Effect of rosehip flour on the properties of wheat dough and bread

Rosen Chochkov[1], Denka Zlateva[2], Petya Ivanova[1], Dana Stefanova[2]

1 – University of Food Technologies, Plovdiv, Bulgaria
2 – University of Economics, Varna, Bulgaria

Keywords:

Wheat bread
Rosehip
Flour
Rheology

Article history:

Received 10.09.2022
Received in revised form 17.12.2022
Accepted 30.12.2022

Corresponding author:

Rosen Chochkov
E-mail: rosen4o4kov@abv.bg

DOI: 10.24263/2304-974X-2022-11-4-6

Abstract

Introduction. The aim of the present study was to investigate the effect of rosehip flour on some properties of wheat dough and bread.

Materials and methods. Bread was prepared from wheat flour with the addition of rosehip flour in the amount of 5, 10 and 15% to replace the equal amount of the wheat flour. The used methods are standardized and generally accepted for evaluation of bread.

Results and discussion. It was found that the addition of different amounts of rosehip flour to wheat flour affected the intensity of gas formation, as the percentage of rosehip flour added had increased, the intensity of gas formation decreased. When adding 5% rosehip flour, there was no significant deterioration of gas formation. Incorporation of rosehip flour into wheat dough resulted in a decrease in water absorption and degree of softening and the lowest results were found in the sample with 15% rosehip flour added. In terms of dough development time and consistency, there were no significant differences between the samples. Dough stability was found to be higher in the samples containing rosehip flour, with the highest value reported for the sample with 5% rosehip flour. Dough and bread color characteristics decreased with increasing the rosehip flour quantity. Darker colour of rosehip flour enriched samples could be due to the original colour of rosehip fibre, which is rather brown and slightly reddish. The substitution of wheat flour with rosehip flour resulted in a decrease in volume, specific volume, height/diameter ratio and baking loss of the wheat bread. Some of the sensory parameters of bread (crust color, aroma and taste) in the rosehip flour supplemented samples were rated higher by the panelists compared to the control sample, regardless of the amount of rosehip flour added.

Conclusions. The rosehip flour could be successfully used as an additive in wheat bread formulation. In the sensory assessment bread samples with rosehip flour in terms of some properties such as crust color, aroma and taste had higher scores than the control sample.

Introduction

Application of novel natural additives to improve the health value of different traditional food products is a new trend in the food preparation (Stabnikova et al., 2021), and among them berries being rich sources of bioactive constituents became very popular (Paredes-López et al., 2010). Rosehip berries have been used, as a powder or an extract, in various formulations in baking to enhance the bread's nutritional value (Kaiyun, 2016). Rosehips (*Rosa spp*.) are members of the genus *Rosa*. Approximately up to 200 species are grown in the world, 25% of them were found in Turkey (Murathan et al., 2016). Members of the *Rosaceae* family have long been used for food purposes. Rosa species have attracted the attention due to their antioxidant, antimicrobial and other properties (Bhave et al., 2017).

Rosehip fruits from the family of *Rosaceae* are an important source of proteins, carbohydrates, energy, sugars, particularly the reducing sugars, ascorbic acid, antioxidants, carotenoid pigments, minerals, organic and fatty acids (Böhm et al., 2003; Demir et al., 2001; Ercisli, 2007; Murathan et al., 2016). Rosehip fruits are used for avitaminosis and in other cases, related to the decrease of immunological defence and vital tonicity of the organism. They contain vitamin C, which accumulates in large quantities at the beginning of fruit ripening. It is well known that vitamin C is used in baking as an oxidant improver to strengthen gluten and improve the structural and mechanical properties of the dough (Amiri et al., 2017). In addition to vitamin C, they also contain vitamins B, K, P, and pectin substances. Seeds contain oils rich in vitamin E (Murathan et al., 2016; Oliinyk et al., 2020; Olsson et al., 2005). Rosehips are important as food raw materials, containing a lot of fiber and other useful substances including relatively big amount (0.7-9.6 mg%) of β-carotene (Tertychnaya et al., 2020).

According to Gül et al. (2011), high fiber breads can be produced by incorporating rosehip seeds. Consumption may be increased by giving comprehensive information about the health benefits of these fiber enriched breads. Cvetković et al. (2009) also reported for effect of rosehip on dietary fiber content of bread. According to data, rosehip increased dietary fiber content in the supplemented bread for about 100%.

Boz et al. (2010) pointed out that rosehip in combination with other ingredients can be used as an improver to wheat dough. The combination of 0.5% Cephalaria and 2.5% rosehip significantly decreased the adhesion and stringiness of dough. Data showed that dough rheological characteristics of organic whole wheat flour could be improved with the addition of different materials such as malt flour, Cephalaria, rosehip and vital gluten.

Vartolomei et al. (2021) concluded that dough development time, dough stability, and softening degree vary significant, showing a combined influence of vitamin C provided by the rosehip powder, and the high fiber content. Moreover, the rosehip powder addition positively influenced the farinograph quality number.

Regarding the quality of bread, the samples prepared from wheat flour with the rosehip powder addition showed a significant increase in height, volume, specific volume, moisture, acidity, and porosity, as well as a slight decrease in elasticity as compared to the control bread (Vartolomei et al., 2021). Some authors indicated that, to ensure high bread quality, it is advisable to use the rosehip flour in an amount not more than 4% of the total mass of flour (Oliinyk et al., 2020). On the other hand, Sen (2013) concluded that the sensory profile of breads produced with 5% rosehip seed flour have been most liked after the control sample of bread.

