Northern Periphery and Arctic Programme

Northern Cereals – New Markets for a Changing Environment

Small-Scale Equipment for Processing of Cereals

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Hilde Halland, Ólafur Reykdal, Peter Martin and Vanessa Kavanagh

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Authors: Hilde Halland, Ólafur Reykdal, Peter Martin and Vanessa Kavanagh

Front page photo: processing line from Thorvaldseyri farm, Iceland. © Ólafur Eggertsson
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O. Eggertsson, fig. 7, 9 and 15
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Northern Cereals Partners:

Matis – Icelandic Food and Biotech R&D

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Agricultural Centre, Faroe Islands

Forestry and Agrifoods Agency; Newfoundland and Labrador, Canada

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1. Introduction

Specialized equipment is needed for the processing of grain for food uses. This includes cleaning, sorting, dehulling, milling and packaging. For certain processes, cracking, crushing, flaking and extruding might be needed.

During communication in the Cereal Project (Northern Cereals – New Markets for a Changing Environment) the need for information on small-scale equipment was obvious. Most of the available equipment is either designed for big industrial plants or for family use at home. SMEs and initiators in the northern regions are not working with huge amount of grain but the family equipment is too time-consuming to use.

The work described in this report was carried out under work package T3 on Cereal Food Production of the Northern Cereals Project. Grain processing from cleaning to packaging is described. Examples are described by figures. Companies providing equipment are listed together with useful links. We hope that this information will be helpful for the small companies starting the use of domestic cereals for food.

2. Processing dried grain

The processing of dried barley grain (less than 15 % water content) has the aim of transforming it into a more palatable and tasteful foodstuff (Delcour and Hoseney, 2010). Before dried grain is ready for milling, several processes are necessary. When setting up a milling system the capacity of each part (the seed cleaner, the dehuller, the mill and the packing equipment) in the process line should match each other (UNIDO, 2004). Expected sales are often used to decide the capacity of the mill (kg/hours), and the other equipment is selected accordingly. The main problem however, in northern areas may be to ensure an adequate supply of raw material.

Barley contains mainly carbohydrates, proteins and lipids. Barley is especially known for its high amount of water-soluble fibre, β-glucan, which has proven to have many health benefits for humans (Wrigley et al. 2016). The distribution of the different constituents is not uniform through the grain, and when processing the grain it is important to know the grain physiology and contents to be able to produce a product that has the desired baking and cooking properties, the desired taste and the desired health properties. Figure 1 is an illustration of a sprouted grain.

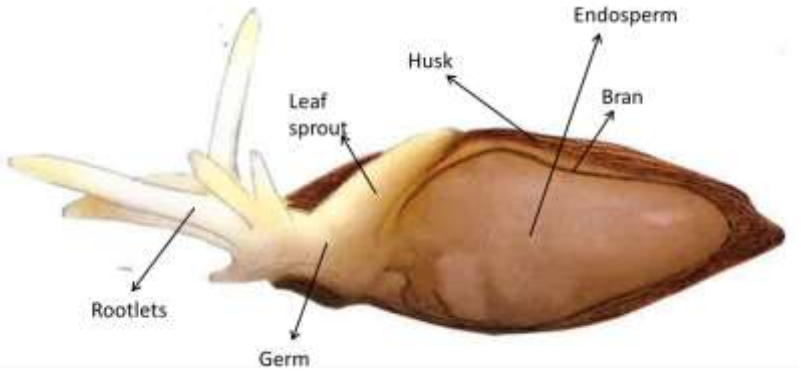

Figure 1. Illustration of a sprouted barley grain.

The husk is the outer hard part of the grain that is not palatable for humans. The hull includes the husk and all the outer layers of the grain including the bran. This part is rich in insoluble fibre and vitamins, in addition to giving much of the specific taste connected with barley. The endosperm makes up about 75 % of a barley grain, and is rich in β-glucans (Wrigley et al. 2016). β-glucans are connected to the health claim allowed by the EU. These health claims are however dose-dependent[1] (Halland et al., 2016). The germ has a high oil content that can cause the flour to become rancid, because of this the germ is often removed in the processing (Delcour and Hoseney, 2010).

When planning for a processing line for grains it is important to remember that dust is a problem in mills worldwide. This can create health problems for millers when they are exposed to excessive dust from the cleaning, hulling, milling or packing processes. A good system to ensure a healthy environment for the workers is essential.

[1] Approved EFSA health claims on beta-glucans, www.EFSA.eu

2.1 Cleaning and sorting

The first processing operation is to clean the grains from impurities such as stones or weed seeds etc. Various cleaning steps are employed by mills. It is usual to separate metals by a strong magnet and to use different mesh sizes, separators and air systems to remove the remaining stones, debris and seeds of undesired dimensions, including broken kernels. For some mills this process is done at the arrival of the grain to the mill, however if the cleaned grain is stored for some time at the mill the cleaning process is repeated again before milling or further processing.

