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EFFECTS OF ROSEHIP SEED FLOUR ON THE RHEOLOGICAL PROPERTIES OF BREAD DOUGH

Hülya GÜL[1], Hicran ŞEN[1]

[1]University of Süleyman Demirel, Faculty of Engineering, Department of Food Engineering, Isparta, Turkey

Corresponding author email: hulyagul@sdu.edu.tr

Abstract

The effects of rosehip seed flour (RSF) on the rheological properties of bread dough were investigated. RSF was substituted with bread wheat flour at the proportions of 5, 7.5 and 10%. RSF was found to have 7.4 % protein, 4.6% lipid, 79.4% dietary fiber, 97.60 g/kg GAE total phenolic, and 759.48 IC50=µg/ml antiradical activity. Among farinograph parameters: water absorption, development time and softening value of RSF added doughs were found lower than the control dough while stability was showed slightly increase as the RSF level increases from 5% to %7.5. However it began to decrease after this level. Textural measurements by using Kieffer dough and gluten extensibility rig studies showed that inclusion of RSP did not cause any significant change at the maximum resistance to extension and extensibility of doughs when 5% of RSP was added. As the level of RSF increased from 5 to 7.5 and 10% respectively, a decrease in extensibility of doughs was observed. The addition of RSF resulted in significant effects on pressure, extensibility and energy of doughs measured with Dobraszczyk/Roberts dough inflation system of the texture analyser. A significant increase was observed in pressure and energy of doughs who were positively correlated with increased level of RSF. On the other hand a weakening was noted at higher levels (from 5% to 10%) when compared with control dough. As a result; substitution at 5 % of RSF gives rheological parameter values at least as good as the control sample and it can be used as valuable ingredient to enhance the functional properties of bakery products.

Key words: *Rosehip, farinograph, Kieffer, dough inflation system, extensibility.*

INTRODUCTION

Rosehips (*Rosa spp*.) are members of the genus Rosa. Approximately up to 200 species are grown in the world, 25% of them are found in Turkey (Murathan et al., 2016a). Members of the *Rosaceae* family have long been used for food and medicinal purposes. Rosehip fruits are good sources of bioactive compounds, phytonutrients and minerals (Murathan et al., 2016b). Due to presence of these compounds rosehip fruits and seeds have prophylactic and therapeutic actions against the infectious and inflammatory diseases, diabetes, gastrointestinal disorders, common cold, diarrhea and urinary tract diseases (İlyasoğlu, 2014).

Rosehip fruits are generally consumed in the form of tea, wine, jam, jellies, and marmalade. Strugała et al., (2016) reported that extracts of rosehip fruit with broad biological activity could potentially be useful as a functional food ingredient. The inside of the rosehip fruit is hairy and contains a large number of seeds which rate between 20-44% (Yıldız and Nergiz, 1996). These seeds, by products of rosehip industry, are used generally as an animal feed, whereas they contain even higher amounts of specific nutritionally valuable and biologically active components. For example the lipid fraction of the rosehip seed contains more than 50% polyunsaturated fatty acids. And also they are a valuable source of minerals, are quite rich in phosphorus and potassium. Hence, these by-products rich in bioactive compounds and dietary fiber could be used as a functional ingredient in bakery foods. To the best of our knowledge, there are no reports on the effects of rosehip seed powder (RSF) on the rheological properties of bread dough. Thus the objective of this study was to determine nutritional and phytochemical composition of the rosehip seed and its effects on the rheological characteristics of bread dough.

MATERIALS AND METHODS

Materials

Commercial bread wheat flour was supplied from Berberoğlu Milling Factory (Burdur, Turkey). Farinographic properties of the flour were as follows: 58.7% of water absorption, 7.9 min stability and 2.2 min of dough development time. The proximate compositions of wheat flour, analysed by the AACC (2001) methods, were 14.5±0 01% moisture, 0.61±0.03% ash, 10.47±0.03% protein, 29.9±0.12 % wet gluten, 96.2±0.20 % gluten index, sedimentation 31±1 ml and falling number 362±2 s. Total dietary fibre assay kit was purchased from Megazyme Company (Wicklow, Ireland). Other chemicals were purchased from Merck (Darmstadt, Germany) and were of analytical grade.

Preparation of RSF

Rosehip seeds were provided by manual separation of the seeds from pomace which was the by product of rosehip marmalade plant. They were dried in a cabinet drier at 55+2C then ground in a hammer mill (Tekpa, Turkey). The ground material was passed through 300 µm sieve. The fraction which passed through sieve was collected and vacuumed in packages with barrier property and used for the study.

