Application and benefits of vegetable flours embedded in rye bakery products

Petya Ivanova*, Iliana Lazova-Borisova
*Agriculture Academy, Institute of Food Canning and Quality –Plovdiv, Bulgaria
Agriculture Academy, Institute of Cryobiology and Food Technology –Sofia, Bulgaria
*E-mail:*petjofi@gbg.bg, iliana_lazova@abv.bg*

Citation
Ivanova, P., & Lazova-Borisova, I. (2022). Application and benefits of vegetable flours embedded in rye bakery products. *Bulgarian Journal of Crop Science, 59*(4) 64-69.

Abstract
A study of pressing from vegetables obtained from the Bulgarian production of vegetable juices from carrots, cucumbers and red beet was conducted. The vegetables are with very good quality and good price. They are dried in a heat pump dryer, at an initial temperature of 45 ° C and circulating air with an initial moisture content of 8-10% at constant (4.6 m/s) and variable speed (from 4.6 m/s to 3.6 m/s after the first 90 min) , in a thin layer, with transversely oriented air flow relative to the product layer.

The dried pressing are ground in a stone mill in the form of vegetable flours, intended for use in food products in order to give a specific taste and increase biological value.

Analyzes were performed on physicochemical indicators - dry matter (by weight), %; moisture, %; antioxidant activity determined by DPPH method and content of total polyphenols. Vegetable flours obtained from pressing of the processing industry are a rich source of biologically active substances and can be used in the development of food products with added nutritional and biological value. The pronounced antioxidant activity is high in the vegetable beetroot flour. The addition of vegetable flours with 40 % from carrots, cucumbers and red beets to whole grain rye flour leads to products of high biological value.

Key words: Bulgarian rye flour “Mina”; rye sourdough; pressing; vegetables; carrots; cucumbers; red beet; good quality; biotechnologies

INTRODUCTION

The production of bread for specific health needs accounts for a large share of total production (Ferreira et.al, 2013; Makris et al., 2007; Mihalkova et al., 2013; Karadzhov et al., 2007). This is bread, which in addition to its normal nutritional value, convincingly shows that it has a healthy effect on one or more functions of the body. There is another large group of people who eat low carb bread. Diabetics are recommended bread with high fiber content and low content of easily digestible carbohydrates, usually the so-called black bread - whole wheat, rye-wheat and multi-grain bread. The formulas of this type of bread often use improvers such as sugar and enzymes that break down some carbohydrates into sugars, and in fact, the consumption of this bread raises blood sugar (Mihalkova et al., 2014; Mihalkova, 2009; Martins et al., 2011; Antonova & Mangova, 2003). The approach to finding the most successful formulas for this bread should be to reduce the carbohydrate content by increasing the fiber content of the finished products. To ensure the production of healthy bread with a high fiber content and without the use of artificial improvers, the technology of making bread with the addition of flours rich in fiber, such as vegetables can be used. Nutritional losses / fiber are a rich source of biologically active substances: fiber, carotenoids, anthocyanins, vitamins, polyphenols and others. (Figuerola et al., 2005; Makris et al., 2007) and by their use in food products they not only improve their sensory qualities, but also enrich their biological value.

In the present work, the nutritional losses of vegetables, physicochemical parameters dry matter and moisture were studied and the antioxidant activity was evaluated by determining the radical scavenging capacity by the DPPH method and the content of total polyphenols.

The pressures (flours) are rich in essential nutrients and available for human consumption, they are used as nutrients in the development of functional foods (Sun-Waterhouse, 2011; Ferreira et al., 2013; Brand - Williams et al., 1995).

In this aspect of the study, the flour obtained from food losses / pressures from vegetable processing in terms of antioxidant capacity (DPPH analysis) is characterized.

MATERIALS AND METHODS

1. Raw materials.

Nutritional losses are obtained as a solid residue from the production of vegetable juices (Martins et al., 2011). Vegetables - cucumbers, red beets and carrots. Raw materials: Bulgarian rye flour ”Mina”, salt, drinking water, dry yeast, dry rye sourdough, vegetable flour (sample 1 with 40% cucumber flour, sample 2 with 40% red beet flour, sample 3 with 40% % carrot flour). Raw materials from the trade network for control and samples 1, 2 and 3 were used. The whole-grain rye flour type 1150, with which the experiments were performed, was delivered by Topaz Mel OOD - Karnobat. Dry baker’s yeast was used by the company-manufacturer “Dr. A. Yotker Narungsmitel KD” - Germany, importer: “Dr. Yotker Bulgaria” EOOD. The table salt used was purchased from the trade network. All raw materials are accompanied by documents of origin and quality. Drinking water is suitable for use under Ordinance 9/2001 on water quality.

