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Fiber and microelements content in various types of wheat bread

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Abstract: Various types of wheat bread are present in the Serbian market: white, brown, whole-wheat, wheat/rye, buckwheat/wheat, half-white and corn/ /wheat bread. This research included the quantification of the content of total fiber, fiber fractions, and microelements (manganese, copper, iron and zinc) in order to check whether the breads on the market contain the amounts that are proven beneficial for health. The aim was also to determine the contribution of these nutrients through the consumption of bread to the recommended daily intake. The results show that the bread from the Serbian market contains a large amount of arabinoxylan (1.2–2.6 g 100 g^{-1}) and that wheat/rye, brown and whole wheat bread are sources of dietary fiber (4.0–4.6 g 100 g^{-1}). Also, an important result is that all types of bread except white, contain more than 15 % of dietary reference values for copper and manganese. The intake of total fiber (+ 100 %), arabinoxylan (+ 117 %), copper (+ 118 %), and manganese (+ 85 %) increases by replacing white bread with whole wheat bread, therefore it is of great interest to raise awareness among consumers about the beneficial foods that should be included in the diet. Methods applied in this research showed acceptable precision and accuracy and also proved to be quite simple for routine analysis work.

Keywords: bread; total fiber; arabinoxylan; beta glucan; microelements.

INTRODUCTION

Recommendations on proper nutrition, as one of the basic prerequisites for a healthy and quality lifestyle, clearly refer to the use of vegetables, fruits, grains, dairy products, protein foods, and oils. These types of foods are good sources of energy and nutrients, but one must take into account the changes caused by their

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processing, which can lead to the loss of important nutritionally active components. No less important are the consumers′ habits that need to be adapted and directed in the function of health.[1]

Bread is the basic component of the daily diet in Serbia – even 86.2 % of the population consume it, mostly white bread (60.1 %).[2,3]

As bread belongs to the group of grain products, depending on whether it is made from whole or refined grains, it is declared as whole-wheat or white bread.[1] There is an important difference between these two types of bread regarding the content of biologically active compounds. In contrast to white bread, whole-wheat bread is rich in dietary fiber, vitamins and minerals.[4]

In whole grain cereals, dietary fiber in the rye is 15.5 % and in wheat, it is nearly 12 % (results are in % dry basis).[5] The content of arabinoxylan, an important dietary fiber component, varies from 4.8 to 7.6 % in wheat and 7.6–12.1 % in rye.[6] The whole grain is composed of 80–85 % endosperm, 12–18 % bran and 2––3 % germ.[7] The total nonstarch polysaccharides of wheat bran consist of arabinoxylan (17–33 %), cellulose (9–14 %), fructan (3–4 %) and *β*-D-glucan (1–3 %).[8] The higher the proportion of wheat bran in the flour, the higher will be the content of arabinoxylan and beta-glucans.[9]

Dietary fiber, vitamins, and minerals are associated with a reduced risk of various diseases.[10] Many studies indicate the beneficial effects of dietary fiber and fiber fractions on health. Arabinoxylan, the most abundant dietary fiber fraction, has been found to be very effective in preventing diabetes and reducing postprandial glycemia.[11,12] The meta-analysis of prospective studies confirmed an inverse relationship between the intake of wholegrain cereals and diabetes mellitus type 2.[13] Also, the meta-analysis by Huang *et al.* showed that high consumption of whole grains or cereal fibers can be associated with a reduced risk of non-communicable diseases (NCD).[14] Wolever *et al.* reported that beta glucan from oats is more effective on lowering LDL-cholesterol than beta glucan from wheat bran.[15] Regular intake of an adequate amount of dietary fiber is considered good for controlling obesity and blood cholesterol levels.[16,17]

Summarizing data from studies that dealt with the mineral composition of grain products, it can be concluded that the most abundant microelements in grains are iron, zinc, manganese and copper.[18,19] The importance of microelements for the human organism is well known. Iron is a component of hemoglobin and, as well as zinc, is important for the functioning of a large number of enzymes.[4] Copper participates in the synthesis of hemoglobin, as well as in redox reactions, while manganese is necessary for many metabolic functions.[20,21] Due to the importance of these elements, their appropriate intake is necessary and for that reason, they are included in dietary reference values (DRVs) for nutrients.[22]

There are three goals of this study: to examine the quality of bread present in the Serbian market from the aspect of the content of fibers and selected microelements, to determine to what extent these types of bread contain fibers and microelements that were proven to be health beneficial and to determine what is the contribution of these nutrients to their recommended daily intakes.