Chemical analysis of RSF

RSF was analysed for moisture (Method 44-01.01;AACC, 2001), ash (Method 08-01.01; AACC, 2001), total lipid (Method 30-25.01; AACC, 2001), protein-N×6.25 (Method 46-12.01;AACC, 2001), total dietary fibre (Method 32-05.01;AACC, 2001), total phenolic (TP) (Singleton and Rossi, 1965) and antiradical activity by using α-diphenyl-β-picrylhydrazyl (DPPH) (Dorman et al., 2003). Colours of dried and ground PSF samples were determined with Minolta CR 400 (Minolta Co Ltd., Tokyo, Japan) and was expressed as brightness, L*, a*, and b* values. The lightness value (L*) represents the black-white colours; a* represents the green-red colours; and b* represents the blue-yellow colours.

Farinograph measurements

PSF blends at 0%, 5%, 7.5% and 10% levels were prepared by replacing wheat flour. The effect of PSF on the mixing profile of the dough was studied using farinograph (Brabender, Duisburg, Germany) according to the standard AACC Method-54-21.02 (AACC, 2001). Water absorption, development time, stability and degree of softening (12 minute after maximum) of control dough and PSF containing doughs were determined. The 300 g mixing bowl was used.

SMS/Kieffer Dough and gluten extensibility ring measurements

Texturometer (TA-XT2, Stable Micro Systems, England) equipped with SMS/ Dough and gluten extensibility ring was utilized to measure the elastic properties of the dough samples according to the methods of Kieffer et. al. (1998). Water was added according to farinograph water absorption for each formula and then mixed until optimum dough development. The test was carried out in ten replicates under the following conditions: pre-test speed 2.0 mm/sec, test speed 3.3 mm/sec, post- test speed 10.00 mm/sec, distance 75 mm, trigger force auto-5 g, data acquisition rate: 200 pps. The resistance to extension (force in g), extensibility (distance in mm) and area under the force vs. distance curve (g.s) values of dough samples were determined.

Dobraszczyk / Roberts (D/R) dough inflation system measurements

Large strain biaxial extensional rheological properties of dough were measured during bubble inflation using the D/R dough inflation method (Dobraszczyk, 1997). Doughs for the dough inflation test were first prepared in a farinograph, using 300 g flour, 2% salt and water (according to farinograph water absorption for each formula) addition and mixed to peak time. Then dough was rolled to a thickness of 8 mm by using roller mechanism. 55mm circular pieces were cut from this sheets by using cookie cutter. Then circular pieces were pressed for 30 sec. The samples and apparatus surfaces were coated with paraffin oil to prevent moisture loss and dough surface drying. The five discs were compressed in turn, then stacked up in holders to prevent moisture loss and rested for 30 min at 25±5 C and tested at TA-XT2 texture analyser (Stable Micro Systems, England) in five replicates under the following conditions: pre-test speed 8.63 cm^3/sec, test speed 26.70 cm^3/sec, volume: 2.000.000 mm^3, Trigger volume: 30.000 mm^3. When the break or rupture of dough bubble was occurred the test stopped automatically. As a result, the following parameters were obtained: bi-axial extensibility, L (mm); tenacity, P (mm) and deformation energy, W (J) at bubble failure.

Statistical analysis
All measurements were performed three times. Statistical analyses were carried out SPSS 16.0 procedures using one-way analysis of variance (ANOVA). $P < 0.01$ was considered to be significant using Duncan's test.

RESULTS AND DISCUSSIONS

Some characteristics of rosehip seed flour
The results of the proximate analysis and colour values of the RSF were presented in Table 1. The ash and crude protein content of RSF were found higher while crude fat was found lower than the report of İlyasoğlu (2014) who was characterized the rosehip (*Rosa canina L.)* seed and seed oil.

Dietary fibers, were the most abundant macronutrients with 79.4 %. This value is higher than the dietary fiber contents of grape seed flour (Gül et al., 2013), Moringa oleifera seeds (Anudeep et al., 2016) and soybean seeds and its by-product okara (Cuenca et al., 2008). Dietary fiber is currently considered a critical ingredient in food products because of its health benefits, among them promoting healthier bowel function, decreasing cholesterol levels in the body, controlling blood glucose levels, preventing constipation, lowering the risk of obesity, certain kinds of cancer and heart disease (Kurek and Wyrwisz, 2015). Thus the RSF used in present study with higher dietary fiber content can be used as an ingredient with specific functions in food production.

