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Influence of Enrichment of Wheat Bread with Pomegranate (*Punica granatum* L) Peels by-Products

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Abstract The influence of the enrichment of wheat bread with pomegranate peels by-products at 5%. 7.5% and 10% levels were investigated. The results show that pomegranate peel contained contain 15.91%, 7.56%, 18.1%, 15.67% and 42.76% protein, lipids, fiber, ash and carbohydrates, respectively. The rheological properties of the dough was tested and revealed that the extensibility decreased from 250 mm in wheat flour to 210, 196 and 170 mm in wheat flour containing 5%, 7,5% and 10% pomegranate peels flour, respectively. While increasing the addition of pomegranate flour caused a decrease in dough stability to 196 and 170 mm, respectively. The addition of pomegranate peels to wheat flour increase the water absorption of the dough from 55.5 to 70.4, 79.2 and 88.1% 5%, 7.5% and 10% of pomegranate peels, respectively. The addition of pomegranate peels also caused an increase in arrived time and a decrease in dough stability. Loaf bread weight increased with increasing pomegranate peels concentration, in contrast, loaf volume and specific volume decreased by increasing pomegranate peels. Enrichment of bread with various levels of pomegranate peels significantly ($P < 0.05$) decreased acceptance of its organoleptic properties by human panelists. Generally, fiber as a food industry by-product is recommended to be used as food additives to gain nutritional and healthy benefit.

Keywords Farinograph, Extensograph, Extensibility, Water Absorption, Dough

1. Introduction

Food industry produces large volumes of wastes, both solids and liquid, resulting from the production, preparation and consumption of food. These wastes pose increasing disposal and potential severe pollution problems and represent a loss of valuable biomass and nutrients. Beside their pollution and hazard aspects, in many cases, food processing wastes might have a potential for conversion into useful products of higher value as by-product, or even as raw material for other industries, or for use as food or feed after biological treatment. These wastes could be considered valuable by-products if there were appropriate technical means and if the value of the subsequent products were to exceed the cost of reprocessing [1].

The pomegranate *Punica granatum* L. (family Punicaceae) is a small tree originating from Asia and cultivated throughout the Mediterranean region, China, India, South Africa, and the Americas. Recently, the plant has attracted the interest of researchers in examining its composition and biological properties. The fruit is consumed mainly fresh or in beverages, and is a rich source of phenolic compounds, including hydrolyzable tannins, which possess high antioxidant activity [2-4].

Pomegranate peel is recognized for its many health-promoting qualities and apparent wound-healing properties [5], antimicrobial activity [6]), anticancer property [7], antiatherosclerotic andantioxidative capacities [8].

Food industry by-products as pomegranate peel are considered important source of nutrient elements to human body so, they are with a great therapeutic and nutrient effect as it supplies vitamins, minerals as well as fiber.

Pomegranate peel has no phytic acid [9], plays an important role in the bakery products as food additives. They are low in fat and good source of dietary fiber, protein and a variety of micronutrients and phytochemicals [10]. Studies of pomegranate peel have also shown that it may have therapeutic activity to its high content in dietary fiber as hypercholesterolemia, diabetes and cancer. So it added to many food products as bakery and meat products [11].

Pomegranate peel contains higher amount of protein, dietary fiber and minerals, which have been shown to have therapeutic activity and food supplementation as a good source of the above nutrients [12].

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Demand for whole wheat bread has increased considerably in the last few years because of its better nutritional image and an increasing preference for its organoleptic characteristics [13]. Bread and baked products are the most important sources of dietary fiber in the total food consumption. Bread with high fiber addition in general is cereal diet and is more effective than low carbohydrate diabetic diet in the control of maturity-onset diabetes. Many studies on high non soluble fiber bread are available but there are not sufficient works on high fiber bread with low phytic acid content, to reduce serum cholesterol. The study aimed to determine the influence of enrichment of wheat bread with various levels of the food industry by-products, pomegranate peels flour via chemical and organoleptic analysis.

2. Materials and Methods

2.1. Preparation of Samples

The materials used in the present study were purchased from the local market. These materials were food industry by-products, pomegranate peels. Pomegranate peels were well washed and dried at 63°C using a fan oven. A laboratory mill was used to give flour. The ingredients which were used in bread making were bought from local market. These ingredients included: wheat flour (72% extraction rate), compressed baker's yeast, sucrose, salt and shortening.

2.2. Chemical Composition

The chemical composition of the different samples was determined. These analyses included the contents of moisture, protein, ash and crude fibre using AOAC [14] methods, while fat contents was determined using AOAC [15] method and carbohydrates content was determined according to FAO [16] by difference as follows:

Carbohydrate %=100–(moisture % + protein % + ash % + fat %+ crude fiber).