Apart from being used as flour, rosehips can also be used in bread making as extracts. Rosehip extract was added when kneading the dough at doses of 5%, 10% and 15% (of flour weight), while the control sample of bread was without extract. When the additive was in the amount of 10%, the specific volume of bread was higher than in the control sample. According to sensory evaluation, the sample with 10% rosehip extract received the highest score (Pozdnyakova et al., 2019). Blinova et al. (2016) reported that the use of extract of rosehips (in an amount of 1.00% and 1.25%) in the production of bread from wheat flour improved its volume and crumb porosity.

The aim of research was to study the impact of rosehip flour added in amounts of 5, 10 and 15% to replace the equal amounts of the wheat flour on properties of wheat dough and bread.

Materials and methods

Materials

For the preparation of bread samples, the following materials were used:

- commercial wheat flour (type 500) (average chemical composition: fat 0.9g/100 g of which saturated 0.3 g; carbohydrates 70.3 g/100 g, of which sugars 3.4 g, fiber 4.0 g/100 g; protein 10.8 g/100 g);
- rosehip flour (average chemical composition: fat 0 g/100 g of which saturated 0 g; carbohydrates 38 g/100 g, of which sugars 3 g, fiber 24 g/100 g; protein 2 g/ 100 g);
- water – according to ISO 6107-1:2004;
- commercial yeast – supplied by Lesaffre Ltd. (Sofia, Bulgaria);
- salt – according to Codex Standard for Food Grade Salt CX STAN 150-1985.

Methods

Preparation of wheat dough and bread samples

Bread was obtained from type 500 wheat flour by a two-phase method. First, the yeast, part of the flour and water were mixed in a ratio of 1:1 in a dough kneading machine (Labomix 1000, Hungary). The control sample was made of wheat flour only, whereas the other samples of bread studied were prepared by adding rosehip flour to replace 5%, 10% or 15% of the wheat flour. The dough thus prepared rose for 60 min at 33°C and was then kneaded until obtaining a homogeneous texture by adding the remaining flour and water according to the recipe, plus salt (1.33 kg/ 100 kg of flour). The bread dough was divided into parts with a specified weight (440 g) and shaped, then left to rest for 60 minutes at 35°C for final fermentation (Tecnopast CRN 45–12, Novacel ROVIMPEX Novaledo, Italy). Then, the pieces of dough were baked in an electrical oven (Salva E-25, Spain) pre-heated to 220 – 230°C. Baking time was 24 min. After baking, the bread was left to cool down for 3 hours at room temperature.

The formulations of the studied samples of bread are presented in Table 1.

Gas formation properties of wheat flour

The gas-formation properties of wheat flour were determined by micro gas-meter, quantifying the gas formed in equal time intervals (15 min). The dough recipe was: flour, 5.0 g; yeast, 0.4 g; water, 3.0 ml. The dough sample fermented at 30°C for 150 min (Karadzhov et al., 1982).

Table 1

The formulations of bread samples (% on the flour basis)

Ingredients	**Bread samples**			
	Control sample (100% wheat flour)	**with rosehip flour (%)**		
		5	**10**	**15**
Wheat flour, g	450	427.5	405.0	382.5
Rosehip flour, g	–	22.5	45.0	67.5
Water, ml	248	248	248	248
Yeast, g	9.00	9.00	9.00	9.00
Salt, g	6.00	6.00	6.00	6.00

Color characteristics of the wheat dough

Color was evaluated in the crumb using a colorimeter „MOMCOLOR – D”. Color was measured on five different points on each sample, taking them in the central and outward parts of the loaf, avoiding its edges (Wricht, 1985). The following parameters were defined: Lightness (L); Color of saturation (D); Color tone (C).

Rheological properties of the wheat dough

The following dough characteristics were determined by a farinograph (Brabender GmbH&Co. KG, Duisburg, Germany): water absorption,%, development time, min, stability, min, degree of softening, farinograph units (FU), and consistency (FU), with AACC Method 54-21.02 (AACC, 2010).

Bread quality

Physical properties. Bread loaf volume was determined after baking and cooling the breads for 3 h at room temperature (20±2 °C) by a rapeseed displacement method (AACC, 2010). The specific volume was calculated by the ratio between volume, cm^3, and mass, g, of each sample. Bread height and diameter were measured by a calliper, and the shape stability (height/diameter) was calculated (Novotni et al., 2012). Bake loss,%, was determined weighing each loaf before and after baking (Kim et al., 2015).

Sensory analysis. Sensory analysis of the tested bread samples was performed by a panel consisting of 25 panelists (52% women and 48% men), who were familiar with sensory analysis of foods but not specifically trained in the evaluation of bread. The panelists were chosen using the following criteria: ages between 20 and 60, non-smokers, without reported cases of food allergies, bread consumers. The tests were performed in a laboratory with good ventilation and sufficient natural lighting. Each sample was labelled with a three-digit random code. The analysis was carried out according to ISO 6658:2017 (Sensory Analysis—Methodology—General Guidance). The panelists were asked to score seven parameters, namely appearance, crust color, crumb color, porosity, aroma, chewability and taste. The intensity of each attribute was presented on a 9-point scale (9, extremely good; 1, extremely bad).

Data analysis

All the tests were conducted with three replications. Data were analysed by one-way analysis of variance (ANOVA) using Statgraphics Centurion statistical program (version XVI, 2009) (Stat Point Technologies, Ins., Warrenton, VA, USA). To compare the means, Fisher's least significant difference test was used for paired comparison with a significance level $\alpha = 0.05$.

Results and discussion

Effect of rosehip flour substitution on gas formation properties of wheat flour

The results regarding the intensity of gas formation of wheat flour (WF), rosehip flour and the samples in which part of the wheat flour (5%, 10% or 15%) was replaced by rosehip flour are presented in Figure 1. The values were measured using a micro gasometer.

