



EFFECTS OF GERMINATION ON TOTAL PHENOLIC COMPOUNDS AND RADICAL SCAVENGING ACTIVITY IN HULL-LESS SPRING CEREALS AND TRITICALE



Z. Kruma¹, L. Tomsone¹, **T. Kince¹**, R. Galoburda¹, S. Senhofa¹,
M. Sabovics¹, E. Straumite¹ and I. Sturite²

¹Latvia University of Agriculture, Faculty of Food Technology, Department of Food Technology, Rigas Street 22, LV-3004, Jelgava, Latvia

²Norwegian Institute of Bioeconomy Research, Fredrik A. Dahls street 20, Ås, Akershus, 1432, Norway

*Correspondence: tatjana.kince@llu.lv

Germination

- Germination, a complex process causing physical, chemical and structural changes in grains, has been identified as an inexpensive and effective technology for improving cereal quality *(Wu et al., 2013)*;
- Is characterized by the growth of the embryo of the grain, manifested by the rootlets growth and increase in length of the shoot (acrospire), with the concomitant modification of the contents of the endosperm *(Guido & Moreira, 2013)*;
- As compared to un-germinated seed, germinated seeds contain high protein, low unsaturated fatty acids, low carbohydrate, mineral content and vitamins *(Narsih et al., 2012; Sharma et al., 2016)*;
- The phenols synthesised during seed germination could help in order obtain enhanced levels of phenols and antioxidant activity resulting in their improved nutraceutical properties *(Zevallos, 2010)*.

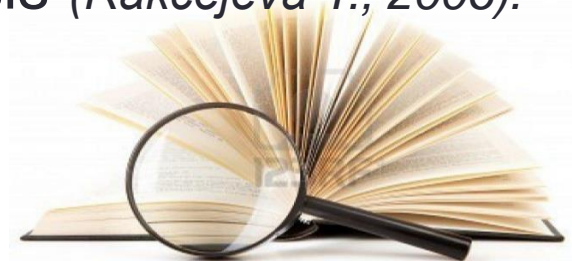


Literature Review

Germinated grains nutritive value

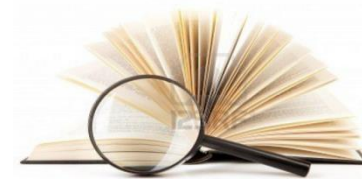
Intense biochemical processes occur during the grain germination time, as a result grain biological value increases:

- ✓ the content of vitamins B₂, E and niacin, total sugar, dietary fibre increase;
- ✓ vitamin C is synthesized;
- ✓ the content of irreplaceable amino acids is increased during the process of protein hydrolysis (*Rakčejeva T., 2006*).



Literature Review

Phenolic compounds in cereals



Literature Review

- Phenolic compounds are considered as a major group of compounds that contribute to the antioxidant activity of cereal (*Peng et al., 2015*)
- Upon germination the concentrations of antioxidants increase (*Peng et al., 2015*)
- Phenolic compounds are mainly concentrated in the bran fraction and covalently bound to indigestible polysaccharides (*Wang et al., 2014*)
- At the initial germination stages phenolics may serve as radical scavengers or antioxidants, while later they could become part of the structural framework of the growing plant and lose some of their antioxidant efficiency (*Cevallos-Casals & Cisneros-Zevallos, 2010*)

Purpose of the research

To evaluate changes in the content of total phenolic compounds and radical scavenging activity at different germination stages of triticale, hull-less barley, hull-less oats, wheat, and rye.



