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Ganeshan Tharshini
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, Haryana, India

Veenu Sangwan
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, Haryana, India

Suman
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
Veenu Sangwan
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, Haryana, India

Formulation and chemical characterization of bread supplemented with pomegranate peel powder

Ganeshan Tharshini, Veenu Sangwan and Suman

Abstract
The present study aimed to formulate bread supplemented with pomegranate peel powder and evaluate its chemical characteristics. All types of supplemented breads were organoleptically acceptable. A significant increase was observed in protein (10.64 to 13.27), fat (5.74 to 6.17%), crude fibre (1.84 to 3.21%) and ash (2.75 to 3.39%) content of supplemented breads. Supplementation of pomegranate peel powder in bread significantly ($P \leq 0.05$) enhanced their dietary fibre, calcium, phosphorus, iron, zinc and magnesium contents compared to control bread. The *in vitro* starch and protein digestibility was 51.79 mg maltose released/g meal and 64.15 per cent, respectively in 100 per cent wheat flour bread which was significantly ($p \leq 0.05$) higher than that of value added bread. Control bread had significantly ($P \leq 0.05$) lower levels of antinutrients as compared to soybean and pomegranate peel powder supplemented breads.

Keywords: Wheat, Soybean, Pomegranate peel powder, Sensory, Nutritional, Bread

Introduction
Bakery products are gaining wide popularity among people of different age groups in various regions world-wide due to their taste and easy accessibility. Bread which is used commonly as an alternative for *chapatti* especially in Asian regions can be nutritionally improved by value addition with pulses, oil seeds and pomegranate peel powder. Soybean (*Glycine max*) is one of the world's most inexpensive and dense source of dietary protein (40%) and also possess numerous beneficial phytochemicals which offer unique health benefits like cholesterol reduction, preventing cardiovascular diseases, cancer, diabetes, controlling blood sugar levels and regulation of menopause. In addition it has versatile end uses for human food, animal feed and industrial materials (Liu 2000) [9]. Pomegranate (*Punica granatum*) is a popular fruit in India and is known for medicinal benefits. Pomegranate fruit is high in natural antioxidants and has properties to scavenge free radicals, fight against cancer, infections and other diseases in humans. Pomegranate peels are usually discarded after consumption or juice production, but if peels are used they can serve as one of the most valuable by-products of the food industry (Moorthy *et al.* 2015) [12]. It can serve as a nutrient rich by-product with therapeutic properties, wound healing properties, immune modulatory activity, antibacterial activity, anti-atherosclerotic and anti-oxidative capacities (Akhtar *et al.* 2015) [1]. The incorporation of available inexpensive pomegranate peel powder and soybean into staple food like bread, cake, biscuits, cookies, etc. which is usually prepared from wheat, will help in formulation of nutrient dense end product (Tharshini *et al*, 2018; Kanatt *et al*. 2010; Ventura *et al*. 2013) [15, 7, 16]. Keeping this in view the present study was planned to formulate bread (incorporating pomegranate peel powder and soybean flour) and to study their chemical characteristics.

Materials and Methods
Procurement of raw material
Grains of wheat (*Triticum aestivum*, WH-1142) used in the study were procured in a single lot from the Wheat and Barley Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. Pomegranate was procured in bulk from the fruit market of Hisar. Soybean (*Glycine max*) flour along with other ingredients required for the development of baked products was purchased from the local market of Hisar.

Processing of wheat grains and pomegranate peel

The wheat grains were cleaned and ground in an electric grinder (Cyclotec, M/s Tecator, Hoganas, Sweden) and flour obtained was sieved through a 60 mesh sieve and packed in airtight plastic containers for further use. The pomegranate fruits were washed thoroughly, peeled and the fruit peels were cut into small pieces and dried in open air under shade. Dried peel was converted into fine powder form and packed in airtight plastic container for further use.

