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Functional bread, or the effects of garlic and its products on certain parameters of bread

KEYWORDS: Bread, garlic, total polyphenol content, element content

SUMMARY

Nowadays, bread is consumed almost every day. Since the beneficial effects of garlic are well-known, we thought that by baking it into bread, a delicious product with physiological benefits could be created. For the experiment, garlic, garlic paste and granulated garlic were used in different concentrations, which were selected on the basis of preliminary studies. For the finished products, it was examined to what extent the enrichments changed the amount of antioxidants and macronutrients in the finished products compared to our control bread. Results were also analyzed using a statistical program, based on which it was found that there were verifiable differences between the experimental loaves in the parameters examined. There was a clear increase in the total polyphenol content, however, varied results were obtained in the case of element content.

INTRODUCTION

Garlic (*Allium sativum L.)* has been grown by mankind since ancient times. It has been used and is used up to this day in several cultures as a spice, a flavoring or as a medicine **[1, 2, 4, 5, 6, 7, 8, 9]**. The results of epidemiological, clinical and preclinical studies have revealed a strong correlation between dietary habits, including garlic consumption, and the occurrence of certain diseases. Garlic itself has been studied extensively in recent decades; more than a thousand studies have been published on this subject **[1]**. Researchers have investigated a number of therapeutic effects of garlic, including its antihypertensive, hypoglycemic, anticoagulant, antimicrobial liver protection and anti heavy metal poisoning properties. By boosting the immune system, it alleviates the symptoms of colds and the flu, and it also exerts anticarcinogenic and chemopreventive activities. Based on these, it can be considered one of the best disease prevention plants **[1, 7, 8, 9]**. The physiologically beneficial effects listed are due, inter alia, to the antioxidant and sulfur-containing compounds found in garlic **[3, 4, 5, 6, 7, 8, 9]**. In food technology, various antioxidant compounds of garlic are used as additives to control rancidity, for example, or to increase product shelf life or nutritional value **[2]**.

Bread is one of the staple foods in the human diet. In ancient times, in the course of the gathering lifestyle, grains were crushed on stones, they were roasted and then mixed with water **[10]**, making this way porridge or flatbread. In certain countries, these foods are still a part of the daily diet. The use of leaven and the baking oven has a history of four thousand years. They were first used by ancient Egyptians **[11, 12]**. Bread making is considered one of the oldest human activities, as evidenced by various written documents **[13, 14]**.

Since only a few researchers have experimented with making and examining garlic bread **[15, 16, 17, 18]**, we considered it important to prepare such a product and to examine its nutritional values.

MATERIALS AND METHODS

GARLIC ANALYSES AND BRAD MAKING

We started our study by measuring the dry matter, total polyphenol and element content of garlic (n=7), garlic paste (n=4) and granulated garlic (n=9) samples. Following this, one product from each group was selected on the basis of the total polyphenol content. Using these, breads with different garlic content were prepared using a unique recipe, and a product was

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also prepared as a control that did not contain garlic or garlic products. Ingredients of the bread included wheat flour (BL 55), salt, cooking oil, 10% vinegar, water at 25 °C, yeast, crystal sugar, 2.8% fat milk. Garlic, garlic paste and granulated garlic were added to the bread in the amounts shown in ***Table 1***. Rise time was 1 hour at room temperature. After forming the bread and resting for 10 minutes, breads brushed with water were baked in an oven (RXB 606, convection oven, Budapest, Hungary) for 15 minutes at 210 °C, with a relative humidity of 95%. Following this the baked products were left in the oven for 6 minutes.

After cooling and drying the total polyphenol and element contents of the breads thus prepared were determined.

Determination of dry matter content

Dry matter content was determined according to standard MSZ 20501-1:2007 **[19]** in a drying oven (Memmert UF 75 Universal Oven, Memmert GmbH+Co. KG, Schwabach, Germany). In this case, samples were dried to a constant weight, and their moisture and dry matter contents were calculated using a formula.

Total polyphenol content (TPC)

The assay was performed according to the method of Singleton et al. **[20]** using the Folin-Ciocalteu reagent. To prepare the reagent, 100 g of anhydrous sodium tungstate and 25 g of anhydrous sodium molybdate were dissolved in 700 ml of distilled water, to which 100 ml of concentrated hydrochloric acid and 50 ml of 85% orthophosphoric acid were added. Finally, 150 g of anhydrous lithium sulfate was added to the solution. The reagent may be stored for up to a year when kept away from light and reducing agents.

During the analysis, 1.00 ml of the sample solution in distilled water was placed in a 100 ml volumetric flask, it was diluted with 60 ml of distilled water, and then 5.0 ml of Folin-Ciocolteau reagent was added. After allowing the mixture to stand for 5 minutes, 15 ml of 25% sodium carbonate solution was added to the reaction mixture, and finally it was filled to mark with distilled water. For the development of the color, the mixture was allowed to stand at 23 °C for 2 hours, and the absorbance of the resulting colored compound was measured in a 1 cm cuvette at 760 nm using a spectrophotometer (Evolution 300 LC, Thermo Electron Corporation, England). Results were expressed in GAE (gallic acid equivalent)/100 g.

