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Mineral content of wheat bread enriched with chestnut and rosehip flour

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Abstract

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Additives that are rich in biologically active substances are suitable for wheat bread supplementation, including raw materials that are not traditional for breadmaking (such as chestnut flour and rosehip flour). The aim of the present study is to examine the mineral content of wheat bread enriched with chestnut flour and rosehip flour (in the amount of 5% and 10%). It was found that the inclusion of these additives in the bread recipe increased the content of all the investigated elements (except sodium). The content of mineral elements was determined using the ICP-AES method. Among the macroelements, the most significant increase in content was that of calcium when 10% rosehip flour was added to the recipe – 296 mg/kg (in the control sample – 108 mg/kg). Among microelements, the iron content had significant increase upon addition of 10% rosehip flour – 14.7 mg/kg. This amount was almost 11 times higher than that measured in the control sample (1.34 mg/kg). The manganese content also increased notably – it was 5.83 mg/kg in the sample with 10% chestnut flour, which is nearly 80% more than in the control sample.

Keywords: wheat bread; enriched bread; mineral content; chestnut flour; rosehip flour

Introduction

Bread has been part of the human diet for thousands of years and it remains the most consumed food in the world, due to its nutritional value and taste. Its quality depends on different physical (i.e. texture, volume, colour) and sensory properties, which could be influenced by factors, such as flour type and other ingredients, bread-making procedure, fermentation, baking time and temperature (Dall'Asta et al., 2013). In recent years, bread has attracted more and more attention as a potential functional food based on its wide distribution and consumption. Therefore, industries and researchers are involved in the optimization of bread-making technology to improve the availability of bioactive compounds, adding different components with nutritional and functional properties (Balestra et al., 2011; Pasqualone et al., 2011). In this context, the use of flours obtained from non-traditional raw materials in the bread formulation to obtain a healthier product containing bio-active compounds, has been widely studied in the literature (Hofmanová et al., 2014; Hruśková et al., 2019; Bojánanská et al., 2021). Non-traditional components can improve the chemical composition of wheat cereal products owing to their high protein, fiber, unsaturated fatty acids or other compounds with a positive effect on human health (vitamins, minerals, antioxidants) (Sanz-Penella et al., 2013). A number of authors have studied the possibility of increasing the content of biologically active substances (including mineral substances) by adding to the bread recipe flours that are not traditional for bread production (Cvetković et al., 2009; Lyu et al., 2020; Mau et al., 2020; Pycia et al., 2020; Wahy-

ono et al., 2020; Twelve et al., 2021). Of interest to the food industry is the possibility of utilizing different types of flour from natural sources available in our country.

European sweet chestnut (*Castanea sativa Mill.*) is mainly grown in continental European regions and has represented one of the most important and sustainable food resources of rural areas for many centuries (Raczyk et al., 2021). Chestnut flour is obtained by grinding dried chestnuts and it has a high starch content (50–60%), relatively high amount of sucrose (20–32%), high-quality proteins with essential amino acids (5–8%), dietary fibres (4–10%), and a low amount of lipids (2–4%) (Dall'Asta et al., 2013; Littardi et al, 2020). According to Borges et al. (2008) chestnut fruits are good sources of minerals – Ca, P, K, Mg, S, Fe, Cu, Zn, and Mn. A number of authors have investigated the possibility of using chestnut flour in bread making, studying its effect on dough rheology (Moreira et al., 2011); on the textural and sensory properties (Bhat et al., 2015; Raczyk et al., 2021); shelf-life (Paciulli et al., 2016); physico-chemical properties an oxidative stability (Paciulli et al., 2018); volatiles of bread (Dall'Asta et al., 2013) and other bakery products.