EXPERIMENTAL

Samples and sample preparation

A total of 69 bread samples were obtained from local markets in Novi Sad. All products on sale in bakeries as well as unpacked products available in food shops were bought on the same day when they were made, while a number of products were prepacked breads with prolonged usage periods, bought within their expiration date.

Bread samples were classified into seven types, based on their characteristics, *i.e.*, main ingredients. This classification was made following Serbian regulations regarding the quality of cereals and cereal products.[23] These seven types were: brown bread (BB, 17 samples), whole-wheat bread (WWB, 12 samples), wheat/rye bread (WRB, 6 samples), buckwheat/wheat bread (BWB, 13 samples), half-white bread (HWB, 7 samples), white bread (WB, 11 samples) and corn/wheat bread (CWB, 3 samples).

The samples were ground and homogenized in a blender, then transferred in polyethylene containers (Lab Logistics Group GmbH, Germany) suitable for foodstuff according to the EU Regulations[24] and deep-frozen at –18 °C until analysis.

Determination of total dietary fiber

The content of total dietary fiber was determined by the enzyme–gravimetric method (AOAC method 985.29), as described by Proski *et al.* (1985)[25], using the K-TDFR enzyme assay kit (Megazime, Bray, Ireland). Phosphate buffer, pH 6.0, and enzymes (heat-stable α-amylase, protease and amyloglucosidase) are required for analysis. Heat-stable α-amylase depolymerizes starch, protease depolymerizes and dissolves proteins, while amyloglucosidase converts starch to glucose. After treating the sample with the mentioned enzymes and adding ethanol to precipitate soluble fiber and remove depolymerized protein and glucose (from starch), the residue was filtered, 95 % ethanol and acetone were added to it, subsequently, and then dried and weighed. Protein content was determined in one part of the residue, using Turbotherm digestion unit Gerhard TT100 and System for protein analysis Gerhardt VAP40 Vapodest. The other part of the residue was incinerated at 525°C to determine the ash content (annealing furnace up to 1100 °C, Elektron, ELP-06, Banja Koviljača, Serbia, were used). The content of total dietary fiber was obtained by subtracting the mass of protein and ash from the mass of the filtered and dried residue. Memmert 400 dryer was used for drying.

Determination of β*-glucan*

Beta-glucan was quantified according to McCleary and Codd by a spectrophotometric method,[26] using the K-BGLU enzyme assay kit (Megazime, Ireland). The samples were suspended and hydrated in a pH 6.5 buffer solution, incubated with the purified lichenase enzyme, and then filtered. An aliquot of the filtrate was completely hydrolyzed with purified β-glucosidase, yielding D-glucose, which was further assayed using the glucose oxidase/peroxidase reagent. The D-glucose thus formed was measured by absorption at 510 nm, by a UV–Vis spectrophotometer (Thermo Scientific Evolution 201, Waltham, MA, USA).

Determination of D*-xylose including xylan and arabinoxylan*

D-Xylose, including xylan and arabinoxylan, were determined by spectrophotometric method using the enzymatic assay kit K-Xylose (Megazyme, Ireland). The assay was per-formed according to the producer instruction manual. The procedure is based on the interconversion of *α*-D-xylose to *β*-D-xylose later being oxidised by NAD^+ to D-xylonic acid. Interconversion of the *α*- and *β*-anomeric forms of D-xylose is catalyzed by xylose mutarotase. The *β*-D-xylose is oxidised by NAD^+ to D-xylonic acid in the presence of *β*-xylose dehydrogenase at pH 7.5. The amount of NADH formed in this reaction is proportional (directly correlated) to D-xylose concentration. NADH is measured by the increasement of the absorbance at 340 nm, by a UV–Vis spectrophotometer (Thermo Scientific Evolution 201, Waltham, MA, USA). Arabinoxylan content is calculated according to the formula:

$$\text{Arabinoxylan (g 100 g}^{-1}\text{)} = 100\times\text{D-xylose content (g 100 g}^{-1}\text{)}/62 \qquad (1)$$