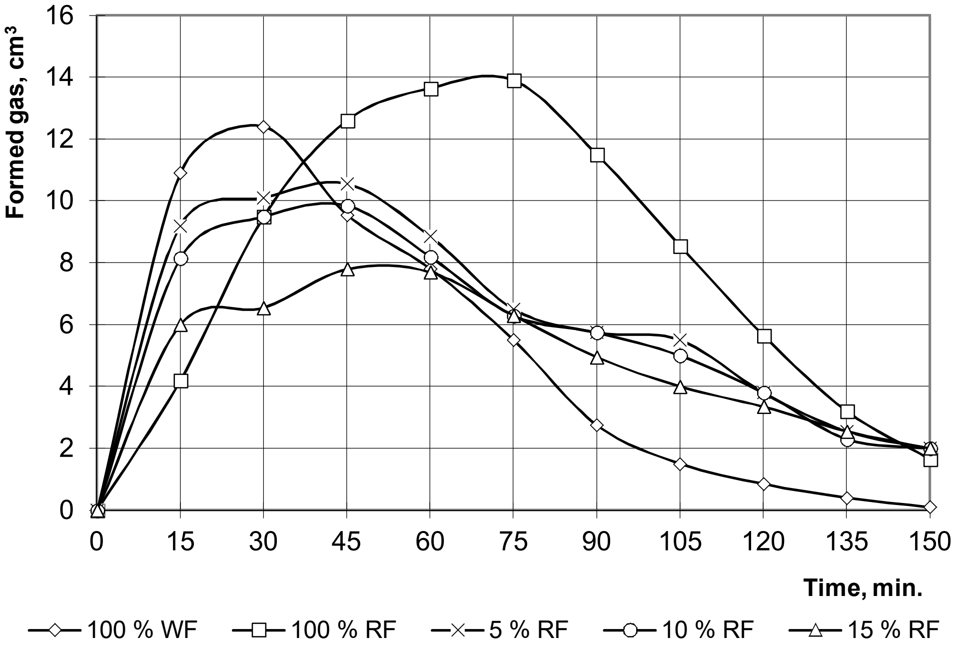

Figure 1. Intensity of gas formation of wheat flour (WF), rosehip flour (RF) and mixtures of wheat and rosehip flour

The amount of gas formed varied significantly depending on the raw materials. In the sample containing 100% wheat flour, the maximum amount of gas, 12.4 cm^3, was formed approximately 25-30 minutes after kneading. In the case of 100% rosehip flour, gas formation was more extensive, with a maximum reported amount of 13.9 cm^3, but this peak was reached after a longer period of time about 70 minutes after kneading. In both cases, however, gas formation followed a common trend - an increase in the amount, reaching a peak (although after a different time) and a sharp decrease in the intensity of gas formation.

As can be seen from the figure, different percentages of rosehip flour added (5%, 10% or 15%) resulted in lower gas formation intensity and smaller volumes of gas evolved were observed. The following dependence was established – the higher the amount of rosehip flour added, the lower the intensity of gas formation. In addition, all three samples had similar course of gas formation – a rise in the amount of gas formed after kneading, reaching a peak, an insignificant decrease, followed by a second peak, in which the maximum amount of gas formed was reached, followed by a decline.

At the beginning – up to the 40th minute after kneading, wheat flour had more intense gas formation than the mixtures containing rosehip flour. After that, there was a significant decline for the wheat flour, while the mixtures containing rosehip flour showed higher gas formation until the end of the measurement (150 minutes after kneading). According to Oliinyk et al. (2020), this might be associated with the strengthening of gluten of wheat flour due to the action of ascorbic acid. It is known that ascorbic acid, turning into dehydroascorbic acid in the dough, oxidizes the SH-groups of gluten proteins, proteolytic enzymes and proteolysis activators, thereby reducing the proteolysis intensity in the dough.

Total amount of the formed gas in wheat flour, rosehip flour and the samples where a part of the wheat flour (5%, 10% or 15%) was replaced by rosehip flour are presented in Figure 2.

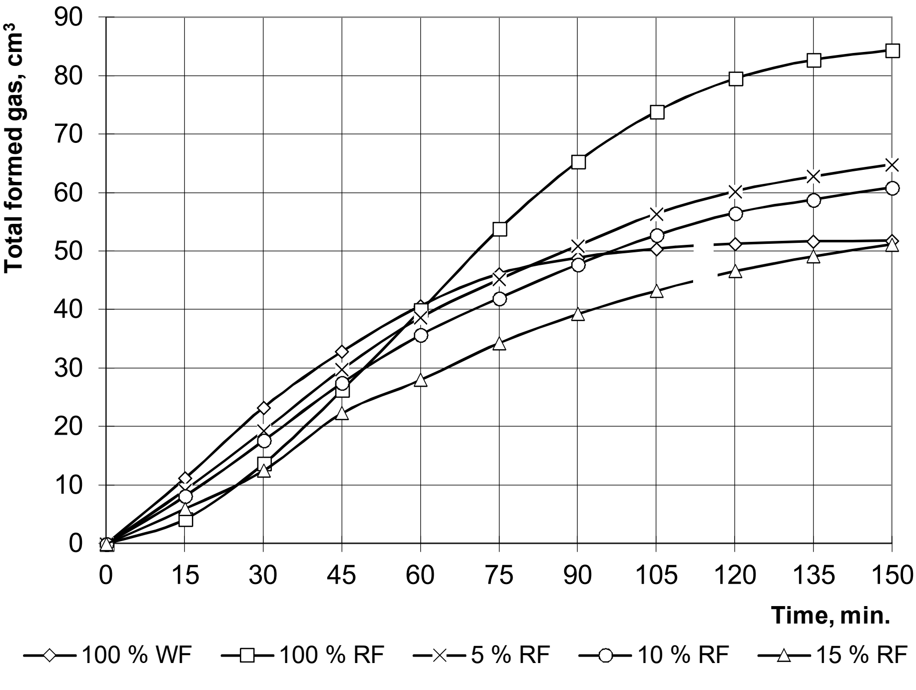

Figure 2. Total formed gas of wheat flour (WF), rosehip flour (RF) and mixtures of wheat and rosehip flour

