HEALTHY MINORCEREALS.eu

NEWSLETTER

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Dear Readers,

In 2016, the HealthyMinorCereals project has produced many significant results. First of all, genetic characterisation has been completed for 262 oat genotypes from 26 countries, 218 rye genotypes from 13 countries, and 265 spelt genotypes from 14 countries. The results will soon be available; a series of scientific papers is now being prepared for publication. Secondly, a major report has been published on the market potential of minor cereals, including oat, rye, spelt, emmer and einkorn, and is now available for download at the project website. As the next step of market studies, four case studies of minor cereals market development were completed during 2016 in the Czech Republic, Estonia, Hungary and Switzerland. A report with interesting conclusions is currently in preparation.

In May 2016, the project consortium met in Potsdam to discuss the progress of the project. A focus has also been on dissemination activities that in 2016 included presentation of first project results at scientific conferences, as well as at a large number of seminars, field days and exhibitions for farmers, crop breeders and the food industry that were organised by project partners in their respective countries.

We wish you an enjoyable read of our newsletter and a successful year of 2017.

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Project Coordinator

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Dissemination Manager

(More information can be found at the project website: www.healthyminorcereals.eu)

Group photo from the 3rd General Assembly meeting held in Potsdam, Germany on 10-11 May 2016

Reports from workpackages

WP 1: Genomic characterisation and analysis of minor cereal accessions

With a low genetic diversity in cereal production, there is potentially a much greater vulnerability to biotic (e.g. diseases, pests etc.) and abiotic (e.g. drought, floods etc.) stresses. These stresses typically result in decreasing of yield, as well as reduced quality of the final grain. An important approach to enhance diversity is to broaden the number of cereal species or varieties that are grown, through exploitation of genetic resources available from seedbank collections of minor cereals and crop wild relatives (CWR). Here, the most promising traits for the fight against biotic and abiotic stresses may be found, but we need to better characterise these genetic resources. The most (cost-) efficient way to map diversity within the gene pools of minor CWR/cereal species is the use of genetic markers. In HealthyMinorCereals, our partners University of Kassel and CRI have now completed the genetic characterisation of oat, rye, spelt and wheat wild relatives for 262 oat genotypes from 26 countries, 218 rye genotypes from 13 countries, and 265 spelt genotypes from 14 countries. For the characterisation of CWR, seeds of 190 accessions (incl. *Aegilops* sp., *Triticum araraticum*, *T. dicoccoides*, *T. boeticum*, *T. dicoccum*, *T. monococcum*) were provided by CRI, of which 39 accessions were selected to perform analysis of interspecific genetic diversity. Preparation of scientific publications is well under way. The obtained data will help breeders to define the most promising materials for the further breeding programmes.

WP2: Phenotyping to determine potential for developing new varieties

Exact phenotyping and selection based on multi-environment field trials is an essential approach used traditionally by plant breeders. Reliable phenotypic data is also a necessary counterpart to the genetic information obtained in WP1 for the selection of breeding material.

Phenotyping data are now completed over three years for 80 accessions of spelt from four locations (Germany, Austria, Switzerland and Estonia), and for 112 oat accessions from two locations (the Czech Republic and Estonia).

Field trials with spelt in Switzerland

The rye collection was phenotyped in Estonia and in the Czech Republic, but winter damage in Estonia caused a serious problem and therefore the phenotyping will continue in 2017.

Selected CWRs were tested for two years in Prague Ruzyně, Czech Republic. The collection of CWR was composed from 344 accessions from 28 different plant species (*Aegilops speltoides, Ae. biuncialis, Ae. markgrafii, Ae. columnaris, Ae. comosa* v. *subventricosa. Ae. triuncialis, Ae. neglecta, Ae. kotschyi, Ae. triuncialis, Ae. crassa, Ae. juvenalis, Ae. tauschii, Ae. cylindrical, Ae. geniculata, Ae. uniaristata, Amblyopyrum muticum* v. *muticum, Aegilotriticum* spp., *Triticum boeoticum, T. araraticum, T. dicoccoides, T. timopheevii, T. monococcum* subsp. *monococcum, Taeniatherum caput-medusae* ssp. *crinitum, Dasypyrum villosum, Hordeum vulgare* subsp. *spontaneum, Secale strictum* subsp. *strictum, Eremopyrum orientale*). The materials were evaluated for development (ground cover, anthesis, maturity) and morphological characteristics of spike traits (spike length, spike colour), awn traits (awn length, awn colour), plant height, lodging, disease tolerance against powdery mildew, leaf rust, stem rust. CWRs with combined resistance against abiotic and biotic stresses will be used in crosses with appropriate adapted material of the investigated cultivated species.

