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The Landrace

Newsletter #16 from Landsorten
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News from Landsorten

General Assembly and Professional Day in Landsorten on 25 February

Landsorten will hold its annual general assembly on 25 February at Mejners - Fra Muld til Mund, Forsingevej 4, 4470 Svebølle

Participation is free, but registration to emilie@landsorten.dk is requested before 18 February

Programme for the day:

10.45-11.00 Arrival and coffee/tea

11.00-12.00 Guided tour of Mejnerts Mølle by Peter Mejnertsen

12.00-12.45 Presentation on grains, flavour and baking by sourdough baker Thomas Christensen

12.45-13.30 Lunch

13.30-15.30 General Assembly in Landsorten

Info about the day

About Mejnerts Mølle

Mejnerts has 1,250 hectares in Svebølle in West Zealand, where they grow and mill flour with a focus on ecology and sustainability, using varieties from Landsorten.

About the speaker Thomas Christensen, Borgerbageriet:

Borgerbageriet conveys the unifying power of bread through workshops in Copenhagen's Northwest neighbourhood. The purpose of Borgerbageriet is to create a community-driven bakery where all citizens can come together to bake bread. Here you can learn about sustainable bread baking, exchange recipes and create community across different bread cultures.

Agenda for Landsorten's general meeting:

1. Election of chairperson and rapporteur
2. Report from the Chairman on the work and plans of Landsorten.
3. Changes to the Articles of Association. The Board proposes expansion of the Board of Directors from 5 to 7 members
4. Approval of accounts 2024.
5. Budget and membership fees for 2025.
6. Election of 3-5 people to the Board of Directors (depending on voting on amendments to the Articles of Association). Up for election in 2025 are: Emilie Berning, Bjarne Hansen and Anders Borgen
7. Any other proposals received. Proposals for item 7 must be received by the board no later than one week before the general meeting.
8. Possibly.

Another project ensures further development of Landorten

In the last issue of The Landrace, we reported that Landsorten had been granted a marketing project by the Danish Plant Foundation to raise awareness of Landsorten varieties and organise an international grain festival in 2026. That was only the positive version of the story, because we were actually rejected on some other applications to secure production. What's the point of marketing if there are no products? Fortunately, the organic research programme Organic RDD has since granted funding for the parts that the Plant Foundation would not support. The project applications in Organic RDD were evaluated over 7 months by an international panel of researchers, Innovation Fund Denmark, ICROFS and GUDP, among others, and in the end less than 1/3 of the applications made it through the eye of the needle, so we are naturally both grateful and also a little proud that our particular project was prioritised.

The new project in Landsorten is called GRAINGOOD, and it ensures support for some of the vital parts of Landsorten's future work, where the project will cover 60% of the costs. Among other things, the project will ensure that Landsorten can improve the quality and propagation of seeds. Until now, Landsorten has simply let members multiply seed with the equipment they have available, but all too often we have encountered the problem that varieties have been mixed together or, for example, a wheat batch has been contaminated with rye, oats, bunt, etc. In the new project, we will have a much better opportunity to sanitise the batches and do more to monitor and ensure quality. In the project, we will also build a mobile cleaning unit that is smaller than the machines that Gl.Buurholt can offer, which will allow us to service growers and clean batches that are too small for the larger cleaning machines that are otherwise available.

The project also gives Agrologica the opportunity to continue the breeding of cereal varieties for Landsorten, and will, among other things, spend more energy on developing genetic markers for other properties than just common bunt, such as baking quality, resistance to rust diseases, etc. We anticipated the joys and wrote about baking quality in the last issue of The Landrace.

Staff and seed situation in Landsorten

As described in the last issue of The Landrace, Landsorten has been affected by illness in the staff group in 2024. Financially, we are reimbursed for part of the salary costs, so in a narrow sense it does not affect Landsorten's finances, but it has meant that many things have been put on hold and we have not been able to develop very much at a time when the association is otherwise going quite fast and where there is a constant need to adapt to developments. We expect everyone to be fully or partially back by the general meeting in February and ready for the many challenges and new tasks that await us in 2025.