Rosehip (*Rosa Canina* L.) is a shrub of the *Rosaceae* family growing in Europe, northwest Africa, and western Asia. Rosehip fruits are an important source of sugars, particularly the reducing sugars, ascorbic acid, antioxidants, carotenoid pigments, organic and fatty acids (Ercisli, 2007; Guimaraes et al., 2010; Murathan et al., 2016, Gül and Şen, 2017), they also contain minerals (Fan et al., 2014; Popovici et al., 2019). The average mineral composition of rosehip flour (mg/100g) is as follows: Ca 169 mg, Fe 1.06 mg, Mg 69 mg, P 61 mg, K 429 mg, Na 4 mg, Zn 0.25 mg, Cu 0.113 mg, Mn 1.02 mg. Rosehip fruits have been used, as a powder or an extract, in various formulas in bakin to enhance the bread's nutritional value and sensory properties (Krolevets, 2017).

Gül and Şen (2017) pointed out that sensory quality and overall acceptability of bread with 5% rosehip flour was almost similar to that of the control sample, thus rosehip flour may be used as a nutritional, healthy, functional and novel ingredient in high fiber bread formulations to produce a bread of acceptable baking properties. Vartolomei and Turtoi (2021) concluded that bread prepared from wheat flour with the rosehip powder addition had 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. Antarkar et al. (2019) presented some research results on physico-chemical properties and nutritional value of cookies with added rosehip and hibiscus powder. They found that the substitution with rosehip and hibiscus powder has a significant share in enhancing the total phenolic content, total antioxidant capacity and other bioactive compounds in cookies.

Although the effect of these two types of flour on the rheological properties of the dough and the quality of traditional or gluten-free bread (volume, porosity, acidity, sensory properties) has often been studied, researches on the mineral composition of wheat bread enriched with chestnut and rosehip flour are scarce.

Mineral substances perform important functions in the metabolism of the human body. Potassium plays a major role in cellular metabolism and is involved in the secretion of hormones and in the regulation and synthesis of proteins and glycogen (EFSA, 2019). Calcium is a key regulator of a multitude of cellular processes, including cell proliferation and cell metabolism, it is responsible for muscle contraction and bone mineralization (Yildirim et al., 2013). Iron is an essential element required for oxygen transport, electron transfer, for oxidase activities and energy metabolism (EFSA, 2019). Insufficient iron intake leads to serious health disorders, most often associated with iron deficiency anemia. According to WHO data, 42% of children under the age of 5 and 40% of pregnant women in the world are anemic. Zinc has a wide range of vital physiological functions (EFSA, 2019). The main role of zinc is that it is included in a number of enzymes that regulate the synthesis of proteins and DNA, the synthesis of hormones and the metabolism of growth factors in the development of children (Salgueiro et al., 2002; Prasad et al., 2014).

The lack of some mineral substances, in addition to causing diseases (osteoporosis, anemia, etc.), acts as an additional factor in some chronic diseases, having a significant impact on the morbidity, mortality and quality of life of the population. That's why it is very important that the food consumed daily acquires the needed amount of minerals.

The aim of the present paper is to study the effect of chestnut flour and rosehip flour (added in the amounts of 5% and 10% on the basis of flour) on the mineral composition of bread made of type 500 wheat flour. Defining the extent to which consumption of enriched bread covers the recommended daily intake of minerals is also within the scope of interest.

Materials and methods

Materials

The following materials have been used for preparing the samples of bread:

– type 500 wheat flour in accordance with Approved standard "Bulgaria" 01/2011 (chemical composition: fat 0.9 g/100 g, 0.3 g of which are saturated fat; carbohydrates 70.3

g/100 g, 3.4 g of which are sugars, fibre 4.0 g/100 g; protein 10.8 g/100 g);

– chestnut flour (chemical composition: fat 3.7g/100 g, 0.7g of which are saturated; carbohydrates 70.9 g/100 g, 29.5 g of which are sugars, fiber 10.8 g/100 g; protein 6.4 g/100 g), commercially available;

– rosehip flour (chemical composition: fat 0 g/100 g, carbohydrates 38 g/100 g, 3 g of which are sugars, fiber 24 g/100 g; protein 2 g/100 g), commercially available;

– water – in accordance with ISO 6107-1:2004;

– pressed yeast – manufactured by Lesaffre Bulgaria Ltd, in accordance with Bulgarian state standard 483:90;

– salt – in accordance with Codex Standard for Food Grade Salt CX STAN 150-1985.