Table 1. Proximate composition and colour values of the RSF

Constituent	Value
Moisture %	6.3 ± 0.05
Ash %	2.3 ± 0.01
Crude protein	7.4 ± 0.58
Crude fat	4.6 ± 0.36
Total dietary fiber	79.4 ± 0.42
Colours	
L	65.2 ± 0.01
a	6.8 ± 0.02
b	14.4 ± 0.01

Total Phenolic Compounds and Antioxidant Activity of RSF
Total phenolic content and antiradical activity of RSF was determined as 97.60 g/kg GAE, and 759.48 IC50=μg/mL respectively. This is rather higher than the findings of İlyasoğlu (2014), who reported that the total phenolics of *Rosa canina L.* seeds as 2554 ± 15 μg/g seed and seed oils as and 215.4 ± 28.0 μg/g seed. However, the rosehip seed had a higher content of TPC than the four different rosehip species (*Rosa L.),* growing in the East Anatolia region of Turkey (Murathan et al., 2016b). The differences might be explained by different growing conditions, genotypes, and extraction conditions. The data suggested that these rosehip seeds might potentially serve as natural sources for dietary phenolic compounds.

The antioxidant activity of the studied seed was lower than the value of petals, fertilized flowers, ripening, and overripe hips, except unripe hips, of *Rosa micrantha* species reported by Quimaraes et al. 2010 and rosehip (*Rosa canina L.*) reported by Strugala et al., (2016). The TEAC (TEAC stands for Trolox Equivalent Antioxidant Capacity) values of the rosehip seeds were found by İlyasoğlu, (2014) to range from 7.29 to 10.71 to μmol TE/g for ethanol and acetone extracts respectively.

Effects of farinograph parameters
The effects of increasing levels (0, 5, 7.5 and 10%) of RSF on wheat flour dough properties is shown in Table 2. There were significant differences ($P<0.01$) in water absorption, development time, stability and softening degree between the control flour (no PSF) and the flour groups with added PSF. With PSF addition, the percentage of water absorption decreased by about one percent. When the PSF percentage increased did not affect this value. By replacing gluten containing wheat flour with different ratios of RSF, the interaction between water and fiber in the dough was restricted.

Stronger flour typically has longer development time and smaller softening degree. But PSF which have a significant level of dietary fiber has caused the weakening of the dough. Fiber in RSF fortified doughs competed for water and delayed gluten development during mixing. Thus a decrease at development times and softening degrees of RSF containing doughs were observed.

Dough stability, was found to increase with the addition of the RSF. These results are in agreement studies on brewer’s spent grain and apple pomace (Ktenioudaki, 2013).

Table 2. The effect of rosehip seed flour on the farinograph properties of dough

Samples	Level of RSF (%)	Water absorption (%)	Development time (min)	Stability (min)	Softening degree (12 min)
Control	0	58.7a (1)	2.2a	7.9d	73.0a
RSF	5	57.5b	1.9b	8.3c	63.0b
	7.5	57.4b	1.9b	8.5b	63.0b
	10	57.4b	1.7c	9.0a	57.0c

(1)=Mean values in same column followed by different letters are significantly different ($P < 0.01$).

Effects of Kieffer dough and gluten extensibility rig parameters

Table 3 listed the resistance to extension (R value), extensibility (E value) and area (A value) of doughs enriched with various substitution levels of RSF. There was no significant difference observed as far as R and E value of control dough and 5% RSF added dough were concerned. The R value of the dough was increased as the substitution level increased over 5%. Whereas the E value was shown opposite effect. Hence, the addition of excessive RSF (more than 5%) resulted in a stiffer and less extensible dough.

However A value was higher in the 10% RSF enriched dough than in the dough enriched with 5% and 7.5 RSF%. The effect of RSF on the rheological properties of dough, less flexible and more rigid, was consistent with previous research using different dietary fiber sources such as Malva aegyptiaca L. leaves powder (Fakhfakh et al., 2017), brewer's spent grain and apple pomace (Ktenioudaki, 2013).

