"Einkorn – Ancient Innovation"
Project No 2013-1-BG1-LEO05-08705

Training book

Project „ EINKORN – ANCIENT INNOVATION"

CONTRACT 2013-1-BG1-LEO05-08705

Czech Republic 23. – 28. 2. 2014

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0. Content

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1. Training plan

23. 2. 2014 – arrival to Prague, transfer to Brno, accommodation, detailed plan for training

24. 2. 2014 – 8:30 excursion to malthouse Kroměříž and malthouse Záhlinice

12:00 – 13:00 dinner

18:00 PIVEX – Gold cup (the contest beers)

25. 2. 2014 – training in Research institute of brewing and malting in Brno

8:30 – 10:30 visit of each department

10:30 – 12:00 ensurence of the quality of barley and wheat

12:00 – 13:00 dinner

13:00 – 14:30 practical skills training

15:00 – 17:00 city tour

26. 2. 2014 – morning departure to Prague, accommodation

8:30 departure to Prague

11:00 – 12:00 accommodation, dinner

13:00 – 15:00 visit of Research institute of brewing and malting in Prague

15:00 – 17:00 discussion

27. 2. 2014 – training in Research institute of brewing and malting in Prague

9:00 – 11:30 00 ensurence of the quality of beer, practical skills training

11:30 – 12:30 discussion, evaluation of training

12:30 – 13:30 dinner

13:30 city tour

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28. 2. 2014 – departure to Sofia

2. Einkorn in the Czech republic

Einkorn is the oldest domesticated wheat species. It has been forced out and substituted by more productive tetraploid (emmer wheat, hard wheat) and hexaploid wheat species (bread wheat, spelt wheat). It belongs to the hulled wheat species, providing good-quality crops in spite of lower yield rate. It has the following strengths: a high proportion of proteins amounting up to 20 percent in some cases. In the other hand, einkorn gluten is not suitable for the baking process and industry. It is, however, suitable for production of unyeasty products, e.g. biscuits, groats, Arabic pita, etc. Einkorn is highly suitable to be grown under organic farming conditions. It does not have any servus requirements for a nutrient supply, it is not usually infested with any common wheat diseases. Certain varieties are inclined to lodging; such crop stands might be overgrown with weeds at the beginning of the growing season as they grow very slowly. The varieties freely available at the market should be chosen and grown. Certain varieties may be also provided by the world gene bank collections. However, growing such varieties, we may face higher risks. It is always necessary to sign a contract with a supplier in order to ensure the sale. The sale price has to compensate for the lower yield rate provided by einkorn.

In the Czech Republic, einkorn wheat is not included in the species list in the Act 219/2003 Coll.; due to this fact varieties of this crop are not registered in the Czech Republic but they can be protected by law. Seed of no Czech variety of einkorn wheat is available in the distribution network in the Czech Republic. Farmers thus can only grow multiplied seed from genetic resources or use imported deeds.

In Austria, einkorn wheat is sown on limited areas. Farmers use their own seed of previously grown landraces, e.g. "Voralberger Einkorn" or varieties obtained from the gene banks ("Ebners Einkor" or "Leipzig Spät"). The "Ebner Einkorn" is distributed by the company Saatbau Linz.in Austria and also in the Czech Republic

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In Hungary, the variety Mv Alkor (sold as Elitmag Kft.) was bred from the genetic resources in the research station Martonvásár. In Germany, three winter varieties of einkorn wheat were bred in the breeding station Breeding Darzau (Albini, Tifi, Terzino) in last years.

Production quality

It is generally acknowledged that wheat compared to sown wheat excels by its high protein content, yellow endosperm color and, on the other hand, low values of rheological characters. Very high protein content (more than 20%) was recorded for example by Borghi et al. (1996) and Grausgruber et al. (2004a). In protein content there are big differences, in terms of amino acid composition (amount of amino acids per grain gram) no big differences compared to sown wheat were found (Acquistucci et al., 1995; Graugruber and Arndorfer, 2002). Certain differences in favor of einkorn wheat were found only in glutamic acid (Abdel-Aal and Hucl, 2002). Total fiber content is less than 10% and it is significantly lower than in durum wheat or sown wheat (Abdel-Aal et.al., 1995; Grausgrober et al., 2004a). This difference is due to a insoluble component of fiber (Abdel-Aal et.al., 1995).