The quality control of determination of total fiber content was conducted using the leftover of the test material from the proficiency testing Nutritional Components in Breadcrumbs (T2454, Fapas, UK). For the quality control of determination of fiber fractions – beta glucan and arabinoxylan quality control materials Barley flour control (Megazyme, Lot 60301e, Ireland) and D-xylose standard (Megazyme, Lot 141005c, Ireland) were analyzed.

Method performance parameters (precision and accuracy) are presented in Table I. The limit of quantification (*LOQ*) was 0.1 mg kg^{-1} for total fiber, 0.3 mg kg^{-1} for beta glucan and 0.1 mg kg^{-1} for arabinoxyan.

TABLE I. Quality control of total dietary fiber, beta glucan and arabinoxylan content determination

Analyte	Precision[a] RSD_r / %	Recovery, %	Quality control material	
			Assigned value	Result
Total fiber	2.6	98	4.24 g 100 g^{-1}[b]	4.16 g 100 g^{-1}
Beta glucan	3.6	96	4.1 %[c]	3.9 %
Arabinoxylan	2.0	104	0.25 mg mL^{-1}[d]	0.26 mg mL^{-1}

[a]Precision under repeatability conditions; [b]breadcrumbs (FAPAS T2454); [c]barley flour control (Megazyme lot 60301e); [d]D-xylose standard (Megazyme lot 141005c)

Determination of microelements

Microelements: manganese, iron, copper and zinc were quantified by inductively coupled plasma mass spectrometry (ICP-MS) after microwave digestion of bread samples.

Test portions of about 0.5 g of grinded and homogenized bread samples were weighed into polytetrafluoroethylene (PTFE) vessels for microwave digestion. Nine mL of 65 % nitric acid (Suprapur®, Merck, Germany) and 1 mL of 30 % hydrogen peroxide (Emsure®, Merck, Germany) were added to the vessels and the mixture was mineralized in a microwave closed digestion system (Ethos Up, Milestone, Italy) by heating up to 200 °C for 15 min, followed by digestion at 200 °C for 20 min, and cooling for 30 min. The digested solutions were quantitatively transferred into 50 mL volumetric flasks and diluted with deionized water (electrical resistivity 18.2 MΩ cm) obtained using a Simplicity® water purification system (Merck Millipore, USA). The blank solution was prepared in the same way.

Trace element levels were determined by inductively coupled plasma mass spectrometer (iCAP RQ, Thermo Scientific, USA) in KED mode of operation. The entire system was controlled with the Qtegra Instrument Control Software (Thermo Scientific, USA). Instrumental conditions were as follows: RF power 1548 W; argon (≥ 99.999 %) flows: 14 L min^{-1} (cooling); 1.1 L min^{-1} (nebulizer); 0.8 L min^{-1} (auxiliary gas); helium (≥ 99.9999 %) flow: 5 L min^{-1} (CCT); acquisition time: 3×60 s; points per peak: 3; dwell time: 10 ns; detector mode: pulse.

The measured isotopes were: ^{55}Mn, ^{56}Fe, ^{63}Cu and ^{66}Zn. For the quantification of these metals, stock solutions of iron, copper and zinc, concentration of 100 μg mL^{-1} each, in 2–5 % nitric acid (AccuTrace™, AccuStandard, USA) and stock solution of manganese, concentration of 100 mg mL^{-1} in 2 % nitric acid (CPAchem, Bulgaria) were used. The intermediate multi-element standard solutions were prepared from these stock solutions. The results were expressed as mg per 100 g of bread samples.