Materials

The grains of conventionally grown:

➤ hull-less barley (cv 'Irbe')



➤ hull-less oat (cv 'Lizete')



➤ rye (cv 'Kaupo')



➤ wheat (cv 'Ellvis')



➤ triticale (cv 'Tulus')



Scheme of experiments



Grains cleaning and washing



Grains soaking in water at the ratio of 1 : 2 (grains to water)
 $\tau=24\pm 1$ h, $t=22\pm 2^{\circ}\text{C}$



Grains germination $\tau=12, 24, 36,$ and 48 h, at $t=35\pm 1^{\circ}\text{C}$ with
 $\phi=95\pm 2\%$ in the dark



Germinated grains were grounded



Grains were analysed

Methods used for research



- **moisture content** of germinated cereals was determined according to the AACC method 44-15A (AACC, 2000);
- the **grain samples were extracted** with ethanol/acetone/water solution in an ultrasonic bath; the extracts were then centrifuged;
- the **total phenolic content** (TPC) of the grain extracts was determined according to the Folin-Ciocalteu spectrophotometric method (*Singleton et al., 1999*);
- **antioxidant activity** of the grain extracts was measured on the basis of scavenging activities of the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical (*Yu et al., 2003*);
- **experimental results** were means of three replications and were analyzed by Microsoft Excel 2010 and SPSS 17.00:
 - *analysis of variance (ANOVA) and Tukey's and Pearson's tests were used to determine differences among samples;*
 - *a linear correlation analysis was performed in order to determine relationship between TPC, antioxidant activity such as DPPH[•], ABTS^{•+} scavenging activity;*
 - *differences were considered as significant at $P < 0.05$.*

