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Introduction

Findings of the ancient grain Emmer date back to 8000 b.c. Nowadays the relic grain, which is an archetype of today's wheat varieties, is still being cultivated in small amounts in Central Europe, northern Africa and North America. Emmer is a tetraploid spelt wheat. Similar to malting of wheat Emmer requires special attention during steeping, germination and kilning.

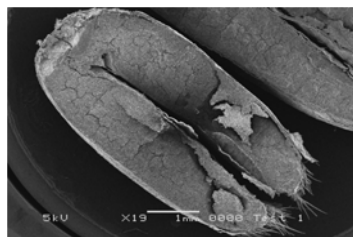


Figure 1. longitudinal cut *Triticum dicoccum* L. kernel using Hitachi TM-1000, magnification = x50

Material and Methods

Response surface methodology was used to investigate the influence of the three malting parameters vegetation time, degree of steeping and vegetation temperature on the quality of emmer malt (Figure 1). Each predictor variable was tested at three levels. Vegetation times were 5, 6, and 7 days, degrees of steeping were 37, 42 and 47 % and vegetation temperatures were 15, 17 and 19 °C. A set kilning temperature of 80 °C (65 and 105 °C for further trials) was used for all malts. A range of malt quality attributes was determined including extract, apparent attenuation limit (AAL), gelatinization temperature, α -amylase activity, β -amylase activity, limit dextrinase activity, Kolbach index, alpha amino nitrogen, viscosity, and colour.

Micromalting

Emmer with average moisture of 17.0 % was used in the malting trials. The samples were grown and harvested in Germany in 2007. Malting was carried out in 0.5 kg batches. Steeping was done at day 1 for 5 hours. At the second day final moisture were reached by additional steeping if necessary. Steeping and germination were done at the same temperatures with 95 % rh.

Analysis

All analysis were according to the standard methods of MEBAK or EBC. Except of amyolytic activities they were determined using commercial analyzing kits from Megazyme, Bray, Ireland.

The measurement of the malt volatiles targets Maillard-products, Strecker-aldehydes, higher alcohols and compounds of the lipid metabolism of barley. These substances act as indicators for a multiplicity of technological factors, like proteolysis or thermal load during kilning. The sample's volatile compounds are expelled by water vapour distillation. The ethanolic distillate is alkalinized and furthermore being saturated with NaCl. The volatile compounds are then extracted via Dichloromethane; the volume of the organic phase is further on reduced by a nitrogen flow. The addition of ammoniac is used to separate organic acids as they are often accountable for coelutions with relevant substances.

[Herrmann, M.; Gastl, M.; Thiele, F.; Back, W.: Malt volatile compound. In: *Brewing Science (Monatsschrift für Brauwissenschaft)* 7/8 (2007), nr. 60, p. 110-117]

Results

The extract values for Emmer, determined using the congress mashing system, ranged between 82.6 and 87.5 %. Typical for dehulled cereals. Figure 2 shows rising extract values with increasing of all malting parameters. α - and β -amylase and limit dextrinase activity showed the same behavior. Not for the attenuation limit, were a high degree of steeping with low temperature has had maximum results like low moisture content in combination with high temperatures.

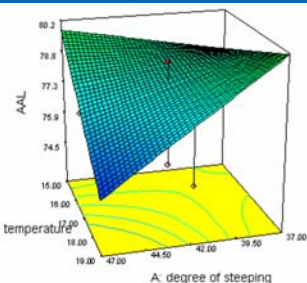


Figure 2: The influence of vegetation temperature and degree of steeping on AAL with 6 d vegetation time

Low degree of steeping as well as high moisture content decreases Kolbach index (Figure 3). Vegetation time and vegetation temperature have a small influence. Maximum colour is obtained with 42 % degree of steeping, 15 °C and independent of vegetation time. The viscosity of the 24 samples ranges between 1.660 and 1.770 mPa × s, which is well known for a malt from wheat related cereals.

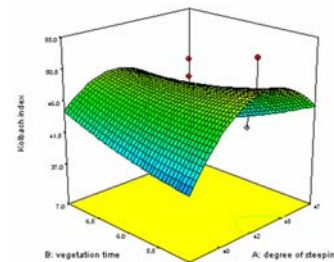
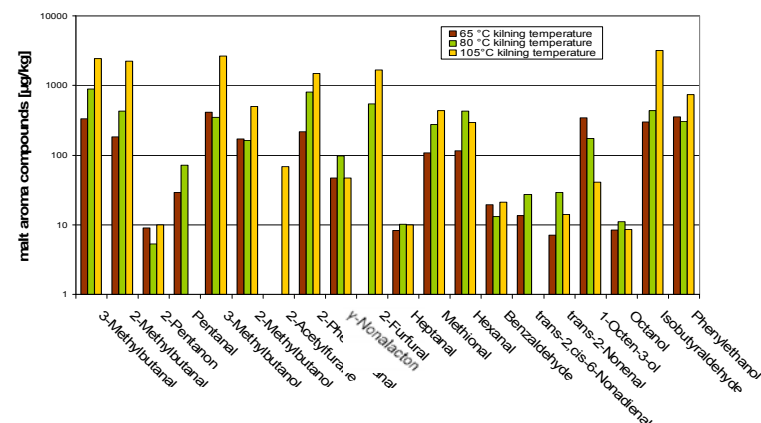


Figure 3: The influence of vegetation time and degree of steeping on Kolbach index with 17 °C vegetation temperature

| | | |
|----------------------------|-------------------|-------|
| extract | %, dm. | 84.9 |
| viscosity | mPa × s | 1.655 |
| AAL | % | 68.7 |
| colour | EBC | 19 |
| pH | | 5.44 |
| Kolbach index | % | 60.2 |
| FAN | mg/100 g malt dm. | 206 |
| DMS-P | ppm | 1.4 |
| α -amylase activity | U/G | 50 |
| β -amylase activity | U/G | 830 |

Table 1: The achieved attributes for the malting regime with 19 °C vegetation temperature, 7 d vegetation time, 47 % steeping degree

The determined malt quality attributes of optimal malted Emmer (Table 1) indicates high extract, quite sufficient AAL, enough proteolytic solution and high colour. Well prepared for its use as raw material for highly aromatic beers.



The sum of malt aroma compounds, especially the sum of the strecker aldehydes (2-Methylbutanal, 3-Methylbutanal, Phenylethanal, Methional and Benzaldehyde) and 2-Furfural depends on the kilning temperature and the thermal load respectively. The strecker aldehydes of Emmer malt aroma compounds rise up to factor 10 (ca. 850 to 8500 µg/kg). Dark barley malt types shows much higher concentrations of this aroma compounds.

Conclusion

In this study, three variables and their effects on Emmer during the malting process were studied. The chosen parameters and their values were moisture content (37, 42 and 47 %), vegetation temperatures (15, 17 and 19 °C) and vegetation time (5, 6 and 7 days). The measured quality parameters were extract, AAL, α -amylase activity, and β -amylase activity, Kolbach index, α -amino-nitrogen, colour, DMS-P and viscosity. These results depicts that Emmer has a good ability to performance dark malts as a raw material for dark beers. Further on malt aroma compounds of different kilned Emmer malts were obtained. As shown it is absolutely possible to produce Emmer malt, which can provide a basis for highly aromatic malts and beers.

