SHORT COMMUNICATION

WATER SOLUBLE VITAMINS B₃, B₂ AND B₁ IN TRITICALE AND HULL-LESS BARLEY GRAINS

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Abstract
Whole cereal grains contain nutritionally significant quantities of vitamins that are important for health. The aim of this study was to assess the amount of vitamins B group in mature and immature triticale and hull-less barley. All grains were obtained from the experimental farm of Latvia University of Agriculture in immature (use the scale of Zadoks, GS75) and mature conditions (GS93) in 2016. The vitamins were determined by AOAC official methods. The highest content of vitamin B₁ (thiamine) was found in mature triticale (0.52±0.01 mg 100 g⁻¹). The amount of vitamin B₂ (riboflavin) was higher in immature triticale (0.40±0.01 mg 100 g⁻¹) compared with other grains mature or immature conditions. Vitamin B₃ (niacin) amount was higher in immature hull-less barley (7.11±0.01 mg 100 g⁻¹) than other grains mature or immature conditions. According to the results of the study can be seen that the immature grains can be used to enrich foods with water soluble B group vitamins. Immature triticale grains are great source of vitamins B₁ and B₂. The mature triticale and hull-less barley and immature hull-less barley, accordingly has potential for the use in production of functional foods and increasing nutritive value of products.

Keywords: immature and mature grains, thiamine, riboflavin, niacin.

Introduction
Human health is closely related with food used in their diet. It is well known that lack of vitamins causes serious violations, the nervous system, skin diseases, type two diabetes (Liu et al., 2000), also some cancers type and more.

For the harmonious function of the human body, it must be provided with vitamins daily. Consumption of wholegrain cereals in their diet can reduce the risk of disease and contribute to the preservation of health.

Therefore, the interest in cereals as a source of bioactive and functional ingredients has increased (Awika, 2011). Recent evidence suggests that the complex mixture of bioactive components gained of whole grain food may be more healthful than individual isolated components (Lui, 2004). Good potential for research is the whole grain triticale and hull-less barley.

Triticale (× Triticosecale) is a type of small grain created by genetically combining wheat (Triticum) and rye (Secale), which grows well in Latvia. Triticale can be used not only for the production of alcohol and animal feed, but also for the enrichment of food products with vitamins. Triticale grains, flour, and products made from this type of grain for consumers are available through both health food and commercial trading places, but, unfortunately, on a limited choice of range of products (Kalnina et al., 2014).

Hull-less or “naked” barley (Hordeum vulgare L. var. nudum Hook. f.) is a form of domesticated barley with an easier-to-remove hull. Barley has always been present in the human diet, and recent studies have shown that during the ripening of barley part of vitamins disappear in the mature kernels. In the last years appearing more publications about the possibility of using advantage of immature barley. For example, immature and mature hull-less barley is possible to use in the preparation of yogurt to increase their nutritional value, including B group’s vitamins (Zagorska et al., 2015). Increased knowledge of the health-protective potential of the outer grain layers urges to re-think the way of using and processing grains for food, therefore hull-less barley role in the human food chain is growing more and more (Poutanen, 2012). The aim of this study was to assess the amount of B group vitamins in mature and immature triticale and hull-less barley, growing and prevalent in Latvia.

Materials and Methods
The analyses were performed at the scientific laboratories of the Institute of Biology, University of Latvia, Salaspils.

Materials
Triticale (Triticosecale) and hull-less barley (Hordeum vulgare L. var. nudum Hook. f.) grains from the experimental farm “Peterlauki” (56° 30.658´ North latitude and 23° 41.580´ East longitude) of Latvia University of Agriculture was harvested at immature conditions (milk stage, use the scale of Zadoks, GS75) and mature conditions(GS93) in 2016. In experiments used grain varieties: triticale ‘Ruja’ and hull-less barley ‘Irbe’. All grain samples with initial moisture content of 65% were dried in a microwave-vacuum dryer at 45–50 °C temperatures till moisture content 11.1%. For determination of B group vitamins, approximately 100 g of sample was ground in a laboratory mill Cyclotec 1093 (AB Foss Analytical, Sweden) and immediately used for analysis.

Methods
The vitamins were determined by AOAC official methods: vitamin B₁ (thiamine) – AOAC 986.27, vitamin B₂ (riboflavin) – AOAC 970.65, vitamin B₃ (niacin) – AOAC 975.14.

Statistical analysis
Statistical analysis was performed with statistical program SPSS 23.0 package for Windows 10. Mean value and standard deviation were calculated. ANOVA analysis was applied in order to see if there are...
significant differences between the mature and immature wheat kernels (p<0.05).

Results and Discussion

Changes in chemical characteristics during ripening of triticale and hull-less barley are reflected in the diagrams below. The content of vitamin $B_1$ in the immature and mature triticale and hull-less barley samples are shown in Figure 1. The highest content of vitamin $B_1$ was found in mature triticale (0.52±0.01 mg 100 g$^{-1}$).

![Figure 1. Content of vitamin B$_1$ (thiamine) in analysed grain samples](image)


The amount of vitamin $B_2$ was higher in immature triticale (0.40±0.01 mg 100 g$^{-1}$) compared with other grains mature or immature conditions in Figure 2. Difference between hull-less barley mature and immature grains is not so pronounced, however, immature grains has a higher vitamin $B_2$ content (0.25±0.01 mg 100 g$^{-1}$).

![Figure 2. Content of vitamin B$_2$ (riboflavin) in analysed grain samples](image)


The results of vitamins $B_1$ and $B_2$ in mature triticale ‘Ruja’ presented by Kalnina et al. (2014) were lower (vitamin $B_1$ (0.36±0.20 mg 100 g$^{-1}$) and $B_2$ (0.10±0.02 mg 100 g$^{-1}$)) than in this study. It could be explained by the annual variation in climatic conditions, also agricultural practices, soil, and technological practices applied. This only confirms that the chemical composition of grain depends on many factors, including the growing place, the weather, and the number of sunny days during harvest, and the storage of samples.

![Figure 3. Content of vitamin B$_3$ (niacin) in analysed grain samples](image)


Vitamin $B_3$ (niacin) content was higher in immature hull-less barley (7.11±0.01 mg 100 g$^{-1}$). The vitamin $B_3$ content decreased more than by 46% for triticale, for hull-less barley 44%, findings clearly indicated that vitamin $B_3$ content decreased during the cereal ripening. In the immature grains are significantly higher (on basis of weight of the product) vitamin $B_2$ (riboflavin) (0.40±0.01 mg 100 g$^{-1}$ in triticale; 0.25±0.01 mg 100 g$^{-1}$ in hull-less barley) and vitamin $B_3$ (niacin) (7.05±0.01 mg 100 g$^{-1}$ in triticale; 7.11±0.01 mg 100 g$^{-1}$ in hull-less barley) content (p<0.05), but amount of vitamin $B_1$ (thiamine) in triticale and hull-less barley is higher in mature grains (0.52±0.01 mg 100 g$^{-1}$ in triticale; 0.34±0.01 mg 100 g$^{-1}$ in hull-less barley).

Conclusions

The amount of B group vitamins in triticale and hull-less barley is significantly affected by grain development stage at the time of harvest.

In the present research concentrations of B group vitamins (thiamine, riboflavin, and niacin) in immature triticale and hull-less barley compared to mature triticale and hull-less barley were established. The highest vitamin $B_1$ (thiamine) content is in mature triticale. Immature triticale and hull-less barley grains are good sources of the B group vitamins: $B_2$ (riboflavin) and $B_3$ (niacin), therefore could be representing a valuable ingredient for production of functional foods.

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References