In terms of the grain mineral composition, Bálint et.al. (2001) reported slightly higher content of iron and magnesium compared to wheat sown, while Jantsch and Trautz (2003) reported increased zinc and magnesium contents. Abdel-Aal et.al. (1995) recorded significantly higher contents of phosphorus and potassium compared to wheat sown. The ash content in wholemeal or classic flour was generally higher than that of wheat durum or wheat sown (D´Egidio et al., 1993; Grausgruber et al., 2004b).

Although grain hardness exhibits a considerable variability, most einkorn wheat samples have a very soft texture (Corbellini at al., 1999). Grain hardness is one of principal characters for the determination of the grain final use. As a result of soft grain, the individual grain fractions are bigger at milling and bran production lower if we assess portion of the individual flour passages (Frégeaz-Reid and Abdel-Aal, 2005). D´Egidio et al. (1993) explains higher flour yield as a result of the absence of a deeper crease in the caryopsis, which is characteristic for species with higher ploidy levels.

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Many authors describe high protein content but gluten is very flowable. Low bakery quality of einkorn wheat is given by low gluten strength, low sedimentation values and rheological characters of pastry (Table 4). For this reason einkorn wheat is not suitable for preparation of classic yeast bread (D´Egidio et al., 1993). Gluten quality pre-determines a perspective use of einkorn wheat for example for production of biscuits, cakes and other sweet products.

The ratio of gliadin and glutenin protein fraction of einkorn is different in comparison with wheat flint. Portion in einkorn is 2:1 while in sown wheat it is usually 1:1 (Frégeaz-Reid and Abdel-Aal, 2005). Nevertheless, varieties with better characters were found (high volume of pastry etc) (Borghi et al. 1996). These authors also state that some varieties can have bakery characters nearly similar to those of wheat sown. Currently these varieteis are registered in Italy and on the market they are traded under the name Monlis.

Einkorn wheat also has higher carotenoid content than other wheats (Frégeaz-Reid and Abdel-Aal, 2005; Hidalgo et.al., 2006 ; Kischmaier et al., 2012). Carotenoids are quite stable in the endosperm even during longer storage (Hidalgo and Brandolini, 2008), probably as a result of lower lipoxygenase activity (Leenhardt et al., 2006).

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3. Ensurence of quality of barley and wheat

Germination energy (GE)

Germination energy is an indicator of physiological quality of caryopses, it is a number of caryopses (%) that germinates under the conditions defined by the test (EBC 2009). 100 caryopses were put into a Petri dish (internal diameter 85 mm) with two filtration papers and 4 ml of water were added with a pipette. The germinated caryopses were removed always after 24, 48 and 72 h. The result is the average of four determinations.

$GE\ (\%) = (n_{24}+n_{48}+n_{72})$

n_{24}, n_{48}, n_{72} – number of germinated caryopses after 24, 48 and 72 h

Germination rate (GR)

Germination rate is calculated from results obtained at the determination of germination energy (4 ml) pursuant to the following formula. It gives vitality of a tested barley grain and deepness of post harvest maturation.

$GR\ (\%) = (5n_{24}+3n_{48}+n_{72})/5$

n_{24}, n_{48}, n_{72} – number of germinated caryopses after 24, 48 and 72 h

Germination Index (GI)

Germination Index is calculated from the results obtained at the determination of germination energy (4 ml) pursuant to the following formula. Germination Index is an undimensional number, it gives rate and uniformity of germination.

$GI = 10*(n_{24}+n_{48}+n_{72})/(n_{24}+2n_{48}+3n_{72})$

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n_{24}, n_{48}, n_{72} – number of germinated caryopses after 24, 48 and 72 h

Literature

EBC Analysis Committee, 2009: Analytica-EBC, Verlag Hans Carl Getränke-Fachverlag,

Nürnberg.

Determination of germination capacity with hydrogen peroxide

Principle

Oxygen accelerates post harvest maturation and live caryopses are able to germinate immediately.