2. Drying method.

The drying was carried out in a heat pump dryer, developed by a team of IKKH-Plovdiv at an initial temperature of 45 °C and circulating air with an initial moisture content of 8-10% at constant (4.6 m/s) and changing speed from 4.6 m / s to 3.6 m / s after the first 90 min), in a thin layer, with transversely oriented air flow relative to the product layer. During the drying process, the mass of the sample was measured for the first hour and a half every 10 minutes, then 30min. At the end of drying, three times the same mass values of the product are taken.

3. Digestion of dried food losses.

After the drying process, the samples are ground in a stone mill with a flour particle size of 900 μm.

Samples of ground vegetable flour are packed in plastic bags without vacuum of 50 g.

4. Methods.

4.1. Physicochemical analyzes:

- Dry matter, (by weight), % - BDS EN 12145;
- Moisture, % - BDS EN 12145.

4.2. The content of total polyphenols in vegetable flours was determined by the method of Singleton and Rossi (1965) in the following modification: In a 10 ml test tube, 0.1 ml of sample extract, ~ 7 ml of distilled water, 0.5 ml of Folin - Ciocalteu - reagent (diluted 1: 4 with distilled water) and 1.5 ml of 7.5% (w / v) aqueous sodium carbonate solution. Make up to the mark with distilled water. After resting for 2 hours at 20 - 25 ° C, the absorbance of the reaction mixture was measured at 750 nm. Similarly, a blank was prepared using distilled water instead of extract. The results obtained are presented as gallic acid equivalents (GAE) per 100 g of extract. 4.3. Determination of radical scavenging ability (DPPH test). Radical capture ability was determined by the method of Brand - Williams et al. (1995) in the following modification: 2250 μl of DPPH solution (2.4 mg of DPPH in 100 ml of methanol) and 250 l of sample extract pre-diluted with distilled water in a volume ratio of 1: 3 were dosed sequentially into the cuvette. Similarly, a blank was prepared using methanol instead of extract. After keeping the closed cuvettes in the dark for 15 minutes at 20-25 ° C, the absorbance of the reaction mixture at 515 nm was measured. The results obtained are presented as Trolox (TE) equivalents per 100 g of extract.

4.4. Mathematical and statistical processing. All analyzes were performed in at least three replicates and the results are presented as averages.

4.5. Determination of fiber content (BDS ISO 5498: 1999).

4.6. Determination of ash content of bread - BDS ISO 2171: 1999.

4.7. Trial laboratory baking - single-phase method of kneading the dough (Karadzhov et al., 2007).

4.8. Determining the volume and color of bread - a method described by Karadzhov et al., 2007.

4.9. Determination of total protein content in bread - Keldal method (BDS 13490-76).

4.10. Determination of the fat content in bread - Soxtec apparatus (BDS 1671-89).

4.11. Nitrogen-free extracts in bread are calculated on the basis of chemical composition.

4.12. Energy value per 100 g of product kJ / kcal / - calculation based on the chemical composition.

4.13. Macro- and microelements have been determined with the help of Atomic emission photometer ICP-MS "Agilent" 8900.

RESULTS AND DISCUSSION

The data from the conducted physicochemical parameters of the vegetable flours are presented in Table 1.

When conducting the moisture parameters, the values of dry matter determined by weight of the tested vegetable flours (Table 1). In the case of vegetable flours, the lowest statistically significant value of moisture is in the case of carrot flour.

Antioxidant activity shows that the highest values are beetroot flour, followed by carrot flour. Cucumber flour has the lowest values according to the cited indicators (Table 2).

Technological preparation

Preliminary preparation of the rye leaven was made by pouring 30 ml of water with a temperature of 38 ºC, standing for 10 minutes to hydrate. Knead the dough from the flour and the other components with a water temperature of 38 ºC.

Figure 1 shows the appearance of the dough involved. The fermentation was carried out for 20 minutes at 36 ºC, stirring and fermentation for another 30 minutes. The final fermentation is 80 minutes. Figure 2 shows the appearance, and Figure 3 shows the section of the bread.