Methods

Preparing the dough and the bread

The samples of bread were obtained by using a two-stage method. First, knead the yeast (2.00 kg/ 100 kg flour), flour (control and experimental samples to obtain 100 g) and water (100 g) of dough in kneading machine (Labomix 1000, Hungary). The control sample was prepared only with wheat flour and the other bread samples tested were prepared with chestnut flour (CF) or rosehip flour (RF) replacing 5% or 10% of wheat flour. These amounts were chosen after previous experimental studies according to which the addition of up to 10% of the selected flours leads to an increase in the biological value of bread without negatively affecting its quality. The dough thus prepared matured for 60 min at 33°C. Then the dough was mixed to obtain a homogeneous mass by adding the other ingredients (flour and water) according to the formulation and salt (1.33 kg/100 kg flour). The dough was left to rest for 20 min and was then divided into pieces of 440 g – pan bread. After shaping, the dough was subjected to a final fermentation at 33 °C for 60 min in a fermenting chamber (Tecnopast CRN 45–12, Novacel Rovimpex Novaledo Trento, Italy). The dough was then baked in an electric floor oven Salva E-25 (Salva Industrial S.L.U., Lezo, Spain), preheated to a temperature of 220–230°C, for 22–24 min. After baking, the breads were allowed to cool for 3 hours at room temperature (Zlateva et al., 2022). The formulations of the studied samples of bread are presented in Table 1.

Mineral Content Determination

To determine the content of mineral elements a validated multistep analysis method was used applying ICP-AES. Mineralization of the sample is performed according to BSS EN 13 805:2015 "Food products. Determination of trace elements. Digestion under pressure." The tests carried out in the accredited laboratory of SGS Bulgaria EOOD, were carried out in accordance with the internal laboratory method (VLM 40:2009).

Statistical Analysis

All analyses were carried out in triplicate. The results are presented as an average mean ± standard deviation. Statistical evaluation was performed by one-way analysis of variance (ANOVA) using Statgraphics Centurion statistical program (version XVI, 2009) (Stat Point Technologies, Ins., Warrenton, VA, USA). Mean differences were established by Fishers test with a significance level $\alpha = 0.05$.

Results and Discussion

The results obtained when examining the content of the macroelements potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), sulfur (S) and phosphorus (P) in the bread samples prepared with 5% or 10% chestnut flour and rosehip flour, as well as in bread samples prepared only with type 500 wheat flour, are presented in Table 2.

It was established that the enrichment of wheat bread with chestnut and rosehip flour affects the content of all examined mineral elements.

The potassium content was the lowest in bread made only from wheat flour – 718 mg/kg, which is consistent with the potassium content of type 500 wheat flour (822.5 ± 45.5 mg/kg). When 5% chestnut flour were added, the potassium content increased by 27%. Replacing wheat flour with the

Table 1. Formulations of bread samples

Ingredients of bread recipe	Control sample of bread	Samples of bread with chestnut flour (%)		Samples of bread with rosehip flour (%)	
		5	10	5	10
Wheat flour, g	450.00	427.50	405.00	427.50	405.00
Water, ml	248.00	248.00	248.00	248.00	248.00
Yeast, g	9.00	9.00	9.00	9.00	9.00
Salt, g	6.00	6.00	6.00	6.00	6.00
Chestnut flour, g	–	22.50	45.00	–	–
Rosehip flour, g	–	–	–	22.50	45.00

Table 2. Content of macroelements in wheat bread, bread with 5% and 10% chestnut flour and 5% and 10% rosehip flour added (mg/kg)

