Starch breakdown and formation of sugars during triticale grains germination

Tatjana Rakcejeva, Dace Klava, Ingmars Cinkmanis, Ruta Galoburda, Evita Straumite, Arta Kronberga

Latvia University of Agriculture, Faculty of Food Technology, Department of Food Technology[1] and Department of Chemistry[2], LV-3001, Jelgava, Latvia
Priekuli Plant Breeding Institute[3], LV-4126, Priekuli, Latvia

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).

Actuality of the research

Cereals for human nutrition

Germination of cereals

Glycemic index (GI)

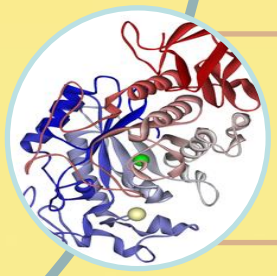
Cereals for human nutrition

Cereal products are the main part of human diet, as they contain high amount of carbohydrates, proteins, dietary fibre, and vitamins of group B.

Cereals contain many phytochemicals, including phytoestrogens, phenolic compounds, antioxidants, phytic acid, and sterols (***Mridula, 2015).***

Triticale ***(× Triticosecale***) is a hybrid of wheat (***Triticum spp.***) and rye (***Secale cereale***) (***Mridula, 2015)***.

Triticale has demonstrated high yield potential even under marginal growing conditions (***Mridula, 2015)***.



Triticale high α-amylase activity (AAA) prior to harvest significantly alters the functional properties of starch, reducing its water-binding capacity and eventually the quality of ready products ***(Lelley, 2006)***.

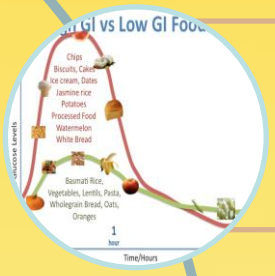
Germination of cereals

The germination process 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 ***(Correia, 2013).***

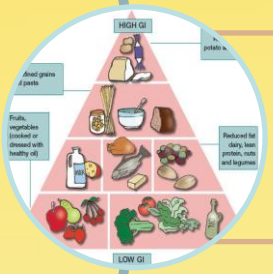
As a result, during germination amylases are produced and partial breakdown of starch into simple sugars occurs ***(Chesworth et al., 1998)***.

Grain biological value increases – the content of vitamins B_2, E, and niacin, total sugar, dietary fibre and glucosamine increase; vitamin C is synthesized, and the content of essential amino acids is increased during the process of protein hydrolysis ***(Rakcejeva, Skudra, 2004).***

Glycemic index (GI)



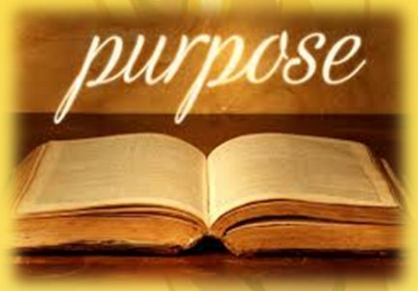
Glycemic index (GI) and glycemic load may be important factors to investigate for the prevention and management of a variety of chronic conditions, including diabetes, obesity, and hypertension *(Wang et al., 2015)*.



The GI provides an assessment of the quality of carbohydrate-containing foods based on their ability to raise blood glucose *(Watanabe et al., 2015)*.

Low GI foods provoke a slower, more sustained blood sugar response, with several studies supporting an association between consuming a lower GI diet and improved glycose control *(Wang et al., 2015).*

Purpose and objectives of the current research



The purpose of the investigation was to evaluate starch and sugars changes in triticale grain germination processes.

Starch content, falling number, structure of starch granules, moisture content, content of individual sugars.

Raw materials

Triticale grains (× *Triticosecale*) variety ‘Inarta’ Year 2014 used in this study were obtained from State Priekuli Plant Breeding Institute, Latvia.

Grain germination:

- Grains cleaning
- Grain washing

t=22±2 °C

- Grain steeping

τ=24±1 h
t=22±2 °C

- Grain germination

τ=12, 24, 36, 48 h
t=35±2 °C
RH=93±2%

Methods

Moisture content

- Determination of the moisture content by the sample drying at a temperature of 130 to 133 °C under precisely fixed conditions under ICC Standard No. 110/1.

Falling number

- Before determination, grains were milled using a mill „PLM 3100/B" (Perten, Sweden) according AACC standard method No. 55-30.01. Falling number (FN) was determined using Hagberg-Perten standard method ISO 3093:2009 in a *„Perten FN 1900".*

Starch content

- An Infratec™ 1241 Grain Analyzer (Foss, Sweden) was used to analyse starch content in triticale grains according to ISO 12099.

