high substitution of eggplant flour. The fiber rich PSCP powder substitution significantly enhanced the fiber content of cookies.

Carbohydrate content of cookies was ranged between 50.83-59.55%. The carbohydrates (59.55) was recorded for T_1 and lowest carbohydrates was recorded for T6 i.e. (50.83%). It was observed that with increasing PSCP the carbohydrates decreased significantly. Uthumporn *et al.* (2014) [17] found the decreasing trend for carbohydrate with increase in eggplant flour. Increase in concentration of fiber reduces the carbohydrate concentration. So the increase in moisture content, crude fats, crude proteins, and crude fibers tends to reduction in carbohydrate content.

Color analysis

The results of color analysis presented in table 4.

Table 4: Color index of cookies

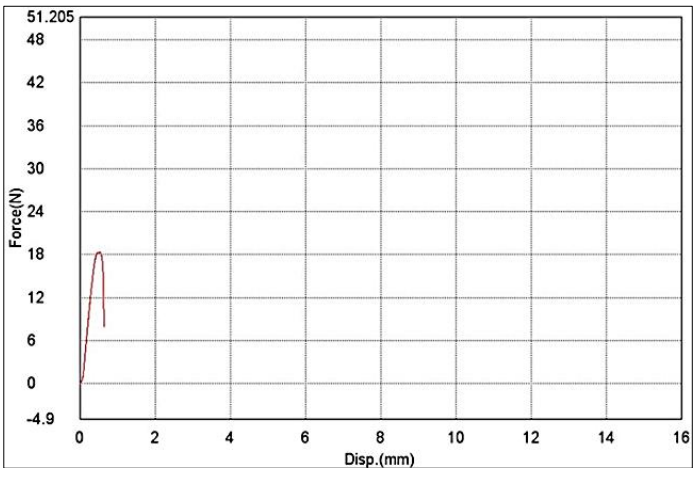
Treatments	Color analysis		
	L*	a*	b*
T_1	56.982	4.980	19.441
T_2	56.963	6.542	19.342
T_3	56.158	7.244	20.814
T_4	55.885	7.619	20.738
T_5	54.789	7.667	20.818
T_6	54.777	8.499	21.093

The parameter *L** indicates the lightness (0 for black, 50 for grey and 100 for white) of sample (Vardin and Yasar, 2012) [18]. The lightness of cookies varied in the range of 56.982 to 54.777. Addition of PSCP increased the darkness of cookies which has resulted in the decrease in *L** value as shown in Table 4. All the samples *viz.* T_2, T_3, T_4, T5, T6 were darker in color than the control T_1. The same results reported by Ingale *et al.* (2017) [10] for substitution of white flour by beetroot powder for preparation of cookies. They stated that lightness decreased with reduction in proportion of wheat flour because of the loss of white color of flour. (Vratanina and zabrik 1978) [19], stated that the decrease in lightness of cookies was observed as the substitution of level of fiber into formulation was elevated.

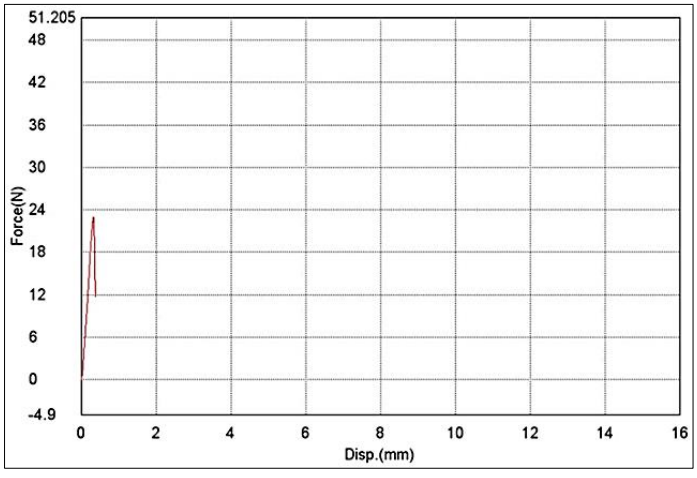
The data on a* value is given in Table 4. Hunter *a** value is an important for many cookies because it is directly related to redness and it is investigated in many studies related to cookies in order to measure the extent of red color change. Redness value for cookies varied in the range of 4.980 to 8.499. *a** increased with increasing PSCP. The values of *a** for all the samples were higher than that of the standard (i.e. all the samples were more reddish with respect to the control). The values of *b** for cookies varied unevenly as percentages of PSCP increased as shown in Table 4. The value of *b** for the all samples ranged between19.342 to 21.093. The values of *b** for all the four samples were higher than that of the control (i.e. all the samples were more yellowish with respect to the control sample).

