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INFLUENCE OF SOME NATURAL SEEDS AND POWDERS ADDITION ON THE WHITE BREAD ANTIOXIDANT PROPERTIES AND OTHER CHARACTERISTICS

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Abstract

Bakery products industry occupies a very important place in people's major consumer products. Bread is a staple product that almost all of us consume every day. These foods provide the human body with an important part of the nutrients it needs for vital activity. A first objective of this work was to obtain two innovative assortments of white bread enriched with different additions: one with the addition of turmeric (Curcuma longa) radix powder and linseeds (Linum usitatissimum) (B1) and the second with the addition of sea buckthorn (Hippophae rhamnoides) fruits powder, sunflower (Helianthus annuus) and white sesame (Sesamum indicum) seeds (B2). A second objective was analysing the two enriched breads in terms of total polyphenols content, antiradical and antioxidant activity compared to the control (B0 - plain white bread). Porosity, proximate composition, energy value of the breads as well as their sensory characteristics were also determined. Total polyphenol content in B2, respectively B1 breads was with 66% and respectively 49% higher than the control (1.41±0.02 mg gallic acid/g). Anti-radical activity of the products was improved by 2.3 times in B2 and with 43% in B1 compared to plain white bread (38.76±0.19%). The porosity of B0 bread was the highest (68%), decreasing for B1 (60%) and B2 (53%) assortments. In terms of proximate composition, the additions of natural seeds and powders resulted in increased lipid and dietary fiber content, compared to the control. At the sensory analysis, B1 and B2 were rated higher than the control, with B2 scoring best (between 4.70 and 4.85).

Key words*: antioxidant activity, bread, polyphenols, seeds, sea buckthorn, turmeric.*

INTRODUCTION

Bread, this basic food for human nutrition, has its origins since the Neolithic, and the art of bread making was initiated by the ancient Egyptians, then developed worldwide (Mondal & Datta, 2008; Arzani, 2019; Ghimpețeanu et al., 2022). The oldest evidence of bread making has been found at a 14,500-year-old Natufian site in the northeastern desert of Jordan (Arranz- Otaegui et al., 2018).

White bread commonly refers to bread made from wheat flour from which the bran and germ layers have been removed from whole wheat grains as part of the flour milling or grinding process, producing a light-colored flour. As plain white bread does not provide a high intake of antioxidants, there is now a growing trend for producers to make white bread with various seeds and other plant-derived additions with a high content of polyphenols and other antioxidants (Dziki et al., 2014; Sęczyk et al., 2017; Meral & Köse, 2019; Shori et al., 2021; Petcu et al., 2023; Ghimpețeanu et al., 2023).

Wheat flour is the main ingredient in bread making and consists mainly of starch (ca. 70-75%), water (ca. 14%) and protein (ca. 10-12%). In addition, non-starch polysaccharides (ca. 2-3%), especially arabinoxylans and lipids (ca. 2%) are minor constituents of flour, but relevant for bread production and quality (Goesaert et al., 2005; Petcu et al., 2019a), including the absence of contaminants (Petcu et al., 2019b).

Curcuma longa, or turmeric is an herbaceous evergreen plant member of the *Zingiberaceae* family and is cultivated extensively in Asia, especially in India and China. By grinding the boiled and dried rhizome a bright yellow powder of this spice is obtained. Turmeric has been used both in Asian cuisine for its flavor and color and in Chinese and Ayurvedic medicine. It is also officially included in the Pharmacopoeia of China and other Asian countries such as Japan and Korea (Laban, 2014; Verma et al., 2018). Chemical composition of *Curcuma longa* rhizomes includes a group of three curcuminoids: curcumin, demethoxycurcumin and bisdemethoxycurcumin, as well as volatile oils, sugars, protein and resins. Curcumin has been shown to be responsible for multiple therapeutic actions: antidiabetic, anticancer, hepatoprotective, cardiovascular protection neuroprotective, and others (Xu et al., 2018).

China's National Health Commission has classified sea buckthorn (*Hippophae rhamnoides* L.) berries as a "food medicine", as they provide numerous nutritional and therapeutic benefits. The fruits contain about 200 types of nutritive and bioactive compounds, such as: carotenoids, superoxide dismutase, polyunsaturated fatty acids, amino acids, vitamins, phytosterols, phenolic compounds, flavonoids. The importance of this fruit is underlined by its significant bioactivity, including anti-cancer, cardiovascular system improvement, anti-diabetic, antithrombotic and anti-obesity activity (Olas, 2016; Wang et al., 2022).

