Brewing with chicken feed

A view from continental Europe on the 2006 barley crop

Brewers in mainland Europe tend to use two row spring barley varieties. A blend with two row winter varieties is acceptable but the introduction of six row winter barleys in the mash vessel gives problems only partially solved by the addition of stabilising treatments. Klaus Niemsch of Stabifix examines the current problems faced by brewers having to use thin corns and unfamiliar 'malting' varieties.

By **Klaus Niemsch**
Stabifix

Identifying haze particles in the laboratory.

A malting barley catastrophe has come to pass. Actually, the pressure on the crop could have been foreseen before the weather dealt the final disastrous blow. The drop in the area under cultivation for two-row spring malting barley, weather-related crop failures and, on top of all that, quality characteristics not compatible with specifications all contributed to the situation. Germany has a shortfall of 1 million tonnes of quality malting barley and there is not much to be had in the rest of Europe. Demand for imported malting barley is increasing in Russia and hardly any malting barley has been harvested in Australia due to another very dry season. The Asia-Pacific region, with China as the largest growth market is thus also undersupplied. Winter barley varieties suitable for brewing that could have been a fall-back in mainland Europe were not sown in sufficient quantities, due to lack of demand. Even with long-term contracts, the required quality is simply not available. *Quo vadis* beer stability?

Certainly, maltsters are in a position up to a point to take technological countermeasures so that inferior spring barleys can be malted, despite premature ripening and water sensitivity. Nevertheless, cell wall breakdown remains a problem and it may be expected that saccharification times will be longer. At the same time, a drop in friabilimeter values and non-homogeneous cell wall dissolution cannot be ruled out. Tests for steeliness thus take on greater importance. It is apparent already that large fluctuations in quality occur in the various cultivation regions and from variety to variety. It has been observed that beers which contain the spring variety Sebastian tended to have higher haze values of over 1.5°EBC.

Improvements

Breeding new varieties over recent years has led to improvements in the processing and quality characteristics of winter malting barleys, in particular, in terms of cell wall dissolution, so that today they are indeed comparable to spring sown varieties. However, when used unblended in the brewhouse, lower extract yield has to be expected. Use of malt from six-row winter barley offers the only way of compensating for the malt shortages. Unfortunately, there are no varieties of this type having really comparable brewing qualities. Furthermore, the goods on offer would not be varietally pure as they are usually destined for the feed market.

It is known that a dramatic drop in extract yield has to be anticipated when using six-row winter barley and that a high number of brew

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cycles is not feasible. Furthermore, β-glucan content rises. Both proteolytic and cytolytic dissolution is inadequate. Final attenuation drops significantly. Taste is described as lacking harmony and taste stability may also suffer. Colloidal stability decreases significantly and does not meet the requirements of the declared best before date. No data is available on fouling characteristics on membranes in kieselguhr-free filtration but it is well to be sceptical.

Aristotle was certainly not a brewer – but his observation 2,300 years ago that the whole is more than the sum of the parts certainly applies to what happens in the brewing processes.

Mashing times get longer, high-short mashing processes or infusion mashing processes are no longer suitable. It is advisable to mash in at a lower temperature of around 45°C. Simultaneously, longer lautering times have to be expected so that the number of brews per day diminishes. A more intensive leaching of barley tannins is another issue. Hazes of up to 10°EBC have been observed in lauter worts. Solids content can also be expected to rise due to lautering difficulties. Upsets in fermentation and also filtration difficulties should be anticipated. It is generally accepted that beers from six-row winter barley have a lower natural colloidal stability. In the case of a multiplicity of varieties and a non-homogeneous pre-filtrate, a specifically set bypass control can give rise to problems when stabilising with ion exchangers.