WP3: Evaluation of biotic and abiotic stresses on minor cereals

Spelt is mostly cultivated in organic farming or on low inputs. As the use of chemical protection is limited or prohibited under these systems, the evaluation of natural resistance to crop disease is an important strategy.

We now have two years' test data on the resistance of 80 varieties of winter spelt to rust diseases (leaf rust, yellow rust and stem rust), along with their resistance to common bunt and fusarium head blight. Rust diseases cause a decrease in both the yield as well as the quality of production. Fusarium produces mycotoxins (e.g. zearalenone, DON etc.) which may cause severe poisoning or even death. Searching for genetic resistance may help to decrease or even eliminate these problems in minor cereals production. Our results have shown a high susceptibility of the tested varieties to stem rust, with an exception of the variety Sofia 1 that showed a medium level of resistance. It seems that, in the past, there was not much exposure of spelt to stem rust (i.e. only infrequent outbreaks of crop disease). This means that spelt varieties featuring a higher level of resistance have not had a chance to develop.

The evaluation of resistance to yellow rust and leaf rust by natural infection was very much affected by the current, natural outbreak of yellow rust in central Europe. In 2015, all the spelt varieties monitored were attacked by yellow rust, as a result of this epidemic. Our evaluation of resistance against rusts in spelt (and also in oats) was influenced by different pathogen strains occurring in the Czech Republic, Switzerland, Austria and Estonia. Differences in rust resistance in two different spelt varieties are shown in the following picture. The more resistant variety is on the left.

Artificial inoculation is used at CRI to test resistance of winter spelt varieties to rusts

Resistance to common bunt has great importance in spelt cultivation. Common bunt produces a fetid trimethylamine odour which can devalue the grain product and its use as human food and animal feed. Infection by common bunt can also cause 50% losses in yield, and it is transferable by seed. Unlike rusts, resistance to common bunt is not specific to the strain of pathogen. On the basis of the two-year results from the Czech

Republic, Austria and Switzerland, we consider the Albin and Sofia 1 varieties to possess the highest resistance.

Resistance to fusarium head blight (FHB) is of particular importance for health safety reasons as pathogens from the fusarium family produce secondary metabolites – mycotoxins. The most frequently monitored of them is deoxynivalenol (DON). Compared to common wheat, spelt usually shows a lower occurrence of this mycotoxin. This is probably due to the glume cover protecting the grain, which is only removed before the processing; the glume covers provide also a good protection for grains during their storage.

On the basis of the one-year evaluation of symptoms after artificial infection complete so far, relatively large differences were found in resistance to FHB between the tested varieties. The highest level of resistance on the basis of symptoms was manifested by several materials including Farnsburg Rotkorn FB6, Fugger Babenh Zuchtveesen, Gugg 4E, Gugg 4H, LW 13 Nuertingen, Muri Rotkorn, Oeko 10, Ostro, Riniker Weisskorn, Roten schlegel dinkel and Rottweiler dinkel ST.6. As with common bunts, the results from three locations (Czech Republic, Austria, Switzerland) were in relatively good conformity, which is connected with the fact that the resistance to fusarium head blight is not specific in terms of species or varieties. More information about the level of resistance to FHB will be available after the determination of the content of mycotoxins in the grains.