In 2024, just under 500ha were cultivated with Landsorten’s varieties, and our seed coordinator reports that seed has been sown or reserved for +1000ha in Denmark, 500ha in the UK and smaller amounts in the Netherlands and Belgium for the coming season.

The weather has been fine in late autumn 2024, and a lot of Mariagertoba and other spring seeds have already been sown in autumn 2024. As a result, most varieties are already largely sold out of seed for the coming season. Of course, it's positive that there's a lot of interest in our varieties, but it creates the

luxury problem that we probably won't be able to supply everyone who wants to establish production. There is a little left here and there:

- Taliko naked oat
- Mariagertoba
- Danish Spelt
- Amy spring wheat
- Oil oats (<1t)
- Our purple wheat
- Balled wheat (<1h)
- Langeland barley
- Babuskha purple naked barley

If you are interested in seed of these varieties, please contact Bjarne Hansen <bjarne@landsorten.dk>

Purple wheat prevents dementia

Coloured cereals are fun to look at, but it's also about health. One of the positive effects of eating coloured cereals is that they boost memory. Healthy people can achieve a 4-fold improvement in memory tests and patients with dementia can achieve almost a doubling by consuming anthocyanins, the active colouring agent in purple and blue wheat. This is better than the effect of dementia medication. The explanation is that anthocyanins activate stem cells in the brain's hippocampus, an area responsible for memory, learning and emotions.

Many of the other substances we consume with food are blocked by the blood-brain barrier, but anthocyanins are able to pass the barrier and reach brain tissue cells where they increase the production of growth factors (including IGF-1). This increase in IGF-1 helps explain how regular consumption of anthocyanins stimulates brain stem cells. Once the stem cells are activated, a positive spiral starts with further increases in various growth factors (BDNF and others). Gradually, more and more active stem cells appear in the hippocampus and this is accompanied by improved memory and functional ability, as demonstrated in experiments with senile animals given either placebo or anthocyanin-containing blueberries for 8 weeks.

Dementia is usually detected relatively late, but long before dementia is diagnosed, the brain has been affected by declining growth factors along with reduced activity and survival of stem cells in the hippocampus. Because anthocyanin has been shown to affect the very processes that are defective in dementia, it has been investigated whether a 12-week daily intake of bilberry juice could improve the brains and functioning of people with dementia. Blueberries, like purple wheat, contain large amounts of anthocyanins. The pilot study was conducted with elderly people with diagnosed dementia. They were given about 500 ml of bilberry juice (6-9 ml/kg) or placebo daily. After 12 weeks, the bilberry group had significantly better memory and learning ability than before the trial started, and they also scored better in tests when compared to the placebo group.

The elegant thing is that they already had established dementia when the trial started, meaning their stem cells were in poor condition. Yet in just 12 weeks, they managed to achieve significant

improvements in their brain function and mental abilities. The effect grows further over time, so if you continue for several weeks, you get even greater effects.

Most anthocyanin studies have been done with blueberries and other coloured fruits, but there is actually a big difference between different anthocyanins. Many anthocyanins are broken down by either heat or in the stomach before they reach the intestines where they can be absorbed by the body. For example, potatoes with a red skin usually become colourless when cooked, so these types of anthocyanins have no positive health effects. Colours in grains in contrast are very stable against both heat and acid in the stomach.

Table 1. Summary of in vitro and in vivo studies conducted on purple wheat products.