Caryopses are steeped in hydrogen peroxide solution. The caryopses that did not develop roots and coleoptile are after 72 h ± 1 h separated and counted. Germination capacity is calculated applying the below given formula. For the determination sieving fractions above the sieve with oblong rounded apertures of diameters 2.5 mm are used after removing fractions, foreign seeds and foreign substances (further only sieving). The method is based on the EBC method 3.5.2.

Procedure

Preparation of hydrogen peroxide solution

Hydrogen peroxide solution, 7.5 g/l. Each time hydrogen peroxide solution is prepared by diluting 5 ml of 30 % (300 g/l) H_2O_2 to 200 ml with water. Hydrogen peroxide (30%) is stored in cold and dark.

Process

Admixtures and caryopses fractions are removed and 2 x 200 caryopses are obtained using a seed counter.

Both replicates are steeped in 200 ml of hydrogen peroxide solution for 2 days at 20.0 ± 0.5 °C.

After 2 days hydrogen peroxide solution is exchanged and replaced with fresh 200 ml of

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hydrogen peroxide solution and incubated for 1 day at 20 ± 0.5 °C.

The solution is strained off. Caryopses which did not develop both roots and coleoptile are separated and counted (n).

Calculation and evaluation

Germination capacity is calculated using the following formula:

$$\text{Klíčivost}\,(\%) = \frac{(200 - n)}{2}$$

Where n – caryopses which did not show root and coleoptile growth

The result is expressed in %, rounded to the nearest whole number.

When reporting results, the method used must be given in brackets after the germination capacity, e.g. germination capacity,= x % (H_2O_2).

Literature

EBC Analysis Committee: Analytica-EBC, Verlag Hans Carl Getränke-Fachverlag, Nürnberg, 2009.

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Germination capacity

Date:						**Time:**
Sample no.	PD	Germinated caryopses (4 ml)				Non-germinated caryopses in H_2O_2
		after 24 h	after 48 h	after 72 h	Σ	after 72 h
	1					
	2					
	s					
GE $_{4ml}$ =				GI =		GC_{H2O2}=
GR =						
Sample no.	PD	Germinated caryopses (4 ml)				Non-germinated caryopses in H_2O_2
		after 24 h	after 48 h	after 72 h	Σ	after 72 h
	1					
	2					
	s					
GE $_{4ml}$ =				GI =		GC_{H2O2}=
GR =						
Name: Date and signature:						

GE (%) = $(\Sigma n_{24}+\Sigma n_{48}+\Sigma n_{72}) / 2$

GR (%) = $[(5\Sigma n_{24}+3\Sigma n_{48}+\Sigma n_{72})/5] / 2$

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$GI = [10*(\Sigma n_{24}+\Sigma n_{48}+\Sigma n_{72})/(\Sigma n_{24}+2\Sigma n_{48}+3\Sigma n_{72})] / 2$

$GC\ (\%) = (400 - \Sigma n) / 4$

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Micromalting test

Principle

Under the agreed conditions of steeping, germination and kilning, malt is made from the delivered samples of barley caryopses or caryopses or seeds of other cereals. The method is based on the method MEBAK Rohstoffe 1.5.3, amendments accepted at Barley & Malt Committee EBC (Perugia, May 31, 2000) and traditional method used in the RIBM.

Procedure

Malting is divided to three parts: steeping including air rests, germination and kilning. Within this text, the air rest after the last steeping is not included into the germination time. Number of steeps, length of the air rests, total time of malting and other parameters are given directly by the customer or based on the agreement with him.

a) Weigh a grain sample of 250 ± 0.2 g, 500 ± 0.3 g or 1000 ± 0.5 g.

b) Assess moisture of the weighed sample using a non-destructive moisture meter

c) Steep the sample in the steeping box with water preheated to the given temperature.

d) After the end of the first steeping water is automatically discharged and following air rest takes place at pre-specified conditions - temperature, air moistening and CO2 exhaustion.

e) Before the next steeping, find out the degree of steeping and select the length of the next steeping accordingly.

f) Steeping is followed by the germination process. Conditions of germination, i.e. air temperature and use of the internal or external air circulation, are given by the customer.

g) Every day the germinating grain must be turned over to prevent inter-growing and forming clusters. Grain can be weighed and using the degree of steeping approximate moisture content in grain can be determined

h) After completing the germination process, blend the sample and weigh it again. After blending, the samples are placed on the kiln.

i) Kilning proceeds at a given pre-agreed increasing temperature gradient.

j) After kilning malt is weighed and malt culms are removed on a germ separator.

k) Malt is sent to the customer or for the analysis of technological parameters in polyethylene bags or in plastic resealable cans.

l) Course of the micromalting test is recorded.