Mineral elements	Mineral content of bread samples, mg/kg				
	Control sample of bread	Bread containing chestnut flour in the amount of		Bread containing rosehip flour in the amount of	
		5 %	10 %	5 %	10 %
K	718 ± 50.77^{d}	913 ± 64.56^{c}	1016 ± 71.84^{bc}	1109 ± 78.42^{b}	1314 ± 92.91^{a}
Ca	108 ± 7.64^{c}	111 ± 7.85^{c}	125 ± 8.84^{c}	221 ± 15.63^{b}	296 ± 20.93^{a}
Mg	158 ± 11.17^{c}	174 ± 12.30b^{c}	187 ± 13.22^{abc}	193 ± 13.64^{ab}	214 ± 15.13^{a}
Na	3014 ± 213.12^{a}	2482 ± 175.50^{b}	2424 ± 171.40^{b}	2282 ± 161.36^{b}	2269 ± 160.44^{b}
S	589 ± 41.65^{b}	973 ± 68.80^{a}	1095 ± 77.43^{a}	693 ± 49.00^{b}	969 ± 68.52^{a}
P	511 ±3 6.13^{d}	586 ± 41.44^{cd}	640 ± 45.25^{bc}	726 ± 51.34^{ab}	812 ± 57.42^{a}

$^{a-d}$: Means in a row without a common letter differ significantly ($p < 0.05$).
Source: author's research

same amount (5%) of rosehip flour increased the potassium content to 1109 mg/kg, which was 55% more than in the control sample. Bread with 10% rosehip flour contained 1314 mg/kg of potassium. This amount was 30% higher than that measured in bread with 10% chestnut flour and 83% higher than that in the control sample. According to Paunović et al. (2019), the potassium content in rosehips is 566.75 ± 4 mg/100 g, while other authors indicate higher values 11891 ± 170.41 mg/kg (Cvetković et al., 2009). Based on the amount of potassium in rosehips, Cvetković et al. (2009) applied a mathematical model to estimate the content of this element in wheat bread when 10% rosehip flour is added. According to them, in bread enriched with 10% rosehip flour, the potassium content would be 834.21 mg/kg, which is close to the result obtained in the present study.

Shafi et al. (2017) studied the calcium content of different samples of chestnut flour and found that its amount was in the order of 356.4 ± 0.02 (ppm) and higher, 509.6 ± 0.06 (ppm). The data in Table 2 show that the calcium content of the control sample is 108 mg/kg, which is lower than the calcium content of wheat flour (203 ± 12 mg/kg). Values close to this were measured for the bread sample prepared with 5% chestnut flour – 111 mg/kg. When the amount of the additive was 10%, the calcium content increased by 17 mg/kg. The enrichment of wheat bread with rosehip flour leads to a more noticeable difference in calcium content. According to Fan et al. (2014), the calcium content of rosehips is 169 mg/100g, and according to Paunović et al. (2019), it is 348.12 ± 2 mg/100g dw. The conducted tests showed that the calcium content was the highest when 10% of wheat flour was replaced by rosehip flour – 296 mg/kg, which was 2.7 times higher than in the control sample and 2.4 times higher than in the sample with 10% chestnut flour. Similar results have been published by Cvetković et al. (2009). They measured the calcium content of dried rosehips (3795 ± 80.61 mg/kg) and concluded that in bread enriched with 10% rosehip flour, the calcium content would be 249.18 mg/kg.

The magnesium content was also increased when chestnut or rosehip flour was added to the wheat bread recipe. Other studies indicate that the magnesium content of chestnut flour ranges from 1158 ± 0.05 (ppm) to 1179 ± 0.04 (ppm) (Shafi et al., 2017). According to literature, the magnesium content of rosehips is from 69 mg/100g (Fan et al. 2014) to 135.61 ± 0.6 mg/100g dw (Paunović et al. 2019). These differences are probably due to the difference in plant genotype, soil-climatic conditions and agricultural cultivation practices. The data in Table 2 show that the sample with 5% chestnut flour contains 174 mg/kg magnesium, and the one with 5% rosehip flour – 193 mg/kg. As the amount of the additives increases, so does the magnesium content. The latter is highest in bread with 10% rosehip flour – 214 mg/kg.

