Northern Cereals

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Northern Cereals – New Markets for a Changing Environment

Small scale test malting at NIBIO Holt, Tromsø, Northern Norway

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INTRODUCTION

In the Northern Cereal project, one of the aims has been to test malting of the cereals grown in the northern areas. Since the producers in northern Norway lacked facilities for malting, test malting has been initiated by NIBIO. At Nibio Holt in Tromsø small scale malting trials of barley were conducted in 2017 and in 2018. Prior to the test malting both knowledge and equipment where lacking so these two trials have been important in building up the competence level of malting. In 2015 northern Norway experienced a very good growing season for barley. Unfortunately, the growing seasons, 2016 and 2017 were cold and wet and insufficient for cereal production for malting in Tromsø. Leaving the locally grown barley varieties with a very low germination and the results from test malting was limited because of this. Malting and malt quality analyses were also performed in 2016 at the test facilities at NMBU (The University of Life Sciences at Ås, Norway). The results of the seven varieties tested were promising, and we reported this earlier in Martin et al. (2016) *Methods used within the project for malting small grain quantities*. In 2017/18 a experiment to test the effect of malting process on different barley qualities were performed.

In this report data from cultivation and test malting at NIBIO Holt are presented.

CULTIVATION OF BARLEY FOR MALTING

The growing season started out very promising in 2016 and we sowed the barley on May 10^{th,} which is the earliest registered sowing date at Holt Research Station. However, due to a cold summer the barley matured very slowly. The fall was dry and harvesting was postponed to increase maturing and drying of the kernels. The early Icelandic and Norwegian varieties, Iskria, Smyrill and Tiril matured, but still had a high moisture level at harvesting. Unfortunately, the germination turned out low (only 66 % for Iskria that had the highest percentage). This is likely due to the high moisture content in the kernels at harvesting causing a harsh treatment to the grain in the old thresher used for harvesting. The Icelandic two-row variety Iskria were chosen for malting and was quality tested at NIBIO Apelsvoll showing the following parameters:

Variety	Sowing	Harvest	Dry matter weight	water %	Thousand kernel weight	Hecto liter weight	Protein %	Germi-nation %
Iskria	May 10th	Oct 4th	223 kg	8,7 %	34,67 g	69,1 kg	12,5 %	66 %

In 2017 the season started very late. Sowing date was May 31st due to a very cold spring. The summer was normal and the fall was good but could not compensate for the late start. The early Icelandic variety Iskria matured and was harvested. Unfortunately, the germination rates were even lower than for the season 2016, only 30 % at the last testing in February 2018. Because of this we decided not to malt the cereal from Holt in 2017. Malting experiments were therefore conducted on commercial bought Tiril-barley with a high germination rate (above 92 %).

TEST MALTING

At NIBIO Holt we are in the same situation as most farms and microbreweries that wants to start malting – we lack specialised equipment. Because of this, we had to use or to modify the equipment found at the station to malt to the best of our abilities. We utilized a room in the research stations greenhouse for the steeping and the germination, and for drying we used drying cabinets used for

drying grass for research purpose, in 2017 our large, 3m^3 cabinet, and in 2018 a small cabinet suitable for maximum 15 kg grain.

Table 1a and b: Plans for malting in 2017 and 2018.

1 a. Malting at Holt March 4th - 13th 2017

Variety Iskria
Germination 66 %
Weight barley 223 kg

	Start	End	Hours	Temp (°C)
1. Steeping				
Wet	4.3 kl 11:30	4.3 kl 19:00	7,5	+ 16 °
Dry	4.3 kl 19:00	5.3 kl 09:30	14,5	16 °
Wet	5.3 kl 10:00	5.3 kl 19:00	9	+ 16 °
Dry	5.3 kl 19:30	6.3 kl 09:30	14	16 °
Wet	6.3 kl 10:30	6.3 kl 14:30	4	+ 16 °
2. Germination				
	6.3 kl 15:30	10.3 kl 10:00	90,5	16 °
3. Drying				
	10.mar		22	30 °
	11.mar		24	35 °
	12.mar		24	39 °
	13.mar		24	39 °

