Effect of organic and conventional farming system on the total phenolic content and antioxidant activity of oats and barley grains

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**Implications**

**Oats.** Total phenolic content (TPC) and radical scavenging activity was higher in hull-less oat varieties cv Stendes Emilija and cv Bikini compared to the other tested varieties independently from the production system. However, part of oat varieties produced significantly higher content of the tested parameters in organic farming conditions than in conventional farming conditions. Significant difference in TPC and radical scavenging activity for the all tested varieties was found in the field experiments including four different climate conditions.

**Barley.** The highest TPC and radical scavenging activity was detected from the grains of hulled barley variety cv Tyra and hull-less barley variety cv Pihl. There was no significant difference between farming systems in general, but the significant interaction between the genotype and the farming system was found. For barley varieties environment and genotype interaction was also stronger than for oat varieties, except of 2,2′-azino-bis 3-ethylbenz-thiazoline-6-sulfonic acid (ABTS) scavenging activity, which was significantly higher in all the barley grain samples grown in Priekuli (Latvia).

**Background and objectives**

Cereals are the main source of carbohydrates, but the most of beneficial properties have been attributed to bioactive chemical compounds, commonly named phytochemicals (Acosta-Estrada et al. 2014). Phenolic compounds are the secondary metabolites found in almost all plants at various concentrations and the investigations are carried out because of their diverse health benefits. Natural antioxidants such as phenolic compounds may prevent chronic inflammation, cardiovascular diseases, cancer and diabetes (Masisi et al. 2016) possibly as a result of their free radical scavenging activity. As consumer knowledge on the health benefits from grain constituents increases, barley and oats are becoming more attractive both for researchers and producers. The objective of the current study was to assess the total phenolic content and radical scavenging activity in grains of hulled and hull-less varieties of oats and barley depending on production system and climate conditions.

**Key results and discussion**

Total phenolic content and antioxidant activity in oats and barley was affected by a variety, production system and climate conditions (growing location).

**Oats.** Overall, the highest TPC and DPPH scavenging activity was measured in grains of hull-less variety cv Stendes Emilija and the lowest activity – in hulled variety cv Laima. The highest ABTS scavenging activity was recorded in grains of hull-less variety cv Bikini while the lowest in grains of the variety cv Laima. It is well documented that oats contain phenolic acids, flavonoids and a group called avenanthramides. Several studies have shown strong antioxidant capacity of these compounds (Yang et al. 2014) thus it possibly would explain high DPPH radical scavenging activity established in our study. It is known that phenolic compounds are strongly related to radical scavenging activity. We also found a strong correlation between TPC and DPPH scavenging activity (*r* = 0.75) and a very strong correlation between TPC and ABTS scavenging activity (*r*= 0.85). The significantly higher TPC, DPPH and ABTS scavenging activity was measured in oat grains cultivated in the organic farming comparing to the grains from conventional farming system. All the tested varieties grown in Priekuli (Latvia) had significantly higher TPC and DPPH scavenging activity compared to the same varieties grown at Stende, Apelsvoll, and Kvithamar. Thus, the content of phenolic compounds was strongly affected by growing environment.

**Barley.** For barley varieties the highest TPC and the highest DPPH and ABTS scavenging activity was measured in grains of hull-less variety cv Pihl and hulled variety cv Tyra, whereas the lowest content was measured in hull-less variety cv Kornelia. Barley varieties showed significantly higher TPC content compared to the tested oat varieties. However, a moderate correlation was established between TPC and DPPH scavenging activity and TPC and ABTS scavenging activity in barley. Generally, the farming system had no significant effect on TPC and DPPH scavenging activity of barley. The relationship between genotype and growing environment was observed indicating the importance of a particular growing climate. It seems that organic farming system is more stressful for the plant growth and therefore could result in a higher content of bioactive substances, which was partly confirmed in the current study. Higher content of phenolic compounds and higher antioxidant activity were measured in oats from organic production system, suggesting that oats might be more sensitive to the management conditions than barley. For barley only some genotypes had similar response. It seems that relationship between environment and genotype is more pronounced for barley cultivars than oats.

**How work was carried out?**

Spring cereals of barley and oats were grown at four locations: two in Norway – Apelsvoll (N 60.7°, E 10.9°), Kvithamar (N 63.5°, E 10.9°) and two in Latvia – Stende (N 57.1°, E 22.3), Priekuli (N 57.2°, E 25.2°). At all locations, the crops were grown in conventional as well as organic production systems. Fertilizers and chemical pesticides were applied according to the agronomical practice of the respective country. Five oat and five barley genotypes were included in the field trials –hull-less oat varieties cv Bikini, cv Nudist (both originated from Norway), cv Stendes Emilija (Latvia) and hulled varieties cv Odal (Norway) and cv Laima (Latvia); hull-less barley variety cv Phil (Norway), cv Irbe and cv Kornelija (both Latvia) and hulled barley varieties cv Tyra (Norway) and cv Rubiola (Latvia).

Extraction and analysis of phenolic compounds and evaluation of antioxidant activity was done according to the methods described by Kruma et al. (2016).Experimental results presented are the means of three replicates. Analysis of variance (ANOVA) and linear correlation analysis were performed.

References

Acosta-Estrada BA, Gutiérrez-Uribe JA & Serna-Saldívar SO 2014. Bound phenolics in foods, a review. Food Chem.152:46–55.

Kruma Z, Tomsone L, Galoburda R, Straumite E, Kronberga A & Åssveen M 2016. Total phenols and antioxidant capacity of hull-less barley and hull-less oats. Agronomy Research. 14 (2):1361–1371.

Masisi K, Beta T & Moghadasian M H 2016. Antioxidant properties of diverse cereal grains: A

review on in vitro and in vivo studies. Food Chem.196:90–97.

Yang J, Ou B, Wise M L & Chu Y 2014. *In vitro* total antioxidant capacity and anti-inflammatory activity of three common oat-derived avenanthramides. Food Chem*.* 160:338–45.