Linseeds (*Linum usitatissimum*), sesame (*Sesamum indicum* L.) seeds and sunflower (*Helianthus annuus* L.) seeds are key sources of phytochemicals in the functional food arena, being rich in polyunsaturated fatty acids, fiber, protein and phenolic compounds (Adeleke & Babalola, 2020; Brigante et al., 2020).

The primary purpose of this work was to obtain two varieties of white bread enriched with different additions of seeds and vegetable powders: one with the addition of turmeric powder and linseeds and the second with the addition of powdered buckthorn fruit, white sesame seeds and sunflower seeds. Another goal of the work was analysis the finished products in terms of total polyphenol content, antiradical and antioxidant activity, porosity, proximate composition, sensory properties, compared to the control (plain white bread).

MATERIALS AND METHODS

Bread preparation

Three types of bread were obtained: plain white bread (B0), white bread with added turmeric and flax seeds (B1), white bread with added buckthorn powder, white sesame seeds and sunflower seeds (B2), using the following raw and auxiliary materials: white wheat flour type 000, water, dry yeast, salt, turmeric powder, flax seeds, sunflower seeds, white sesame seeds, and buckthorn powder, all sourced from the domestic market. Table 1 shows the recipes used to bread assortments preparation.

Table 1. Recipes for bread assortment preparation

Bread type / Materials (%)	B0	B1	B2
White flour type 000	58.0	56.0	56.0
Water	40.0	40.0	39.0
Salt	1.4	1.1	1.1
Dried yeast	0.6	0.6	0.6
Turmeric powder		0.6	
Flax seeds		1.7	
Sea buckthorn powder			0.6
Sunflower seeds			1.7
White sesame seeds			1.0

To obtain the bread varieties, all the ingredients (flour, water, yeast, salt, turmeric and sea-buckthorn powders, seeds) were first weighed according to the recipes. Water was heated before being poured over the ingredients. The flour was placed in a bowl, then the yeast, salt and other ingredients were added, followed by the water. All these ingredients were kneaded well and the dough was left to rise for an hour at room temperature, after which it was divided and the loaves formed. Loaves were baked in an electric oven (Bosch HBG633NB1) at 180°C for 60 minutes. The baked loaves were removed from the oven and left to cool for at least 4 hours. Samples were taken from the obtained products for physical-chemical and sensory analysis (Figure 1).

B0 B1

B2

Figure 1. The three types of breads: B0 - plain white bread (control); B1- white bread with turmeric powder and linseeds, B2 - white bread with sea buckthorn powder, white sesame and sunflower seeds (Source: original photos)

Assessment of the total polyphenol content

Folin-Ciocalteu method was used for total polyphenol content (TPC) determination in breads as well as in turmeric and sea buckthorn powders, flax seeds, white sesame and sunflower seeds. For this, extracts in 70% ethanol were made from each sample (crust and crumb in mixture) and the same steps were performed as described by Dumbrava et al., (2020) with results expressed in mg gallic acid/g of sample.

Assessment of the antioxidant activity

For the three bread assortments, respectively for turmeric powder, sea buckthorn powder, flax seeds, white sesame and sunflower seeds, cupric ion reducing antioxidant capacity analysis method (CUPRAC) was applied, using the same ethanolic extracts as for the determination of TPC and the same working steps as Dumbrava et al., (2020).

Assessment of the antiradical activity

The antiradical activity of breads and added powders and seeds was evidenced by analysis of free radical 2,2-diphenyl-1-picryl-hydrazyl (DPPH) scavenging activity (RSA), using the same working method as described in our previous paper (Dumbrava et al., 2023).

Breads porosity assessment

To determine the breads porosity, in the middle of each type of bread, a slice was cut with parallel sides and a thickness of 60 mm. Using a perforator, previously greased with oil, a cylinder of core was removed from the middle of the slice. To obtain the core cylinder, the perforator was pressed and twisted into the mass of the core. The height of the core cylinder must be 60 mm and checked with a ruler. The core cylinder was weighed to two decimal places. Three determinations were made in parallel from the same sample (Petrusha et al., 2018).