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Tests

When the malt market became aware of the above problems, tests were carried out with various malt blends in a large brewery (Tab. 1). The results are, indeed, not representative but can be used to show trends which serve as a pointer to possible technological countermeasures. In test A, 100% two-row spring barley of the Scarlett variety was used. Test B processed a blend consisting of 50% of variety A and 50% of the two-row Tiffany winter malting barley. Blend C consisted of 50% of variety A, 20% of variety B and an additional 30% of six-row winter barley, presumably Esterel. It is conceivable though that this might also have been a varietal blend. In test D, the hot cast wort was pre-clarified in the whirlpool with 30 ml/hl of Stabisol W. This is a silica sol (300m^2/g surface area and 14 nm micropore size) which reduces the solids content in the wort. As well as that, it brings down protein present and causes both solids and protein to be separated off in the whirlpool.

Table 1: Details of the grist make for four brewing trials

A	100 %	2-row	Spring malting barley	Scarlett
B	50 %	2-row	Spring malting barley	Scarlett
	50 %		Winter malting barley	Tiffany
C	50 %	2-row	Spring malting barley	Scarlett
	20 %	2-row	Winter malting barley	Tiffany
	30 %	6-row	Winter barley	presumably Esterel
D		Blend C, plus 30 ml / hl Stabisol W in Whirlpool		

Table 2: Wort analyses from the four trial brews

All worts at OG12°P	A	B	C	D
Final attenuation %	82.0	79.1	76.2	77.2
Total N ppm	970	1005	1201	1100
Coagul. N ppm	14	18	27	24
FAN ppm	210	203	178	174
pH	5.1	5.1	5.2	5.2
β-Glucan ppm	210	285	478	390
Viscosity mPas	1.76	1.84	2.15	2.0
Solids ppm	180	210	580	256
Polyphenols ppm	206	240	283	254
Anthocyanogens ppm	98	104	120	111

Table 3: Fermentation analyses

Decrease of extract	A	B	C	D
24 hours after pitching %	1.3	0.9	0.6	0.9
Degree of attenuation %	82.0	78.1	74.9	77.2

Table 4: Beer analyses

	A	B	C	D
Original gravity %	12.10	12.0	12.15	12.10
Residual ferm. extract %	0.0	0.2	0.4	0.2
pH	4.30	4.40	4.55	4.45
Total N. ppm	698	883	1004	905
FAN ppm	92	102	106	100
Glucan ppm	142	159	301	287

Table 2 shows the analytical characteristics of the worts. They have been calculated on the basis of 12% original gravity. Final attenuation in test A is considerably higher. It drops by 0.9 percentage points when the portion of winter malting barley goes up to 50%. Final attenuation was dramatically worse in test C. Pre-clarification with silica sol did not lead to any pronounced improvement in final attenuation. As expected, total nitrogen content was lower in wort A, protein contribution from winter barley is clearly noticeable.

Compared to C, the silica sol cleared out considerable quantities of flocculated protein. When using six-row winter barley, the portion of coagulable nitrogen is considerably higher, though the FAN content of 180 ppm is clearly lower in the case of winter barley. This may possibly lead to upsets in fermentation as well as to increased diacetyl formation. As expected, β-glucan contents were considerably higher in tests B, C and D, especially when using malt from six-row winter barley. This is also reflected in viscosities. In the case of winter barley malt, the solids content in the cast wort was surprisingly higher. Silica sol gave rise to a definite improvement, also in this case. Elevated tannin levels when using winter barley malts were analytically confirmed, as expected.

Table 3 provides information on

Table 5: Results	A	B	C	D
Filtration batch hl	8580	7820	4330	6890
Fspec. hl/m^2.h (Raible index)	4.7	4.2	2.8	3.9
Filter feed				
Haze 0°C EBC	32	67	143	80
Polyphenols ppm	123	149	187	156
Anthocyanogens ppm	78	88	101	89
P40 ml	19	18	16	18
T 125 ml	10	9	6	9
Filtered / stabilised				
Haze 0°C EBC	0.4	0.6	1.4	0.7
5 days 60°C / 1 day 0°C EBC	1.2	1.8	3.9	2.1
Polyphenols ppm	105	125	139	127
Anthocyanogens ppm	35	41	72	66
P 40 ml	42	37	32	38
T 125 ml	24	20	17	21

fermentation characteristics. Pitching temperature was 11°, yeast addition about 20 million yeast cells/ml. Start of fermentation with an extract decrease of 1.3% after 24 hours was satisfactory in test A. Even with 50% coming from winter malting barley, the level of A was no longer reached. C had a considerably slower start of fermentation. In the case of D with pre-clarified wort, we reached the level of the test with 50% two-row winter malting barley, demonstrating that reduced solids content is important for start of fermentation.

