Improving flavor stability during beer aging through protection against oxidation in the brew house

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Introduction

For many years the brewers were only controlling colloidal stability of the beer. Researches have been focused on the clarity of the beer in order to guarantee one year shelf life. A local brand beer will be consumed between 4 to 6 months after production. However, would a beer be drinkable after 6 months to one year, in respect with "Best Before Date" in variable storage conditions?

LOX, lipid auto-oxidation and free radicals produce staling potential during brewing process from mashing until wort clarification. AEB-Group has studied different antioxidant to determine the adequate formulation insuring the best beer flavor stability during aging.

ANTIOXIN® SBT : A full protection, no residue

After years of trials with industrial and micro brewers, AEB-Group has developed an innovative reducer combination to avoid oxidation reaction in the brewhouse (to be added on mash tun and cereal cooker). The optimum complex:

- Ascorbic acid:
  - Oxidation by direct reaction with O_2, avoiding mash to be altered
  - Heat destruction at the end of mashing
- Sulphite:
  - Reacting with free radicals avoiding mash oxidation
  - Volatilized at the end of mashing
- Gallotannin and elagitannin:
  - Complex formation with metals and protecting wort until the end of boiling
  - Removed by precipitation with trub

Tasting panels results

Classical antioxidant:

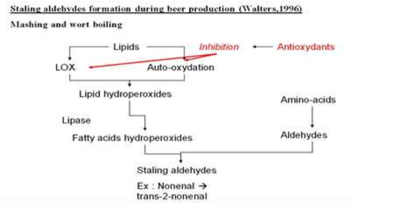
- Significant decrease of cardboard taste (no E-2-nonenal)
- Improvement of freshness on aged beer, better drinkability
- Metallic taste

ANTIOXIN® SBT : in accordance with GC results

- No cardboard taste detected (no E-2-nonenal)
- Improved freshness of aged beer, optimal drinkability
- No metallic taste
- Better taste equilibrium
- Better perception of bitterness

Reference

1. Bart Vanderhaegen, Hedwig Neven, Hubert Verachter, Guy Dedelinckx; The Chemistry of Beer Aging; Food Chemistry 95 (2006) 357-381
2. Jeroen J. Baert, Jessika De Clipeleer, Paul S. Hugues, Luc De Cooman, Guido Aerts; On the Origin of Free and Bound Staling Aldehydes in Beer; Journal of Agricultural and Food Chemistry; November 13 2012

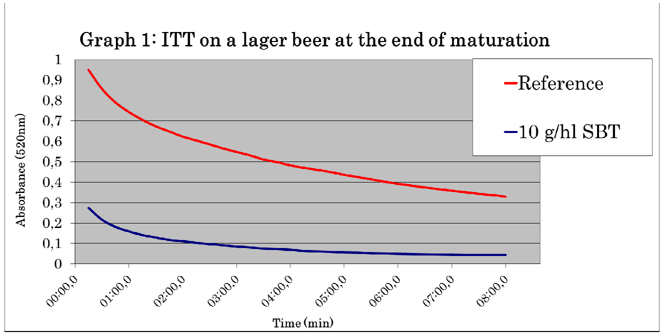


ITT Measuring redox potential of wort or beer

2,6-dichloroindophenol (DCPIP) is dark blue on its natural form and colourless when oxidized. Added to a matrix, it reduces by oxidizing the wort or beer, changing colour in the sample. On one hand, when a matrix is already oxidized, it will resist to further oxidation. Therefore, decolouration will be slow and partial. On the other hand, a treated wort or beer will be quickly oxidized and DCPIP decolouration will be fast.
ITT method allows to measure redox potential of a wort or beer as shown on graph 1.

$$DCPIP_{Ox} \xrightarrow{\text{matrix oxidation}} DCPIP_{Red}$$

Dark Blue — Spectrophotometer measurement — Colourless



Lager beer colour at the end of ITT reaction

Oxidized beer sample

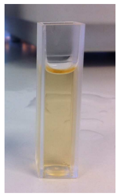
Very slow decolouration

Residual colour at the end of measurement

⇒ Beer oxidized

Reference

Protected beer sample



Fast decolouration

No residual colour

=> fresh beer

SBT

GC-Head Space analysis for aldehydes

These two trials have been conducted on similar conditions and dosing for each trial.

1. ***Trial 1*** between none protected brew (control) and protected brew (Antioxin® SBT). This Trial 1 has been done on a Lager Beer.
2. ***Trial 2*** between traditional antioxidant (ascorbic acid and metabisulphite) compared with full protection (Antioxin® SBT). This *Trial 2* was made on a special beer.

Trial 1	Control	ANTIOXIN® SBT	Δ
2-methylpropanal	8,4 ppb	7,0 ppb	-16,67%
2-methylbutanal	3,3 ppb	3,3 ppb	0,00%
3-methylbutanal	7,2 ppb	6,1 ppb	-15,28%
Methional	7,9 ppb	3,2 ppb	-59,49%
Benzaldehyde	4,2 ppb	2,4 ppb	-42,86%
Phenylacetaldehyde	14,5 ppb	12,0 ppb	-17,24%
(E)-2-nonenal	0,120 ppb	0,085 ppb	-29,17%

Trial 2	Traditional Antioxidant	ANTIOXIN® SBT	Δ
2-methylbutanal	4,92 ppb	3,7 ppb	-24,21%
2-methylpropanal	42,80 ppb	46,4 ppb	8,29%
3-methylbutanal	13,35 ppb	11,9 ppb	-10,86%
Methional	10,13 ppb	7,2 ppb	-28,87%
Phenylacetaldehyde	24,75 ppb	20,2 ppb	-18,59%
Furfural	360,00 ppb	309,5 ppb	-14,03%
Hexanal	0,97 ppb	0,7 ppb	-28,50%
Benzaldéhyde	3,65 ppb	1,5 ppb	-58,08%
(E)-2-nonenal	0,105 ppb	0,105 ppb	0,00%

Conclusion

Industrial experience and their result have demonstrated that the use of each antioxidant separately was not very efficient. Because of their synergy, vitamin C combined with sulphites used in the brew house could improve flavour stability during beer aging.

Combination between tannins and classical antioxidant has brought the best result. Vitamin C picks up O_2 instead of the mash; sulphites will neutralise free radicals during their formation avoiding major degradation of the wort. Finally, tannin will decrease free radicals and will also complex heavy metals such as *Fe*. As tannin pass in the wort through filtration until clarification, protection remains in the kettle, avoiding further oxidation reaction. By settling down with the trubb, wort turbidity can also be improved.

Tasting and GC-Head space complete ITT measurements in the brewhouse, demonstrating improvement with figures. Full protection (SBT) allows brewer to offer a fresher product that will keep a better resistance during distribution system, until the final consumer.

Fresh | ANTIOXIN® SBT (Optimal freshness) > Vit C + SO_2 (Fresh + metallic) > Tannin (E-2-nonenal present) > Sulphites (a small improvement) > no protection | **Oxidized**