Porosity was calculated using the relation (Petrusha et al., 2018):

$$\text{Porosity (\%)} = \frac{V - \frac{m}{\rho}}{V} \cdot 100$$

where:

V is the volume of the core cylinder (cm^3);

m - mass of the core cylinder (g);

ρ - density of the compact core (g/cm^3);

ρ = 1.31 (g/cm^3) for white flour bread and speciality breads.

Assessment of the proximate composition and energy value

The proximate composition of the finished products B0, B1 and B2 was determined using the following ISO methods: protein SR ISO 937:2007, total lipids SR ISO 1443:2008, mineral substances SR ISO 936:2009, sugar SR ISO 91-2007, and fiber according to ISO 13906:2007, moisture SR ISO 1442:2010, using FOOS Fibertec 2010 & M6, Sweden. The difference between 100 and the sum of protein, total fat, dietary fibre, minerals and moisture content was calculated to determine the carbohydrate content. Energy value of the three finished products was calculated by sum of the caloric intake of carbohydrates, lipids and proteins, considering that 1 g lipid provides 9 kcal, 1 g carbohydrate: 4 kcal and 1 g protein: 4 kcal.

Statistical analysis

Microsoft Excel 2010 software was used to process statistical data obtained from triplicate analyses for TPC, antioxidant activity, antiradical activity, porosity and proximate composition.

Sensory evaluation

The sensory evaluation of the three bread varieties was carried out according to ISO 4121:2002 by a panel of 20 evaluators (men and women) aged 20-55 years, using a hedonic rating scale from 1 to 5. Panelists assessed: external appearance, appearance in section, odor, taste, texture, chewing behavior, general acceptability. For sensory analysis, written informed consent was obtained from each evaluator, respecting the ethical requirements of the European Union Guidelines on Ethics and Food Research (Alfonsi et al., 2012). The evaluation was carried out under the same working conditions, acceptability levels, interpretation of score ranges as Dumbrava et al., (2020).

RESULTS AND DISCUSSIONS

Total polyphenols content

TPC results from the three bread assortments and the wheat white flour, added powders and seeds are shown in Table 2.

Table 2. TPC in the three breads assortments and in added powders and seeds

Sample	TPC (mg gallic acid/g)
B0	1.41±0.02
B1	2.10±0.08
B2	2.34±0.11
White wheat flour	2.11±0.06
Turmeric powder	22.11±0.23
Sea buckthorn powder	20.88±0.46
Linseeds	23.16±0.24
Sunflower seeds	19.52±0.12
White sesame seeds	85,46±0.44

Table 2. shows that between the natural powders and seeds used to obtain B1 and B2 bread assortments, white sesame seeds had the highest TPC (85.46±0.44 mg gallic acid/100 g), followed by linseeds (23.16±0.04 mg gallic acid/g) and turmeric powder (22.11±0.23 mg gallic acid/g). In the case of finished products, B2 was the richest in total polyphenols (23.35±0.19 mg gallic acid/g), the lowest concentration of these compounds being found in B0 (1.41±0.02 mg gallic acid/g). The addition of sea buckthorn powder, flax seeds, sunflower seeds, white sesame seeds and turmeric powder to plain white bread resulted in substantial increases in TPC of the finished product (by 66.19% for B2 and 49.04% for B1, respectively).

For different types of white wheat flour, depending on storage conditions and periods, Zhang et al. (2021) reported TPC values ranging from 1.91 to 2.84 mg gallic acid/g, and our results fall within this range. Elleuch et al., (2007) found for white sesame a TPC value (87.77 ± 3.15 mg gallic acid equivalents (GAE)/g) close to that in this paper. Also, Deme et al. (2021) reported close values of TPC for flax seeds of different varieties ranging from 20.53 mg GAE/g to 25.41 mg GAE/g. The range of values found by Romani et al., (2017) for different varieties of sunflower seeds (between 11.48 and 20.23 mg GAE/g), includes our results.