WP3 is also investigating the optimisation of spelt production under conditions of drought stress. Trials were established in autumn 2015 in southern Crete, a typical semi-arid Mediterranean region, using 3 fertility treatments (sheep manure, chicken manure and mineral fertiliser), 2 irrigation regimes (with and without supplementary irrigation in spring) and 4 spelt varieties (Rubiota, Filderstolz, Oberkulmer, Zurcher Oberlander Rotkorn). The 2015-2016 growing season was dryer than usual as the total rainfall was only 278 mm, while the average for the area is 400 mm. Preliminary results from the first trial indicate that:

- Fertility treatment affected grain yield.
- Plots that received organic fertilization (sheep or chicken manure) gave similar grain yields, and higher than plots that received mineral fertilization.
- All 4 spelt varieties gave similar grain yields.
- Plots that received supplementary irrigation in the spring resulted in higher number of plants, tillers and ears per unit area when compared with the non-irrigated plots (see pictures below).
- Irrigation had a significant effect on lodging and plant height with irrigated plots to result in taller and more lodged plants when compared with the non-irrigated plots.
- Grain yield was more than 150% higher when supplementary irrigation was applied.
- Straw yield increased approx. 70% with irrigation.
- The main disease problem was caused from the fungi *Gaeumannomyces graminis*

A replicated trial was established in autumn 2016, to be harvested and evaluated in summer of 2017.

Irrigated (left) and non-irrigated (right) plot of spelt on Crete, Greece in 2016

WP4: Effect of agronomic management practices on the performance of minor cereals

Fertiliser use is one of the greatest concerns in food and feed production because it is associated with significant negative impact on the environment (e.g. greenhouse gas emissions, eutrophication of freshwater and marine ecosystems etc.). Also, doses of fertilizers (higher as well as lower) might have an influence on grain composition (e.g. protein content and quality) and associated processing qualities e.g. lodging and disease susceptibility patterns. It is, therefore, important to assess the performance of different minor grain cereal genetic material when cultivated under different agronomic practices, in terms of (a) yield (b) grain quality parameters and (c) disease levels.

Field trials to evaluate the effects of agronomic practices on the performance of four varieties of each spelt, rye and oat have continued in 2016 in the UK (spelt and rye), Czech Republic (spelt and oat) and Estonia (rye and oat). Field trials to evaluate the effects of tillage and weed control practices were established at CRI (spelt and oat) and UNEW (spelt and rye) in 2015, but the trial with autumn-sown spelt at CRI was severely damaged by rooks. It will be repeated in the 2016-17 and 2017-18 seasons.

The oat trial was not affected as it was spring-sown. Field trials with variety mixtures and intercropping were established in autumn 2015 and spring 2016. Harvests are completed and analyses are ongoing.


Field trials with oat in the Czech Republic

WP5: Effect of variety mixtures and intercropping on performance of minor cereals

Improved rotation designs and intercropping/varietal mixtures are being used and recommended in many European countries as a mechanism to reduce nutrient losses from agricultural land and maintain productivity. Field experiments with spelt, rye and oat started in the season 2015/2016 and will be repeated in the season of 2016/2017.

WP6: Optimising processing and product development strategies to optimize market potential

The higher nutritional grain quality of minor cereals, and specific taste (rye, oat and hulled wheats: spelt, emmer, einkorn,) are essential factors in their growing popularity among consumers. However, minor cereals still requires innovative solutions for their development into food products, which are being investigated in WP6. So far, peelability tests of spelt, einkorn and emmer, flour milling experiments and laboratory scale baking assays and rheological assessments were performed in Germany by ILU. Strengths and weaknesses of different spelt, emmer and einkorn genotypes, cultivated in different fertilization and growing conditions were revealed. Baking tests were performed both at ILU and a commercial bakery of Reiner Stolzenberger, with final products tested by customers.






New baking recipes using the wholemeal flour of spelt, emmer and einkorn were tested at the project partners ILU and Stolzenberger’s Bakery; also customers at Stolzenberger’s Bakery were involved in sensory testing and tasting the new products

WP7: Assessing nutritional content of minor cereals and their effects on human cell cultures

To date, an analysis of more than 600 minor cereal genotypes have been undertaken by Sabanci University, with results obtained on nutritional content including trace minerals, antioxidants and β-glucan. Analysis of the data is in progress, including identification of the most contrasting genotypes. New results will be presented in the next newsletter.