Preparation of bread

Ingredients

Supplementation level (%)	Wheat flour (g)	Soybean flour (g)	Pomegranate peel powder(g)	Compressed yeast (g)	Sugar (g)	Fat (g)	Salt (g)	Water (ml)
Control(100%WF)	100	-	-	3	10	3	2	60
Type I (WF:SBF:PPP::88:10:2)	88	10	2	3	10	3	2	60
Type II (WF:SBF:PPP::86:10:4)	86	10	4	3	10	3	2	60
Type III (WF:SBF:PPP:: 84:10:6)	84	10	6	3	10	3	2	60

WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

Wheat flour, soybean flour, pomegranate peel powder, sugar and salt were mixed.Yeast was dissolved in water and added to above mixture 1-2 minutes after commencement of mixing. Then to this mixture fat was added. The dough was kneaded and fermented for 30 minutes at 30±1 °C in incubator. Dough was remixed for 25 sec. at room temperature. Again it was kept for proofing for 20 minutes at 30±1 °C in incubator. Bread container was greased with oil and proofed dough was placed into it. Final proofing was carried out for 55 minutes at 30±1 °C in incubator. It was baked, in preheated oven, for 10-12 minutes at 240 °C. Breads were cooled for 20 minutes at room temperature.

Organoleptic and chemical evaluation of bread

Bread was subjected to sensory evaluation with respect to color, appearance, aroma, texture, taste and overall acceptability by a panel of 10 semi trained judges, using 9 point hedonic scale.

Samples were analyzed for moisture, crude protein, crude fat, ash and crude fibre content by employing the standard methods of analysis (AOAC, 2000) [3]. Total, soluble and insoluble dietary fiber constituents were determined by the enzymatic method given by Furda (1981) [5]. Calcium, iron, zinc and magnesium in acid digested samples were determined by Atomic Absorption Spectrophotometer according to the method of Lindsey and Norwell (1969) [8]. Phosphorus was determined colorimetrically by using the method of Chen *et al.* (1956) [4]. *In vitro* starch digestibility was assessed by the method of Singh *et al.* (1982) [14]. *In vitro* protein digestibility was determined by the modified method of Mertz *et al.* (1983) [11].

Statistical analysis

Mean, standard error and CD (critical difference) were calculated for analysis of data (Sheoran and Pannu, 1999) [13].

Results and Discussion

Organoleptic acceptability of bread

The data on organoleptic acceptability of bread is presented in Table 1. The colour score of the control bread was 7.30 (liked moderately) and that of value added breads was 7.20 (liked moderately) at 88:10:2, 7.30 (liked moderately) at 86:10:4 and 7.00 (liked moderately) at 84:10:6 levels of supplementation (wheat flour: soybean flour: pomegranate peel powder). Appearance score of control bread was 7.10 which was found in the category of 'liked moderately' The appearance score of breads prepared from 88:10:2, 86:10:4 and 84:10:6 level of supplementation (wheat flour: soybean flour: pomegranate peel powder) were 7.15, 7.40 and 7.10, respectively which also fell in the category 'liked moderately'. The score for the aroma of the control bread was 7.10 (liked moderately). The aroma score of breads supplemented with soybean flour and pomegranate peel powder was 7.35, 7.40 and 7.50 (liked moderately) at 88:10:2, 86:10:4 and 84:10:6 levels of supplementation, respectively. The textural score of the control bread was 6.80, and was in the category of 'liked moderately'. Type I, II and III breads prepared from wheat flour supplemented with soybean flour and pomegranate peel powder had texture scores of 6.75, 6.80 and 6.75, respectively which was found in the category of 'liked moderately'. Control bread obtained 7.10 mean score for taste which was in the category of 'liked moderately'. Mean scores of taste of breads supplemented with soybean flour and pomegranate peel powder were 7.25, 7.40 and 7.15 at 88:10:2, 86:10:4 and 84:10:6 level of supplementation, respectively which also fell in the category 'liked moderately'. The control bread had mean score of overall acceptability 7.08 whereas breads made of wheat flour, soybean flour and pomegranate peel powder at 88:10:2, 86:10:4 and 84:10:6 level of supplementation had mean overall acceptability scores of 7.14, 7.26 and 7.1, respectively. The overall acceptability score of all types of breads was in the category of 'liked moderately'. All type of breads developed were organoleptically acceptable. Our findings were in agreement with those of Mehder (2013) [10] who reported that one per cent pomegranate peel incorporated pan bread was organoleptically acceptable. Jain (2013) [6] reported a significant ($P \leq 0.05$) increase in scores of taste, appearance and color in soy-supplemented buns. Similarly, Altunkaya *et al*. (2013) [2] reported that 2.5 per cent pomegranate peel supplemented bread had a good acceptance in the subjective evaluation (>5) whereas 10 per cent supplementation scored the lowest.