Textural analysis of cookies

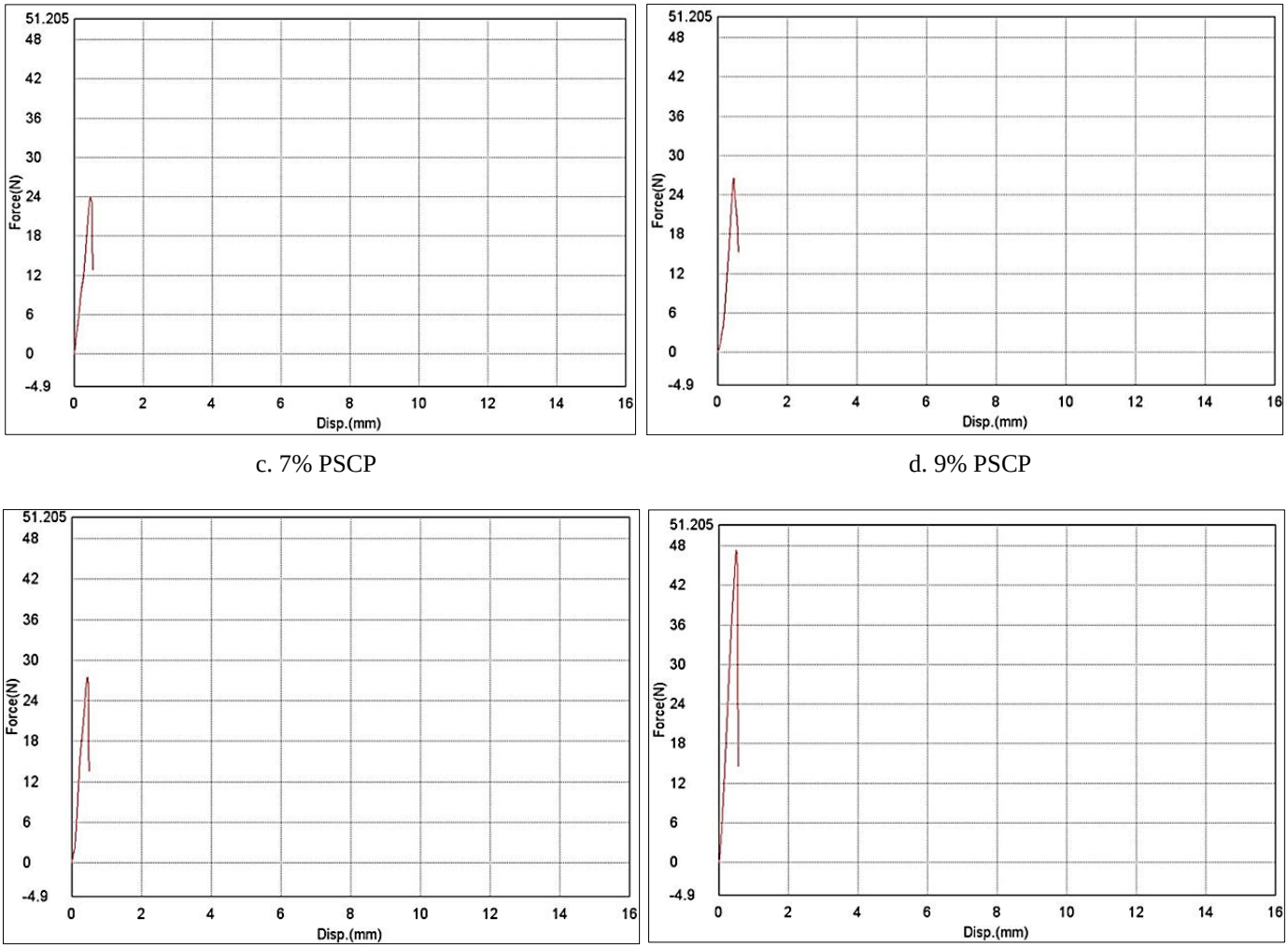
According to three points bending test, the peak force required was 18.35, 22.98, 23.87, 26.51, 27.44 and 47.39 for T_1, T_2, T_3, T_4, T_5 and T_6 respectively. Data clearly shows the increase in the breaking force with increase in the content of PSCP in the cookies. The texture profile graphs are shown in Fig 2. The lowest force was recorded for the control treatment (T_1) whereas highest force was recorded for the T_6 treatment having highest content of PSCP.



a. 0% PSCP



b. 5% PSCP



c. 7% PSCP

d. 9% PSCP

e.11% PSCP

f. 13% PSCP

Fig 2: Texture profile graphs of the cookies

Ingale *et al.* (2017) [10] reported the increase in hardness of the cookies with addition of beetroot powder. The increase in hardness may be attributed to the dilution of wheat protein with beetroot protein and fiber. Uthumporn *et al.* (2014) [17] also found significant difference between hardness of control cookies and cookies substituted with eggplant flour and stated that hardness much affected by composition of flour. There was a positive correlation of fiber and protein with hardness of cookies (Pizza and Masi, 1997) [12]. According to Noda *et al.* (2000) [11], dough prepared from high absorption flour will have hard texture because fiber component contributes to the higher water holding capacity. Therefore high fiber content in the PSCP powder was evidence to production of harder cookies.

Sensory evaluation of cookies

Table 5: Sensory evaluation and color index of cookies

Treatments	Appearance	Taste/flavor	Texture/ Consistency	Overall acceptability
T_1	6	6	8	7
T_2	7	8	7	7
T_3	7	9	8	8
T_4	6	7	6	6
T_5	6	5	6	6
T_6	7	6	7	7

The data about sensory evaluation regarding appearance, texture, taste and overall acceptability and the results of color analysis are presented in Table 5.

The data indicate that the score for the appearance of cookies ranged from 6.0-7.0, while taste ranged from 5.0-9.0, texture score ranged from 6.0-8.0 and overall acceptability ranged from 6.0-8.0. The overall acceptability of T_3 was higher (8.0) with the score for appearance, texture and taste as 7, 8 and 9 respectively. Thus T_3 (7 percent PSCP) was better and was mostly accepted.

Conclusion

Cookies prepared from 93 percent wheat flour and 7 percent pomegranate de-oiled seed cake powder blends were organoleptically accepted. The fresh cookies had average moisture content 3.32 percent, ash content 2.64 percent, crude fat 24.68 percent, crude protein 9.96 percent, crude fiber 4.58 percent and carbohydrate 56.39 percent. Good quality cookies with enriched fiber can be prepared by using 7 percent pomegranate de-oiled seed cake powder without affecting the overall quality.

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