WP8: Enhance the market prominence for minor cereals

One key factor for the successful introduction of new minor cereal varieties and/or new products into the market is a sufficient consultation with farmers and producers who will be the intended users, and the actors on the rest of the value chain (e.g. processors, handlers, retailers and consumers) and who will benefit from the new varieties/products. Following the publication of the report by FiBL on the market potential of minor cereals, based on agricultural statistics, market data, additional expert interviews and a literature review of consumer trends, four case studies of minor cereals market development were undertaken. The case studies investigated key processes that affect the minor cereals market development — for spelt and naked oats in the Czech Republic, spelt in Estonia, and einkorn in Hungary. The case study In Switzerland examined the use of traditional varieties of spelt (UrDinkel), and the example of a regional cooperative Gran Alpin producing wheat, rye, barley, spelt, naked oat, and buckwheat on fields above the usual altitude limit of arable farming. The case studies report will be published soon.

Some examples of products from minor cereals available in Switzerland

WP9: Demonstration activities

HealthyMinorCereals is undertaking also demonstration activities involving the close participation of food industry partners to apply our improved understanding of the properties of minor cereal grains for milling and food processing, and how to best stabilise or increase the nutritional value of final food products during industrial food production.

Healthy minor components are located in the outer grain layers, so wholemeal flours have to be used for product development in order to maintain its high nutritional value. Before we could start with product development for baking, extrusion, and pasta production trials, we had to optimize the milling process. The first step was to determine which type of mill would be the most suitable for the milling of minor cereals. Three different types were used (roller, friction - stone, impact mills) for optimization of the process. The stone milled flour was found unsuitable for extrusion and pasta production processes, due to the coarse ration. It can be used for bread manufacturing if the desired product has a rustic appearance, and if there are no high-quality demands regarding specific volumes. With different kind of sieves and also different sieve sizes we found the appropriate setup for milling in order to reach high water absorption and good dough rheological properties with high baking quality. For extrusion, wholemeal flour should not be as fine as possible, only fine enough to pass the die. Coarse bran cannot be recommended, because the throughput is lower than using finer bran. Also, the appearance of the final product is positively influenced by using wholemeal flour with a different particle size of the bran.

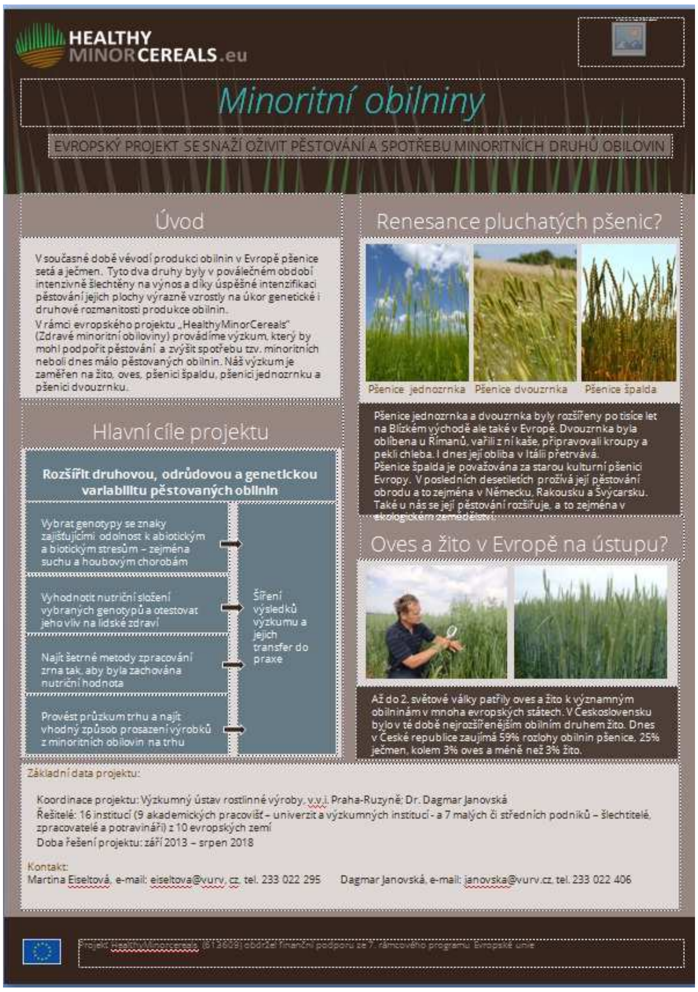
Based on these assessments, Partner BGK performed initial extrusion trials at industrial scale, in order to confirm the feasibility of the above mentioned findings. Samples of emmer, einkorn, spelt and rye (with corn as control) were extruded, and a selection of resulting products is shown below.

