



Using unfermentable sugars during fermentation to improve the palate fullness, flavor and oxidative stability of beer

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INTRODUCTION

Several breweries use non-fermentable sugars to increase the beer palate fullness. Besides the direct addition of sugars to the final beer, it is a standard procedure to add this kind of sugars at the end of the wort boiling process prior to fermentation. This procedure has advantages especially for sugars with low solubility.

The aim of this study was to investigate the influences of non-fermentable sugar added prior to fermentation on:

- Fermentation process
- Palate fullness
- SO₂ formation
- Beer flavor (focus: sweetness)

The influences of the addition of non-fermentable sugars such as polydextrose, Palatinose™ (isomaltulose), and Vitalse® was investigated in direct comparison to the addition of fermentable sugars (glucose and sucrose) in the same concentration. This was necessary to get a deeper insight into the general influence of the increase in osmotic pressure in comparison to an accelerated yeast metabolism on the SO₂-formation and beer flavor.

TEST METHODS

• Fermentation trials:

The fermentation trials were carried out using a base wort (10 °P/ 9,5 °P original gravity) and adding individual amounts of sugars to increase the final wort extract by 1%, 2%, 3% and 5%.

The fermentations were carried out simultaneously and under same conditions (RH-yeast 11°C). Yeast growth, SO₂-production, extract and pH development of every trial was monitored.

• SO₂-determination using Continuous Flow Analysis (CFA):

The determination of SO₂ was carried out by CFA under an optimized procedure using a Teflon membrane. SO₂ is released from beer at 95°C as gas and is dialyzed into a formaldehyde solution. P-rosaniline is added and binds with the SO₂-formaldehyde complex at 45°C forming a red coloured complex measured by colorimetry at 560 nm [2].

• **Color:** according to MEBAK-Method 2.12.2 [1]

• **Extract:** according to MEBAK-Method 2.9.2.3 [1]

• **Viscosity:** according to MEBAK-Method 2.28 [1]

• **Osmolarity:** SOP TU Berlin, OsmoLAB One/16S

• **pH:** according to MEBAK-Method 2.13 [1]

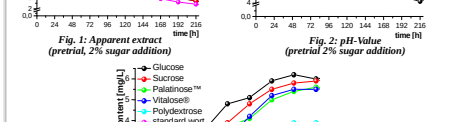
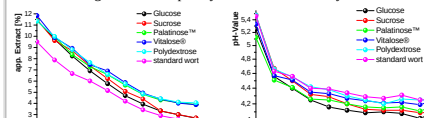
• **Sensory:** a trained DLG sensory panel tested every trial with focus on palate fullness and sweetness compared to the control beer, where 0% sugar was added (Pilsner-type)

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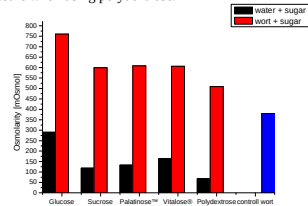
Companies **Südzucker Group** and **BENE-Palatin GmbH** are gratefully acknowledged for support. Palatinose™ (isomaltulose) and Vitalse® are products of BENE-Palatin GmbH, a member of Südzucker Group.

RESULTS

In the pre-trial 2 % of different sugars were added to the wort to investigate the influence of non-fermentable and fermentable sugars added prior to fermentation on the SO₂-formation. As expected the addition of non-fermentable sugars led to a higher extract at the end of fermentation while fermentable sugars were completely fermented after 9 days of fermentation.

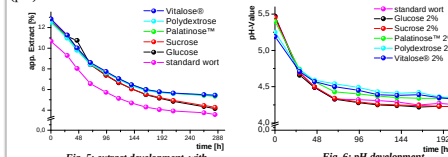


Compared to the standard wort without sugar addition, the results in Figure 3 demonstrate a general sugar dependent increase in SO₂ during fermentation. The highest increase in SO₂ results from the fermentable sugars glucose and sucrose followed by the non-fermentable sugars Palatinose™ & Vitalse®. The lowest increase in SO₂ results from polydextrose and can be explained by the lowest increase of osmotic pressure. The varying influences of the sugars on the osmotic pressure in a 5% sugar solution and the wort after addition prior fermentation (5%) is demonstrated in Figure 4. In logical order to the molecular size and the number of the molecules, which are required to increase the wort extract about 5%, the monosaccharide glucose causes the highest increase in osmotic pressure followed by the disaccharides Sucrose, Palatinose™ & Vitalse®. A longer chain of sugars causes a diminished increase in osmotic pressure. This explains the lowest increase in osmotic pressure when using polydextrose.