It was found that rosehip flour formed the largest amount of gas of all the samples examined, 85 cm^3. For the wheat flour and mixtures with rosehip flour added, the curves are comparable with insignificant differences in the amount of gas released. However, the amount of gas decreased when the proportion of rosehip flour was increased. For the sample containing 5% rosehip flour, the total gas formed was 64 cm^3, for the sample with 10% rosehip flour, the result was 61 cm^3. When replacing 15% of the wheat flour with rosehip flour, a total of 51 cm^3 formed gas was found, which 20% was less than the sample with 5% rosehip flour. The figure clearly shows that when different types of flour were mixed in different ratios, gas formation differs. A study pointed out that the addition of rosehip powder in doses of 1-7% on the basis of wheat flour increased the amount of carbon dioxide, probably due to the high content of mono- and disaccharides. According to Lapytska (2020), this is due to the fact that adding rosehip flour to the dough enhances alcoholic fermentation, because of the stimulating effect of biologically active substances in the rosehip flour on the activity of the yeast. On the other hand, the introduction of rosehip flour at more than 5% on the basis of flour resulted into a loss of carbon dioxide due to the limited elasticity of the gluten framework (Kobilova et al., 2021).

Effect of rosehip flour addition on farinograph characteristics of wheat dough

Results concerning the effect of rosehip flour on the farinograph properties of dough are presented in Table 2.

Table 2

Effect of rosehip flour on the farinograph properties of dough

Samples	Water absorption (%)	Consistence (UB)	Dough development time (min)	Stability (min)	Degree of softening (UB)
Control sample (100% WF)	62.4 ± 0.14^a	500 ± 0.0^a	1.5 ± 0.0^a	7 ± 1.0^a	170 ± 3.61^a
Rosehip flour, 5%	61.2 ± 0.22^a	500 ± 0.0^a	1.5 ± 0.0^a	13 ± 2.0^b	110 ± 4.36^b
Rosehip flour, 10%	61.0 ± 0.44^b	520 ± 0.1^b	1.5 ± 0.0^a	9 ± 2.0^a	60 ± 3.05^c
Rosehip flour, 15%	60.8 ± 0.32^c	500 ± 0.0^a	1.5 ± 0.0^a	8 ± 2.0^a	50 ± 3.46^d

$^{a\text{-}d}$: Means in a column without a common letter differ significantly ($p < 0.05$).

Different authors (Amjid et al., 2013; Berton et al., 2002) reported that the hydration of the flour during kneading is of crucial importance for the dough properties and the quality of the bread. By increasing the amount (5%, 10% and 15%) of rosehip flour added, the farinograph properties of the wheat dough changed. A decrease in water absorption was established, and in the samples with 10% and 15% rosehip flour, the differences compared to the control sample were statistically significant. Gül and Şen (2017a) pointed out that by replacing gluten containing wheat flour with different ratios of rosehip flour, the interaction between water and fiber in the dough was restricted. In terms of dough development time and consistency, there were no differences between the tested samples, regardless of their composition. Vartolomei et al. (2021) found a slight variation in the dough development time when rosehip flour was added (in an amount from 0.5% to 2.5%), but the differences were not statistically significant. Other authors also reported variations in dough development time (Sudha et al., 2007). Smaller softening degree was reported for the fortified samples. Other authors, studying the same problem, concluded that fiber in rosehip flour fortified dough competed for water and delayed gluten development during mixing. Thus, a significant decrease at softening degrees of rosehip flour containing dough was observed.

According to Fu et al. (2008), dough stability time provides some indications regarding the tolerance of flour to mixing and kneading. Dough stability was found to be higher in the samples with the addition of rosehip flour, with the highest value reported for the sample with 5% rosehip flour. Other authors (Kohajdová et al., 2011; Nassar et al., 2008) also found an increase in dough stability time in samples fortified with fiber-rich additives explaining it through a higher interaction of fibres, water, and proteins in flour. Boz et al. (2010) reported that the use of rosehip with other ingredients in wheat dough could improve the dough rheological characteristics of whole wheat flour.

Effect of rosehip flour addition on color of wheat dough and bread

Color characteristics of the control sample of dough and the three formulations with rosehip flour added are presented in Table 3.

From the data presented in Table 3, it is clear that the addition of rosehip flour had a significant effect on the colour characteristics of the dough. The values of all three measured parameters (L, C and D) decreased with increasing the degree of replacement of wheat flour with rosehip flour. Dough brightness (L) had the highest value in the control sample. The addition of 5% rosehip flour resulted in a 15.7% decrease in the value, while at 15% the measured value was 31% lower than that of the wheat flour control sample. Darker colour of rosehip flour enriched samples could be due to the original colour of rosehip fibre, as pointed out by Gül and Şen (2017b), which is rather brown and slightly reddish. Dough colour tone (C) and dough saturation number (D) also differed most significantly from those of the control sample when the degree of replacement with rosehip flour was the highest, 15%.

Color characteristics of the control sample of bread and the three bread samples with rosehip flour added are presented in Table 4.