For the quality control of the entire analytical procedure the certified reference material (CRM) NIST® SRM® 1568b (National Institute of Technology, USA) was analyzed. Method performance parameters (precision and accuracy) are presented in Table II. The limit of quantification (*LOQ*) was 0.20 mg kg^{-1} for manganese, 0.80 mg kg^{-1} for iron, 0.16 mg kg^{-1} for copper and 0.40 mg kg^{-1} for zinc.

TABLE II. Quality control of the determination of microelement content

Analyte	Precision[a] RSD_r / %	Recovery, %	CRM	
			Certified value[b], mg kg^{-1}	Result, mg kg^{-1}
Manganese	3.6	103	19.2±1.8	19.7
Iron	4.7	101	7.42±0.44	7.49
Copper	5.9	97	2.35±0.16	2.27
Zinc	3.3	100	19.42±0.26	19.36

[a]Precision under repeatability conditions; [b]NIST® SRM® 1568b rice flour

Data analysis

Results obtained in this experiment were analyzed using the SPSS version 20.0 program (Chicago, IL, USA). The sample size was shown and descriptive statistics (mean, median, minimum and maximum) were calculated. Principal component analysis (PCA) was applied to integrate the results of chemical parameters, discover the possible correlations among measured parameters, and classify them in a factor plane. The analyzed fiber, fiber fractions and microelements of breads were used to generate the PCA model. The level of significance was set at 0.05.

RESULTS AND DISCUSSION

The content of fibers and microelements in different bread types

The content of total dietary fiber, fiber fractions (arabinoxylan and β-glucan) and microelements determined in bread samples is presented in Table III. The results are expressed as g per 100 g for fiber and fiber fractions, and as mg per 100 g for microelements, wet weight both. The parameters of descriptive statistics are presented in the same Table III.

Total fiber, arabinoxylan and β-glucan

In Table III it can be clearly observed that BB, WWB and WRB did not substantially differ among themselves concerning total fiber, beta glucan and arabinoxylan contents, and the same was true for BWB, HWB, WB and CWB when compared among themselves. Therefore, based on these results the examined samples were divided into two aggregate groups: the first one (a total of 35 samples) included BB, WWB and WRB samples, while the second one (a total of 34 samples) included BWB, HWB, WB and CWB samples.

TABLE III. Content of fiber fractions, total fiber and microelements in different bread types; *SD* – standard deviation, BB – brown bread, WWB – whole-wheat bread, WRB – wheat/rye bread, BWB – buckwheat/wheat bread, HWB – half white bread, WB – white bread, CWB – corn/wheat bread (CWB)