Wheat Type	Food Type	Model Used	Subjects and Assay	Health Effects	References
Purple, black, and white wheat	High fat diet supplemented with wheat	Animal study (12 weeks)	Male Swiss albino mice (age 6–7 weeks, 20–22 g)	Both black and purple wheats reduce total cholesterol, triglyceride, and free fatty acid levels in serum, with the restoration of blood glucose and insulin resistance	Sharma et al., 2020 [6]
Purple wheat	Bran and anthocyanin-rich powder	In vitro study	ABTS, DPPH, and ORAC assays	Exceptional antioxidant properties	Abdel-Aal et al., 2018 [7]
Purple wheat	Bran-enriched crackers and convenience bars	In vitro study	ABTS, DPPH, and ORAC assays	Exceptional antioxidant properties	Gamel et al., 2019 [36]
Purple and yellow wheat	Bread	In vitro study	ABTS and DPPH assays	Bread (crust and crumb) made from purple wheat has higher antioxidant activities	Yu and Beta, 2015 [38]
Purple wheat and durum semolina	Anthocyanin-rich pasta (25% bran)	Cell culture	Human intestinal epithelial Caco-2 cells	Both types of cooked pasta suppress IL1β-stimulated expression of NF-κB in the cellular model	Parizad et al., 2020 [45]
Purple and common wheat	Fresh noodle	In vitro study	ABTS and DPPH assays	Increased antioxidant capacity with the addition of purple wheat bran	Park et al., 2022 [51]
Purple wheat	Home- and laboratory-made whole purple wheat infant cereals	In vitro cellular antioxidant activity In vitro cellular proliferation	Primary human fetal small intestine cell line (FHs 74 Int, CCL-241, American Type Culture Collection (ATCC), Manassas, VA)	Higher cellular antioxidant activity than lab made red rice and commercial infant cereals No toxicity against the fetal small intestine cell line	Hirawan et al., 2011 [54]
Purple and common wheat	Milled wheat in pelleted form Coarse meal Crushed wheat kernel	Animal study	Wistar Albino male rats (age of 9 weeks, *n* = 64). Chickens of the hybrid combination COBB 500 (age of 39 days, *n* = 32) Fingerlings of common carp (*Cyprinus carpio* L.) (*n* = 100).	Significant higher antioxidant status in the liver of rats and chickens fed purple wheat No significant differences in hepatopancreas enzymes of fish	Mrkvicová et al., 2016 [81]
Purple and regular wheat	Diet containing 60% purple or regular wheat High-fat diet to induce dyslipidaemia	Animal study (6 weeks)	Dyslipidaemic male rats (weight 180–210 g, *n* = 42)	Reduced triglyceride, total cholesterol and low-density lipoprotein, fatty liver, and mitigation of lipid metabolism disorders and renal injury in groups fed purple wheat diet	Lan et al., 2022 [82]
Purple and common wheat	Pelleted feed (purple wheat plus anthocyanin)	Animal study (61 days)	Broiler rabbits (*n* = 18 HYLA female rabbits, age of 32 days)	No significant effects on plasma biomarkers, oxidative stress enzymes, and antioxidant activity	Stastnik et al., 2019 [83]
Purple wheat	Anthocyanin-rich methanol extract	Animal model (Study duration = the whole life span of the Nematodes)	Wild type strain N2 worms of nematode *Caenorhabditis elegans* and mev-1(hn1) mutants	10% extension of life span Inhibition of insulin/IGF-1-like signaling pathway Increased stress response and reduced oxidative stress	Chen et al., 2013 [84]
Purple and common wheat	Wheat diet	Animal study (5–6 months)	Male mice of C57Bl/6J strain (age 2.5 months, Neurodegenerative disorder induced by central injection of an amyloid beta	Prolong memory extinction and improve neurodegenerative disorder	Tikhonova et al., 2020 [85]
Purple, blue, black, and white wheat	Acidified methanol extract	Cell culture	Murine macrophage cell line RAW 264.7	Reduced nitrite oxide production in lipopolysaccharide-induced pro-inflammatory stress. Inhibition of pro-inflammatory cytokines (TNF-α and IL-1β)	Sharma et al., 2018 [86]
Purple wheat	Bran-enriched crackers and convenience bars	Human study—A randomized, semi-blinded crossover acute Study	Healthy participants, 4 servings (6.7 mg anthocyanins and 176–213 mg phenolic acids, plasma antioxidant status and short-term markers of inflammation markers	Few anthocyanin metabolites in urine and none in plasma No short-term impact on plasma antioxidant activity or inflammatory biomarkers, IL-6 and TNF-α	Gamel et al., 2019 [88]
Purple wheat and regular wheat	Bran-enriched convenience bars	Human study A randomised, single-blind parallel-arm study for 8 weeks.	Overweight and obese adults (*n* = 29) with chronic inflammation (high-sensitivity CRP > 1 mg/L)	Significant reduction in IL-6 and increase in adiponectin within the purple wheat group and lower TNF-α in both groups comparing to the starting point	Gamel et al., 2020 [89]

It is inevitable that some of the anthocyanin is degraded during the kneading, rising and baking of bread, but in general, anthocyanin content is best preserved with sourdough leavening compared to yeast leavening and by baking at high temperature for a short time rather than baking at low temperature for a long time. One study suggests that stone-ground flour appears to be better at retaining anthocyanins in purple wheat than roller-ground flour.

