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Effect of the process of flaking of einkorn (*Triticum monococcum* L.) on some basic chemical properties and biologically active compounds in the flaked product

Влияние на процеса флейковане на еднозърнест лимец (*Triticum monococcum* L.) върху някои основни химични показатели и биологично активни вещества във флейкования продукт

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ABSTRACT

Nowadays, flaked product became quite popular. The aim of the present paper is to study the effect of the process of flaking of einkorn (*Triticum monococcum* L.) on some basic chemical properties, the biologically active substances and the antioxidant activity of the flaked product. The chemical parameters (contents of moisture, ash and fats) were determined according to ISO standard methods. Protein content was determined by the method of Lowry. The following biologically active compounds were also determined: total polyphenols, antioxidant activity (% DPPH) and total carotenoids. The analyses carried out showed that the flaking has certain effect, although to small extent, on the values of the properties of the flaked einkorn studied. The moisture content and the total amount of carotenoids were found to decrease while the amounts of fats, proteins and total polyphenols increased. The results obtained from the analyses of the flaked product were compared to these of wholegrain einkorn flour and it was found that the differences were considered to be immaterial although some of them were statistically significant. It was found also that the process of flaking does not affect the amount of mineral substances and the antioxidant activity of the flaked einkorn compared to einkorn flour.

Keywords: flaking, einkorn, polyphenols, carotenoids, flour

ABSTRACT

Днес, флейкованите продукти стават все по-популярни. Целта на тази статия е изследване влиянието на процеса „флейковане" на еднозърнест лимец (*Triticum monococcum* L.) върху някои основни химични показатели, биологичноактивни вещества и антиоксидантната активност на флейкования продукт. Химичните характеристики (влагосъдържание, пепелно съдържание и мазнини) в изследваните проби е определено според стандартни ISO методи. Протеините са определени по метода на Лоури. От биологичноактивните вещества определени бяха: общите полифеноли, антиоксидантната активност (%DPPH) и общите каротеноиди. От направените анализи се установи, че флейкованието, макар и в незначителна степен, оказва влияние върху стойностите на изследваните показатели на флейкования еднозърнест лимец. Констатира се намаляване на влагосъдържанието и общите каротеноиди, а количеството на мазнините, протеините и общите полифеноли се

увеличава. Резултатите от анализите на флейкования продукт са сравнени с тези на пълнозърнесто лимецово брашно, като съществуващите разлики между тях са видимо незначителни, но някои от тях са статистически значими. Установява се, че процесът „флейковане" не оказва влияние върху количеството минерални вещества и антиоксидантната активност на флейкования лимец, спрямо брашното от лимец.

Ключови думи: флейковане, лимец, полифеноли, каротеноиди, брашно

INTRODUCTION

Cereals like barley, oats, rye, einkorn, wheat, kamut (khorasan), millet, etc. are important part of human nutrition (Kreisz et al., 2008). They and their derivatives are the main source of carbohydrates and energy. They contain also significant amounts of proteins, nutritious fibers, vitamins and mineral substances (McKevith, 2004). The einkorn (*Triticum monococcum* L.) is diploid 2n=2x=14 (Nakov et al., 2016b; Čurná and Lacko-Bartošová, 2017) and it is one of the oldest cereals suitable for organic agriculture. Einkorn and einkorn flour contain large amounts of proteins and mineral substances. They also have strong antioxidant ability (Nakov et al., 2016a). Nowadays, the flaked products became quite popular. The basic technological operations for their production are cleaning of the seeds, sorting, peeling, treatment of seed surface with brushes, heating, drying, fractionation and rolling (flaking). The main process is that of "flaking". By increasing the temperature during the process, the grains are heated and, as a result, the flaked products are quickly formed and then easily decomposed in human organism (Goudar and Sathisha, 2016).

The aim of the present paper is to study the effect of the process of "flaking" of einkorn (*Triticum monococcum* L.) on some basic chemical properties, biologically active substances and antioxidant activity of the flaked product.

MATERIALS AND METHODS

Materials

Whole grain flour of einkorn (*Triticum monoccocum* L.) and flaked einkorn grown in the Plovdiv region.

The einkorn grain samples were subjected to dehusking to remove the outer husk of the seeds and then steamed for 20 minutes. The flaked samples were placed in hot air oven (105 °C) and completely dried and then subjected for homogenization.

Methods

Chemical characteristics

The samples were prepared for analysis according to AACC Method 62-20A.The moisture content in the samples was determined by the method described in ISO 6540. The fat content was determined according to ISO 6492:1999. The amount of protein contained in the samples was determined by the method of Lowry et al., (1951). The ash content in the samples studied was determined according to ISO 5984:2002.