Table 1: Mean scores of sensory characteristics of bread

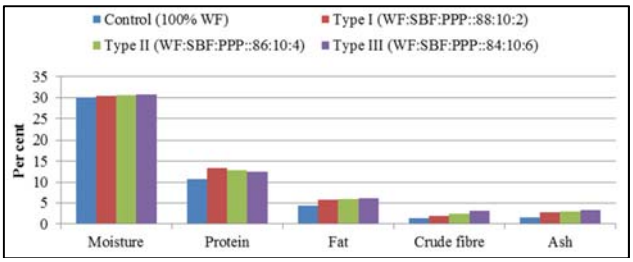
Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Control (100% WF)	7.30±0.15	7.10±0.10	7.10±0.10	6.80±0.25	7.10±0.18	7.08± 0.11
Type I (WF:SBF:PPP::88:10:2)	7.20±0.29	7.15±0.24	7.35±0.21	6.75±0.38	7.25±0.25	7.14±0.25
Type II (WF:SBF:PPP::86:10:4)	7.30±0.30	7.40±0.27	7.40±0.22	6.80±0.44	7.40±0.27	7.26±0.28
Type III (WF:SBF:PPP::84:10:6)	7.00±0.42	7.10±0.37	7.50±0.27	6.75±0.48	7.15±0.38	7.10±0.36

Values are mean ± SE of ten observations
WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

Chemical characteristics of bread

Proximate composition

The data pertaining to proximate composition of bread is presented in Fig.1. Moisture content in 100 per cent wheat flour bread was 30.08 per cent while that of Type I, II and III breads were 30.38, 30.64 and 30.81 per cent, respectively. The protein and fat contents in control breads were 10.64 and 4.38 per cent, respectively which were significantly ($P \leq 0.05$) lower than Type I (13.27 and 5.74 per cent, respectively), Type II (12.83 and 5.98 per cent, respectively) and Type III (12.39 and 6.17 per cent, respectively) breads. However it was observed that protein content of Type III bread was significantly ($P \leq 0.05$) lower than that of Type I. The crude fibre and ash contents in control breads were 1.34 and 1.54 per cent, respectively which significantly ($P \leq 0.05$) increased in all types of value added breads from 1.84 to 3.21 per cent and from 2.75 to 3.39 per cent, respectively on supplementation with soybean flour (10%) and pomegranate peel powder (2 to 6%). It was observed that fat, crude fibre and ash contents of Type III breads were significantly higher than that of Type II and Type I breads. Similarly Type II breads possessed significantly ($P \leq 0.05$) higher contents of fat, crude fibre and ash compared to Type I bread.



Values are mean ± SE of three independent determinations
WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

Fig 1: Proximate composition of bread (% on dry matter basis)