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Conditions for malting barley varieties within testing of varieties for the registration. These conditions can be chased according to specific requirements of a customer.

Parameter	Description of the parameter	Value of the parameter
Time (hour)	Total malting time	144 ± 1
Water content (%)	at the beginning of germination	45 ± 1
Temperature (°C)	of water during steeping	15 ± 1
	of air during germination and air rests	15 ± 1
	At the beginning of kilning (below the floor)	55 ± 2
	At the end of kilning (above the floor)	80 ± 2
Weight of the sample (g)	-	500 ± 0.3; 1000 ± 0.5

Specification:

a) The steeping time also includes the last air rest. During steeping the grain is immersed into water for a few hours every day. Three steepings are usually conducted. The third steeping can be replaced by spraying in case that a sample received a sufficient amount of water which could cause a higher degree of steeping.

b) To the sample that does not contain a required degree of steeping, 15 ± 1 ml of water is added to achieve 500 g of the sample original weigh.

For micromalting fractions above the sieve with oblong rounded apertures of diameters 2.5 mm are used, unless agreed otherwise. The varieties of spring and winter malting barley must be malted using the same method. No additives can be used.

The course of the micromalting tests is recorded into the laboratory book "Micromalting Test".

Calculation and evaluation

Repeatability of the method can be checked by monitoring the degree of steeping.

The formula for calculation of the degree of steeping:

$$SD = \frac{(H - h) \cdot 100}{H}$$

where SD – degree of steeping (%)

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H – weigh of the steeped sample (g)

h – weighed-out barley in the dry matter (g)

Literature

Methodensammlung der Mitteleuropäischen Brautechnischen Analysenkommission. *Brautechnische Analysenmethoden Rohstoffe*. MEBAK, Weihenstephan-Freising, Germany, 2006.

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Malting Quality Index (MQI)

MQI currently used in the Czech Republic and the Slovak Republic was valid from the year 1995 (Psota et al. 1995). Much has been changed since.

Production capacity concentration of breweries and malt houses has been increased and first of all the difference between requirements on qualitative parameter values for production of Czech type beer and for malt exported abroad was sharpened.

From these but other reasons as well it was decided to adjust the current MQI. Adjustment was made on the session of the Committee for Quality Evaluation of Malting Barely Varieties at RIBM, PLC on March 21st, 2002 in Brno. The Committee was composed of representatives of firms and institutions from the Czech and Slovak Republics, presented above in the head of this article.

Evaluated Parameters

Selection of evaluated parameters for MQI was carried out by brewing and malting experts from the CR and SR in the year 1995 (Psota et al. 1995).

To evaluated parameters we range: protein content in barley grain, extract yield in d.m., relative extract at 45 °C, Kolbach index, diastatic power, apparent final attenuation, malt friability and β-glucan content in wort.

Determination of Weights and Limit Values

Weighs and limit values of evaluated parameters were determined subjectively based on experience and requirements of present malt houses and breweries' representatives (Table 1).

Tab. 1 *Limit values and weights of qualitative parameters*

	Unacceptable limit	*Optimal limit*	*Regression equation coefficients*		*Weight*
	1	9	a	b	W
Pb	**9,5**	**10,2**	**-107,57**	**11,43**	**0,01**
Pb	**11,7**	**11,0**	**134,71**	**-11,43**	
E	**81,5**	**83,0**	**-433,67**	**5,33**	**0,30**
VZ45	**35,0**	**40,0**	**-55,00**	**1,60**	**0,20**
VZ45	**53,0**	**48,0**	**85,80**	**-1,60**	
K	**40,0**	**42,0**	**-159,00**	**4,00**	**0,10**
K	**53,0**	**48,0**	**85,80**	**-1,60**	
DP	**220**	**300**	**-21,00**	**0,10**	**0,10**
FA	**79,0**	**82,0**	**-209,67**	**2,67**	**0,10**
F	**79,0**	**86,0**	**-89,29**	**1,14**	**0,10**
BGw	**250**	**100**	**14,33**	**-0,05**	**0,10**
			Sum of weights		**1,01**