Obtained grains

Triticale

Hull-less
barley

Wheat

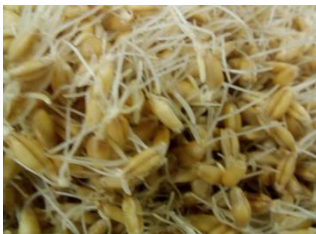
Hull-less
oat

Rye

24h



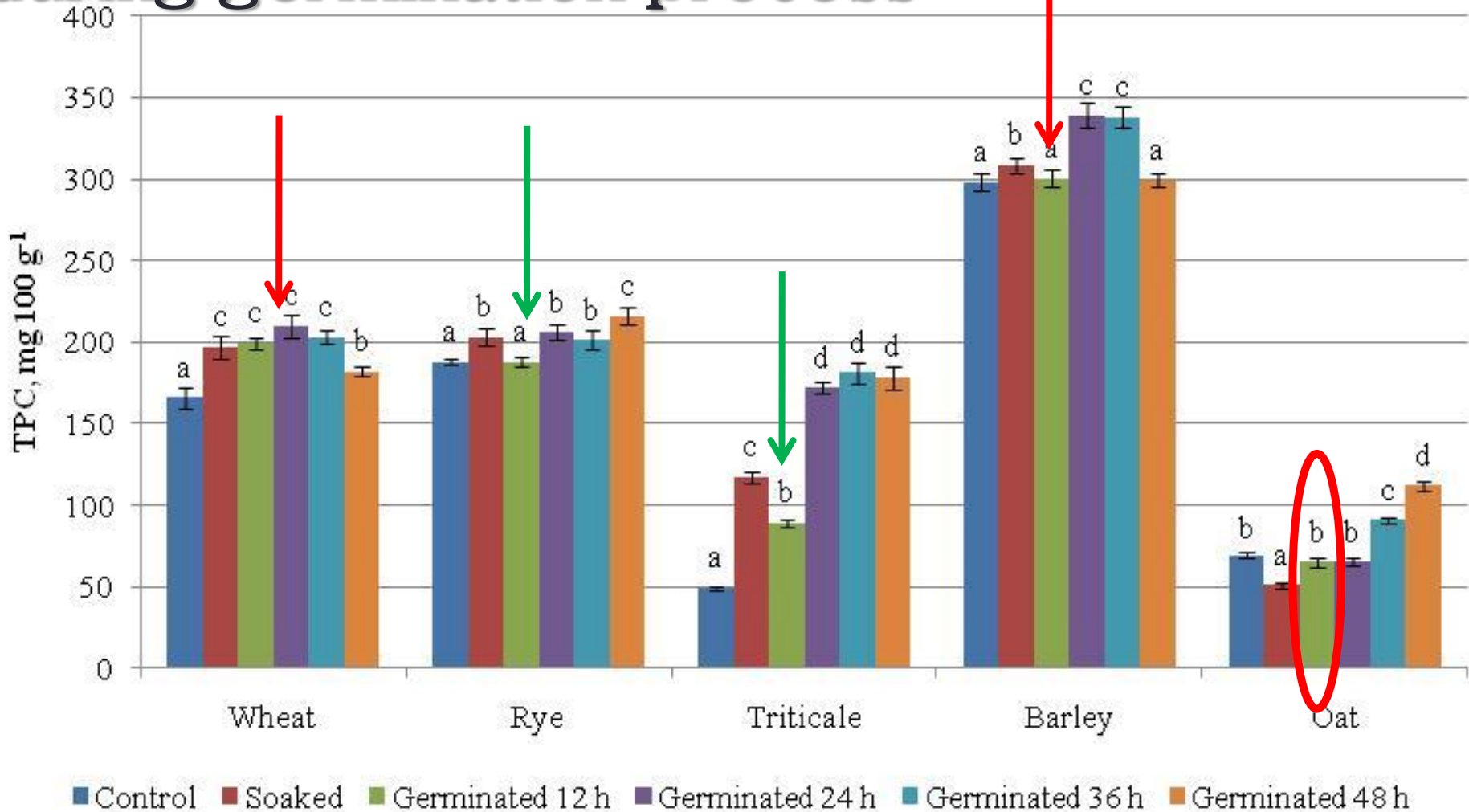
36h



48h

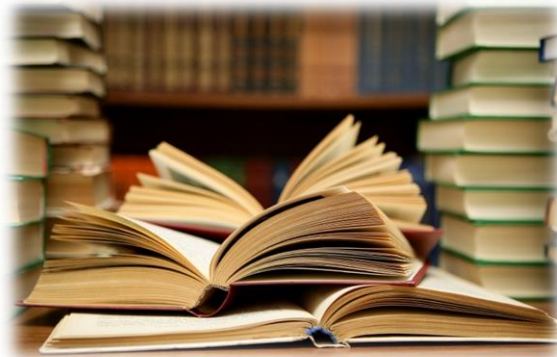


Dynamics of total phenolic content TPC during germination process

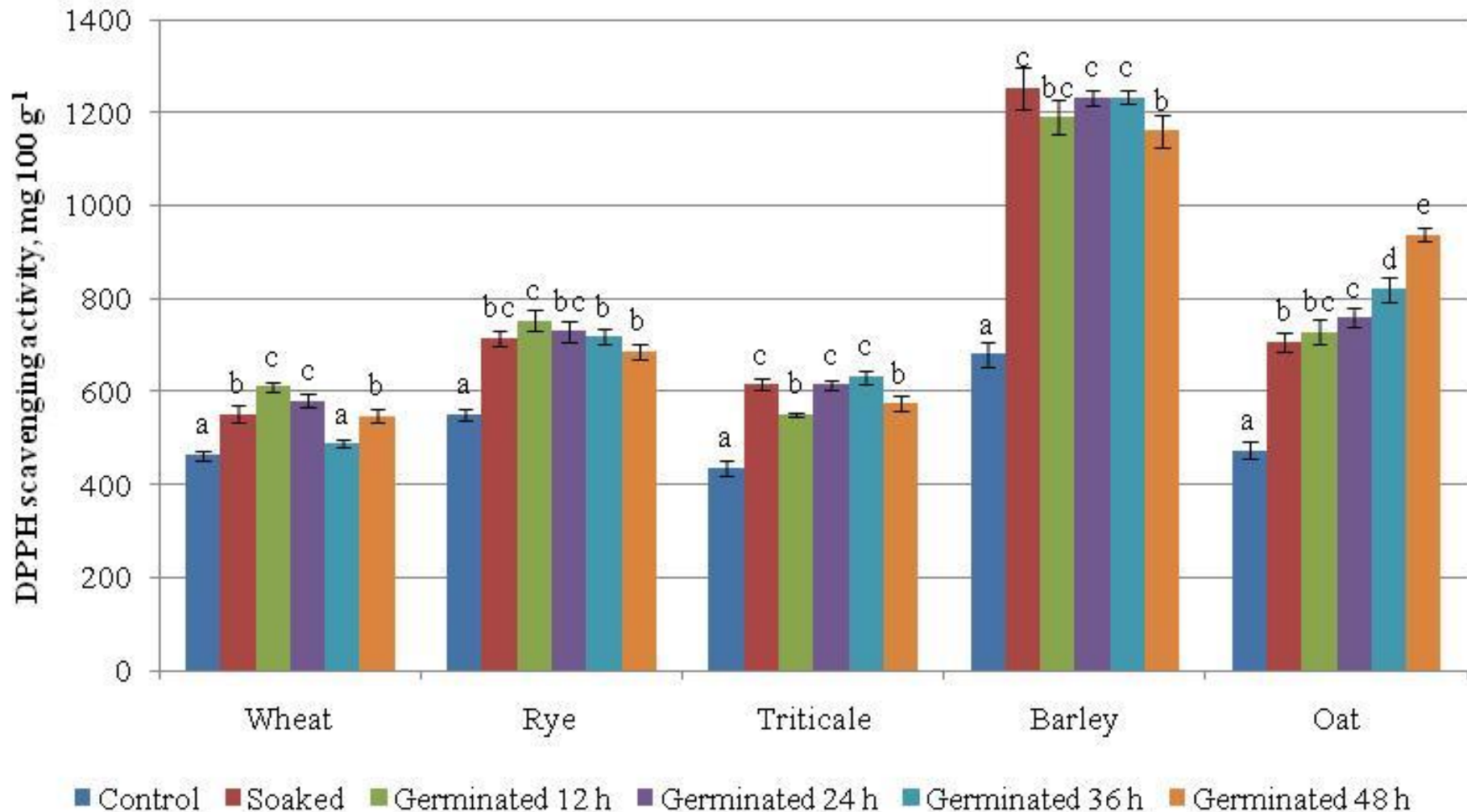


Dynamics of total phenolic content TPC during germination process

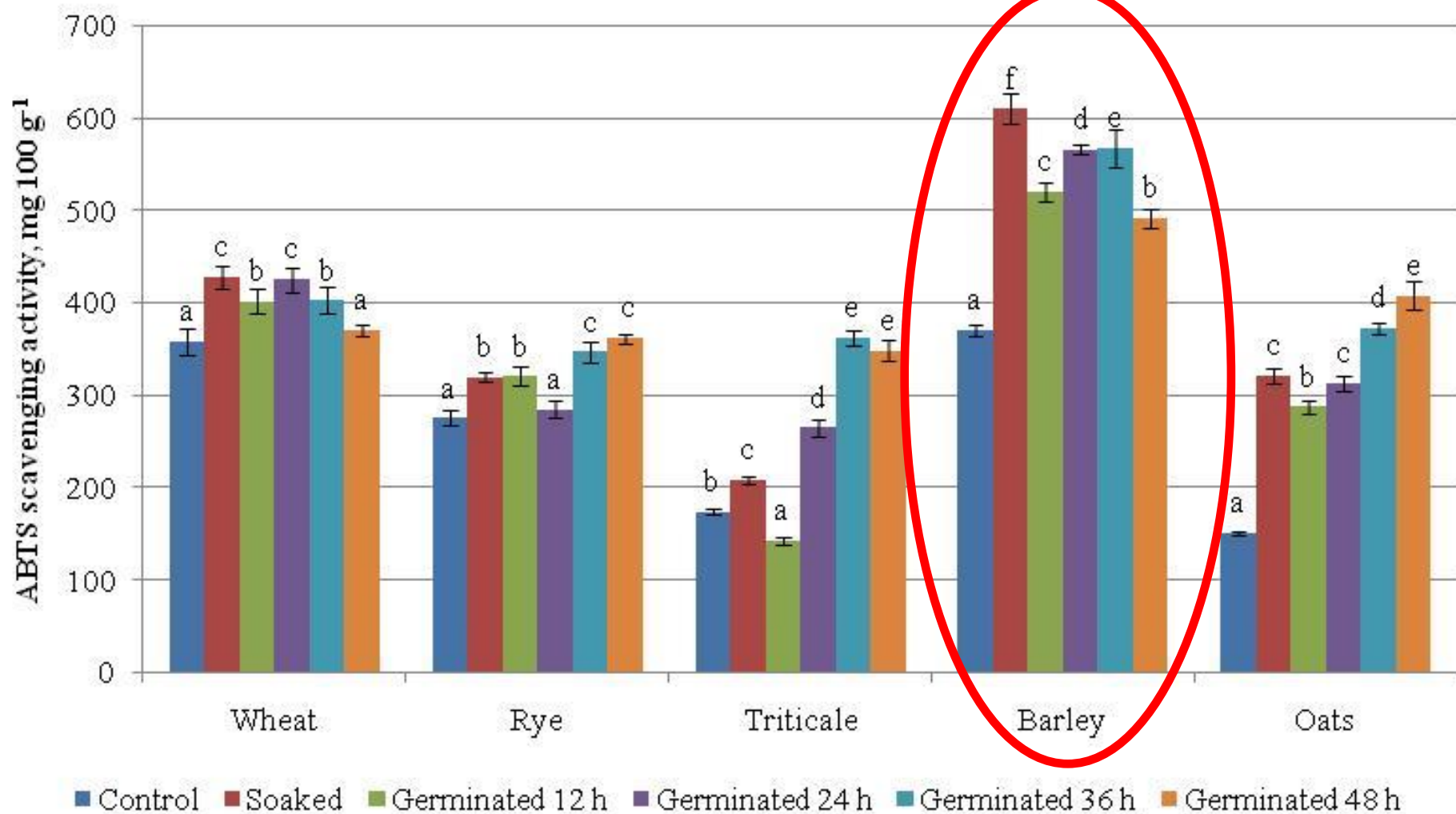
- Increase of TPC most probably occurs due to distribution of phenolic acids during germination process by starch enzymatic hydrolyses (*Maillard et al., 1995; Tian et al., 2004*)
- Germinated seeds are reach in total phenolic then raw and soaked seeds (*Chen et al., 2016*)
- Different seeds accumulated phenolics and antioxidant activity showed the general trend distribution of 7 day sprouts > raw seeds > steeped seeds (*Cevallos-Casals & Cisneros-Zevallos, 2010*)