1 b. Malting at Holt February 7th - 15th 2018

Variety Tiril (commercial)
Germination 92 %
Weight barley 13,5 kg
Weight malt 11,5 kg

	Start	End	Hours	Temp (°C)
1. Steeping				
Wet	7.2 kl 13:00	7.2 kl 20:00	7	8-10 °
Dry	7.2. kl 20:00	8.2 kl 08:30	12,5	8-10 °
Wet	8.2 kl 08:30	8.2 kl 17:30	9	8-10 °
Dry	8.2 kl 17:30	9.2 kl 08:30	15	8-10 °
Wet	9.2 kl 08:30	9.2 kl 10:30	2	8-10 °
2. Germination				
	9.2 kl 10:30	14.2 kl 08:30	118	8-12 °
3. Drying				
	14.2 kl 09:00	15.2 kl 08:30	23,5	65 °
	15.2 kl 08:30	15.2 kl 10:30	2	75 °
	15.2 kl 10:30	15.2 kl 13:00	2,5	80 °
	15.2 kl 13:00	15.2 kl 15:30	2,5	85 °

THE MALTING PROCESS

1. Cleaning and sorting

Cleaning for impurities is important to stop stones and other debris to end up in the malt. In addition, sorting of the grain in even sizes is important for an even germination of the grains and an optimum malt yield. When the initial grain quality is variable, this step is especially important. If possible the best is to sort the malting barley in sizes above 2,5 mm to ensure to include the best grains and high yield of malt.

The first year the grain was screened by hand. The sieve was not suitable for neither a good cleaning nor sorting of the grain so this was a part of the process that needs considerable improvement. The second year we chose to malt a much smaller amount of grain and because of this we could clean the grain in small-scale seed cleaning equipment present at Holt. However in 2018, this cleaned grain (Iskria) later turned out to have a too low germination rate so instead we chose to malt a pre-cleaned commercial batch of Tiril.

Fig 1. In 2017 we were cleaning the grain manually over a fine sieve.

Fig 2. In 2018 a small scale cleaning equipment where utilized for cleaning the grain.

2. Steeping

The next step in the malting process is the steeping. In this step, the grain is soaked to absorb water that the grain needs for the germination. To ensure that the grain does not "drown" it is important to change the water several times as well as to send air through the water during the steeping process. The reason for this is that the grain "breathes", the grain consumes oxygen and emits carbon dioxide.

Since we do not have good equipment for aeration, the grain was put in several plastic crates and filled with water. The water was changed according to the plans shown in table 1a and 1b, and 2-4 times in the wet-cycle water was flushed through the soaked grains in the cradles. This procedure of using many small plastic crates is not suited for larger quantities. 200 kg grains that were malted in 2017 was quite laborious when using this procedure for steeping. In this process, it is also important to remember that the grains swell considerable (about 40 %) and gradually need more space in the steeping process.

This steeping method however has the advantage of in addition, to clean the grain. Small dust and debris, as well as weed seeds that are lighter than the grains washes out when we change the water.

It is recommended to use clean water that holds 10-15°C and usually the steeping takes about 40 to 50 hours. The steeping process is shorter in warmer water and with small thin grains. The steeping process is complete when the roots penetrate through the hull and become visible as a white dot. It is also possible to measure the water uptake to determine the completion of the steeping process more accurate (optimal is about 43 %). In 2017, the room temperature was set to 16 degrees, but during the sunny day the room temperature increased, in 2018 the temperature was lower, between 8 and 10 degrees C. When the grain breaths, heat is produced and since it was used relatively small amounts of water the temperature in the water would vary in the steeping process.

Fig 3 and 4. Steeping was done in plastic crates.