Lim et al. (2011) reported close values for TPC in turmeric (21.95 mg gallic acid/g) but much lower values in plain wheat bread (0.31 mg gallic acid/g) and turmeric-enriched bread (1.51 mg gallic acid/g), respectively, than in this paper. In bread with the addition of different proportions of sea buckthorn pomace powder Stanciu et al. (2023) found TPC values (between 1.70 and 2.30 mg gallic acid/g) comparable to those reported by us.

Antioxidant activity

The antioxidant activity for finished products as well as for white wheat flour, seeds and added powders, measured by the cupric ion reducing antioxidant capacity method, is presented in the Table 3.

The strongest antioxidant activity of the raw and auxiliary materials used in bread making, was reported in sea buckthorn powder (59.64 ± 0.90 mg Trolox/g), followed by turmeric powder (55.42 ± 0.81 mg Trolox/g) and white sesame seeds (50.16 ± 0.61 mg Trolox/g). In terms of finished products, B2 showed the highest antioxidant activity (29.85 ± 0.20 mg

Trolox/g), 93% higher than B1 and 9 times higher than B0.

Table 3. Antioxidant activity of the finished products, white wheat flour, seeds and added powders

Sample	Antioxidant activity (mg Trolox/g)
B0	3.31±0.08
B1	15.33±0.14
B2	29.85±0.20
White wheat flour	4.52±0.11
Turmeric powder	55.42±0.81
Sea buckthorn powder	59.64±0.90
Linseeds	49.28±0.64
Sunflower seeds	31.18±0.48
White sesame seeds	50.16±0.61

For white wheat bread, Meral & Köse (2019) determined (TEAC method) much lower values of antioxidant activity (between 0.17 and 0.25 mg Trolox/g) while and Yu et al. (2013), using the ORAC assay, found higher values (8.08 mg Trolox/g) than those reported in this paper, but for white wheat flour they determined a lower value (3.13 mg Trolox/g) than ours. Meral & Köse (2019) determined the antioxidant activity (TEAC method) for white wheat bread enriched with added pomegranate seeds and grape seeds, respectively, reporting values of 0.28-0.67 mg Trolox/g and 0.55-0.74 mg Trolox/g, respectively, much lower than those for enriched breads in this paper.

Free radical scavenging activity

The DPPH free radical scavenging activity (RSA %) determined for the finished products, white wheat flour, seeds and powders used is presented in the Table 4.

Of the additional ingredients added to B1 and B2, white sesame seeds had the strongest RSA (98.82 ± 0.41%). Sea buckthorn powder, although poorer in total polyphenols than turmeric powder, showed stronger RSA (95.14 ± 0.38%, compared to 93.86 ± 0.52% for turmeric powder). B2 bread had the highest RSA (88.00 ± 0.32%), followed by B1 (55.65 ± 0.29%). It is observed that the additions in B1 and B2 led to a significant increase in antiradical activity compared to control: with 43.58% in the case of B1, respectively by 2.27 times in the case of B2.

Table 4. Free radical scavenging activity (RSA) of the finished products, white wheat flour, seeds and added powders

Sample	RSA (%)
B0	38,76±0.19
B1	55,65±0.29
B2	88.00±0.32
White wheat flour	40.12±0.21
Turmeric powder	93,86±0,52
Sea buckthorn powder	95.14±0.38
Linseeds	91.18±0.26
Sunflower seeds	88.64±0.34
White sesame seeds	98.82±0.41

Breads porosity

The results obtained for the three bread assortments porosity are shown in Table 5.

Table 5. Porosity of breads

Sample	Porosity (%)
B0	68.27±0.42
B1	60,63±0.46
B2	53.12±0.58

The highest porosity was B0 (68.27 ± 0.42%), while breads with different additions showed decreases: 60.63 ± 0.46% for B1 and 53.12 ± 0.58% for B2. Ghendov-Mosanu et al. (2020) also found that porosity values of white bread decreased with increasing amount of sea buckthorn flour added (between 72.7 ± 1.3 and 59.7 ± 1.5%). The same authors reported a higher porosity for plain white bread (72.3 ± 1.4%), while Coțovanu and Mironeasa (2022) found lower value (64.33 ± 0.11%) than in this paper.

Proximate composition and energy value of finished products

The proximate composition and energy values determinations for breads led to the results presented in Table 6.