Characteristics of the test after kneading

Control - rye flour, rye sourdough, dry yeast, salt, water

normal texture, sticky, soft, puffy dough, light beige color

Sample 1 - rye and carrot flour 40%, rye sourdough, dry yeast, salt, water

normal texture, well-developed, light beige color with an orange tinge

Sample 2 - rye and red beet flour 40%, rye sourdough, dry yeast, salt, water

normal consistency, less sticky than sample 1, well developed, pale beige color with a reddish tinge

Sample 3 - rye and cucumber flour 40%, rye sourdough, dry yeast, salt, water

Table 1. The moisture parameters of the vegetable flours (%)

Raw materials	Moisture,%
Carrot flour	3.92
Cucumbers flour	5.96
Red beet flour	4.68

Figure 1. Appearance of the dough from left to right: control, samples 1, 2 and 3

Table 2. Antioxidant activity and total polyphenols of vegetable flours

Raw materials	Antioxidant activity, µmol TE/100 g	Total polyphenols, mgGAE/100 g
Carrot flour	25000.00	725.00
Cucumbers flour	66.67	160.00
Red beet flour	24583.33	700.00

normal consistency, less sticky than sample 1, well developed, pale beige color

Figure 2 and Figure 3 show the upper and lower bark - well-formed, good in cut, no roughness, medium porosity and porosity of the middle in the control, samples 1, 2 and 3.

Table 3 shows the humidity of the control and samples 1, 2 and 3, which vary from 45.68% to 47.54%, with the highest mass is sample 3 (259.4 g), the volume of sample 3 is the most -low 390 cm3 and the volume of sample 1 is the highest 500 cm3.

Table 4 shows the physico-chemical composition of the bread. In terms of acidity, the control (6.2◦H) has the highest acidity and sample 2 (5.9◦H) has the lowest content. There is no significant difference between the different samples. With regard to the proteins with the highest content is sample 1 (9.43%), respectively with the lowest content is the control (5.95%), which is 3.48% less. Regarding the fats with the highest content is sample 1 (2.89%), and with the lowest content is the control (0.66%). With regard to the fibers with the highest content is sample 2 (6.84%), and with the lowest content is sample 1 (4.33%), which is 2.5 times less.

With regard to the ash content, sample 2 has the highest content (1.92%) and sample 1 (1.16%) has the lowest content. There is no significant difference between the different samples. With regard to carbohydrates with the highest content is the control (39.96%), and with the lowest content is sample 1 (32.07%).

Figure 2. Appearance of the bread from left to right: control, samples 1, 2 and 3

Figure 3. Section of the bread from left to right: control, samples 1, 2 and 3

Table 3. Quality assessment of types of bread

Types of bread	Mass g	Volume sm^3	L mm	H mm	W mm	Moisture %	Dry substance %
Control	248.4	410	123	50	82	47.54	52.46
Sample 1	253.5	500	126	52	82	46.72	53.28
Sample 2	254.3	450	125	51	82	45.68	54.32
Sample 3	259.4	390	122	53	82	45.70	54.30

Table 4. Physico-chemical characteristics of the types of bread

Types of bread	Acidity ◦H	Protein %	Fat %	Fiber %	Ash %	Carbohydrates %
Control	6.2	5.95	0.66	5.10	1.72	39.96
Sample 1	6.1	9.43	2.89	4.33	1.16	32.07
Sample 2	5.9	7.60	1.25	6.84	1.92	31.68
Sample 3	6.0	8.14	1.22	5.32	1.82	30.70

When using vegetable flour, the carbohydrate component decreases.

Table 5 shows the energy value, which varies from 204 kcal / 100g product to 357 kcal / 100g product, and in the control is the lowest (204 kcal / 100g product), and respectively in sample 2 with the participation of red beet flour 40% increases to 357 kcal / 100g product.

Table 6 shows the mineral composition in bread (mg / kg). In terms of Fe content in the control is low (21.7 mg / kg), and with the use of 40% red beet flour increases in sample 2 (32.5 mg / kg). The Zn content in the control was low (13.7 mg / kg), and with the addition of 40% red beet flour it increased in sample 2 (39.7 mg / kg). The content of Mg in the control is low (1.3 mg / kg), and with the addition of 40% red beet flour increases in sample 2 (5.3 mg / kg). The finished products are rich in Fe, Zn, Mg.

Antioxidant activity shows that the highest values are bread with beet flour and Bulgarian rye flour, followed by bread with Bulgarian carrot flour and rye flour. The bread with Bulgarian cucumber flour and rye flour has the lowest values according to the cited indicators (Table 7).