Starch structure

- Starch granules of grain samples were observed using triocular microscope "Leica DM 2500 LED HD" (Leica Microsystems, Germany); via 10×20 magnification of the microscope.

Individual sugars'

- The content of individual sugars (fructose, glucose, sucrose, and maltose) in the control (non-germinated), steeped and germinated triticale grain sample extract was determined by high-performance liquid chromatography (Shimadzu LC 20 Prominence, Japan).

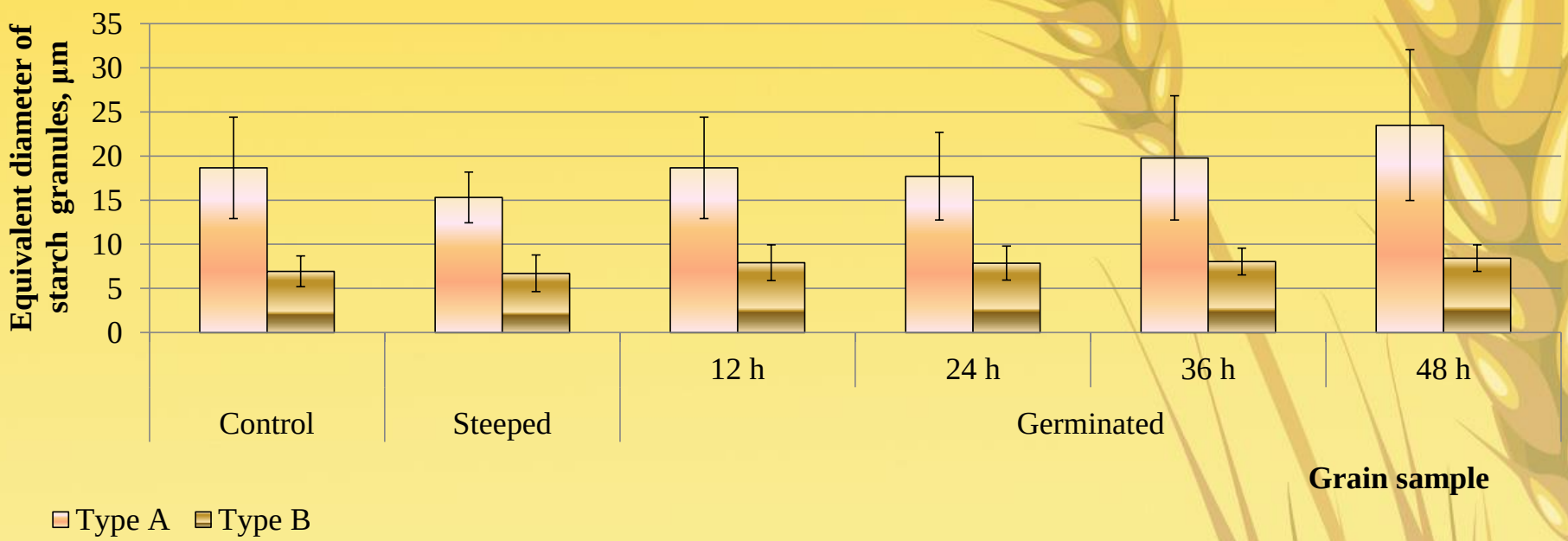
Results

http://germination.ca/delivering-more-choice-to-the-marketplace-march-2015/

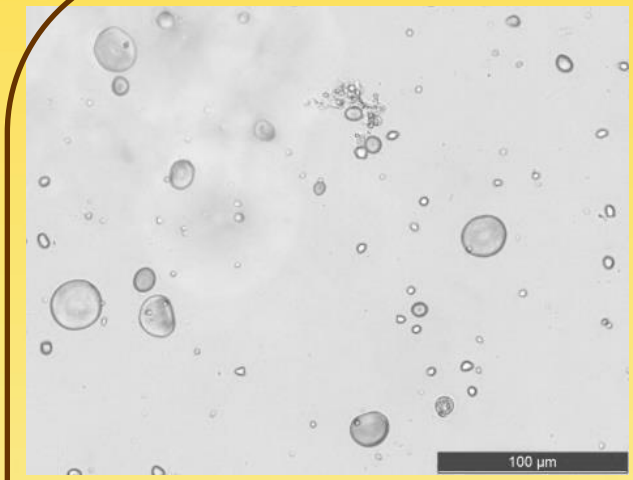
Falling number, moisture, and starch content in triticale grains

No.	Grain sample	Falling number, s	Moisture content, %	Starch content, % in dry matter
1	Control (non-germinated)	62	13.27±0.30	68.9±0.8
2	Steeped	63	47.31±0.09	69.4±0.1
3	Germinated for 12 h	63	48.30±0.22	67.1±0.3
4	Germinated for 24 h	63	47.38±0.34	65.0±0.2
5	Germinated for 36 h	63	49.72±0.11	64.3±0.1
6	Germinated for 48 h	63	48.72±0.12	61.0±0.3