We live in a world with oxygen in the atmosphere, so all carbon-containing material will eventually decompose into CO_2 and water, unless there is something to prevent it. This also applies to the bodies of humans and all other living organisms. The reason we stay alive without rotting is because we have a number of anti-oxidative processes in our bodies, and one of them is the antioxidants in our food. That's why antioxidants in general are so important for our nutrition. In general, we eat too few antioxidants in a modern diet of highly processed food made from raw materials that are low in antioxidants. Therefore, blueberries, purple wheat and other foods that have a high concentration of anthocyanins and other antioxidants are generally beneficial. Anti-inflammatory foods are generally foods that are high in antioxidants, and this is important to counteract the part of the food that only contains energy and is therefore inflammatory for the body. Cereals are high in starch and also gluten, both of which are highly inflammatory for the body, and the anthocyanins in the bran of purple wheat are good antioxidants that can counteract the inflammatory effects of the starch and gluten.

Cancer cells develop in the body at low pH, which is caused by poor oxygenation. This is why cancer can be prevented with daily exercise that gets the blood pumping well throughout the body. Many studies also show that anti-inflammatory diets high in antioxidants have a similar function to exercise and prevent several types of cancer. The high incidence of cancer in populations with modern lifestyles is therefore partly attributed to the lack of antioxidants in our basic diet. So there is good reason to eat a more colourful plant-based diet, including purple wheat, blue wheat and, for that matter, the Yellow Sunshine Wheat.

References on the health effects of purple wheat and blue wheat:

Francavilla, A.; Joye, I.J. Anthocyanins in whole grain cereals and their potential effect on health. Nutrients **2020**, 12, 2922.

Abdel-Aal, E.-S.M. Anthocyanin-Pigmented Grain Products. In Advances in Cereal Science: Implications to Food Processing and Health Promotion; Awika, J.M., Piironen, V., Bean, S., Eds.; Oxford University Press, Inc.: Washington, DC, USA, 2011; pp. 76-109

Zhu, F. Anthocyanin in cereals: Composition and health effects. Food Res. Int. 2018, 109, 232-249.

Bartłomiej, S.; Justyna, R.K.; Ewa, N. Bioactive compounds in cereal grains-occurrence, structure, technological significance and nutritional benefits-A review. Food Sci. Technol. Inter. 2012, 18, 559-568.

De Pascual-Teresa, S.; Moreno, D.A.; Garcia-Viguers, C. Flavanols and anthocyanins in cardiovascular health: A review of current evidence. Int. J. Mol. Sci. 2010, 11, 1679-1730.

New rust protection for organic grain

A couple of years ago in The Landrace no. 10 we wrote a little about the plant diseases stem rust and yellow stripe rust, as these diseases can cause major damage to organic grain. We have now worked more with these diseases and have gained a better understanding of what we can do in organic farming to avoid them, and especially how we can breed new varieties with good resistance.

Rust diseases are a group of highly specialised plant diseases that can affect most plant species. Cereals can also be attacked by several rust species and can be very loss-causing. In Denmark, yellow rust in wheat and triticale is the worst nowadays, but previously stem rust was the most common.

Stem rust can spread epidemically from wheat plant to wheat plant during the growing season, but it has deciduous barberry as an intermediate host. This means that, as a rule, it has to start all over again every year by spreading from barberry to wheat to start a new epidemic. In the good old days, livestock in Danish agriculture were actually allowed to graze in the fields instead of being locked up in small cages and stables as they are now.