Dynamics of DPPH radical scavenging activity during germination process



Dynamics of ABTS cation scavenging activity during germination process



Correlation between TPC, DPPH radical scavenging activity, ABTS cation scavenging activity in grains

Cereal	Pearson's correlation coefficient		
	TPC/DPPH	TPC/ABTS	DPPH/ABTS
Wheat	0.59*	0.89**	0.55
Rye	0.31	0.55	0.45
Triticale	0.82*	0.89**	0.56*
Hull-less barley	0.48	0.56	0.94**
Hull-less oats	0.65*	0.56	0.98**
All cereals	0.63**	0.79**	0.77**

TPC/DPPH – correlation between total phenolic content and DPPH radical scavenging activity;

TPC/ABTS – correlation between total phenolic content and ABTS radical scavenging activity;

DPPH/ABTS – correlation between DPPH radical scavenging activity and ABTS radical scavenging activity

* correlation is significant at $p < 0.05$

** correlation is significant at $p < 0.01$

Conclusions

The germinated grains contained significantly more phenols than non-germinated grains.

The highest amounts of phenols were measured in hull-less barley grains and it was significantly higher ($P < 0.05$) than in the grains of wheat, rye, triticale and hull-less oats.

However, in triticale and hull-less oats increase in phenol compounds was the highest. In order to obtain the highest TPC and antioxidant activity the optimum germination time was 24 h.

The closest correlation between TPC, DPPH radical scavenging activity, ABTS cation scavenging activity was recognised in hull-less barley grains.

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the Norwegian Financial Mechanism 2009-2014 under Project Innovative approach to hull-less spring cereals and triticale use from human health perspective (NFI/R/2014/011)





Thank you for attention