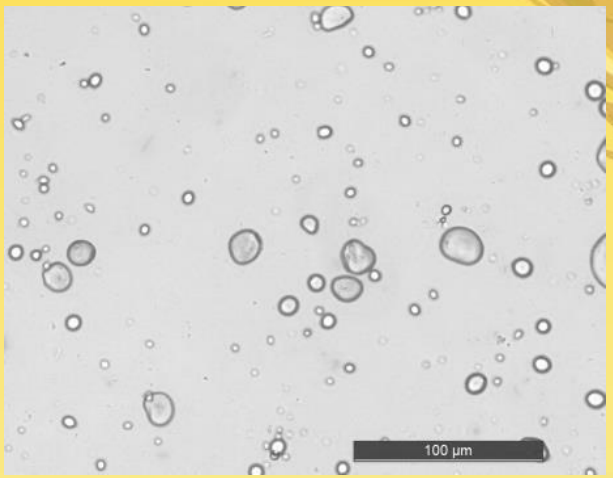
Changes of grain starch granules' diameter



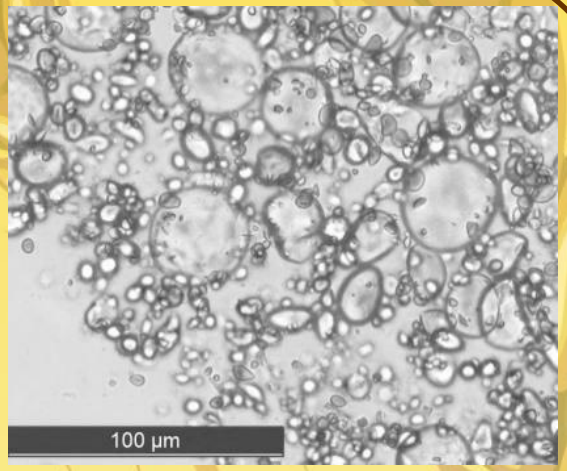
Light microscopy images of triticale grain starch granules