3. Germination

In 2017 the germination started March 6th at 15:30 and ended after 90,5 hours on March 10th at 10:00. In 2018 the germination started February 9th at 10:30 and ended after 118 hours on February 14th at 8:30. The wet grain were spread out on a table in the greenhouse that were about 2m wide and 5 m long. Under the grain we put a thin layer of perforated plastic film. In 2017 the amount of grain filled the complete table in a 10 cm thick layer. In 2018 only about one fourth of the table was used in a 3-4 cm thick layer. During the germination period, the grain was turned about 2-3 times a day, and sprinkled with water at turning.


Fig. 5 and 6. Already the first morning on the germination table the first rootlets appeared. 2017 (to the left) and 2018 (to the right).


Fig 7 and 8. These photos show the grains when the germination ended in 2017(to the left) and in 2018 (to the right).

To test how far the germination had proceeded, four batches of 100 seeds were randomly picked out and length of hypocotyl measured for evaluation of germination. The hypocotyl sprout should be about 2/3 of the grain length when the germination ends, to achieve optimal malting quality. The leaf sprout were somewhat variable in length and in 2017 the test in addition showed that only 27 % of the grains had germinated at all (even though the initial germination test of the grain showed 66 % germination). In 2018 the germination was very good, in the four tests it was close to 100 %. Even though the germination test before the malting started showed that the grain malted in 2018 (commercial Tiril) germinated fast (in comparison to the grain grown at Holt) since the temperature in the germination room was kept low (8-10 degrees C), the germination took 27,5 hours longer than germination of Iskria in 2017 (Table 1 a and b).

The literature gives varied information on optimal germination temperatures. Some uses 16 degrees C. For grain with variable quality, it is an advantage to keep the temperature low to ensure a more even result. However, the germination time will be longer at lower temperatures.


Fig. 9 and 10. 2017: When the germination ended, only 27 % of the grain had germinated. The hypocotyl of the sprouted grains were of uneven lengths between 1/3 and the double of the grain length.

4. Drying

In 2017, the amount of grain were too large for the small dryer cabinet, and a large grass dryer was used. This dryer can take up to 3 m^3. The grain was packed in netting-bags for easier handling. Each bag weighing about 4-4,5 kg. At start maximum aeration was provided to ensure that much of the humidity went out of the grain fast. However, the valves were closed after 2 hours since the temperature did not raise above 35 degrees C. Unfortunately the temperature of the dryer still did not increase above 40 degrees C even after two days in the dryer. With the very high humidity in the bags and the low temperature in the dryer it turned out that the grain had started developing mould. The drying process was therefor stopped. And, the malting proved a failure in 2017.

It might be that avoiding using the netting-bags as well as drying the grains on shelfs in a thinner layer could have saved the malt. However, the situation at present at Holt is that we do not have equipment to successfully dry good malt in quantities larger than approximately 15 kg.



Fig. 11, 12 and 13. The drying process in 2017.

In 2018 a much smaller batch of grain were malted and after the germination the grain were placed in a smaller dryer that has a large temperature range. The grain was placed on shelfs in the drier in layers of about 3 cm thickness. The malt was dried according to the plan for the malting in 2018 (table 1 b). After the process was finished, after 28 hours, the malt was packed in a paper bag for storage.



Fig 14 and 15. The drying process in 2018.

This malt is not tested due to the fact that we did not use cereals grown in northern Norway. However, we will use this for local brewing at the research station.

CONCLUSION

Even though the test malting has not been as successful as we might have hoped, we have gained much knowledge in these trials. Future test malting will proceed in the following years at NIBIO Holt. In addition, as figure 16 shows, we are slowly improving the quality of the equipment on the farm and this too will affect the possibility of doing quality test malting at the research station.

Fig 16. After the malting ended, we received a new screen to our small-scale seed grading machine from Westrup. This is a screen with 2,5 mm slotted holes, meaning for the future we can sort out the larger grains for malting.