Element content measurement

Sample preparation was carried out according to the method of Kovács et al. (1996) **[21]**. During the analysis, 2 g of the sample was placed in a 500 ml digestion tube. 10 ml of concentrated nitric acid was added to the sample. The contents of the tube were predigested for 30 minutes in a 60 °C aluminum digestion block. Following this, 3 ml of hydrogen peroxide was added to the sample, and the mixture was digested for a further 90 minutes after raising the digestion temperature to 120 °C. At the end of the digestion time, 50 ml of high purity water was added to the mixture and it was filtered through an MN 640W filter. The final sample volume was adjusted to 100.0 ml. The element content of the samples was measured using an ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometer) (Thermo Scientific iCAP 6300, Cambridge, UK) instrument at the following wavelengths: Ca (317.9 nm), K (766.4 nm), Mg (279.5 nm), Na (589.5 nm), P (185.9 nm), S (180.7 nm). The excitation energy of the ICP instrument was set to 1200 W.

Statistics

Analytical tests were performed in triplicate. The results were evaluated using the SPSS statistical software (version 13; SPSS Inc. Chicago, Illinois, USA) to determine the mean and the standard deviation, and to determine statistically significant differences between the results obtained, one-way analysis of variance (Tukey és Dunnett's T3 test) was used.

Results

Analytical results of garlic and garlic products

The dry matter contents of garlic paste and garlic samples were nearly identical (34.3-39.9%). In the case of granulated garlic samples, this vale ranged between 94.9 and 97.0%. For the total polyphenol and element contents to be comparable, results were analyzed on a dry matter basis. Based on this, in terms of the total polyphenol content, the granulated samples gave the lowest values (61.9-161 mg GAE/100 g). Relatively higher values were obtained in the case of the garlic paste samples (155-260 mg GAE/100 g). Garlic samples had the highest TPC values, between 295 and 418 mg GAE/100 g. In terms of the element content, varying results were obtained. From a statistical point of view, garlic paste samples could always be distinguished from the garlic and granulated garlic samples. However, in the case of magnesium, calcium, potassium and phosphorus, the results of the granulated samples did not differ from the element content of the garlic samples. When selecting the products, the total polyphenol content was taken into account. The garlic and garlic-based products with the highest values were selected for the experiment. The element contents of the products selected by us were as follows (expressed in mg/kg):

Garlic: Ca: 408±8; K: 20691±114; Mg: 1032±4; Na: 286±4; P: 4864±100; S: 9730±67;

Garlic paste: Ca: 2191±4; K: 6210±87; Mg: 242±2; Na: 65524±233; P: 1211±4; S: 3332±78;

Granulated garlic: Ca: 668±8; K: 11957±71; Mg: 848±6; Na: 571±18; P: 4091±51; S: 6906±12.

Bread analysis results

There were no significant differences in the dry matter contents of the prepared breads (61.5-71.7%). It, of course, depended on the added garlic and garlic products. Values of about 70% were measured in breads with granulated garlic, while the other parameters were measured from the pre-dried sample. Since they did not differ from each other significantly in terms of the dry matter content, the measured values are the results of the pre-dried samples.

Total polyphenol content results

Figure 1 shows the total polyphenol content of the breads: a value of 50 mg GAE/100 g was measured in the case of the control bread, while increasing the amount of garlic and garlic products resulted in a higher total polyphenol content.

Compared to the control bread, a continuous growth can be seen. The growth was not significant in the case of the products with garlic paste, however, there were verifiable differences between the products with garlic or granulated garlic compared to the control. Comparing the same flavorings, our statistical results proved that there was no significant difference between flavorings F_1 and F_2 in the case of the products with garlic. In contrast, there were verifiable differences between breads F_1 and F_3, as well as between F_2 and F_3 in terms of the total polyphenol content. No significant differences were found with increasing concentrations in the case of flavoring with garlic paste or enrichment with granulated garlic. When enrichment was carried out with the same amounts of different additives, there were statistically significant differences in only two cases, namely for breads enriched with 17 grams of garlic (F_1 and G_1), and for breads K_1 and G_1. In all other cases, there were no significant differences.