In the case of test A, final attenuation had reached 82% after 6 days so that fermentation was regarded as completed. In beer B, the remaining extract of 1 percentage point in the degree of fermentation was still acceptable. C with 50% winter malting barley and six-row winter barley at 74.9% was unsatisfactory by comparison. In this case too, addition of silica sol proves to be advantageous for fermentation by clearing the wort.

Results of analyses

The results of the beer analysis are tabulated in Table 4. In the case of beer C, 0.4% fermentable extract remained, confirming the results from fermentation. As expected, pH was higher in the winter barley batches compared to spring barley. Nitrogen values were considerably higher in test C. Also in this instance, silica sol was able to remove protein. Consumption of free amino nitrogen is significantly less for beers with six-row winter barley, reflecting fermentation characteristics. As in the wort, β-glucan levels are visibly lower when using spring malting barley or winter malting barley suitable for brewing. Even a 30% blend of six-row barley contributes considerable quantities of β-glucan to the beer.

As well as effects on taste and taste stability, filtration characteristics and beer stability are are also of major interest. All beers were treated with 40 g/hl Stabifix Strong xerogel and 15g/hl PVPP (Polyclar-R). Tab. 5 shows the results obtained.

Again, significant differences are apparent, in particular in relation to filter performance or in the specific filtration factor in accordance with Raible in hl/m^2.h. A dramatic deterioration of 50% in filter capacity for the blend consisting of 50% spring barley, 20% winter barley and 30% feed barley constitutes an expensive production upset. Silica sol improves the situation considerably compared to test C, but does not quite reach the filter performance of B, and comes nowhere near that of A. Thus, use of silica sol indeed provides a manifest improvement, nevertheless loss of capacity has to be expected arising from the six-row winter barley.

In terms of beer stability, the experience has been confirmed once again that six-row winter barley gives rise to changes for the worst and that haze values at the kieselguhr filter outlet do not meet quality specifications. This is also confirmed by nephelometric titration (Schneider Test) by comparing the P40 and T125 values. It can be concluded from this that, in order to reach adequate colloidal stability which matches the best before date, it is necessary to add increased combined quantities of silica gel for protein removal as well as PVPP for tannin adsorption. However, the sludge space in the filter may be taken up more rapidly as a result of the increased amount of silica gel in the kieselguhr cake. In such an event, it is advisable to carry out silica gel stabilisation upstream in the maturation tank in the case of problem beers, preferentially using silica gels with high bentonite contents that are highly effective although such a regime will lead to higher beer losses, handling problems and a risk of iron pick up. The PVPP portion of stabilisation should also be readjusted as it can be seen that winter barley contributes higher levels of tannins. Stabilisation with hydrogel (with a lower concentration of active stabiliser) may not be sufficient in many instances.

Different factors

It is a dubious proposition to offer a general solution for beer stabilisation that applies to every case. The different factors entering into the equation vary too much. If we look at the brewing process "holistically", beer stabilisation proper is only the last element in a long process chain. Parameters such as raw materials quality, brewhouse procedures, fermentation, storage and filling, and even the equipment itself have a significant bearing on the product's shelf life.

As far as the outlook is concerned, it may be said that this malt crash will not be the last one. Farmers have to become interested again in planting spring barley and maltsters have to be left with a sufficient margin so that they have something to look forward to from the business. The degree to which climate change will make European weather even more unpredictable cannot be anticipated or, as in Australia, water supply problems will lead to a contraction in growing area. Circumstances are driving trends towards winter barley.

A further conflict is in the making between production and purchasing departments. Should technologists have to allow relaxation of the specification for quality characteristics for the time being? Then will the purchasing department seek to have this carry over into subsequent years in order to lower costs, because the customer has apparently already accepted a reduction in beer quality? ■

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Big bag filling at the Stabilfix plant at Bad Koestritz in Germany.