Table 3

Effect of rosehip flour on color characteristics of wheat dough

Samples	Dough brightness (L)	Dough color tone (C)	Dough saturation number (D)
Control sample (100% WF)	112.5 ± 2.78^a	-2.000 ± 0.06^a	174.8 ± 1.00^a
Rosehip flour, 5%	94.8 ± 0.35^b	-2.050 ± 0.02^b	150.2 ± 1.12^b
Rosehip flour, 10%	83.2 ± 0.79^c	-2.057 ± 0.00^c	138.5 ± 1.39^c
Rosehip flour, 15%	77.4 ± 1.04^d	-2.060 ± 0.01^c	121.9 ± 0.87^d

$^{a-d}$: Means in a column without a common letter differ significantly ($p < 0.05$).

Table 4

Effect of rosehip flour on color characteristics of wheat bread

Samples	Bread Brightness (L)	Bread Color tone (C)	Bread Saturation number (D)
Control sample (100% WF)	113.6 ± 1.01^a	-1.880 ± 0.03^a	158.3 ± 0.66^a
Rosehip flour, 5%	94.4 ± 1.82^b	-2.050 ± 0.04^b	148.6 ± 0.20^b
Rosehip flour, 10%	81.3 ± 0.56^c	-2.059 ± 0.00^c	128.5 ± 1.13^c
Rosehip flour, 15%	77.0 ± 1.73^d	-2.062 ± 0.00c	115.3 ± 0.72^d

$^{a-d}$: Means in a column without a common letter differ significantly ($p < 0.05$).

Different authors were studied the change in the colour of bread when additives had been included in the recipe. Erkan et al. (2006) concluded that instrumental measurement of baked products' colour was an inevitable quality check that could be used in determining the effects of ingredient or product formulation, process parameters and storage conditions on baked products. According to Callejo (2011), crumb color is highly related with ingredients (recipe). The use of flours, other than wheat, contributed to changes in the crumb color. Incorporation of rosehip flour decreased the brightness (L), colour tone (C) and bread saturation number (D) values which was most pronounced when 15% rosehip flour were included in the bread recipe. Increasing rosehip flour content led to the decrease in yellowness and resulted in the higher redness of bread crumb. This is due to the color of rosehip, which contain anthocyanins-compounds (Drożdż et al., 2014). A similar trend was found by Gül and Şen (2017b), who investigated the color characteristics of bread replacing 5%, 7.5% and 10% of wheat flour with rosehip flour. The results published by Boz et al. (2013), who studied the improvement of the quality of bread using different plant materials, are similar. They pointed out that the addition of rosehip flour decreased crumb L colour value. Therefore, crumb L colour value was lower in all samples containing rosehip. However, as mentioned by Gomez et al. (2003), the bread crumb colour is usually similar to the colour of the ingredients because during the baking the crumb does not reach as high temperatures as the crust.

Effect of rosehip flour substitution on physical properties of wheat bread

The results regarding the influence of added rosehip flour on the volume of bread are presented in Figure 3.

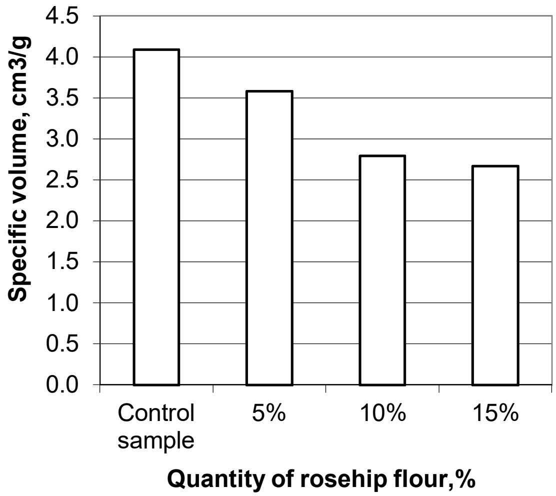

Figure 3. Effect of rosehip flour on the specific volume of wheat bread

Replacing part of the wheat flour with rosehip flour led to a change in the bread volume. The dependence between the amount of the additive and the change in the volume was pronounced. The highest volume was measured in the control sample (100% WF) – 1225 cm^3. The inclusion of 5% rosehip flour in the bread recipe caused a reduction in the volume by 13.5%. When 10% of the wheat flour were replaced by rosehip flour, the volume of the bread was 858.5 cm^3, which was 30% less than the control sample and 19% less than the sample with 5% rosehip flour. The most significant change in the bread volume was found with the inclusion of 15% rosehip flour – a reduction of 32% compared to the bread made from wheat flour only.

The specific volume varies from 4.09 cm^3/g (in the control sample of bread) to 2.67 cm^3/g (in the bread sample with 15% rosehip flour added). The control sample had the highest specific volume, and the more rosehip flour was included in the bread recipe, the denser it was. It was found that a high fibre content in rosehip flour dilutes gluten proteins during dough kneading, leading to a soft and inelastic dough. Thus, bread has a significantly smaller specific volume (Van Hung et al., 2007).

H/D index and baking loss of the tested samples of bread are presented in Table 5.

Table 5

Effect of rosehip flour on H/D index and baking loss of wheat bread

Samples	Height/Diameter	Bake loss,%
Control sample (100% WF)	0.60±0.01	11.04±0.08
Rosehip flour, 5%	0.55±0.01	10.60±0.03
Rosehip flour, 10%	0.56±0.02	9.89±0.08
Rosehip flour, 15%	0.57±0.01	9.44±0.04

The height/diameter ratio differed between the control and rosehip flour -supplemented samples. It is well known that bread volume correlates with the moisture of the dough. Thus, Gallagher et al. (2003) stated that higher moisture positively influences bread volume. A higher water absorption was already found for the control sample.