Project communication, cooperation and publicity

During 2016, results of the HealthyMinorCereals project were presented at the following conferences (presenters and titles of their presentations are given):

- 15th International Cereal and Bread Congress, Istanbul, Turkey, 18-21 April 2016; Lyubenova et al.: Antioxidant capacity of selected minor cereals;
- XIX International Workshop on Smuts and Bunts, Izmir, Turkey, 3-6 May 2016; Dumalasová and Bartoš: Reaction of winter wheat and spelt wheat genotypes to common bunt and dwarf bunt;
- International conference Oats 2016, Russia, St. Petersburg, 11-15 July 2016; Lyubenova et al: Antioxidant capacity of selected European oat genotypes and Leišová-Svobodová et al.: Diversity of oat genetic resources;
- National conference “Cereal varieties, agro-technology and fertilization”, Põltsamaa, Estonia, 23 February 2016; Tupits and Tamm: First results on rye and oat fertilization input type and level.

A number of seminars, field days and food days were organised for farmers, crop breeders, food industry and consumers in Switzerland, Germany, UK, Czech Republic, Estonia and Austria.



Poster displayed and field plots with varieties of minor cereals presented at the field day in Nabočany, Czech Republic on 9-10th June 2016; Martina Eiseltová – Dissemination Manager and Jana Chrpová – WP leader on biotic and abiotic stresses of minor cereals present the project

Guided tour at the seminar organised by CRI in Prague on 22 June 2016 presenting crop wild relatives of minor cereals

Presentation of spelt varieties to farmers by the Swiss partner Getreidezüchtung Peter Kunz (GZPK)

GZPK breeds new varieties of spelt for organic farming

Finally, a video has been produced by Czech media presenting the value of minor cereals and information on agronomy and biotic stresses (in Czech with English subtitles), and is available to view here.

Partners in the HealthyMinorCereals project

The project consortium includes nine academic centres (six research institutes and four universities) and seven SMEs located in 10 European or Associated countries.

1. Crop Research Institute (CRI), Czech Republic, Coordinator
2. PRO-BIO Trading Company Ltd. (PROBIO), Czech Republic
3. Selgen a. s. (SEL), Czech Republic
4. University of Newcastle upon Tyne (UNEW), United Kingdom
5. Gilchesters Organics Ltd. (GIL), United Kingdom
6. Sabanci University, Faculty of Engineering and Natural Sciences (SU), Turkey
7. Research Institute of Organic Agriculture (FiBL), Switzerland
8. Getreidezüchtung Peter Kunz (GZPK), Switzerland
9. Volakakis Nikolaos (GEO), Greece
10. Estonian Crop Research Institute (ETKI), Estonia
11. University of Natural Resources and Life Sciences (BOKU), Austria
12. Institut für Lebensmittel-und Umweltforschung e.V. (ILU), Germany
13. Stolzenberger’s Bakery (SB), Germany
14. University of Kassel, Section of Organic Breeding and Agro-Biodiversity (UNI KASSEL), Germany
15. Grupa BGK Spółka z o.o. (BGK), Poland
16. Hungarian Research Institute of Organic Agriculture (ÖMKi), Hungary

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