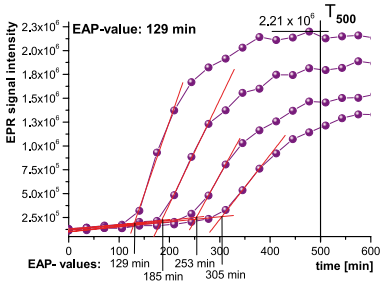

Fig. 5: ESR measurement of beer, EAP after SO_2-addition 0,2,4,6 mg/L.

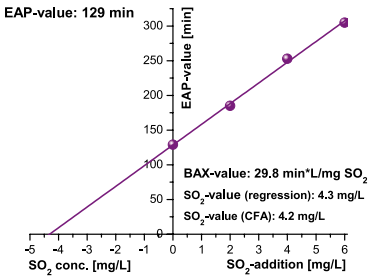

Fig. 6: BAX evaluation by linear fit of EAP values (BAX = slope).

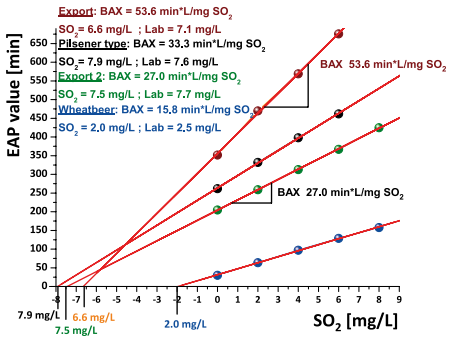

Fig. 7: Comparison of BAX determination of different beers.

The BAX provides additional information about the anti- and pro-oxidative properties of the beer matrix regardless of the SO_2 content. The BAX is affected by the content of metallic ions, pH, hop-acids, sugar, proteins, Maillard reaction products, etc. and gives information about the consumption rate of the existing antioxidative potential during storage.

Advantages of the New EAP-Determination and Beverage Antioxidative indeX (BAX) for the Brewing and Beverage Industry

- Significantly improved procedure for the evaluation of the oxidative stability of beverages (beer, juice, wine, etc.).
- The high significance and great detail of the »EAP determination« opens new areas of application:
  a) Detection of influences caused by ingredients contained in beverages on the oxidative stability
  b) Detection of influences of individual steps in the brewing/production process on the oxidative stability
  c) Application in the field of packaging materials.
  The new EAP determination seems predestined to show in great detail the effects of different packaging materials caused by O_2 permeation (crown caps, O_2-scavengers, swing closures, PET bottles, etc.)
- An additional advantage of the BAX determination is the indirect determination of the SO_2-content
- The high significance and great detail of the EAP determination leads to a correspondingly high acceptance of the analysis method and its results

With the new »EAP determination« it is also possible to reduce expenses in the range of the spin trap reagent (40–50 samples per week: annual savings ~ 15.000 US $). Besides the higher significance of the EAP values, the breweries that in future are going to employ »EAP determination« and Beverage Antioxidative indeX (BAX) as a matter of routine, will be able to detect deviations in the brewing process in time and to intervene selectively, but they will also be able to considerably lower the costs in the area of quality assurance.

Technische Universität Berlin

»EAP-Determination« and »Beverage Antioxidative indeX (BAX)«

Advantageous Tools to Evaluate the Oxidative Flavour Stability of Beer and Beverages

Based on an Invention of
Technische Universität Berlin and Universität des Saarlandes
– Licensed by IPAL, Germany –

Electron spin resonance spectroscope
MiniScope MS 400 Magnettech GmbH / www.magnettech.de

Contact:
Technische Universität Berlin / *Berlin Institute of Technology*
Institut für Lebensmitteltechnologie und Lebensmittelchemie / *Department of Food Technology and Food Chemistry*
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»EAP-Determination« and »Beverage Antioxidative indeX (BAX)«
Advantageous tools to evaluate the oxidative flavour stability of beer and beverages

For the prognosis of the flavour stability of beer the electron spin resonance (ESR) spectroscopy has been used for several years now to ascertain the so-called lag time of beer.

