



Evaluating malting quality in Canadian barley

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Canada has a compulsory merit based variety registration system, administered by The Canadian Food Inspection Agency (CFIA). Merit is evaluated in Co-operative Trials supervised by the Prairie Registration Recommending Committee for Grain (PRRCG). The Barley and Oat Subcommittee of the PRRCG is responsible for malting barley. This committee consists of three evaluation teams, each has responsibility for a specific area of performance. These teams are made up of scientists, producers, grain marketers, maltsters, brewers and extension specialists. The Agronomy and Breeding team evaluates field performance including yield, straw strength, maturity and kernel physical characteristics. The Pathology team evaluates resistance to a number of diseases including net blotches, smuts, rust, scald, septoria, barley yellow dwarf, root rots and fusarium. The quality team evaluates malting quality through laboratory and pilot scale tests. This team has veto power recognizing the primary importance of quality.

The primary source of data considered by these teams are the cooperative pre-registration tests and subsidiary tests such as the collaborative malting test. Before entrance into these tests, the potential cultivar must show merit compared to Canadian checks under Canadian conditions. A minimum of six station-years of data are required for this purpose. Once in the test, two years of data are normally required in the coop test and two years in the collaborative test. The cooperative tests are grown at more than 20 sites in all of the major agricultural regions of the prairies as well as observation sites in the United States and in eastern Canada. All Canadian malting barley is produced in the prairie provinces of Saskatchewan, Alberta and Manitoba. Only those lines which show merit are retained for further testing. To be recommended for registration all data is taken into consideration and a variety must have the support of the full barley and oat subcommittee.

Commercial evaluation commences after registration is approved by the Variety Registration Office of the Canadian Food Inspection Agency. Commercial evaluation normally requires satisfactory, plant scale, malting and brewing of at least two crops. Thus a successful variety will have undergone a minimum of eight years of testing and a timespan of more than ten years will have elapsed from the initial cross. The Canadian Malting Barley Industry Group rates all of the commercially available varieties for their industry acceptance. Their categories are as follows: Recommended,

Limited Increasing Demand, Limited Decreasing Demand and Not Recommended. Farmers use these ratings to determine the level of risk they wish to take on.

Quality Evaluation

Quality evaluation takes place at three levels, the breeder level, the variety registration level and the commercial acceptance level. The amount of material available for testing and type of testing is of course different at each level. At the breeder level seed is limited and thus tests are designed around this limitation. Most breeders begin the evaluation at the F5 level on single rows. This material is evaluated through the use of infrared analysis of the barley seed and/or of barley micromalts. It is possible to malt as little as five grams of material however errors are very high with this small a sample and thus a minimum of 25 grams is preferred. Some breeders also conduct wet chemistry evaluations at this level. From single rows, lines are normally entered into replicated yield trials and material from these trials is micro-malted and evaluated through the use of infrared technology and wet chemistry. Particular attention is paid to extract, enzymatic activity, total and soluble protein and beta-glucan. These tests are under the direct control of the breeder and are aimed at eliminating unacceptable lines rather than identifying the very best lines. These are normally followed by multi-site replicated yield tests and micro-malts from these are thoroughly evaluated to determine which lines should proceed to Cooperative testing. Some breeders use other laboratories to supplement their own results.

Cooperative pre-registration tests are grown at a number of locations across western Canada. Samples from each site are submitted to the Grain Research Laboratory (GRL) of the Canadian Grain Commission for evaluation for malting suitability using basically the same criteria that a commercial selector would use for selecting malting barley. That is kernel plumpness, germination, protein content and general appearance. Four sites are selected based on the quality of the grain and samples are submitted for malting and chemical analysis of these malts. Seed from two locations is submitted to private sector companies and two to the GRL. Typically these have been ConAgra malting in Calgary Alberta and Anheuser-Busch in St. Louis MO. These laboratories use the standard procedures that they would use in their own quality assurance program. The GRL uses 500 gram samples of sized barley (6/64 screen) and conduct duplicate analyses on the resulting malts. The malting schedule is designed to simulate commercial malting conditions. Malts are tested for quality using the following tests: fine grind extract, 70° C course grind extract, fine/70° C difference, soluble protein, soluble protein to total protein ratio, wort viscosity, wort beta-glucan, diastatic power and alpha amylase activity. The tests are the standard methods of the American Society of Brewing Chemists, with the exception of the 70 degree extract, which is a specialized test developed to exaggerate differences in endosperm modification of the malts. The test is similar to the standard course extract, with exception of the 70° C seed strike-in. The results of these malt analyses are used by the quality team of the registration subcommittee to determine which lines have the potential for future registration. The team indicates which first year entries they consider to be good enough for further testing in the coop program. Finally the committee identifies those first year lines that have the greatest potential from a quality perspective and these are entered into a separate subsidiary collaborative program which involves the malting industry directly.

The collaborative pilot scale malting trials investigate the malting quality of potential malting barley lines under pilot scale conditions. The collaborative program involves the GRL, the malting industry and the Brewing and Malting Barley Research Institute (BMBRI), an institute funded by the malting and brewing industries of Canada. The collaborative program tests the quality of a limited number of lines but on a larger scale than the coop test. Barley is grown at over ten locations across the prairies under commercial conditions and up to 200 kilograms of barley are delivered to the BMBRI, the administrators of the program. The BMBRI then sends barley to individual malting companies and to the GRL for pilot scale malting tests. Finished malt is evaluated using similar methodology to that for the co-op testing, although conditions are somewhat more commercial. These tests are conducted for two years and the data is added to the package which is considered in determining the suitability of the line for registration.