Dietary fibre

The data pertaining to dietary fibre content of bread is presented in Table 2. Total dietary fibre content of control bread was 7.39 per cent which significantly ($P \leq 0.05$) increased to 8.19, 8.69 and 9.28 per cent in Type I, Type II and Type III breads respectively. Soluble dietary fibre content of control bread was 1.27 per cent, which also significantly ($P \leq 0.05$) increased to 1.65, 1.93 and 2.26 per cent at 88:10:2, 86:10:4 and 84:10:6 level of supplementation of wheat flour, soybean flour and pomegranate peel powder, respectively. Similarly insoluble dietary fibre content of control bread was 6.13 per cent and that of supplemented breads increased significantly ($P \leq 0.05$) to 6.54 per cent in Type I, 6.76 per cent in Type II and 7.01 per cent in Type III breads. As the level of substitution with pomegranate peel powder increased from 2 to 6 per cent there was a significant ($P \leq 0.05$) increase in total, soluble and insoluble dietary fibre contents of breads. The differences in dietary fibre contents of different types of value added baked products were due to differences in level of incorporation pomegranate peel powder while soybean flour was kept constant at 10 per cent level.

Table 2: Dietary fibre content of bread (% on dry matter basis)

Products	Total Dietary Fibre	Soluble Dietary Fibre	Insoluble Dietary Fibre
Control (100% WF)	7.39±0.03	1.27±0.02	6.13±0.02
Type I (WF:SBF:PPP::88:10:2)	8.19±0.03	1.65±0.02	6.54±0.02
Type II (WF:SBF:PPP::86:10:4)	8.69±0.02	1.93±0.01	6.76±0.02
Type III (WF:SBF:PPP::84:10:6)	9.28±0.03	2.26±0.02	7.01±0.02
CD(P≤0.05)	0.07	0.04	0.04

Values are mean ± SE of three independent determinations
WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

Total minerals

The result of total mineral contents of bread is presented in Table 3. It was observed that the control bread contained 58.20, 207.29, 3.13, 1.58 and 68.40 mg/100g of calcium, phosphorus, iron, zinc and magnesium, respectively. All types of soybean flour and pomegranate peel powder supplemented breads had significantly ($p \leq 0.05$) higher total mineral contents than control. Type I bread possessed 70.06, 244.79, 3.66, 1.76 and 80.22 mg/100g of calcium, phosphorus, iron, zinc and magnesium, respectively. Type II bread contained 71.17, 236.46, 3.62, 1.72 and 81.39 mg/100g of calcium, phosphorus, iron, zinc and magnesium, respectively while Type III bread contained 72.27, 228.12, 3.58, 1.68 and 82.47 mg/100g of calcium, phosphorus, iron, zinc and magnesium, respectively. There was non-significant difference in the iron content of different types (Type I, II and III) of breads. Calcium content of Type III bread was significantly ($p \leq 0.05$) higher than Type I bread while zinc content of Type I and II breads was significantly ($p \leq 0.05$) higher than that of Type III bread. A significant ($p \leq 0.05$) decrease was observed in phosphorus content of soybean flour and pomegranate peel powder supplemented breads from 244.79 to 228.12 mg/100g. The increase in mineral contents of bread might be due to high contents of calcium, phosphorus, magnesium, iron and zinc in soybean flour as compared to wheat flour and pomegranate peel powder. Moreover pomegranate peel powder also possessed higher calcium and magnesium contents than wheat flour.

Table 3: Total mineral content of bread (mg/100g, on dry matter basis)

Products	Calcium	Phosphorus	Iron	Zinc	Magnesium
Control (100% WF)	58.20±0.42	207.29±4.17	3.13±0.03	1.58±0.03	68.40± 1.83
Type I (WF:SBF:PPP::88:10:2)	70.06±0.581	244.79±5.21	3.66±0.03	1.76±0.02	80.22±1.90
Type II (WF:SBF:PPP::86:10:4)	71.17±0.20	236.46±4.29	3.62±0.02	1.72±0.04	81.39±1.96
Type III (WF:SBF:PPP::84:10:6)	72.27±0.37	228.12±3.12	3.58±0.02	1.68± 0.02	82.47± 2.03
CD(P≤0.05)	1.59	7.71	0.17	0.02	2.49

Values are mean ± SE of three independent determinations
WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