Parameter	Value type	Bread type						
		BB (17)	WWB (12)	WRB (6)	BWB (13)	HWB (7)	WB (11)	CWB (3)
Arabinoxylan	Mean	2.4	2.6	1.7	1.5	1.4	1.2	1.6
g 100 g^{-1}	*SD*	0.9	0.7	0.7	0.3	0.3	0.5	0.7
	Median	2.4	2.7	1.5	1.4	1.4	1.3	1.4
	Maximum	4.3	3.6	3.0	2.2	1.9	2.0	2.4
	Minimum	1.3	1.6	1.1	1.2	0.9	0.4	1.1
β-Glucan	Mean	0.8	1.0	1.2	0.5	0.3	0.4	0.3
g 100 g^{-1}	*SD*	0.5	0.5	0.2	0.3	0.1	0.2	0.1
	Median	0.8	1.0	1.2	0.4	0.3	0.3	0.3
	Maximum	1.7	1.7	1.5	1.2	0.4	0.9	0.4
	Minimum	0.2	0.3	1.0	0.2	0.2	0.2	0.3
Total fiber	Mean	4.4	4.6	4.0	2.9	2.6	2.3	2.3
g 100 g^{-1}	*SD*	1.4	1.1	1.1	0.7	0.5	0.8	0.6
	Median	4.0	4.5	4.0	3.0	3.0	2.0	2.0
	Maximum	7.0	6.0	6.0	4.0	3.0	4.0	3.0
	Minimum	3.0	3.0	3.0	2.0	2.0	1.0	2.0
Mn	Mean	1.08	1.05	1.26	1.01	0.71	0.54	0.73
mg 100 g^{-1}	*SD*	0.48	0.68	0.99	0.68	0.18	0.40	0.40
	Median	0.92	0.85	1.05	0.69	0.79	0.51	0.52
	Maximum	1.96	2.71	2.62	2.45	0.95	1.42	1.29
	Minimum	0.31	0.21	0.20	0.30	0.44	0.11	0.38
Fe	Mean	1.90	1.51	1.96	1.51	1.60	1.01	1.15
mg 100 g^{-1}	*SD*	0.65	0.66	1.15	0.57	0.40	0.63	0.37
	Median	1.67	1.40	1.78	1.35	1.53	0.85	0.95
	Maximum	3.22	3.15	4.02	2.90	2.43	2.38	1.66
	Minimum	0.94	0.71	0.51	0.86	1.14	0.39	0.84
Cu	Mean	0.22	0.22	0.18	0.34	0.19	0.12	0.16
mg 100 g^{-1}	*SD*	0.10	0.16	0.15	0.27	0.11	0.10	0.04
	Median	0.18	0.16	0.15	0.26	0.16	0.10	0.15
	Maximum	0.42	0.56	0.40	1.11	0.42	0.37	0.21
	Minimum	0.10	0.03	0.02	0.07	0.05	0.02	0.13
Zn	Mean	1.28	1.14	1.14	1.20	0.88	0.72	1.07
mg 100 g^{-1}	*SD*	0.57	0.75	0.74	0.63	0.44	0.44	0.29
	Median	1.19	0.88	0.93	0.86	0.82	0.56	1.26
	Maximum	2.48	3.20	2.13	2.61	1.64	1.86	1.29
	Minimum	0.43	0.44	0.31	0.56	0.25	0.22	0.67

The determined value of total fiber content in bread samples from the first aggregate group was around 4 g 100 g^{-1}, while in the second group, it was around 2 g 100 g^{-1}.

Data on fiber content in various types of bread were presented by many authors.[4,27–30] Most of those results for WB[4,28–30] were in agreement with the results of the current study, while Lee *et al.* have reported a slightly higher value (3.45 g 100 g^{-1}).[27] However, greater differences in fiber content were observed in case of wholegrain and wholemeal bread. Carocho *et al.* presented lower values (3.3 g 100 g^{-1}), while Kurek *et al.* obtained higher results (about g 100 g^{-1}).[4,29] On the other hand, Benítez *et al.*, presented a content of total fibers similar to the content obtained in this study (4.9 g 100 g^{-1}).[30] In the case of WWB, WRB and CWB obtained results (4.6, 4.0 and 2.0 g 100 g^{-1}, respectively) were similar to those reported in the study of dietary fiber in Serbian diet, carried out by Dodevska *et al.* (7.03±1.11, 6.16±0.89 and 3.41±0.57 g 100 g^{-1} of dry matter, respectively), where a substantially smaller number of bread samples was analyzed.[28] Noorth *et al.* in their manuscript presented two healthy bread products that contained about 7 g of total fiber per 100 g of product.[31]

Based on the results of the current study, the claim "source of dietary fiber" according to the European Regulation (EC) no. 1924/2006[32] may be applied to brown, integral and wheat/rye bread, since the total content of dietary fiber in these samples exceeded 3 g per 100 g.

Results for the arabinoxylan contents in the first aggregate group of bread samples were greater than those in the second one. Thus, for example, the values for arabinoxylan in BB and WWB (2.4 and 2.6 g 100 g^{-1}) were almost twice greater than in BWB, HWB and WB samples (1.5, 1.4 and 1.2 g 100 g^{-1}, respectively). Regarding arabinoxylan, the current study confirmed that wholemeal or rye bread are good source of it. The amounts of arabinoxylan were greater than those presented by Benitez *et al.*, because, in their study, the analyzed breads were made from different percentage compositions of white flour, cereal products and seeds.[30]

Regarding the content of β-glucan, the first aggregate group of bread samples, especially WWB and WRB samples, stood out in comparison to the samples from the second group. The contents of beta-glucan in WWB and WRB samples were 2.5 to 3-fold greater than the average β-glucan content in the samples from the second group.