The average technological losses, on the other hand, changed slightly in a decreasing manner along with the increased percentage of rosehip flour. The values ranged from 11.04% for the control to 9.44% for the sample containing 15% rosehip flour. It can be assumed that rosehip flour retains water more firmly and the evaporation of water during the technological process was lower for the enriched samples.

Effect of rosehip flour substitution on sensory characteristics of wheat bread

The results obtained in the sensory analysis of wheat bread and breads enriched with rosehip flour (in the amount of 5, 10 and 15%) are presented in Figure 4.

The bread appearance is, for most consumers, one of the main criteria for evaluating the bread quality and is of great importance as a decision-making element of purchasing. In the present study, the bread samples with addition of rosehip flour differed in appearance from the control mainly by their lower height and volume. Moreover, there was a relationship between sensory and instrumental measured parameters. The scores, given by the panelists to the appearance of the control and rosehip flour substituted breads were in correlation with the values found for the instrumental measurements of the volume (Fig. 3), with decreasing values as the proportion of rosehip flour increased in the formulation. Similar results were also established by Gül and Şen (2017b). Van Hung et al. (2007) stated that the addition of fiber dilutes the proteins and prevents the formation of the optimal gluten network, explaining the decrease in bread volume when fiber-rich raw materials are added, such as rosehip flour.

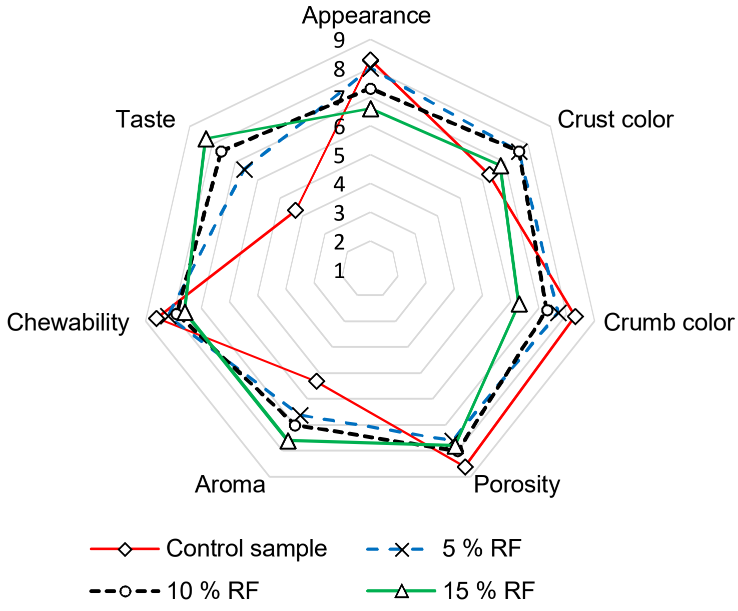

Figure 4. Effect of rosehip flour on sensory characteristics of bread.

Often, the color of bread is the first sensory characteristic perceived by the consumer, and color tends to influence consumer attitudes toward the product. The enriched bread samples had a more pronounced and more intense brown color of the crust, which increased as the amount of rosehip flour increased. The crust of the samples was thin, smooth and soft.

As the percentage of rosehip flour increased, the color of the bread crumb become darker and the whiteness decreased. This might be due to the high ash and anthocyanin content of rosehip flour. This accounted for the lower scores given by the panelists to the bread samples containing rosehip flour. There was a difference of almost 3 grades in the scores for the wheat bread and the bread with 15% rosehip flour added.

The control sample had smaller and evenly distributed pores and a higher porosity which was the reason for the higher scores given by the panelists. The porosity decreased with increasing the quantity of rosehip flour in the formulation. By comparing the samples containing rosehip flour with the control, it could be noted that rosehip flour had a positive influence on bread aroma which was most pronounced for the sample with 15% rosehip flour added. More than 30 aroma compounds were detected in the rosehip including terpenes, alcohols, esters, and aldehydes (Pashazadeh et al., 2021) which determined the stronger and much more pleasant aroma of the samples containing rosehip flour.

As pointed by Boz et al. (2013), chewiness is related to the effort needed to chew a solid sample, such as bread, to a steady state of swallowing. The crumb chewiness depends on the crumb firmness, cohesiveness and springiness. The highest chewiness value was determined for control sample (8.6), while a decreasing trend in the ratings of rosehip flour enriched samples was found. The scores range from 8.2 for the bread with 5% rosehip flour to 7.6 for the sample with 15% rosehip flour added.

The taste of the control sample was rated the lowest. The results showed that a higher amount of rosehip flour contributed to a much more pleasant taste and an increase in the scores given by the panelists. Rosehip flour contains a lot of substances with a pronounced taste (organic acids, phenolic compounds, and sugars) that determine its influence on the taste of wheat bread.

Other authors also studied the influence of rosehip flour on the sensory properties of bread and found that rosehip flour had a positive influence especially when used in low concentrations (up to 2%) (Ghendov-Mosanu et al., 2020). Kobilova et al. (2021) and Olsson et al. (2005) found that the addition of rosehip flour to the formulation favourably affected all sensory indicators of the finished products, especially taste, aroma and porosity.

Conclusions

1. The replacement of 5%, 10% or 15% of wheat flour with rosehip flour affected the intensity of gas formation: as the percentage of rosehip flour added increased, the intensity of gas formation decreased.
2. Incorporation of rosehip flour into wheat dough resulted in a decrease in water absorption and degree of softening. In terms of dough development time and consistency, there were no differences between the samples. Dough stability was found to be higher in the samples containing rosehip flour with the highest value reported for the sample with 5% rosehip flour added.
3. Dough and bread color characteristics (L, C and D) decreased with increasing the degree of replacement of wheat flour with rosehip flour in the range of 5 – 15%.
4. It was found that the substitution of wheat flour with rosehip flour at the amount of 5%, 10% or 15% resulted in a decrease in volume, specific volume, height/diameter ratio, and baking loss of the wheat bread.
5. Some of the sensory parameters of wheat bread, such as crust color, aroma and taste, in the bread with rosehip flour were rated higher by the panelists compared to the control sample, regardless of the amount of rosehip flour added.