Abbreviations:
Pb - grain protein content
E - extract yield d.m.
VZ45 - relative extract at 45 °C
K - Kolbach index
DP - diastatic power
FA - apparent final attenuation
F - friability
BGw - β-glucan in wort

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Calculation of Point Evaluation for Individual Parameters

Nine-point scale has been used where 9 points mark the best parameter level, 1 point then non-acceptable parameter level.

Absolute parameter value conversion to point evaluation is carried out using linear regression equation.

$$y = a + bx$$

where a and b are coefficients (Table 1), x is absolute value of the given parameter.

$$a = 1 - b * NH$$

$$b = (9\text{-}1)/OH - NH)$$

where OH is optimal limit and NH is non-acceptable limit of absolute values of the given parameter. At some parameters (protein content in barley grain, relative extract at 45 °C and Kolbach index) optimal range is determined. It is assessed with 9 points. Absolute values of these parameters lower or higher than optimum have point evaluation lower than 9 points. It means that two equations are used for point conversion at these parameters (one for sub-optimal values, the other for super-optimal values).

Malting Quality Index Calculation

Malting Quality Index calculation results from modification of so-called "superiority measure" (Lin, Binns 1988). This system can easily be modified and it enables after foregoing agreement to change a number of observed parameters or to exchange the observed parameters by others.

Calculation of MQI for the given variety "j" from individual parameters of malting quality:

$$MQI_j = 9 - \sqrt{P_j}$$

where

$$P_j = \square(B_{ij}\text{-}9)^2 W_i / \square\square W_i$$

where

B_{ij} = point evaluation of i-th parameter of j-th variety,

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W_i = weight of *i*-th parameter

MQI acquires values from "1" (worst, non-acceptable) to "9" (best, optimal).

As weighed average of squares of variations of individual parameter point evaluation from the maximal value "9" is mainly regarded, genotypes even in individual malting quality parameters are in advantage. It means that a variety receiving in all parameters point evaluation "8" has a higher MQI value than for example a variety that achieved at malt extract 7 points, at relative extract 9 points, at Kolbach index 7 points, at diastatic power 9 points and at all other the parameters 8 points although simple average as well as weighed average of both varieties is the same.

Conclusion

Presented system of barley malting quality evaluation continues in already used system of "Malting Quality Index". Change has resulted from different opinions on the quality of malt for Czech breweries and on the quality of malt for export, and from new knowledge in the research area of beer and raw materials. MQI calculation procedure remains the same. Some limit values and weights of evaluated parameters are amended. New amendment further enables based on the decision of the Committee for Quality Evaluation of Malting Barley Varieties at RIBM, PLC to revise results achieved with the help of MQI and at the same time reflects some features that are not assessed in this system scope but that bring at the given parameter better utility value than the current assortment of registered varieties does. For the first time this system will be used for harvest year 2002.

Literature

LIN, C. S., BINNS, M. R.: A superiority measure of cultivar performance for cultivar x location data. Can. J. Plant Sci., **68**, 1988, 193-198.

PSOTA, V., KOSAŘ, K., LANGER, I., PAŘÍZEK, P., DZUBÁK, I., NOVOTNÝ, R., DOVIČOVIČOVÁ, E., DOBEŠ, I., FIALA, Vl., KROFTA. V.: Ukazatel sladovnické jakosti [Malting Quality Index], Kvasny Prumysl, 41:393, 1995.

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4. Ensurence of the quality of beer

Sensory evaluation of beer

Introductory lecture (sensory properties of beer, sensory evaluation of beer, used sensory tests)

Practical skills training

- identification od five added flavor to the beer
- series od bitterness
- series of fullness
- triangle test (pale vs. lager beer)

The test will take place in the recently opened sensory centrum.

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5. Notes

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