Table 3. The effect of rosehip seed flour on the Kieffer dough and gluten extensibility values of dough

Samples	Level of RSF (%)	Resistance to extension, R (g)	Extensibility, E (mm)	Area (g.s)
Control	0	19.7^{c}	22.6^{a}	239.5^{a}
RSF	5	19.3^{c}	22.1^{a}	218.1^{c}
	7.5	24.8^{b}	20.1^{b}	218.7^{c}
	10	30.1^{a}	16.9^{c}	230.5^{b}

(1)=Mean values in same column followed by different letters are significantly different ($P < 0.01$)

Effects of Dobrasczcyk/Roberts dough inflation system parameters

Figure 1 showed that a partial substitution of wheat flour by the RSF on the rheological characteristics of the dough (P, L and W). Bi-axial extensibility was measured by Dobrasczcyk/Roberts dough inflation system which determines dough rheology under conditions of strain similar to those of baking expansion (Dobraszczyk, 1997; Dobraszczyk and Morgenstern, 2003) was significantly affected from the addition of RSF in to bread wheat flour.

When the substitution level increased, the tenacity of the dough (P) was significantly (p<0.01) higher from 90.5 mm (control sample) to 206. 4 mm and 222.9 mm at 5% and 10% substitution level respectively. However, a significant (p<0.01) decrease in the extensibility (L) was observed.

By comparing the control L values they decreased from 32.10 mm to 21.6 mm, 20.5 mm and 15.7 mm for 5, 7.5 and 10% addition levels of RSF respectively. W value was increased in doughs which contain RSF.

Higher W value was obtained at 7.5% RSF doughs with 176.3 J. But at 10% PSF W value began to decrease.

Although almost similar results (for P, L and W values) were obtained between 5% and 7.5% RSF addition level, the difference at the 10% additional level was even more pronounced.

The main lines of the results Kieffer dough and gluten extensibility rig and Dobrasczcyk/ Roberts inflation system are in agreement with each other. Rheological behaviour of doughs after addition of RSF were changed at same trend at both measurements.

Their results showed that by incorporating higer levels of RSF will ncrease the force and decrease the extensibility.

The effects observed in the reduction of the extensibility and increase of the resistance to extension of the dough is related to gluten network changes due to fiber rich RSF addition. Higher levels of addition of RSF in the flour caused more dilution of the gluten matrix, weakening its extensible characteristics. In terms of manufacturing of products, these findings mean lower retention of gas and lower volume and higher firmness.

The negative effect on the formation of the gluten network by excess amounts of fiber were also reported from Gül et al. (2009).

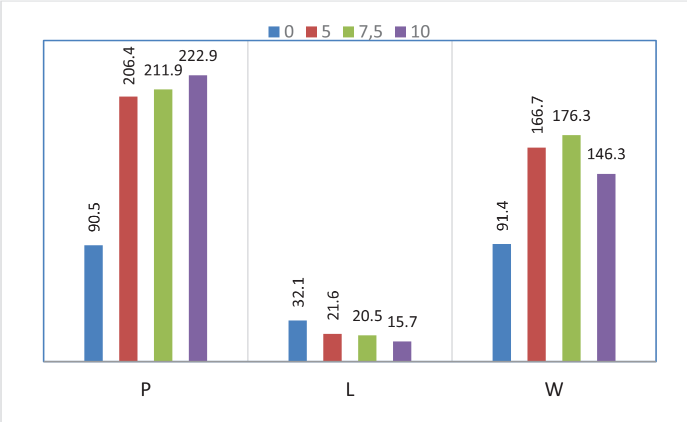

Figure 1. Dobrasczcyk/Roberts dough inflation system values of doughs substituted with 0, 5, 7.5 and 10% PSF. P (mm): tenacity, L (mm) extensibility, W (J): deformation energy

CONCLUSIONS

In the preparation and processing procedures of rosehip to various food products can lead to discard its seeds. The findings of this study showed that rosehip seed was a valuable by product with its high concentration of dietary fiber, ash, protein, total phenolics and antioxidant activity. Antioxidative dietary fibers are important class of food ingredients that can be added to introduce extra health benefits to various bakery products.

Rheological properties of dough are closely related to quality of baked products because the changes in dough rheology during development affect both the incorporation of gas bubbles and their ability to hold gas and volume of loaf bread. The addition of RSF in dough formulations had varying effects on the dough properties. Incorporating RSF to wheat flour was lead to decrease of water absorption, development time, softening degree, extensibility and area of Kieffer measurement, while it was lead to increase stability, resistance to extension, tenacity and deformation energy of dough. Marked weakening was noted at higher levels (7.5% and 10%) of supplementation as compared with control dough.

Based on all results, substitution at 5% of RSF gives rheological parameter values at least as good as the control sample. On the other hand if producers want to produce non aerated bakery products at which no need to higher volumes, RSF can be used much more concentrations than 5%. As a result; we can suggested, that rosehip seeds could be used as a food ingredient due to their high nutritional content and functional abilities.

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