2.3. Rheological Properties of Bread Dough

For the determination of rheological properties of bread dough, Farinograph and Extensograph equipments were used. These tests were accomplished according to AACC [17] methods. The Farinograph properties included: water absorption (amount of water required for the dough to have consistency of 500 Brabender units line), arrival time (the time in minutes required for the curve to reach the 500 Brabender unit line after the mixer will be started and water will be added, mixing time (the time in minutes from the first addition of the water to development of dough's maximum consistency), stability (the time in minutes elapsing when the top of the curve interacts first 500 B.U. line leaves that line) and softening of wheat flour dough and its blends with pomegranate peel. These properties were determined using a Farinograph type (PL) (Barbender Farinograph, Germany). 300 grams of tested samples (14% moisture basis) were used.

The Extensograph test was carried out using Extensograph to measure the following data:

dough extensibility (E) (the total length of the base of the extensogram measured in millimeters), dough resistance to extension (R) (the height of the extensograph curve was measured in Brabender units after 5 minutes from the start, dough energy (represented by the area in Cm^2 out lined the curve) and the peak height (the maximum height of the extensograph curve measured in Brabender units).

2.4. Bread Making

Bread was made using the 100 - g straight dough method. The basic formula included 100 g of flour, 2 g of compressed baker's yeast 1 g of sucrose, 2 g of salt, 1 g of shortening, water as needed, and different concentrations of pomegranate peels, which have been added at 5, 7.5 and 10% concentration on a flour replacement basis. The dough was fermented for 60 min. at 30°C followed proof period for 15 min. Breads were baked at 230°C for 25 min.

2.5. Bread Baking Characteristics

The average weight of prepared form control wheat bread and wheat bread enriched with various levels of pomegranate peels was recorded after cooling the bread loaves. The bread loaf volume was measured by rapeseed displacement method according to AACC [17] method. The specific volume (cm^3/g) was calculated by dividing volume of the loaf by its weight [18].

2.6. Orgranoleptic Evaluation of Baked Bread

Control wheat bread as well as bread containing various levels of pomegranate peels flour were subjected to orgranoleptic evaluation. Trained and untrained panelists (10 members) were asked to rank various samples for color, odor, flavor and texture on a scale of 10 to zero [19].

2.7. Statistical Analysis of Data

The data of organoleptic evaluation were statistically analyzed using computerized program Scientific Computer centre using Duncan Multiple Range Test (one way ANOVA test) according to Amitage and Berry [20].

3. Results and Discussion

From the results presented in Table (1) it could be noticed that the wheat flour (72% extraction) contained, 13.19%, 1.24%, 0.56% , 0.68% and 84.34% protein, lipids, fiber , ash and carbohydrates respectively. These results confirmed those obtained by El- badrawy [21] who found that wheat flour, 72% extraction contained 84.35% carbohydrates. 13.11% protein, 1.51% lipids and 0.42 fiber. However, in case of pomegranate peel, it was found to contain 15.91%, 7.56%, 18.1%, 15.67% and 42.76% protein, lipids, fiber, ash and carbohydrates, respectively.

Minerals contents of wheat flour (72% extraction rate) and pomegranate are also shown in Table (1). The iron (F), Copper (Cu) and Zinc (ZN) were, 20, 21 and 20 ppm in wheat flour, respectively, while these elements were 306, 189 and 7ppm, respectively in pomegranate, respectively. However, all samples contained very low amounts of Lead (Pb) which lower than the average permissible amounts 100-300 µg/day suggested by FAO and WHO [22].

3.1. Rheological Properties of Dough Prepared from Wheat Flour Containing 0-10% Pomegranate Peel Skin

Table (2) presents the results of rheological properties of wheat flour dough and wheat flour enriched with various levels of pomegranate peels. The extensibility of the dough decreased from 250 mm for wheat flour alone to 210 mm for wheat flour containing 5% pomegranate flour, while increasing the addition of pomegranate flour to 7,5% and 10% caused a decrease in dough stability to 196 and 170 mm, respectively. Maximum resistance to extension was found to be increased from 420 for wheat flour alone to 563 mm for wheat flour containing 5% pomegranate flour, while increasing the amount to 7,5% and 10% caused a increase in dough resistance to (B.u) extension to 781 and 833 B.U, respectively.

The addition of pomegranate peels to wheat flour increase in water absorption of the dough (Table 2). It was increased from 55.5 to 70.4, 79.2 and 88.1% for wheat flour and with addition of 5%, 7.5% and 10% of pomegranate peels. The results also indicated that addition of pomegranate peels to wheat flour caused an increase in arrived time and a decrease in dough stability. Arrival time was found to be 1.5, 4.5, 5.75 and 9.45 min, dough stability was found to be 11.5, 11.67, 12.21 and 12.33min at the levels 0%, 5%, 7.5% and 10% of pomegranate peels, respectively. Softening of dough after 20 min was found to be 40, 34, 30 and 26 min, while after 10 min was 0 at different levels.