Sorting may be useful to ensure a good result. Especially when pearling the barley, it is best to have grain that is uniform in size and weight, preferable a plump grain (Wrigley et al. 2016).

Figure 2. Grain cleaner from Rutherfords, Orkney.

Figure 3. Grain cleaner from Engsko, Dyrk mølle, Norway.

Figure 4 and 5. Small scale grain cleaner and grain sorter from Westrup, from Nibio Holt, Norway.

2.2 Dehulling and pearling

Before the milling process, the hull must be removed. In barley the hull adheres tightly to the seed, and must be removed before making it into a foodstuff since this is low in palatability for humans. How much of the hull that is removed determines much of the properties and health benefits in the finished product. The pearling rate determines how much of the outer layers are removed. A 10 % pearling rate (10 % weight removal) eliminates much of the outer hard hull (husk). At a 15 % pearling rate also the layers pericarp and testa is removed, and at a 30 % pearling rate the pearled grain is devoid of any outer layer (Wringley et al. 2016). The content of insoluble dietary fibre in pearled barley decreases with increasing pearling rate. In general, the whiter the grain, the more of the bran has been removed. However, a considerable part of the beta-glucans remains in the dehulled and pearled grain since these compounds are found in the endosperm.

Figure 6. Dehuller/Pearler from Engsko, Dyrk Mølle, Norway.

Dehulling is usually accomplished in a pearler (Wrigley et al. 2016). Hulling, pearling and polishing is the processes where the grain is subjected to abrasion on an abrasive surface (Baik and Ullrich, 2008). Surfaces for hulling can be knives, stones or perforated plates (Clark and Rottger, 2006). There are four main types of hullers for different types of grains: the abrasive huller, the abrasive cone huller, the Engelberg huller and the rubber roll huller (Clark and Rottger, 2006). The rubber-roll is most common in larger mills.

The by-products of this process is used for fibre and vitamin enrichment of other foodstuffs. One example is pasta where 50 % of the standard durum wheat is substituted with this barley pearling by-product. The result being a darker product with good cooking abilities and a healthier product. In addition, the husks as a by-product can be used as biofuel.

Figure 7. Dehuller from Westrup at Thorvaldseyri farm, Iceland.

Figure 8. Old dehuller from Kistefossen mill in Troms, Norway.

2.3 Milling

When the grain (consisting of the endosperm and bran) has been cleaned and hulled it can be milled. In whole grain the bran is milled together with the endosperm. The bran can be separated from the endosperm in the desired amount. Much of the wholesomeness and the baking traits of the flour depend on the percentage of bran incorporated in the flour.

There are many types of mills on the market. The roller mill is used by many larger milling companies. In the first steps of this milling process the bran is separated from the endosperm in the "break systems", the endosperm (and parts of the bran that are not removed) is then lead to different sized sieves until all has passed through the 132 µm sieve in the "reduction system" and is finally collected as flour (Delcour and Hosney, 2010). Stone mills were historically the only system for milling flour, and many mills still use this system. Today also new mills are using this system marketing the flour as stone milled flour as a sign of extra quality. Today, porcelain is often used instead of stone in modern facilities. On stone mills the whole fraction of the grain is ground together as whole grain flour, or the bran is removed before milling to ensure whiter flour. The pressure on the stones determines the coarseness of the flour. The flour is sieved after the milling process to remove unprocessed grain or other debris. In many regions of Africa, hammer mills are the most important type of mills used (Clark and Rottger, 2006). In hammer mills there are hammers in the mill which grind the grains through impact.

Figure 9. Hammer mill from Thorvaldseyri farm, Iceland

Figure 10. Steinmølle fra Engsko, Dyrk mølle, Norway.

Figure 11. Millstone at Barony Mill, Orkney

Figure 12. Horizontal millstone from Shetland

Figure 13. The old water mill at Dyrstad in Troms, northern Norway

Figure 14. Kistefossen mill in Øvre Salangen, Troms, northern Norway. The mill was driven by a franchise turbine, and was shut down in 1950.

When describing the yield it is common to define the percent extraction. The extraction rate is 100 % for whole grain flour and it is further separated into the percentage of bran and white flour. White flour can further be separated into different grades depending partly on its particle size. Commonly the flour part (when bran and other parts that are not the endosperm are subtracted) adds up to about 72 % extraction rate (Delcour and Hosney, 2010). The flour is then sold in different types depending on the extraction rate and the fineness of the grading.

2.4 Other processing

After the grain is hulled or pearled it is also possible to make cracked/grits products from barley. This is used in a wide range of foodstuff and can be easier to process than whole grains in breads, cereals, soups or salads etc. Worldwide it is also common to use barley as a healthier substitute for rice. The barley is then cut along the crack and polished to resemble white rice (Baik and Ullrich, 2008).

Another processing method for whole dehulled grains is flaking. These are sold (as more commonly known oat-flakes) for example as “quick cooked flakes”, “regular flakes” or “thick flakes” (example from Montana Milling Inc.). The grains are then first softened by partially cooking them in steam (FAO, n.a.), and thereafter pressed or rolled into flakes before drying. Cooked and dried grain may also be cracked, milled or ground to granules or powder and used as a ready-to-eat snack or furthered processed (Wrigley et al. 2016).