Biologically active compounds

Flaking einkorn and einkorn flour (1 g) were treated with 10 mL methanol (methanol/water 80:20 v/v) at room temperature for 2 h. The mixture was filtered through a Whatman N° 1 filter paper. Exactly 0.3 mL of the extract was mixed in a test tube with 1.5 mL freshly prepared Folin-Ciocalteu reagent (1:10). After 5 min period, 1.5 mL of 6.0% Na_2CO_3 solution was added. The solution was stirred vigorously and then kept in the dark at room temperature for 90 min. The absorption was measured at 725 nm with a HALO RB-10 spectrophotometer (Dynamica Scientific Ltd., Newport Pagnell, UK). A blank reference with methanol 80% instead of the extract was also prepared. The total polyphenols were expressed as mg gallic acid equivalent (GAE)/100 g dry matter.

Antioxidant activity was measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical cation according to Wang and Ryu (2013). Exactly 200 µL of phenolic extract were mixed to 3.9 mL freshly prepared

solution of DPPH in methanol (0.1 mM), vigorously stirred and left at room temperature for 30 minutes. The absorption was measured at 517 nm with a HALO RB-10 spectrophotometer (Dynamica Scientific Ltd., Newport Pagnell, UK). A methanol solution was used as a reference. The antioxidant activity of the extracts was recorded as percentage of inhibition of the DPPH radical.

Total carotenoids content was determined by the method proposed by Harborne (1973). Exactly 100 mg of sample were mixed with 10 mL 80% acetone, stirred for 10 min and centrifuged for 10 min at 3000 rpm with a Multifuge 3 L-R Centrifuge (Heraeus, Germany). The absorption of the supernatant was measured at 480 nm with a HALO RB-10 spectrophotometer (Dynamica Scientific Ltd., Newport Pagnell, UK). Total carotenoid content was reported as mg/kg DM.

All the analyses were performed in triplicate. Analysis of variance (ANOVA) and Fisher's Least Significant Difference test (LSD) at P<0.05 were performed with the software XLSTAT 2017 and Microsoft Office Excel 2013.

RESULTS

The ANOVA (not presented) highlighted significant differences (P<0.05). Figure1 shows the results obtained from the determination of the chemical properties studied – contents of moisture, ash, fats and proteins in einkorn flour and flaked einkorn.

The moisture content in the raw materials used depends to great extent on the climatic conditions during their storage. As can be seen from Figure 1, the einkorn flour has slightly higher moisture content (12.31±0.04%) compared to the einkorn flakes (12.03±0.00%). The data are statistically significant (P<0.05).

The ash consists of all the mineral substances contained in the food and, respectively, in the samples analyzed. The ash content in the foods helps absorb the carbohydrates and the other organic compounds, as well as it is part of the normal human metabolism (Mousa and Mousa, 2014). The figure shows also that the amount of mineral substances contained in einkorn flour was the same as that in einkorn flakes.