Acknowledgment. Authors would like to thank to the Ministry of Education and Science of Bulgaria about the subsidy in accordance with the Ordinance on the Terms and Procedure for the Evaluation, Planning, Allocation and Expenses of the State Budget Funds for the Financing of the Inherent Research Activities of the State Higher Education Institutions. The acknowledgements are also to the academic management of University of Economics – Varna for the allocations in project NPI-55/2021 "Improving the quality and usefulness of food – trends and innovative practices (on the example of bread)".

References

AACC International. (2010), *AACC Approved Methods of Analysis, 11th ed.,* AACC International, St. Paul.

Amiri A., Shahedi M., Kadivar M. (2017), Structural properties of gluten modified by ascorbic acid and transglutaminase, *International Journal of Food Properties*, 20(2), pp. 1588–1599, DOI: 10.1080/10942912.2017.1349141.

Amjid M., Shehzad A., Hussain S., Shabbir M., Khan M., Shoaib M. (2013), A comprehensive review on wheat flour dough rheology, *Pakistan Journal of Food Sciences*, 23(2), pp. 105–123.

Berton B., Scher J., Villieras, F., Hardy J. (2002), Measurement of hydration capacity of wheat flour: Influence of composition and physical characteristics, *Powder Technology*, 128(2-3), pp. 326-331, DOI: 10.1016/S0032-5910(02)00168-7.

Bhave A., Schulzova V., Chmelarova H., Mrnka L., Hajslova J. (2017), Assessment of rosehips based on the content of their biologically active compounds, *Journal of Food and Drug Analysis*, 25(3), pp. 681–690, DOI: 10.1016/j.jfda.2016.12.019.

Blinova O., Prazdnichkova N., Trots A., Makushin A. (2016), The use of syrop from hips in the production of bread from wheat flour, *Modern Science Success*, 3(1), pp. 45–47.

Böhm, V., Fröhlich K., Bitsch R. (2003), Rosehip – a “new” source of lycopene? *Molecular Aspects of Medicine*, 24, pp. 385–389, DOI: 10.1016/S0098-2997(03)00034-7.

Boz H., Karaoğlu M., Kotancilar H., Gerçekaslan K. (2010), The effects of different materials as dough improvers for organic whole wheat bread, *International Journal of Food Science & Technology*, 45(7), pp. 1472–1477, DOI: 10.1111/j.1365-2621.2010.02289.x.

Boz H., Karaoğlu M. (2013), Improving the quality of whole wheat bread by using various plant origin materials, *Czech Journal of Food Sciences*, 31(5), pp. 457–466, DOI: 10.17221/410/2012-CJFS.

Callejo M. (2011), Present situation on the descriptive sensory analysis of bread, *Journal of Sensory Studies*, 26(4), pp. 255–268, DOI: 10.1111/j.1745-459X.2011.00341.x.

Cvetković B., Filipčev B., Bodroža-Solarov M., Bardić Ž., Sakač M. (2009), Chemical composition of dried fruits as a value added ingredient in bakery product, *Food Processing, Quality and Safety*, 36(1–2), pp. 15–20.

Demir F., Özcan M. (2001), Chemical and technological properties of rose (*Rosa canina* L.) fruits grown wild in Turkey, *Journal of Food Engineering*, 47, pp. 333–336, DOI: 10.1016/S0260-8774(00)00129-1.

Drożdż W., Tomaszewska-Ciosk E., Zdybel E., Boruczkowska H., Boruczkowski T., Regiec P. (2014), Effect of apple and rosehip pomaces on colour, total phenolics and antioxidant activity of corn extruded snacks, *Polish Journal of Chemical Technology*, 16(3), pp. 7–11, DOI: 10.2478/pjct-2014-0042.

Erkan H., Celik S., Bilgi B., Koskel H. (2006), A new approach for the utilization of barley in food products: barley tarhana, *Food Chemistry*, 97(1), pp. 12–18.

Ercisli S. (2007), Chemical composition of fruits in some rose (*Rosa spp.*) species, *Food Chemistry*, 104, pp. 1379–1384, DOI: 10.1016/j.foodchem.2007.01.053.

Fu L., Tian J.-C., Sun C.-L., Li C. (2008), RVA and farinograph properties study on blends of resistant starch and wheat flour, *Agricultural Sciences in China*, 7(7), pp. 812–822, DOI: 10.1016/S1671-2927(08)60118-2.

Gallagher E., Kunkel A., Gormley T., Arendt E. (2003), The effect of dairy and rice powder addition on loaf and crumb characteristics, and on shelf life (intermediate and long-term) of gluten-free breads stored in a modified atmosphere, *European Food Research and Technology*, 218, pp. 44–48, DOI: 10.1007/s00217-003-0818-9.

Ghendov-Mosanu A., Cristea E., Patras A., Sturza R., Niculaua M. (2020), Rose Hips, a Valuable Source of Antioxidants to Improve Gingerbread Characteristics, *Molecules*, 25(5659), pp. 10–18, DOI: 10.3390/molecules25235659.

Gomez M., Ronda F., Blanco C., Caballero P., Apesteguia A. (2003), Effect of dietary fiber on dough rheology and bread quality, *European Food Research and Technology*, 216, pp. 51–56, DOI: 10.1007/s00217-002-0632-9.