Malt is germinated and dried grain, mainly used as the main ingredients in beer and malt whiskey. In this process much of the starch is converted to sugar. In the drying process, the grains get a darker colour and, according to the drying temperature, the sugar can be caramelized. Milling malt gives a flour with a different taste and a darker colour.

2.5 Packaging

The packaging of the final product from the mill (whole grain, pearled barley, grits, flakes or different types of flour) is the last step before it leaves the mill for the bakery, grocery store or other sales outlets. The sizes of the sacks or bags depend on who is the end customer. Individual consumer units tend to be smaller.

Figure 15. A silo with bagging equipment at Thorvaldseyri farm, Iceland.

3. Equipment review

Figure 16. Dyrk Mølle from Norway chose to buy a complete milling line from the company Engsko in Denmark. The mill they chose has a capacity of 200 kilos per hour. The complete line was installed in the fall of 2017.

Worldwide there are numerous companies selling complete milling lines or single unit equipment for cleaning, sorting, dehulling, pearling, milling, packaging as well as other types of specialized processing equipment. The equipment comes in all sizes from kitchen size equipment to gigantic processing lines, as well as at all prize levels. For the new mill it is important to know the needs, both in terms of capacity and in terms of specifications needed in the finished product. When setting up a milling system the capacity of each piece in the line should match each other. The larger suppliers of milling equipment might have few varieties suited for capacities that are common for the northern area. The price however, is most often, what sets the limitation for the company's choice for new equipment. Choosing to buy new equipment might in addition mean that the company will easily get help with the installation and with necessary service for the equipment.

3.1 Examples of processing equipment companies

Engsko, United milling system, a Danish company that offers complete tailor made milling systems as well as various types of mills: https://unitedmillingsystems.com/products/

Westrup, Seed and Grain Processing Equipment and Machinery, a Danish company that offers complete milling plants as well as various types of mills: www.westrup.com/products

Buhler, a Swiss company operating internationally that has equipment mainly for larger milling plants: www.buhlergroup.com

Streckel & Schrader is a German company selling machines for cleaning, husking and flaking of grain: www.streckel-schrader.com/english/products.html++/page/3/

Unibak is a Norwegian company selling baking equipment to the baking industry. They can also provide stone mills of sizes 20 to 100 kilos per hour. Contact them for info and prices: www.unibak.no/default.asp

Alvan Blanch Developmet, a U.K. company selling equipment of all sizes, but mainly larger sizes; driers, cleaners and mills: www.alvanblanchgroup.com/products

Pleasant Hill Grain is a company from USA selling appliances for food production including mills and flakers from kitchen size up to mills with capacities of 500 kilos grain per hour: https://pleasanthillgrain.com/appliances/grain-mills

Seedburo Equipment Company is a US based company selling various equipment for grains, feed and seeds: www.seedburo.com

Getreidemühlen Reisinger is a company in Austria which sells kitchen sized equipment for cereal processing. Information can be found on the website: http://www.getreidemuehlen.at/en

Matrevolution is a Swedish company and supplier of kitchen sized equipment for food production. www.matrevolution.se/category/kvarnar-for-mjol

Wonder Mill is a small kitchen size mill that is said to be able to grind about 40 kilo grain per hour: www.thewondermill.com

Fieldstone Organics is a Canadian company selling kitchen sized mills and flakers: https://www.fieldstoneorganics.ca/products/mills-flakers.php

3.2 Useful links

Norway

Norkorn: Bransjeorganisasjon for norske bygdemøller og kornsiloer: www.nhomd.no/bransjeforeninger/norkorn/

Iceland

Vélfang Ltd, www.velfang.is, tel. +354-580-8200, Skarphéðinn Karl Erlingsson, ske@velfang.is. Vélfang has helped companies to find small-scale equipment for food and feed processing.

Jötunn Vélar ehf, www.jotunn.is, tel. +354-480-0400, Finnbogi Magnússon, fm@jotunn.is

Ólafur Eggertsson, Þorvaldseyri, oli@thorvaldseyri.is, tel. +354-487-8815. Ólafur has imported driers and other specialized equipment for cereal processing.

5. Handbooks and literature

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Appendix 1: Cereal and equipment glossary

English	**Norsk**	**Íslenska**
Cracking	Krakkelering	Brot
Crushing	Knusing/klemming/valsing	Það að kremja
Cultivar	Sort, kultivar	Yrki, afbrigði
Dehusking	Avskalling	Afhýðing, ysta lag
Dehulling	Avskalling	Afhýðing
Extruder	Ekstruder	Þrýstisjóðari, extrúder
Mill	Mølle, kvern	Kvörn, mylla
Pearling	Polering	Perlun
Pelleting	Pelletering	Það að framleiða kúlur
Variety	Sort	Yrki, afbrigði