3.2. Weight, Volume and Specific Volume of Bread Samples

The effect of enrichment wheat bread with pomegranate at various levels is presented in Table (3). Loaf bread weight increased with increasing pomegranate peels concentration. It increased from 150g for wheat flour (72% extraction) to 155, 159 and 163 g at the levels 0%, 5%, 7.5% and 10%. This enrichment may be due to the high water retention for high fiber content of pomegranate peels. Loaf volume and specific volume decreased by increasing pomegranate peels addition. Loaf volume decreased from 400 cm, at control sample to 396, 380 and 365 cm. with 5%, 7.5% and 10% respectively. These decreases may due to the dilution of gluten [13], and high fiber content of pomegranate peels beside the slow formation of gluten network, which the parameter which was cleared by dough development time. This may be due to the high ability of dietary fiber components to swell and absorb more water as cited by Sosulski and Cadden [23].

Table 1. Chemical composition of wheat flour (72%) and pomegranate peels and wheat flour

Constituents material	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Carboh-yd rates (%)	Iron ppm	Copper ppm	Zinc ppm	Lead ppm
Wheat flour (72%)	13.19	1.24	0.56	0.68	84.34	20	21	20	0.007
Pomegranate peels	15.91	7.56	18.1	15.67	42.76	306	189	7	0.005

Table 2. Rheological properties for dough prepared form flour wheat containing 0-10% pomegranate peels

Flour blend		EXT (B.U)	RTE (B.U.)	WAB (%)	Arrived time (min)	Stability (min.)	Softening of dough	
Wheat Flour	P. P						After 10 min	
100	0	250	420	55.5	1.5	11.5	0	40
95	5	210	563	70.4	4.5	11.67	0	34
93	7	196	781	79.2	5.75	12.21	0	30
90	10	170	833	88.1	9.45	12.35	0	26

EXT = Extensibility; P. P = Pomegranate peels; RTE = Resistance to extension;
WAB = Water absorption

Table 3. Effect of enrichment of wheat bread with pomegranate peels on loaf bread weight and volume

Blend		Loaf weight (g)	Loaf volume cm^3	Specific volume (cm^3/g)
Wheat Flour (g)	P.P			
100	0	150	400	2.66
95	5	155	396	2.60
92.5	7.5	159	380	2.53
90	10	164	365	2.46

• Kilo calorie / 100 g on dry wt. basis
PP = pomegranate peels

Specific volume of bread decreased from 2.66 cm/g in control sample to 2.60, 2.53 and 2.46 cm/g. with 5%, 7.5% and 10% addition of pomegranate peels, respectively.

Generally, it could be concluded that the poor baking quality of bread enriched with pomegranate peels has been attributed to the dilution of the functional gluten proteins and/or the interaction between fibrous materials and gluten which can partly explain the poor baking quality of both pomegranate bread. Lai *et al* [24] attributed the loss of bread volume of bread made from wheat with added non-flour fractions to the binding of bran to a relatively large amount of water and changing the appearance and the handling properties of the dough. Therefore, the gluten was not properly hydrated and developed at normal absorption levels. The use of an inappropriate absorption level results in a reduction in loaf volume [24]. Lai *et. al*. [25] attributed the negative effects of shorts in bread making to glutathione from germ and methoxylhydroquinone (MHQ) types of compounds from the other shorts fractions. Similar results were obtained by Chen *et al.* [26] when they used apple fiber, wheat and oat bran as a source of fiber.

3.3. Organoleptic Properties of Bread Enriched with Pomegranate Peels

Data from Table (4) showed that, all organoleptic properties for bread samples. Enrichment of bread with various levels of pomegranate peels significantly ($P < 0.05$) decreased acceptance of its organoleptic properties by human panelists who gave lower scores for the sensory attributes of wheat bread enriched with pomegranate peels flour as compared to control. The best organoleptic properties of bread were those of control bread as well as bread enriched with 5% pomegranate peels. The decreasing in appearance scores with higher replacement levels could be attributed to the dark colour of thes samples as the panelists usually prefer white than the darker grades. And agrees with that stated by Abd El-Basir *et. al.* [27].

Table 4. Organoleptic properties of bread and bread supplemented with pomegranate peels, at 5.7 and 10% levels each

Organoleptic Attribute	Control wheat bread	Pomegranate peels (%)		
		5	7.5	10
Color	9a	8a	7.7b	6c
Odor	9a	7b	6c	6c
Flavor	9a	7b	6c	6c
Texture	9a	8a	7b	6c
Overall acceptability	9a	8a	7b	6c
LSD	0.003	1.03	4.02	1.031

• Results are average of three replicates.

4. Conclusions

It could be concluded that incorporation of the food industry waste, pomegranate peels flour in wheat flour dough improve its baking characteristics, and the produced bread posses an acceptable sensory quality especially the bread enriched with low levels of pomegranate peels flour. The utilization of low cost dietary fiber sources must be encouraged. Future studies are needed to investigate the effects of these wastes and their products as well as food industry by-products on chronic diseases.

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