Microelements

Investigated microelements: Mn, Fe, Cu and Zn were quantified in all bread samples. The descending order of microelements according to their content was Fe > Zn > Mn > Cu. It is noticeable, comparing all tested samples, that the content of microelements was the lowest in WB. On the other hand, the highest content was observed in WRB in the case of Mn and Fe, and BB and BWB in the case of Cu and Zn.

Numerous authors have dealt with the analysis of microelements in various types of bread. Basaran included several types of bread in his research (multi--grain, wholemeal, whole wheat, rye and white bread), which were quite similar to those from the current study. However, he reported much higher values for Cu (from 0.27 to 0.65 mg 100 g^{-1}) and Mn (from 1.16 to 4.30 mg 100 g^{-1}).[33] Higher values for Cu (from 0.38 to 0.84 mg 100 g^{-1}) were also obtained by Carocho *et al*.[4] In the current study, Cu content was relatively uniform in all bread types (Table III), except BWB, where it was the highest (0.34 mg 100 g^{-1}). A similar result for Cu content (0.38±0.01 mg 100 g^{-1}) was reported by Rogaska *et al*.[34] The highest content of Mn was found in WRB (1.26 mg 100 g^{-1}), as it was reported for Polish wheat-rye bread "Magnus", which showed much higher Mn level (10.41±0.47 mg kg^{-1}).[35] Contrary to that, Mn content in WRB investigated in the current study was about 2.5-fold higher than those investigated by Carocho *et al*.[4] Iron was the most abundant element in all bread types (1.01–1.96 mg 100 g^{-1}), which is in agreement with other studies.[4,35,36] Fernandez-Canto *et al.* reported slightly different data for wholegrain bread, where Mn was the most abundant (4.8 mg 100 g^{-1}).[19] The Zn content ranged from 0.72 in WB to 1.28 mg 100 g^{-1} in BB samples, corresponding well with results reported for wholemeal and wheat/rye bread and refined bread.[4,19] However, in the formulations of the so--called healthy breads (Salutello and HealthBread) developed by Noorth *et al.*, made from whole grains and with a high fiber content, the content of Zn (2.3 and 2.0 g 100 g^{-1}, respectively) and Fe (2.4 g 100 g^{-1} for both breads) were much higher than those obtained in the current study.[31]

The intake (contribution to the recommended intake) of fibers and microelements from various bread types

The regulation of the Republic of Serbia[37] is aligned with the European Dietary Reference Values for Nutrients.[22] The reference intakes for adults are Fe 14 mg per day, Zn 10 mg per day, Mn 2 mg per day, and Cu 1 mg per day. Based on the determined content of microelements in various bread types and dietary reference intakes (DRIs) for adults, Fig. 1 presents the contribution of one portion of bread, *i.e.*, 30 g, then of 100 g of bread, as well as of 166 g[38] of bread per day to the DRVs for minerals (Fig. 1a and b) and recommended intakes of fibers (Fig. 1c). If the intake of bread at the daily level is 166 g, only Mn from WRB and Cu from the BWB sample is near the 50 % of the respective DRV. However, they are not the type of bread traditionally represented in the daily diet of the Serbian population.[39] The upper Cu level for the adult population of the EU is set at 5 mg per day, making these breads contribute 11.3 % of this limit.[40]

In relation to a portion of 30 g of bread, Cu contribution ranges from 2.82 to 9.36 % of its DRV, while Mn contribute in larger amounts, from 4.28 to 9.69 % of its DRV. This means that one portion of bread is not a source of either Cu or

Mn, but at a level of consumption of 100 g, all types of bread except WB contribute a minimum of 15 % of DRVs for these two elements. The contributions of Fe and Zn remain below 15 % of their respective DRVs even at the level of consumption of 100 g of bread (Fig. 1a).