Before barbed wire and electric fences became widespread, barberry, with its long branches and thorns, was a common fence plant around the fields. As early as the 1600s, at least in France, it was recognised that there was a connection between barberry and stem rust in grain, and in Denmark, NP. Schøler wrote the article "Om Berberissernes skadelige Indflydelse især på Rugen" in 1813 and later in 1818 "En afhandling om Berberisens skadelig Virkning på Sæden" in Landoeconomiske Tidender. The problem and the connection between barberry and rust diseases in grain has been known for a long time, but it wasn't until the late 1800s that people started to do something about it. It gained particular momentum after the German De Bary proved in 1865 that stem rust in cereals and barberry was caused by the same fungus. The 1869 Fence Act in Denmark established that neighbours could demand that barberry be removed from fences if they grew grain. However, Rostrup estimated in 1897 that around 4% of the grain crop was still lost to stem rust, and with the Barberry Act of 1903, barberry was almost completely eradicated in Denmark, except for a few plants at Møns Klint. Barberry still grows in gardens, but it is a different species of barberry and is not an intermediate host for stem rust. The barberry law was repealed again in 1992, as there is virtually no stem rust in Denmark and most wheat is sprayed with pesticides anyway.

The fact that stem rust no longer occurs in Denmark is not only because we don't have wild Barberry or other plants in hedgerows in the landscape. It is also because combating stem rust was one of the primary focus areas of the Green Revolution in the 1960s, when Norman Borlaug from the Wheat Research Centre in Mexico, among others, developed wheat varieties with resistance to the disease. The Sr31 resistance gene, in particular, became widespread around the world because, in addition to resistance to stem rust, it actually increased yields. What's not to like?

When a single resistance gene becomes widespread in an area, it puts a lot of selection pressure on diseases to develop virulence and in 1999, stem rust was found in Uganda in varieties that were otherwise considered resistant. The new strain was named Ug99, and of course it quickly spread to other countries and has now arrived in Europe, and along the way it has evolved further so that there are now several strains that can infect wheat varieties with the Sr31 resistance gene.

Chris Khadgi Sørensen from Aarhus University has tested 600 wheat varieties from Agrologica, and it turns out that several of the varieties have resistance to stem rust, although this is not something I have targeted. We have a breeding programme to develop Sunshine wheat, which is bread wheat that

produces yellow flour. The yellow flour trait is due to a gene called Y, which comes from a wild grass, *Thinopyrum pontium* (=Agropyron *Elongatum*). It turns out that the Y gene is closely linked to both the resistance genes Lr19 and Sr25, so when we select wheat varieties with yellow flour, we get resistance to rust as well. Sr25 (Stem Rust Resistance gene no. 25) is one of the few resistance genes that provides resistance to the aggressive stem rust strain Ug99.

There are several types of rust resistance, and two types in particular stand out. One type provides resistance in the early development of the plant and is very specific. This means that the plant is either completely resistant or completely susceptible to an infectious species. The other type provides adult plant resistance, which is less specific and thus provides less effective resistance, but on the other hand provides resistance against several races or even in some cases against several different rust diseases. If a variety has adult plant resistance, don't get hysterical about a small rust spot on a leaf, because the risk of it developing an epidemic is small. The most effective approach is to have a combination of both specific young plant resistance and general adult plant resistance. Both Lr19 and Sr25 are specific resistance genes, so even though yellow wheat has both genes, in future breeding programmes it would be ideal to combine them with a resistance gene that provides general adult plant resistance. We will probably focus on Lr34/Yr18/Sr57, for example, which, although it causes wilting leaf tips, is very broad-spectrum against many rust diseases simultaneously.

Organic farming faces many challenges, and stem rust is not one of the most acute. Still, it makes sense to be prepared because stem rust is spreading all over the world and climate change is making the world more uncertain, also for organic farming. Some resistance genes only confer resistance to a single rust disease, while others confer resistance to several diseases at once. Therefore, it makes sense to choose resistance genes that not only provide resistance to the diseases that are present this year, but also protect against the diseases that may come in the coming years. If we don't have effective resistance genes and have to cross with wild grasses to get new resistance, it could take decades to develop cultivable resistant varieties. Therefore, the project funded by the Foundation for Organic Agriculture has provided valuable knowledge about which resistance genes we currently have in our gene pool and which resistance genes we should have to be secure in the future environment.

Find previous issues of the newsletter at: https://www.agrologica.dk/publikationer