Gül H., Gül M. (2011), High fiber bread consumption and consumers' awareness: a case study from Isparta, *Proceedings of the International Food Congress Novel Approaches in Food Industry*, May 26-29, Çeşme, Izmir, Turkey, p. 899.

Gül H., Şen H. (2017a), Effects of rosehip seed flour on the rheological properties of bread dough, *Scientific Bulletin. Series F. Biotechnologies*, 21, pp. 330–335.

Gül H., Şen H. (2017b), The influence of rosehip seed flour on bread quality, *Scientific Bulletin. Series F. Biotechnologies*, 21, pp. 336–342.

ISO 6658:2017 (2017), *Sensory Analysis–Methodology–General Guidance*, ISO, Geneva.

Kaiyun L. (2016), *Eye-Protecting Anti-Radiation Pineapple Bread and Preparation Method*, Thereof. Patent CN 105341087 A.

Karadzhov G., Vangelov A. (1982), Apparatus for determining the gas-forming properties of flour, *Scientific Works of Higher Institute of Food Industry – Plovdiv*, 29(1).

Kim W., Lee G. (2015), Comparison of imported wheat flour bread making properties and korean wheat flour bread making properties made by various bread making methods, *Journal of Korean Society of Food Science and Nutrition*, 44(3), pp. 434–441, DOI: 10.3746/jkfn.2015.44.3.434.

Kobilova N., Raxmatov E., Shomuradova N., Murtazaevave K. (2021), Research of the influence of powders from rosehips from rosehips on indicators of national peels, *Journal for Innovative Development in Pharmaceutical and Technical Science*, pp. 171–173.

Kohajdová Z., Karoviˇcová J., Jurasová M., Kukurová K. (2011), Effect of the addition of commercial apple fibre powder on the baking and sensory properties of cookies, *Acta Chimica Slovaca*, 4, pp. 88–97.

Murathan Z., Zarifikhosroshahi M., Kafkas E. (2016), Determination of fatty acids and volatile compounds in fruits of rosehip (*Rosa* L.) species by HS-SPME/GC-MS and Im-SPME/GC-MS techniques, *Turkish Journal of Agriculture and Forestry*, 40(2), pp. 269–279.

Nassar A., Abdel-Hamied A., El-Naggar E. (2008), Effect of citrus by-products flour incorporation on chemical, rheological and organoleptic characteristics of biscuits, *World Journal of Agricultural Sciences*, 4, pp. 612–616.

Novotni D., Cukelj N., Smerdel B., Bituh M., Dujmi´c F., Ćurić D. (2012), Glycemic index and firming kinetics of partially baked frozen gluten-free bread with sourdough, *Journal of Cereal Science*, 55(2), pp. 120–125, DOI: 10.1016/j.jcs.2011.10.008.

Oliinyk S., Samokhvalova O., Lapitska N., Kucheruk Z. (2020), Studying the influence of meals from wheat and oat germs, and rose hips, on the formation of quality of rye-wheat dough and bread, *Eastern-European Journal of Enterprise Technologies*, 1, pp. 59–65, DOI: 10.15587/1729-4061.2020.187944.

Olsson M., Andersson S., Werlemark G., Uggla M., Gustavsson K. (2005), Carotenoids and phenolics in rose hips, *Acta Horticulturae*, 690, pp. 249–253, DOI: 10.17660/ActaHortic.2005.690.38.

Paredes-López O., Cervantes-Ceja M. L., Vigna-Pérez M., Hernández-Pérez T. (2010), Berries: improving human health and healthy aging, and promoting quality life—A review, *Plant Foods for Human Nutrition*, 65(3), pp. 299–308, doi:10.1007/s11130-010-0177-1.

Pashazadeh H., Ozdemir N., Zannou O., Koca I. (2021), Antioxidant capacity, phytochemical compounds, and volatile compounds related to aromatic property of vinegar produced from black rosehip (*Rosa pimpinellifolia* L.) juice, *Food Bioscience*, 44, pp. 1–10, DOI: 10.1016/j.lwt.2021.112716.

Pozdnyakova O., Zakharenko M., Nazimova E., Romanov A. (2019), Technological aspects of obtaining extract from rose hips and its use in bread production, *Achievements of Science and Technology in Agro-Industrial Complex*, 12, pp. 102–106.

Stabnikova O., Marinin A., Stabnikov V. (2021), Main trends in application of novel natural additives for food production, *Ukrainian Food Journal*, 10(3), pp. 524–551, DOI: 10.24263/2304-974X-2021-10-3-8.

Sudha M., Baskaran V., Leelavathi K. (2007), Apple pomace as a source of dietary fiber and polyphenols and its effect on the rheological characteristics and cake making, *Food Chemistry*, 104(2), pp. 686–692, DOI: 10.1016/j.foodchem.2006.12.016.

Tertychnaya T., Mazhulina I., Vysotskaya E., Andrianov E., Glotova I. (2020), New formulas of muffins of functional purpose with rosehip and broccoli, *Journal of Critical Reviews*, 7(9), pp. 1732–1740, DOI: 10.31838/jcr.07.09.309.

Van Hung P., Maeda T., Morita N. (2007), Dough and bread qualities of flours with whole waxy wheat flour substitution, *Food Research International*, 40(2), pp. 273–279, DOI: 10.1016/j.foodres.2006.10.007.

Vartolomei H., Turtoi M. (2021), The influence of the addition of rosehip powder to wheat flour on the dough farinographic properties and bread physico-chemical characteristics, *Applied Science*, 11(24), 12035, DOI: 10.3390/app112412035.

Wricht W. (1985), *The measurement of colour*, Bilger Hatto, London.