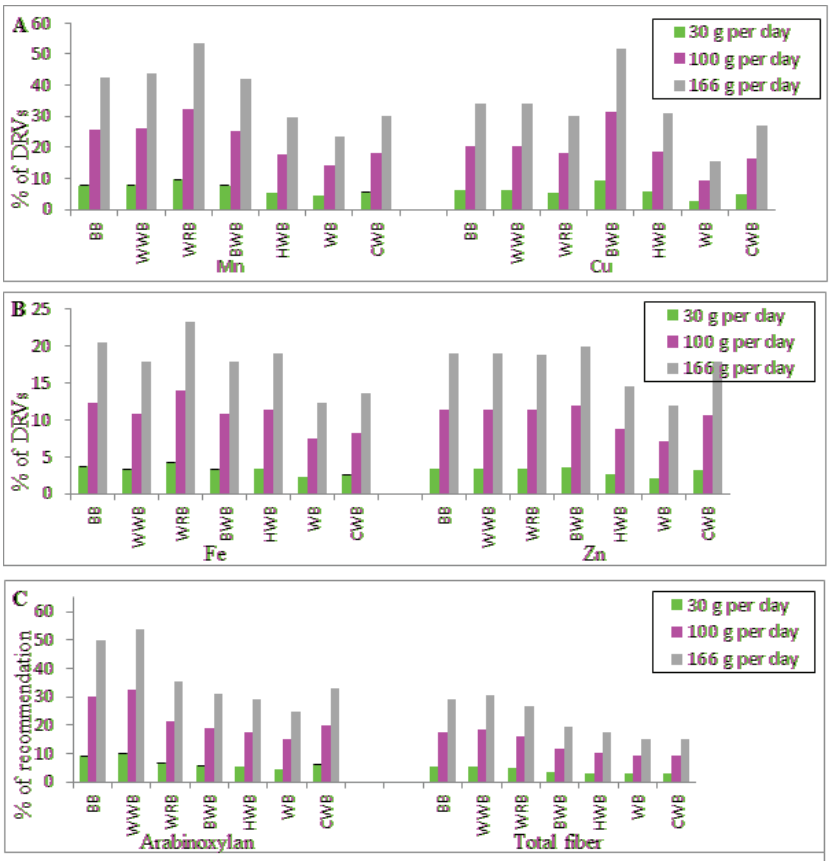

Fig. 1. Contribution of investigated bread types to the Dietary Reference Values (DRVs) of: a) manganese (Mn; 2 mg per day) and copper (Cu; 1 mg per day), b) iron (Fe, 14 mg per day) and zinc (Zn, 10 mg per day) as well as to the recommendations for intake of c) total fibers (25 g per day) and arabinoxylan (8 g per day), related to the intake of 30, 100 and 166 g of the tested bread types.

According to Regulation (EC) No. 1924/2006, a product could bear a nutritional claim of being a source of a nutrient if contains no less than 15 % of its respective DRV.[32]

Total fiber (contribution range from 2.8 to 5.5 % of recommended intake) and arabinoxylan (contribution range from 4.5 to 9.8 % of recommended intake) do not reach 15 % of the recommended intake in case of consumption of one 30 g-portion of bread. If the consumption amount increases to 100 g, the contribution of arabinoxylan rises to 15–32.5 % of the recommended intake. For total fiber, higher contributions per 100 g of bread were observed in BBW, BB and WRB bread samples (18.4, 17.6 and 16 % of recommended intake).

Principal component analysis (PCA)

Principal component analysis was applied to integrate the results of chemical parameters, discover possible correlations among measured parameters and classify the parameters in a factor plane. The analyzed fiber, fiber fractions and microelements of breads were used to generate the PCA model.

