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Mineral content of the Jubilejnaja 50 winter wheat (Triticum aestivum L.) in different growing years and areas in Hungary

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SUMMARY

Wheat is considered to be among the most widely grown cereal crops both in Hungary and worldwide. In Hungary, its acreage varies from 1.0 to 1.2 million hectares, thus making up a major portion of the total crop production. The crop of winter wheat plays a significant role in our diet. It is an important source of minerals for mankind, since its organic and inorganic macro- and microelement content are of paramount importance to the daily nutrient uptake of our bodies, and this is especially true in the case of consuming whole grain products.

Analyzing literature sources, data regarding the mineral content of wheat are quite diverse. Nowadays, this is also supplemented by the following question: Is the nutrition physiological value of the cultivated varieties somehow affected by the use of intensive agrotechnology?

The Jubilejnaja 50 variety was chosen as the subject of our investigation and the evolution of the mineral content (P, K, Ca, Mg, Zn, Mn, Cu, Fe) was analyzed over two years and in several Hungarian growing areas, comparing these to available Hungarian literature data and examining the directions of possible changes.

Based on our measurement results, it can be stated that in the case of the minerals examined, taking into account the variations between the different growing areas, the values obtained correspond to the literature data, they align with them well. For better comparability, relative standard deviation values were also taken into consideration. Regarding the elements analyzed, the largest variations between the growing areas examined were obtained in both years examined in the case of zinc and copper. The standard deviations in the case of zinc were 33% in 2003 and 21.2% in 2004, while in the case of copper it was 23.6% in 2003 and 22.2% in 2004. The lowest relative standard deviation was observed in the case of magnesium, with values of 9.8% in 2003 and 8.6% in 2004.

In summary, it can be stated that to be able to draw reliable conclusions, data from a number of experimental sites and from different years need to be compiled, and these should be processed using an appropriate statistical method.

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Introduction

Winter wheat makes up a major portion of the total crop production in Hungary. From year to year, its acreage varies from 1.0 to 1.2 million hectares **[22]**. Wheat plays a decisive role in our diet in Hungary as well as in many countries around the world, it is considered a staple food. This is why the chemical composition of the wheat grain, its organic and inorganic macro- and microelement content are of paramount importance in the daily nutrient uptake of our bodies **[6, 17, 26]**. Basic data regarding the mineral content of winter wheat are given by Dworak, Pais, Győri, Oury et al., Sipos, Zhao et al., as well as Burján and Győri, among others **[5, 20, 9, 11, 19, 23, 26, 3]**. In recent years, the production of winter wheat has undergone significant changes as a result of the intensive agrotechnical procedures applied. However, the question arises as to how the cultivation of available varieties under these conditions influences the development of quality indicators, that is, their nutrition physiological and animal nutrition values which, of course, also includes the changes in the chemical composition of the winter wheat grain **[2]**. Various studies included the determination of the yield stability of the varieties **[21]**, as well as the determination of their different quality parameters **[10, 18]**. These results may indicate that there may be significant differences between the varieties from year to year.

All in all, wheat grain is a significant source of minerals and nutrients for mankind **[26]**. A number of researchers have shown that a significant proportion of minerals entering the human body comes from cereals **[12]**. Of course, in assessing this, it should also be taken into account that the distribution of minerals in the wheat grain is not uniform. Although most of the minerals are contained in the husk of the wheat grain (bran), in many countries, the endosperm part of the wheat grain, which is much poorer in minerals, is used for human consumption **[16, 24]**.

There are many chemical elements that can be found in the wheat grain, however, looking at literature data, the picture is rather varied regarding the composition of minerals, related data and literature sources are shown in the following table ***(Table 1)***.

From the data in the table it can be concluded that it is difficult to draw a uniform conclusion regarding elemental composition studies, since the development of the mineral content can be influenced significantly by certain elements of agrotechnics and the conditions of the growing area.

Using the above-mentioned intensive agrotechnics to increase crop yields has again placed great emphasis on elemental composition studies. The mineral content of winter wheat has been determined by researchers in a number of publications **[1, 25]**, based on different considerations, such as various wheat varieties and nutrition physiological aspects.

Therefore, based on our available measurement results, changes in the elemental composition were investigated for the Jubilejnaja 50 variety grown in dfferent areas over two years. During the analysis, data obtained for the minerals, namely P, K, Ca, Mg, Zn, Mn, Cu and Fe, were compared to available literature data.

Materials and methods

Winter heat samples on which the investigations were based originated from two growing years (2003 and 2004) and 16 different cultivation areas. Test samples were primarily derived from an agrotechnical experiment where the effects of various growind areas were investigated under different ecological conditions (different soil types), and the yields achieved were evaluated. The winter wheat variety investigated was Jubilejnaja 50.