The conducted study established that the addition of chestnut and rosehip flour to wheat flour causes a decrease in the sodium content. The sodium content of type 500 wheat flour is 31.00 mg/kg, while according to some authors, it is below the detectable minimum in rosehip flour (Paunović et al. 2019; Igual et al., 2022). The sodium content of wheat bread is 3014 mg/kg. If 5% or 10% chestnut flour is added to the recipe, the sodium content decreases by 17.7% and 19.6%, respectively. A decrease in the sodium content when the amount of chestnut flour is increased was established also by Mir et al. (2019). In the samples enriched with these same amounts of rosehip flour, the sodium content was 2282 mg/kg and 2269 mg/kg, respectively.

The flours used as additives increased the sulfur content of the wheat bread. The lowest values were those measured in the control sample – 589 mg/kg, while the highest content was in the samples prepared with the addition of chestnut flour. When 10% of wheat flour was replaced with chestnut flour, the sulfur content increased almost twice (1095 mg/kg). An increase in the sulfur content in snacks when the

amount of chestnut flour in the recipe is increased was established also by Mir et al. (2019).

About 85% of phosphorus is bound with calcium in the form of apatites, which are involved in building the bone system, 14% is contained in soft tissues, and 1% in extracellular fluids (EFSA, 2019). Its amount in bread increases more significantly when rosehip flour is used. The sample with 5% rosehip flour contained 42% more phosphorus than the control sample and 24% more than the sample to which the same amount of chestnut flour was added. When rosehip flour is 10%, the phosphorus content reaches 812 mg/kg (1.6 times more than in the control sample). These results are supported by a study by Paunović et al. (2019), according to whom rosehips are a good source of phosphorus (94.68 ± 0.4 mg/100g dw).

The results of the determination of the examined microelements iron (Fe), manganese (Mn), copper (Cu), nickel (Ni) and zinc (Zn) are presented in Figure 1.

It was found that the content of microelements depends on both the type and the quantity of the additive.

The data presented in the Figure 1 show that the iron content varies widely, with the lowest values measured in the control sample of bread – 1.34 mg/kg. This value is close to the iron content in wheat flour – 1.38 mg/kg. It is twice as high in the sample enriched with 5% chestnut flour. When the amount of the additive is increased to 10%, the iron content reaches 4.18 mg/kg, which is more than 3 times that of the control sample. Pereira-Lorenzo et al. (2006) studied chestnuts from 47 cultivars grown in different regions of Spain. They measured an average iron content of 18.8 ppm, with a range of 14 ppm to 23.8 ppm, and point out that the differences between cultivars were due to the genetic differences of the plants (Pereira-Lorenzo et al. 2006). The addition of rosehip flour to the wheat bread recipe also increases the iron content of the finished product. Its amount is almost 9 times higher in the sample with 5% rosehip flour than in the control sample, while in bread with 10% rosehip flour, the iron content increases up to 11 times compared to wheat bread, reaching 14.7 mg/kg. Rosehips are valued for their chemical composition and health effects on the human body. Paunović et al. (2019) found the iron content of rosehips to be 1.22 ± 0.02 mg/100 g dw. This result is close to the data published by Fan et al. (2014) – 1.06 mg/100 g, and therefore rosehips can be considered a good source of iron. A higher value was measured by Cvetković et al. (2009), who also examined the iron content of rosehips – 13.16 ± 0.25 mg/kg.

The manganese content of wheat bread is 3.26 mg/kg. Manganese content in wheat flour varies within very wide limits (3.9±0.2 – 14.7±1.8 mg/g^{-1}) depending on the botanical species and variety of wheat, growing conditions, grinding characteristics, etc. (Araujo et al., 2008). When 10% chestnut flour was included in the recipe, the amount of this microelement increased to 5.83 mg/kg, which was almost 80% more than in the control sample. These results are supported by the data provided by Pereira-Lorenzo et al. (2006), according to whom manganese is in the highest amount of all microelements in the composition of chestnuts. The amount of manganese when 5% or 10% rosehip flour was added was 4.42 mg/kg and 5.19 mg/kg, respectively.