In vitro starch and protein digestibility

The data pertaining to dietary fibre content of bread is presented in Table 4. In the control bread the starch and protein digestibility was 51.79 mg maltose released/g meal and 64.15 per cent, respectively which was significantly (P≤0.05) higher than that of all types of breads developed. The starch and protein digestibility of Type I bread was 50.78 mg maltose released/g meal and 63.39 per cent, respectively which was significantly (P≤0.05) higher than that of Type III bread which possessed starch and protein digestibility of 49.38 mg maltose released/g meal and 62.89 per cent, respectively. A non-significant difference was observed in the starch digestibility of Type I and II breads while protein digestibility of Type II (63.10 per cent) bread was significantly (P≤0.05) lower than that of Type I bread. The differences in the starch and protein digestibility of control and value added baked products might be due to differences in the starch, protein and antinutrient contents of raw flours and pomegranate peel powder used for product development. Moreover the biological utilization of protein is primarily dependent on its digestibility.

Table 4: *In-vitro* starch and protein digestibility of bread (on dry matter basis)

Products	Starch digestibility (mg maltose released/g meal)	Protein digestibility (%)
Control (100% WF)	51.79±0.34	64.15± 0.08
Type I (WF:SBF:PPP::88:10:2)	50.78±0.14	63.39±0.02
Type II (WF:SBF:PPP::86:10:4)	50.08±0.14	63.10±0.03
Type III (WF:SBF:PPP::84:10:6)	49.38±0.27	62.89±0.02
CD(P≤0.05)	0.79	0.14

Values are mean ± SE of three independent determinations
WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

Anti-nutritional factors

The data pertaining to anti-nutritional factors i.e. phytic acid, polyphenol content, trypsin inhibitors and saponins of bread is presented in Table 5. Control bread had 221.07 mg/100g phytic acid, 254.86mg/100g polyphenol and 209.00 TIU/ g trypsin inhibitors which were significantly (P≤0.05) lower as compared to soybean and pomegranate peel powder supplemented breads. Type I bread contained 271.73 mg/100g phytic acid, 278.35 mg/100g polyphenol and 253.33 TIU/ g trypsin inhibitors, respectively while phytic acid and polyphenol contents in Type II bread were 301.96 mg/100g and 309.78 mg/100g, respectively which were significantly (P≤0.05) higher than that of Type I and significantly (P≤0.05) lower than that of Type III bread. Type III bread had 320.62 mg/100g, 325.33 mg/100g and 234.33 TIU/ g of phytic acid, polyphenol and trypsin inhibitors, respectively. Saponin was not detected in control bread while 0.51, 0.50 and 0.52 g/100g were found in Type I, Type II and Type III breads, respectively. A non-significant difference was observed in the trypsin inhibitor and saponin content of Type I, II and III breads. The differences in the anti-nutrient contents of control and value added baked products were due to higher contents of anti-nutritional factors in soybean flour compared to wheat flour. Pomegranate peel powder also contained higher content of phytic acid and polyphenols than wheat flour.

Table 5: Anti-nutritional factors of bread (on dry matter basis)

Products	Phytic acid (mg/100g)	Polyphenol (mg/100g)	Trypsin inhibitors (TIU/g)	Saponins (g/100g)
Control (100% WF)	221.07±1.54	254.86±3.06	209.00±1.26	ND
Type I (WF:SBF:PPP::88:10:2)	271.73±3.08	278.35±1.93	253.33±6.33	0.51±0.02
Type II (WF:SBF:PPP::86:10:4)	301.96±2.35	309.78±1.38	240.67±1.12	0.50±0.05
Type III (WF:SBF:PPP::84:10:6)	320.62±2.35	325.33±1.98	234.33±2.34	0.52±0.02
CD(P≤0.05)	9.187	8.00	25.68	NS

Values are mean ± SE of three independent determinations
WF = Wheat Flour, SBF = Soybean Flour and PPP = Pomegranate Peel Powder

Conclusion

The breads developed with incorporation of pomegranate peel powder and soybean flour possessed higher sensory and nutritional qualities compared to wheat flour breads. Thus value addition of bread with peels can be an effective way for utilization of peels which are usually discarded and can also serve the purpose of improving the chemical characteristics of end products.

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