The three types of breads (B0, B1 and B2 respectively) had a very similar protein (6.24 ± 0.10, 6.32 ± 0.09 and 6.57 ± 0.11 g/100 g respectively) and total carbohydrates (46.05, 45.30 and 45.29 g/100 g respectively) contents. Sugars are almost non-existent in the products.

Total fats are better represented in the breads with different additions, so that in B1 the quantity is double, and in B2 is 3.24 times higher than in B0 (0.68 g/100 g). While in B0 saturated lipids are almost absent (0.01 g/

100 g), in B1 the amount reaches 0.31 g/100 g and in B2 is 0.22 g/100 g.

Table 6. Proximate composition and energy value of breads

Parameters	B0	B1	B2
Proteins (g/100 g)	6.24±0.10	6.32±0.09	6.57±0.11
Lipids (g/100 g)	0.68±0.02	1.36±0,04	2.20±0.03
Saturated fatty acids (g/100 g)	0.01±0.01	0.31±0.02	0.22±0.01
Carbohydrates (g/100 g)	46.05	45.30	45.29
Sugar (g/100 g)	0	0.02±0.01	0.07±0.01
Dietary fiber (g/100 g)	0.15±0.02	0.84±0.04	0.70±0.02
Moisture (g/100 g)	45.00±0.94	44.00±0.92	43.00±0.88
Mineral substances (g/100 g)	1.88±0.02	2.18±0.04	2.24±0.06
Energy value (kcal/100 g)	215.28	218.72	227.24

The additions in B1 and B2 breads also increased the dietary fiber content of B1 by 5.6 times and of B2 by 4.7 times compared to control (0.15 ± 0.02 g/100 g).

Sensory analysis

Sensory analysis of the breads led to the results shown in Figure 2.

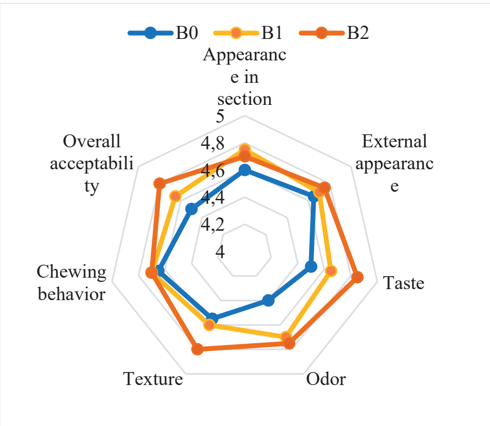

Figure 2. Global values of the sensory evaluation of breads using a 5-point hedonic scale

From organoleptic point of view, all three bread assortments were well evaluated by the tasters, obtaining scores above 4 for all characteristics. B1 and B2 breads were the best rated, with B2 scoring between 4.7 and 4.85 and B1 between 4.6 and 4.75. Apart from the appearance in section, where B1 scored the highest: 4.75 points, B2 had the best results in sensory analysis.

CONCLUSIONS

Obtaining bakery products enriched with various natural additives to enhance their antioxidant properties, nutritional value and sensory characteristics is a common trend nowadays.

This work aimed to obtain two innovative bread assortments: one enriched with added turmeric powder and flax seeds (B1), and the second with sea buckthorn powder, white sesame seeds and sunflower seeds (B2), using white wheat flour as principal raw material.

Of the natural ingredients added to B1 and B2, the highest content of total polyphenols was found in white sesame seeds, followed by flax seeds and turmeric powder. These natural additions resulted in a significant increase in the total polyphenol content of B1 and B2 compared to control.

The best antiradical and antioxidant activity was determined for white sesame seeds, followed by sea buckthorn powder and turmeric powder, and among the finished products, for B2. It was shown that the addition of sea buckthorn powder, sunflower seeds and white sesame seeds, respectively turmeric powder and flax seeds in the matrix of plain white bread led to a remarkable improvement of the antioxidant activity of the products obtained compared to the control.

The breads porosity was influenced by the ingredients added to the matrix of the white bread, thus showing a decrease in porosity in breads with additions, the lowest value being recorded for B2.

From a nutritional point of view, B1 and B2 provide significant additional dietary fiber and fat compared to plain white bread.

In the sensory analysis the enriched breads B1 and B2 were evaluated with very good scores, superior to the control, and of these, except the appearance in section, where B1 was the best evaluated, B2 recorded the highest scores, proving a very high level of acceptability.

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