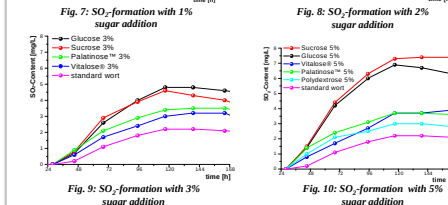
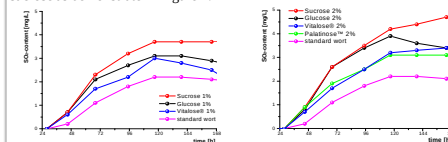
Further investigations were carried out using wort with an amount of sugar added to a base wort which increased the final extract by 1%, 2%, 3% and 5%.

The characteristic fermentation process is demonstrated in Figure 5 (Extract) & 6 (pH) on the basis of the 2 % increase of the final extract.



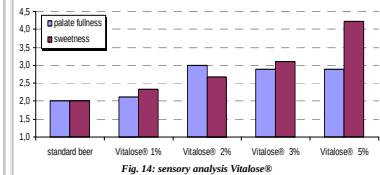
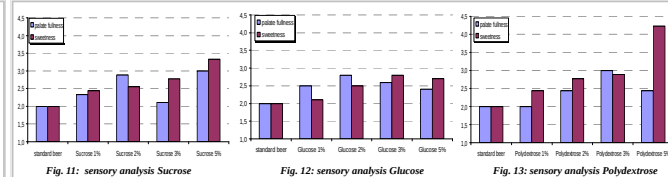
In analogy to the pre-trial the addition of the non-fermentable sugars led to a higher extract at the end of fermentation while fermentable sugars were approximately complete fermented (RH-yeast 11°C). In comparison to the non-fermentable sugars and the standard wort, the pH decrease during fermentation is slightly accelerated when adding fermentable sugars (Fig. 6).

In all cases of the sugar addition the highest increase in the SO₂-content resulted from the fermentable sugars glucose followed by sucrose, as shown in Figure 7, 8, 9 & 10. This can be explained by the easier utilization of glucose in the yeast metabolism and in particular by the higher osmotic pressure of glucose against sucrose as demonstrate in Figure 4.



In dependence to the sugar addition up to 3 % also the non-fermentable sugars Palatinose™ & Vitalse® lead to a significant increase in the SO₂-content. With more than 3 % there wasn't a further increase in the SO₂-content detectable followed by the non-fermentable sugars Palatinose™ & Vitalse®.

The low increase of the SO₂ when using polydextrose in comparison to the other sugars could be verified by the 5% sugar addition (Fig. 10) and can be explained by the lowest increase in osmotic pressure.



In the sensory analyses it was generally detectable that up to a specific sugar addition the increase of palate fullness is significantly higher than the increase of sweetness. Dependent to the used sugar a reversal point was detectable where the sweetness is coming to the fore and the panel classifies the influence on the sweetness much stronger in comparison to the influence of the palate fullness. Non-fermentable sugars like Palatinose™ and Vitalse® demonstrate a significant increase in palate fullness with a negligible influence on the sweetness. An addition more than 2% influences sweetness and over lays the influence on the palate fullness. With polydextrose is the reversal point shifted up to 3 % because the minor effect on the sweetness.

CONCLUSION

Taking into consideration all data it can be concluded that the increase of the final wort extract up to 2% by the use of non-fermentable sugars prior fermentation is a useful tool to improve the palate fullness and oxidative beer stability. The results demonstrate impressively that the increase of the osmotic pressure by addition of non-fermentable sugars is responsible for a higher formation of SO₂ during fermentation. The higher SO₂ content in the final beer should improve the oxidative beer stability and the additional increase in the non-fermentable extract after the fermentation is responsible for a better palate fullness. A higher sugar addition prior fermentation is inadvisable because the influence on the sweetness of the beer is coming up and over lays the positive effect on the palate fullness and typical beer taste.

BIBLIOGRAPHY

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- [2] Kunz T, Schiwelk V, Harms D, Methner F. Optimized analysis methods for the determination of SO₂ in beer and malt. Brauwelt International.2009; 27:216-220.



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