The copper content was also affected by the addition of chestnut or rosehip flour to wheat bread. The difference in copper content was more noticeable when the bread was supplemented with chestnut flour. The amount measured in the control sample was 0.95 mg/kg, and with 10% chestnut flour added, the copper content was 1.15 mg/kg. A high copper content in chestnuts has been found also by Pereira-Lorenzo et al. (2006).

The addition of chestnut and rosehip flour did not significantly affect the nickel content of the tested samples. The amount in the control sample was 0.26 mg/kg, while

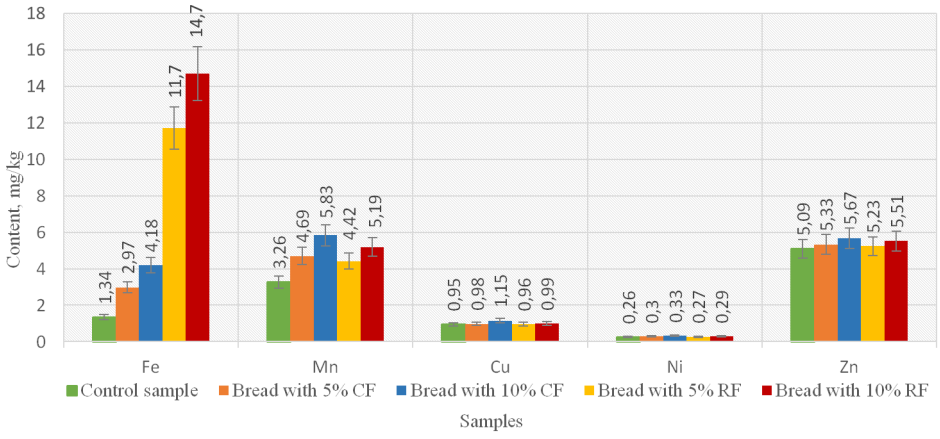

Fig. 1. Content of microelements (mg/kg) in wheat bread and bread enriched with chestnut flour (CF) or rosehip flour (RF) – 5% and 10%

Source: author's research

the highest measured value was 0.33 mg/kg – in the sample enriched with 10% chestnut flour, but the differences were not statistically significant. In the human body, nickel is part of the nickel-containing metalloenzyme urease and can participate in nitrogen metabolism (Paunović et al. 2019).

Although the addition of chestnut or rosehip flour increased the zinc content of the studied samples, the values obtained were relatively similar to each other. The control sample contained 5.09 mg/kg zinc. The addition of 5% or 10% chestnut flour increased the zinc content to 5.33 mg/kg and 5.67 mg/kg, respectively. The zinc content was affected to a lesser extent when rosehip flour (5% and 10%) was used – it was 5.23 mg/kg and 5.51 mg/kg, respectively.

The need to determine an adequate intake of minerals is indisputable. In this regard European Food Safety Authority (EFSA) published a Summary report on the Dietary Reference Values for nutrients of the European population (EFSA, 2019). The report differentiates the recommended minerals intake depending on the sex and age characteristics of the population.

Table 3 presents data on the extent to which the reference values for the intake of mineral elements are achieved when consuming 250 g of bread from the studied samples (an amount close to the daily average consumption of bread per capita in Bulgaria).

For men and women in the age over 25 years, the recommended daily intake of iron is 11 mg. The extent to which the daily consumption of bread from the control sample satisfies the recommended daily intake is only 3.05%. If the bread contains 5% or 10% of chestnut flour, the body's daily need for iron will be met at 6.75% and 9.50% respectively. The consumption of bread supplemented with 10% rosehip flour would provide the body with 1/3 of the required daily intake.