Plant scale commercial acceptance tests are arranged by the owner, the agent for their variety, the Canadian Wheat Board and the malting and brewing industry. Commercial fields are contracted and subject to acceptability are commercially malted and brewed. The whole range of commercial quality assurance tests are conducted on these malts and brews. A minimum of two crops are normally required before the industry is prepared to pass judgment on commercial acceptability of a new variety. Thus the process ordinarily takes at least three years to complete.

It is at this latter level of quality evaluation that the new Canadian Malting Barley Technical Centre (CMBTC) will play a role. It will have the capability of producing small-scale commercial malts and brews which will help to determine the optimum schedules for the new varieties and also to cater to the specialized requirements of the various industry players both domestic and overseas.

CMBTC

The environment at the time of initial discussions had a major influence on its establishment. The Canadian industry was in a consolidation mode and was being taken over by foreign owned companies. This led to reduced emphasis on Canadian in-house research effort and capability. At the same time marked increases in the potential for foreign sales were occurring. The competition for these sales is keen, particularly with Australia and Europe. Limited technical support for marketing existed and companies were more reluctant to make their staff available for this purpose, especially if there was no direct benefit to them. There was no "independent" research or demonstration facility available.

Discussions began in 1997 involving the BMBRI and the Canadian Wheat Board (CWB). A clear need was seen but it was decided that a separate organization was required. An implementation committee was established in 1999 and involved the CWB, GRL, Canadian International Grains Institute, malting and brewing industry, grain industry and breeders. The CMBTC was incorporated as a non-profit organization in May, 2000. In August Dr. Yueshu Li was hired as the malting director and oversaw the development of design for the malting and brewing equipment. Shortly after Rose Bemrose was hired to handle administrative affairs. In November, Dick Leach was hired as the managing director/brewing director. Prior to his hiring, he contributed to the finalization of the equipment design and acquisition. A contract

was signed with the Canadian Grain Commission to locate the facility in their building. In July of 2001, two technicians were hired to support the operation of the facilities. The malting plant was installed in July and the brewery will be installed in September. Full operational capability should be reached by November.

Start-up capital was provided by the members, government and agency grants. Operating funds are derived from membership fees and fees for service provided. The mandate of the CMBTC is applied research, technical support, problem solving, customer education and training for the Canadian barley, malt and brewing industries, domestically and internationally. Its vision is: to become the primary technical support resource for the marketers of Canadian malting barley and malt; to become a credible and respected center for applied malting and brewing research; to be a source of expertise for problem solving in the malting and brewing industry; and to become a centre for training and teaching of malting and brewing science.

The facilities are located in the Canadian Grain Commission building in Winnipeg and include a 100 kg pilot malting system, a 30 l micropilot brewing system, a 30 hl pilot brewing system and a malt and beer analysis laboratory. This equipment will produce and analyze commercial quality malt and beer. It will have a high degree of flexibility while at the same time permit detailed process control and data acquisition.

The malting system consists of a steep tank with the capacity to handle 100 kg of barley, two germination vessels and a kiln. One of the germination vessels can be used for uni-malting. Process control includes CO₂, temperature, pH, O₂, and relative humidity in the germinator and in the kiln temperature, relative humidity and CO₂.

The pilot brewery has a 3 hl capacity and consists of a mash and cereal cooker, lauter tun, mash filter, whirlpool tank, brew kettle, four cylindro-conical fermenters/storage (each can be used as uni-tanks, diatomaceous earth and sheet fillers, pasteurizer and bottler. Brewing process control includes mashing to 0.1° C, lautering D.P., flow and turbidity, kettle contents and evaporation rate, fermentation/storage temperature, pH, gravity and dissolved O₂ and filtration D.O. and turbidity. The 30 l micro-pilot brewing system was carried over from the BMBRI and will be used for special research projects.

CMBTC services will include: 1) new and existing variety evaluation, suitability to customer needs, malting and brewing characteristics, technical data sheets, seminars on malting and brewing with these varieties and special projects for breeders and other scientists; 2) applied research in areas such as quality component identification and characterization, hullless barley malting and brewing potential, new product development and malting or brewing studies for third parties; and 3) technical services, support visits to domestic and foreign plants, problem solving and education/extension activities.

The CMBTC looks forward to reaching full operational status in the coming weeks and to fulfilling its vision of serving the Canadian and international malting and brewing industries.

Table 1. Quality Evaluation

Stage Location - Evaluation

F ₂₋₅	Early generations	Breeder's lab, barley and 25 g malt
F ₆₋₉	Advanced generations	Breeder's and other labs, 50-100 g malt
F ₉₋₁₂	Pre-registration	
	Coop	GRL and Industry 500-1000 g malt
	Collaborative	GRL and Industry 500 g - 30 kg malt
F ₁₃₋₁₆	Commercial	4-6 carlots malted and brewed
	Acceptance	