Element content analysis results

Element content analysis results are shown in ***Table 2***. Several elements were measured, but only the more important ones are mentioned in the study. The calcium content of the breads was between 453±12 and 518±16 mg/kg. As the results show, the calcium content of the breads with garlic or granulated garlic was lower than that of the control bread, and this was confirmed by statistical analysis. In the case of the products with garlic paste, there was no verifiable difference compared to the control. Comparing the same flavorings, in the case of the samples with garlic and granulated garlic it can be seen that the products with lower concentrations had a higher calcium content than the 34 and 51 g enrichment, which was also confirmed by statistical calculations. There was a significant difference in the calcium content in the case of breads F_1-F_2, F_1-F_3, G_1-G_2 and G_1-G_3. In the case of the products with garlic paste, the highest concentration enrichment resulted in the highest calcium content, which was significantly different from that of breads containing less garlic paste. Concerning the same concentrations, no significant difference could be detected between the breads enriched with 17 grams of garlic paste or granulated garlic, however, there was a significant difference in the other cases. In the case of the 34 gram enrichment, the samples could always be distinguished in terms of calcium content. There was no significant difference when 54 grams of garlic or granulated garlic was added, but there were verifiable differences in the other cases in terms of calcium content.

There were also differences in the potassium content results. Compared to the control, breads F_1, F_2, K_1, K_2 and G_1 were the ones where no significant differences were found. In the other cases, there were verifiable differences in terms of the potassium content. No significant difference could be found between F_1 and F_2 with the same flavoring, however, there were verifiable differences in the case of the other samples. When applying the same concentrations, the same tendency is observed in the case of potassium. Based on our results it can be stated that a significant difference only between the breads with garlic and garlic paste could not be verified.

Regarding the magnesium contents of our products, the results of the breads with garlic and garlic paste differed significantly from those of the control, while the samples enriched with granulated garlic had similar values. In the case of the same flavorings, there was no statistically verifiable difference for the products with garlic and garlic paste. In the case of the breads with granulated garlic, the results of samples G_1-G_3 were different in terms of the magnesium content. Looking at the same concentrations, significant differences were observed in terms of magnesium concentration between the product with garlic paste and granulated garlic at the lowest enrichment level, between the breads with garlic and granulated garlic, as well as between the ones with garlic paste and granulated garlic when applying 34 grams, and in all cases when using the highest concentrations.

In the case of sodium content, as can be seen from the results, the breads were always different from the control. When looking at the breads with the same flavoring, it can be seen and can be statistically verified that there is no significant difference between the breads enriched with 35 and 51 grams of garlic, however, using the first concentration resulted in a verifiable difference compared to the others. When using garlic paste, differences were found between all of the concentrations. Sodium content also increased with increasing concentration. In the case of samples with granulated garlic, no difference was found between G_1 and G_2 in terms of the sodium content, however, the difference was significant in all other cases. When using the same concentration, it was found that there was no verifiable difference between the samples with garlic and granulated garlic at the 17 gram enrichment level, but in all other cases there was a difference.

The phosphorus content of the breads was as follows: breads F_3, K_1, K_3, G_2 and G_3 showed a significant difference compared to the control bread. In the case of the same flavorings, no significant difference could be detected between products F_1 and F_2 with garlic, and in the case of the enrichments with garlic paste. In all other cases, there was a verifiable difference in the phosphorus content. When applying the same concentrations, there were only two cases where there was no difference: between samples F_1 and G_1 at the lowest enrichment level, and between samples F_2 and K_2 at the 34 gram treatment level. Significant differences could be detected in the case of all other breads and concentrations.

In the case of sulfur content, all samples showed a difference compared to the control. When applying the same enrichment, significant differences were observed in all cases between the garlic and granulated garlic treatment. For the breads with garlic paste, only in the case of K_2 and K_3 was there no verifiable difference. When applying the same concentrations, there was no significant difference in two cases: for samples F_1 and K_1 in the case of the 17 gram enrichment, and samples F_2 and K_2 in the case of the 34 gram treatment.

Conclusions

Our research started with the analysis of garlic and garlic-based products; based on their total polyphenol content, a garlic, a garlic paste and a granulated garlic were selected from among them. Using the listed ingredients at various concentrations, breads were baked. In addition to the enriched products, a control sample was also prepared. Our objective was to produce breads with increased amounts of compounds with antioxidant activity, and to achieve changes in the element content during the enrichment process. Based on our results it can be stated that, in terms of the total polyphenol content, breads with garlic and granulated garlic showed a significant difference compared to the control bread. With respect to the element content, it was always the garlic bread containing the highest amount of additive that showed a difference compared to the control. The calcium, magnesium and sodium content of this product decreased, but the amount of potassium, phosphorus and sulfur increased. In the case of breads with granulated garlic, the enrichments with 34 and 51 grams were the ones that differed significantly from the control in terms of both TPC and element content, with the exception of magnesium. Therefore, based on our results, we recommend the consumption of breads with garlic and granulated garlic, since we have been able to prepare a special product, both in terms of taste and smell. Breads made with garlic paste had a higher sodium content than the other products, which was due to the salt added during the production of the garlic pastes. However, the higher than usual sodium chloride content may be a cause for concern, since a high sodium intake is characteristic of most food consumers. Excessive intake of table salt may pose a cardiovascular risk. For this reason, preparation and consumption of this type of bread is only recommended to a lesser extent. Nevertheless, we believe that we have achieved our objective and this has been confirmed by the results of this study.

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