Regarding the content of calcium, the wheat bread provides 2.84% of the recommended daily intake (950 mg/d). The consumption of bread with the addition of 10% rosehip flour would supply the body with 2.4 times higher amount of calcium than the sample prepared with the same amount of chestnut flour. And compared to the control sample, it would be almost three times higher.

To maintain good health, a person needs a certain amount of phosphorus available in food. Wheat bread provides 23.23% of the required amount – 550 mg/d for men and women. A higher degree of satisfaction of the recommended daily intake of phosphorus is given by the sample with 10% rosehip flour – it provides 36.91% of the required amount.

According to the EFSA report, the body need of magnesium is 350 mg/d for men and 300 mg/d for women. Adding chestnut or rosehip flour would contribute to a higher magnesium intake. The highest result was found in the sample with 10% rosehip flour added – 15.29% of the required amount of magnesium for men and 17.83% for women.

The recommended daily intake of copper is 1,6 mg/d for men over 25 years of age and 1.3 mg/d for women at the same age. Consumption of wheat bread provides 14.84% of this amount for men and 18.3% for women. If 5% or 10% of the wheat flour is replaced with chestnut flour, then the body's daily need for Cu will be met at 15.31% or 17.97% for men and 18.84% or 22.12% for women.

As seen from Table 3, bread enriched with chestnut or rosehip flour would provide a higher intake of manganese.

Table 3. Extent of satisfaction of the recommended daily intake (RDI) of mineral substances, (in%) when consuming 250 g of bread daily

Mineral elements	Sex	RDI mg/d	Extent of satisfaction of the recommended daily intake of mineral substances, when consuming 250 g of bread daily, in %				
			Control sample of bread	Bread containing chestnut flour in the amount of		Bread containing rosehip flour in the amount of	
				5%	10%	5%	10%
Iron	Men/Women	11	3.05	6.75	9.50	26.59	33.41
Calcium	Men/Women	950	2.84	2.92	3.29	5.82	7.79
Potassium	Men/Women	3500	5.13	6.52	7.26	7.92	9.39
Magnesium	Men	350	11.29	12.43	13.36	13.79	15.29
	Women	300	13.17	14.5	15.58	16.08	17.83
Phosphorus	Men/Women	550	23.23	26.64	29.09	33.00	36.91
Manganese	Men/Women	3	27.17	39.08	48.58	36.83	43.25
Copper	Men	1.6	14.84	15.31	17.97	15	15.47
	Women	1.3	18.27	18.84	22.12	18.46	19.04
Zinc	Men	9.4	13.54	14.18	15.08	13.91	14.65
	Women	7.5	16.97	17.77	18.90	17.43	18.37

Source: calculated by the authors

Population reference intakes for zinc may range: 7.5 – 12.7 mg/d for women and 9.4 – 16.3 mg/d for men, depending on phytate intake. The extent to which the recommended values are met when consuming wheat bread are 13.54% for men and 16.97% for women (for the lower limit of the referenced values). When 10% chestnut flour is added 15.08% of the recommended intake for men and 18.90% for women are satisfied respectively. In comparison, for the sample with 10% rosehip flour, this score would be 14.65% for men and 18.37% for women.

Conclusions

Based on the results obtained in the present study, it can be concluded that the supplementation of wheat bread with chestnut and rosehip flour, in amounts of 5% and 10%, respectively, increases the content of all minerals examined (except sodium). Of the macroelements, the content of calcium was most significantly affected when 10% rosehip flour is added to the recipe – 296.00 mg/kg (108 mg/kg in the control sample). Of the microelements, the iron content increased most significantly – 14.7 mg/kg (11 times higher that in the control sample) in the bread with 10% rosehip flour added. As for the rest of the microelements, the enrichment caused an increased from 11.4% (zinc) to almost 80% (manganese) compared to the control sample. The consumption of wheat bread enriched with chestnut or rosehip flour is a suitable way to improve the intake of minerals and reach levels much closer to the recommended daily intake.

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