Table 5. Energy value of the bread (kcal/100g product)

Types of bread	Energy value kcal/100g product
Control	**204**
Sample 1	**282**
Sample 2	**357**
Sample 3	**257**

CONCLUSIONS

The results of the conducted scientific experiments give grounds for the following conclusions:

➢ Vegetable flours obtained from food losses of the processing industry are a rich source of biologically active substances and can be used in the development of food products with added nutritional and biological value. The pronounced antioxidant activity is high in vegetable red beet flour, followed by carrot flour.

➢ The finished products are rich in Fe, Zn, Mg and are free of GMOs, artificial colors and preservatives. The new assortments are suitable for the mass consumers and have significant benefits for their health.

➢ The development of new functional food products complements the production list in our country.

Table 6. Mineral composition of the bread (mg/kg)

Types of bread	Macroelements, mg/kg					Trace elements, mg/kg					
	Ca	K	Mg	Na	P	B	Ba	Cu	Fe	Mn	Zn
Control	383	2020	1.3	17.4	1.3	0.16	0.40	3.39	21.7	0.20	13.7
Sample 1	356	2022	2.3	18.3	1.5	0.21	0.34	3.56	25.4	0.20	18.7
Sample 2	478	2079	5.3	20.6	2.5	2.21	0.25	3.78	32.5	0.20	39.7
Sample 3	384	2020	4.4	18.6	1.5	0.21	0.25	3.76	29.4	0.20	23.6

Table 7. Antioxidant activity and total polyphenols of breads

Type of bread	Antioxidant activity, µmol TE/100 g	Total polyphenols, mgGAE/100 g
Carrot flour and rye flour	28000.00	825.00
Cucumbers flour and rye flour	74.79	180.00
Red beet flour and rye flour	28683.33	970.00

REFERENCES

Antonova, N. & Mangova, M. (2003). Grain Biochemical Characterisation of Mina Naked oat. 10th Yugoslav Congress of Nutrition. Belgrade, 16-19 October. Journal "Zito-Hleb/ Cereal-Bread". Novi sad. Serbia. Vol.30, 2, 65-69 (Bg).

Brand-Williams, W., Cuvelier, M. E. & Berset, C. (1995). Use of a Free Radical method to evaluate antioxidant activity. Food Science and Technology-Lebensmittel-Wissenschaft and Technologie 28(1): 25–30.

Ferreira M. S. L., Santos M. C. P., Moro T. M. A., Basto G. J., Andrade R. M. S. & Gonçalves, E. C. B. A. (2013). Formulation and characterization of functional foods based on fruit and vegetable residue flour. Journal of Food Science and Technology, DOI: 10.1007/s13197-013-1061-4.

Figuerola, F., Hurtado, M. L., Estévez, A. M., Chiffelle, I., & Asenjo, F. (2005). Fibre concentrates from apple pomace and citrus peel as potential fibre sources for food enrichment. Food Chemistry 91(3): 395-401.

Karadzhov G., Vassileva, R., & Nikolova, **M.** (2007). Bread, Bakery and Confectionery Technology, Sofia, Matcom Ltd (Bg).

Makris, D. P., Boskou, G. & Andrikopoulos, N. K. (2007). Polyphenolic content and in vitro antioxidant characteristics of wine industry and other agri-food solid waste extracts. Journal of Food Composition and Analysis 20(6): 125-132.

Martins R. C., Chiapetta S. C., Paula F. D. & Gonçalves E. C. B. A. (2011). Evaluation isotonic drink fruit and vegetables shelf life in 30 days. Brazilian Journal of Food and Nutrition 22(4): 623-629.

Mihalkova, N. (2009). Another scientific proof of the positive influence of bread on human health. Food industry. - No. 2, 50-52 (Bg).

Mihalkova, N., Ivanova, S., Petrova, I., & Marinova, G. (2013). Healthy Bread of Mixed Flour, Agriculture Plus, Nos. 6,18-21 (Bg).

Mihalkova N., Ivanova, S., & Angelov, L. (2014). Receiving Bread with Healthy Ingredients - a mixture of rye, oat and wheat flour, Journal of Mountain Agriculture on the Balkans, vol. 17, 5, 1200-1219 (Bg).

Sun-Waterhouse, D. (2011). The development of fruit-based functional foods targeting the health and wellnes market: a review. International Journal of Food Science & Technology 46(5).