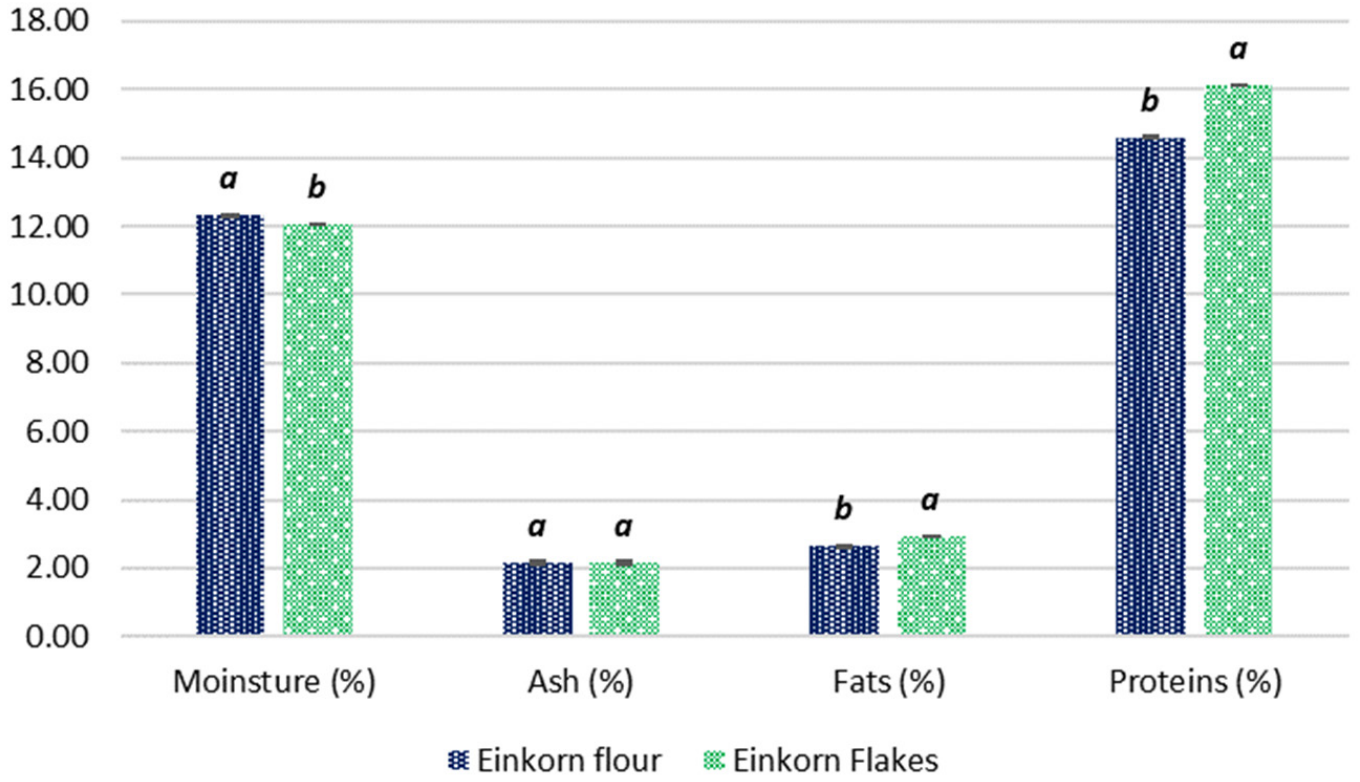

Figure 1. Chemical properties of einkorn flour and einkorn flakes (*The data presented are the average of three consecutive measurements ± the standard deviation; **Within the same sample, means followed by different letters are significantly different at P<0.05 (ANOVA, Fisher's LSD))

The data about the ash content are statistically significant (P<0.05). It is well known from the scientific literature that einkorn (*Triticum monococcum* L.) contains twice as much fats compared to the common soft wheat (Hidalgo and Brandolini, 2014). It can also be seen from Figure 1 that the flaked einkorn contains slightly more fats (2.94±0.00%) compared to the einkorn flour (2.65±0.01%). The data are statistically significant (P<0.05). The qualitative and quantitative analyses of the protein content in cereals are very important for their nutritious and technological properties (Hidalgo and Brandolini, 2014). Figure 1 shows that einkorn flakes contained more proteins (16.10±0.00%) compared to einkorn flour (14.60±0.02%). The data are statistically significant (P<0.05).

The concentration of phenolic compounds in whole grain cereal depends on the type of grains, variety, as well as from which part of the grains the analyses were done. Most often, the phenolic acids and flavonoids are found in the cereals. Phenolic substances are commonly found in the coating of the grains (Gangopadhyay et al., 2015). Besides, different methods of extraction and different means of extraction give different results when determining the phytochemicals in different types of food (Kosović et al., 2015).

The values of the contents of biologically active compounds (total polyphenols and total carotenoids) and the antioxidant activity of the samples of einkorn flour and einkorn flakes analyzed are presented in Figure 2.

It can be seen from Figure 2 that the process of "flaking" leads to insignificant decrease of the total amount of carotenoids. The einkorn flour had 8.00±0.00 mg/kg while the einkorn flakes 7.40±0.28 mg/kg total carotenoids. The data are statistically significant (P<0.05). Einkorn is an underutilised wheat species with high protein, lutein and tocols content, particularly suited for infant and specialty foods (Hidalgo et al., 2008). Numerous researches indicate that these compounds have positive effects on health by protecting against solar radiation, enhancing the immune response, inhibiting some cancers, and in the case of lutein, protecting the macula region of the retina and preventing the cataracts (El Gharras, 2009; Hidalgo and Brandolini, 2014).