Samples were ground with a Retsch Sk-3 mill and, following size reduction and homogenization, a wet digestion procedure according to the method of Kovács et al. was used **[14, 15]**. According to the method, 1 g portions of the samples were weighed into the digestion tubes, and then predigestion and main digestion were carried out using nitric acid and hydrogen peroxide. Following the digestion, samples were filtered through filter paper, and 25 ml of the filtrate was transferred into a scintillation vial. To determine the element content of the digested samples, an Optima 3300 DV (Perkin-Elmer Ltd., UK) ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometer) was used. Measurements were carried out at the Instrument Center of the University of Debrecen. Our results are given on a dry matter basis. The results obtained were evaluated using the SPSS 22.0 statistical program package. Average, absolute and relative standard deviation values were calculated.

Results and evaluation

In terms of our analytical results, it can be stated that the values measured align well with the values found in the literature in the case of both years examined and all of the growing areas investigated ***(Table 1)***. Also in accordance with the same literature data, it can be stated that significant variations can be observed between the years and growing areas examined. It is clear in the literature sources that the amounts of the individual elements vary over a wide range. This is not surprising, since the ecological conditions of the given year, the properties of the available growing area, as well as the combinations of the agrotechnical elements applied can influence the mineral content of the wheat grain and, in general, the quality parameters of the wheat in various ways. Accordingly, in the two years examined values between 2,300 and 4700 mg/kg were determined for phosphorus for the different growing areas, while measurement results ranged between 2,100 and 3,800 mg/kg in the case

of potassium. In terms of the calcium content of the samples, similar average values were obtained for the two years examined, the measured values being 425.4 mg/kg in 2003and 428.5 mg/kg in 2004, which again align well with available literature data. To assess the variation properly between the growing areas in each year of cultivation, relative standard deviations were also calculated. We found that both in 2003 and 2004, the highest relative standard deviation values were measured in the case of the zinc content and the copper content. In the case of zinc, taking into account the average value for the growing areas (23.1 mg/kg), the relative standard deviation in 2003 was 33%. The value of the same indicator was 23.6% in the case of copper. For this mineral, the average value for the different growing areas was 3.6 mg/kg. In the next growing year (2004), the relative standard deviations were 21.2% for zinc and 22.2% for copper, respectively. The average value for the different growing areas was 22.1 mg/kg for the former element and 3.6 mg/kg for the latter one.

The lowest relative standard deviation values were obtained in the case of magnesium in both years examined. For this element, in the growing year 2003, the relative standard deviation between the different growing areas was 9.8% relative to the average, while the value was 8.6% in 2004. In terms of the average value for the different growing areas, 960.6 mg/kg was found in 2003 and 1013.4 mg/kg in 2004, respectively.

Our analytical results for the Jubilejnaja 50 winter wheat variety are shown in ***Figure 1*** for the growing year 2003 and in ***Figure 2*** for the growing year 2004.

Conclusions

Wheat, one of our major global cereal crops, accounts for a significant proportion of the plant products grown and, on the whole, it provides very important minerals to the human body. This is especially true for the consumption of whole grain products, since in this case the husk of the grain, which is very rich in minerals, is also consumed. The question arises as to whether their nutritional value changes in some way these days in the case of the intensive cultivation technologies and the different varieties.

Our analytical results came from samples obtained over two growing years and from 16 different growing areas, where the effectiveness of intensive agrotechnical treatments was examined under typically different ecological conditions. The winter wheat variety examined was Jubilejnaja 50, whose mineral content was determined. Our measurement results showed a significant standard deviation compared to the average of the different growing areas, since the mineral content of the crop is fundamentally determined by the ecological conditions of the growing area. Furthermore, the values obtained do not differ from literature results, they align with them well. The highest relative standard deviation was observed in both years examined in the case of copper and zinc, relative to the average of the growing areas. The relative standard deviations were 23.6% in 2003 and 22.2% in 2004 for copper, while the values were 33% in 2003 and 21.2% in 2004 for zinc, based on the average for the growing areas. Magnesium had the lowest relative standard deviations with values of 9.8% in 2003 and 8.6% in 2004. Based on these data, it is worth considering that the high relative standard deviation of zinc, an element of major importance in terms of nutrition physiology, may shed new light on the zinc supplementation of products and the need to consume mixed products made from different wheat varieties.

Finally, when processing the available data, the assumption has been confirmed that far-reaching conclusions regarding the evolution of mineral content and its indirect effects can only be drawn if taking into account data collected over several years from a number of growing areas.

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