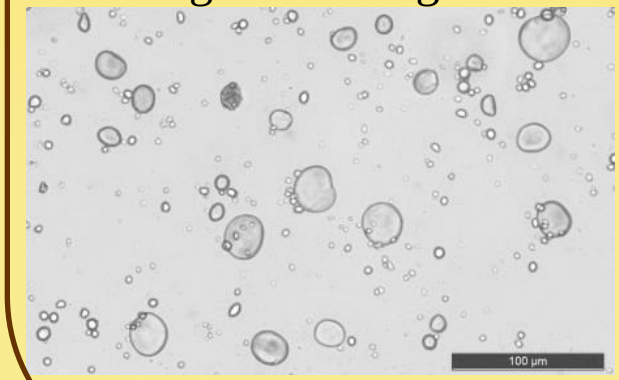
Non-germinated grains



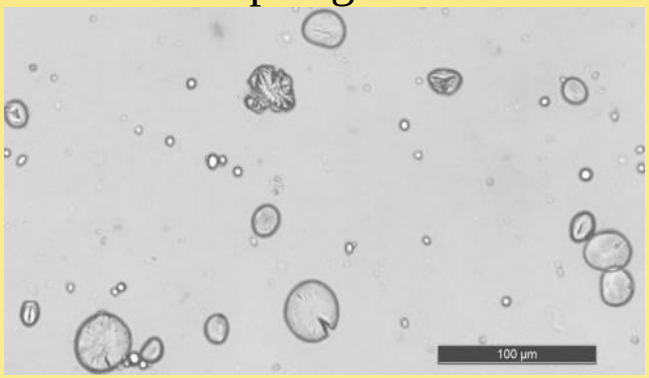
Steeped grains



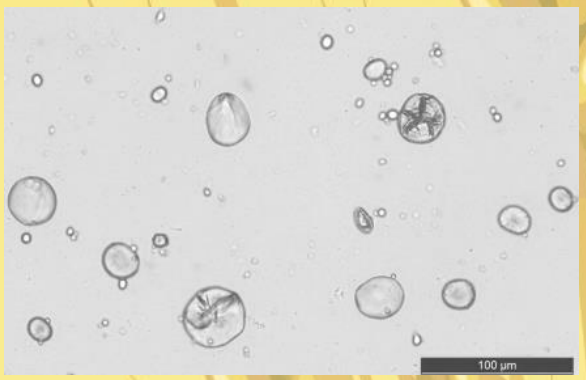
Germinated for 12 h



Germinated for 24 h

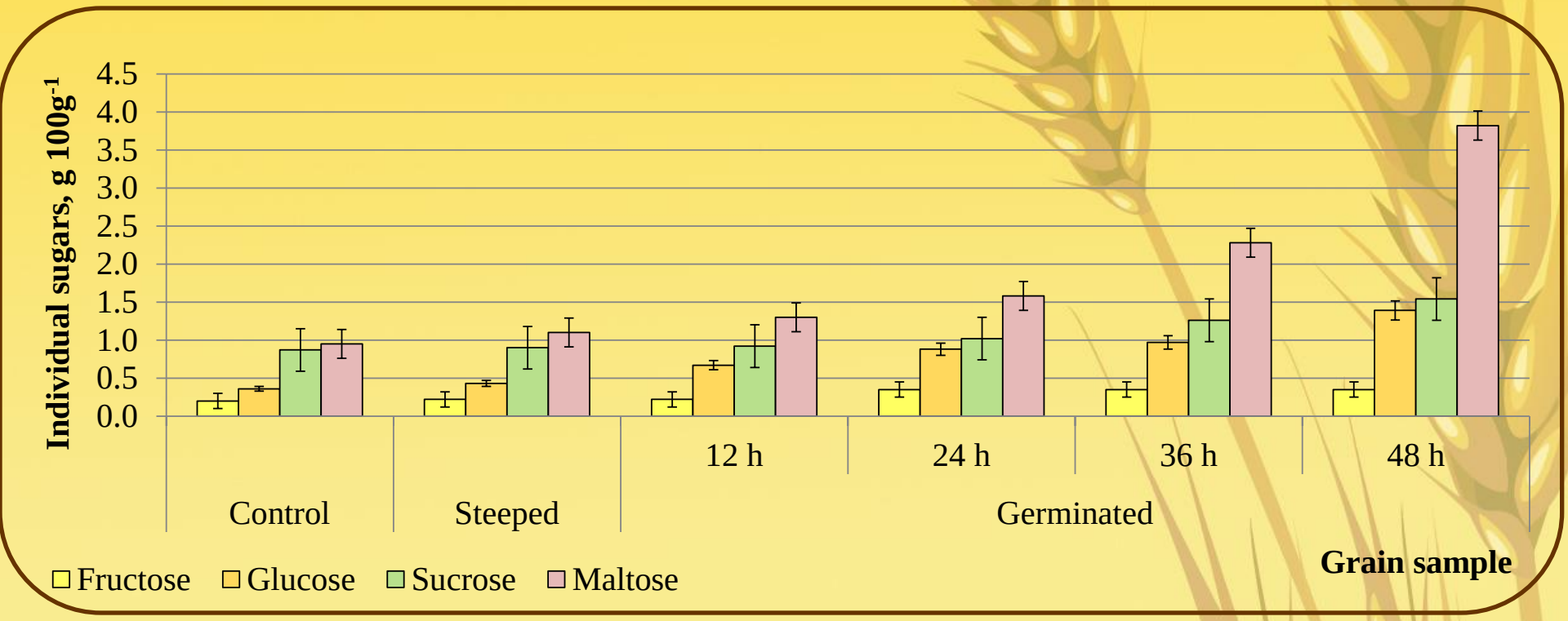


Germinated for 36 h



Germinated for 48 h

Individual sugars composition in triticale grains



Conclusions

- For obtaining germinated triticale with the possibly lowest glycemic index germination time for cereals should not exceed 24 h at controlled temperature and RH in dark.
- During germination for 24 h, the falling number of analysed grains was 62 s indicating elevated enzyme activity in grains, which resulted in starch changes, namely, breakdown, and therefore starch content decreased by 6%.
- During triticale grain steeping breakdown of A-starch granules occurred as a result of increased α-amylase activity.
- During triticale grain germination for 12, 24, and 48 h, at controlled conditions, starch granules swelled, as a result the diameter of A-granules disk shape increased, but the shape of B-starch granules was not changed significantly ($P>0.05$).
- During steeping and germination the content of fructose increased 2.0 times, glucose – 2.5 times, sucrose – 1.2 times, and maltose – 1.7 times.

Acknowledgement

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 for human health perspective (NFI/R/2014/011).

Thank you for attention!

Tatjana Rakcejeva, Dace Klava, Ingmars Cinkmanis, Ruta Galoburda, Evita Straumite, Arta Kronberga

Latvia University of Agriculture, Faculty of Food Technology, Department of Food Technology[1] and Department of Chemistry[2], LV-3001, Jelgava, Latvia
Priekuli Plant Breeding Institute[3], LV-4126, Priekuli, Latvia

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 for human health perspective (NFI/R/2014/011).

www.fppt.info