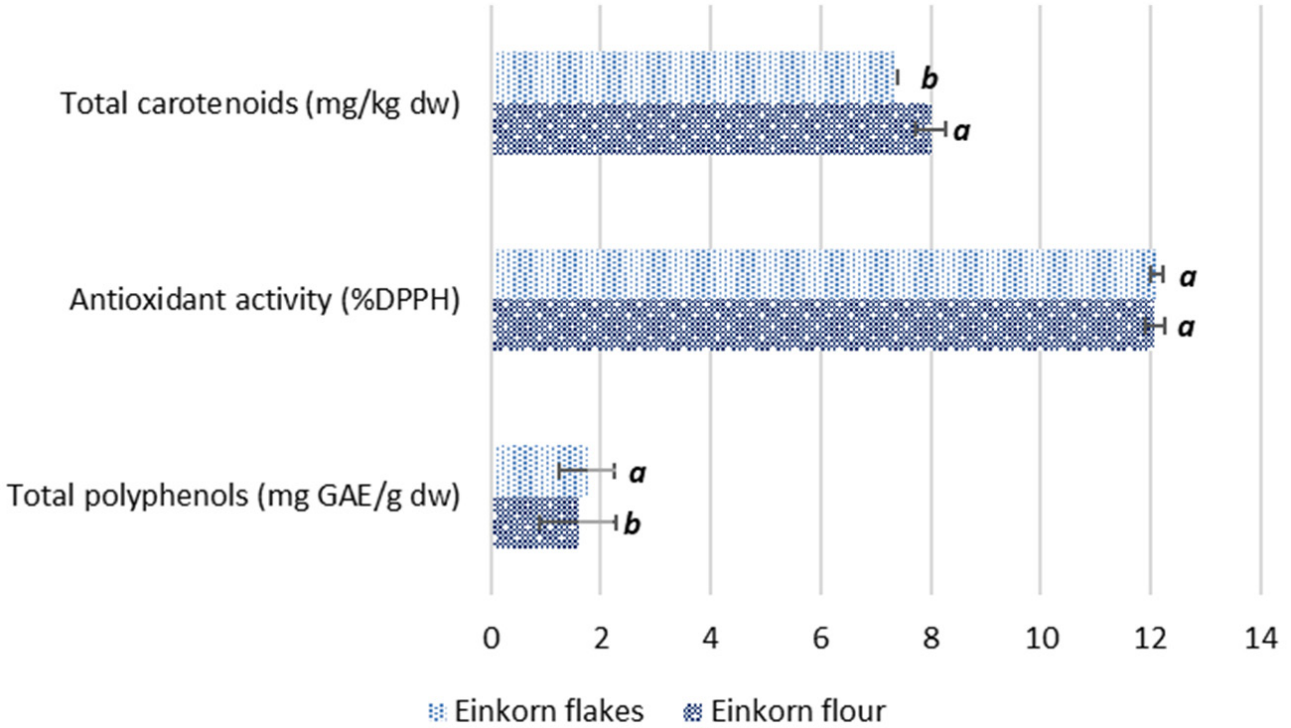

Figure 2. Biological active compounds in einkorn flour and flaking einkorn (*The data presented are the average of three consecutive measurements ± the standard deviation; *Within the same sample, means followed by different letters are significantly different at P<0.05 (ANOVA, Fisher's LSD))

The basic role of antioxidants in the body is the reaction with free radicals, compounds that have more unpaired electrons. Antioxidants from cereals are thought to act as direct "captors" of free radicals, enzyme antioxidant cofactors, or as direct antioxidants (Fardet et al., 2008). The antioxidant activity slightly increased during the process of "flaking" of einkorn. Einkorn flakes contained 12.12±0.19% DPPH while einkorn flour 12.08±0.11% DPPH. The data are statistically insignificant ($P<0.05$). The process of flake preparation affects also the total content of polyphenols, although to small extent. The einkorn flour had 1.59±0.5 mg GAE/g total polyphenols compared to 1.75±0.7 mg GAE/g in einkorn flakes. The same tendency was reported in the literature by Goudar and Sathisha (2016). The data are statistically significant ($P<0.05$).

CONCLUSIONS

1. It was established that the process of "flaking" of einkorn has certain effect on the values of the chemical properties studied, compared to the einkorn flour. The moisture content decreased while the amounts of fats and proteins increased. The process of "flaking" does not affect the ash content in einkorn flakes.
2. The biologically active substances present in the flaked product also changed slightly their values compared to einkorn flour. The total carotenoids decreased while total polyphenols increased.
3. The antioxidant activity of einkorn flakes was not affected by the process of "flaking".
4. The statistical processing of the data showed that despite the insignificant differences observed in the values of the properties analyzed – moisture content, fats, proteins, total carotenoids and polyphenols, the process of "flaking" is of certain statistical significance.

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