According to PCA for bread samples (Fig. 2), the highest content of total fiber, arabinoxylane, Zn and Cu (which show a strong positive correlation with the first axis: 0.917, 0.848, 0.722 and 0.686, respectively) were observed in BB, WWB and BWB (it can also be seen from their position), while WRB is the most significant source of β-glucan, Mn and Fe (strong positive correlation with the second axis: 0.757, 0.709 and 0.664, respectively).

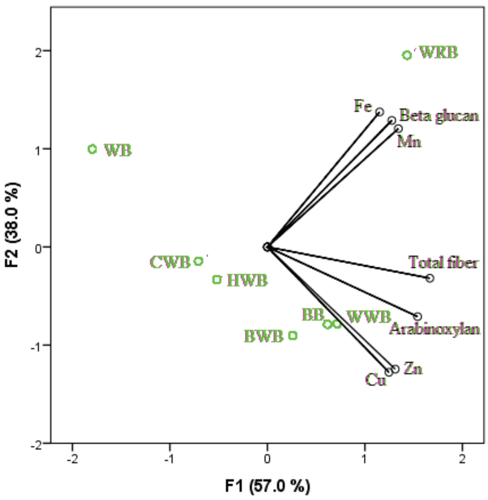

Fig. 2. The biplot of PC1 and PC2 of total fiber, fiber fractions and microelements content of various bread types.

CONCLUSION

Bread is present in the Serbian diet on daily basis, mostly as white bread. Considering that whole wheat bread, compared to refined, contains more fiber and microelements, and knowing the habit of consuming large amounts of bread in this region, if white bread were to be replaced with whole wheat, thus introduced fiber and microelements would have a significant contribution to the total daily intake of these nutrients. Just by replacing white with whole wheat bread, the intake of total fiber would increase by 100 %, especially arabinoxylan

(117 %). There would also be an increase in microelements intake, particularly copper (+ 118 %) and manganese (+ 85 %).

The increased intake of fiber and microelements through the consumption of staple food such as bread, supports, in the overall result, the intake of the amounts of nutrients that are proven to be adequate for maintaining health and which are associated with reduction of the risk of certain chronic diseases. Therefore, special attention must be paid to raising awareness among consumers about the food that should be consumed, as well as about its health impact.

ИЗВОД

САДРЖАЈ ВЛАКАНА И МИКРОЕЛЕМЕНАТА У РАЗЛИЧИТИМ ВРСТАМА ПШЕНИЧНОГ ХЛЕБА

АЗРА РЕЦЕПОВИЋ-ЂОРЂЕВИЋ[1], МАРГАРИТА ДОДЕВСКА[2], МИЛИЦА ЈОВЕТИЋ[3] и МАРИЈАНА АЧАНСКИ[4]

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На тржишту Србије присутне су различите врсте пшеничног хлеба: бели, црни, интегрални, пшенично/ражени, хељдино/пшенични, полубели и кукурузно/пшенични хлеб. Ово истраживање је обухватило одређивање садржаја укупних влакана, фракција влакана и микроелемената (мангана, бакра, гвожђа и цинка) како би се проверило да ли хлебови са тржишта садрже количине ових хранљивих материја за које је доказано да су корисне за здравље. Циљ је био и да се одреди колики је допринос ових хранљивих материја препорученом дневном уносу конзумирањем хлеба. Резултати показују да хлеб са тржишта Србије садржи велику количину арабиноксилана (1,2–2,6 g 100 g^{-1}), а да су пшенично/ражени, црни и интегрални хлеб извори дијететских влакана (4,0–4,6 g 100 g^{-1}). Такође, важан резултат је да све врсте хлеба осим белог садрже више од 15 % референтних вредности у исхрани за бакар и манган. Заменом белог хлеба интегралним повећава се унос укупних влакана (+ 100 %), арабиноксилана (+ 117 %), бакра (+ 118 %) и мангана (+ 85 %), стога је од великог интереса подизање свести потрошача о корисним намирницама које треба укључити у исхрану. Методе примењене у овом истраживању су показале прихватљиву прецизност и тачност и такође су се показале прилично једноставним за рутински аналитички рад.

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