The lag time value determined by this method is seen as a criterion for the endogenous antioxidative potential of beer and itself is directly correlated to the oxidative beer stability. The lag time measurement is based on the indirect detection of the radical generation in beer during accelerated beer ageing at raised temperatures (60 °C). The formed short-lived reactive radicals can be monitored by trapping with spins traps and the detection of the long-lived spin trap adducts using ESR spectroscopy.

For a certain period of time, the radical generation can be delayed or prevented by the endogenous antioxidative activity of beer (lag phase). After the lag phase the amount of spin adducts begins to increase rapidly with time. Our research activities have shown that the lag time measurement used until now is a method which can only reflect the ratios in a beer sample in a distorted way.

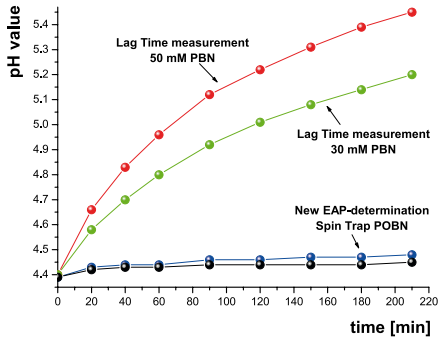

Fig. 1: Dependence of the pH from spin trap (beer ageing at 60 °C).

The distortion of the lag time values is caused by the spin trap reagent (PBN) used; more detailed, by a pH-effect during accelerated beer ageing depending on the PBN concentration.

The pH-effect caused by the spin-trap-reagent PBN is the reason for an increase of the pH-value during the measurement and is therefore responsible for the acceleration of the radical generation in the beer sample (Fig. 1). The consumption of the endogenous antioxidative potential occurs faster and the falsification of the lag time value increases with a growing oxidative beer stability (Fig. 2).

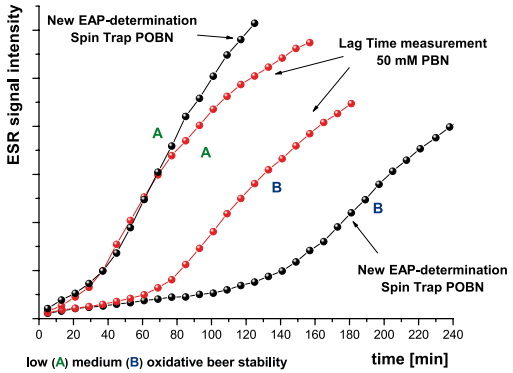

Fig. 2: New »EAP Determination« compared to conventional lag-time measurement.

The non-linear deviations from the actual conditions within the beer caused by the pH-effect of PBN are significant because they can amount to as much as 500 % at a high beer stability range. Against this background, it was urgent to develop a new method, in order to be able to determine the endogenous antioxidative potential of beers.

The functional principle of the new »EAP-determination« is based on the avoidance of the pH-effect on the radical generation in beer samples of the lag time measurement used until now can be almost completely avoided.

This demonstrably leads to a higher significance of the measurement results and makes it possible to directly observe and detect the fundamental influences on the generation of radicals that are relevant for beer stability without distortions but with high resolutions.

Additional investigations have shown that the new »EAP determination« is especially suited for depicting and assessing the influence that specific brewing process stages and specific beer ingredients do have on the oxidative beer stability (O_2, SO_2, ascorbic acid, metallic ions, maillard reaction products, pH, etc.)

This new method is equally suited for other beverages such as RTD`s, juice, wine (Fig. 3) and seems to be predestined to show with high accuracy the influences on the beverage stability caused by oxygen permeation through different packaging materials.

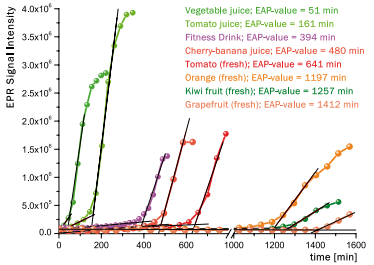

Fig. 3: EAP Determination of fruit and vegetable juices.

The »EAP determination« makes an unbiased examination of the flavour stability possible resulting in a beer matrix dependent linear correlation between the SO_2 content and the EAP-value (Fig. 4). For that reason the EAP determination offers a new beneficial index number for the evaluation of the flavour stability (Fig.5, 6, 7); the so called Beverage Antioxidative indeX (BAX).

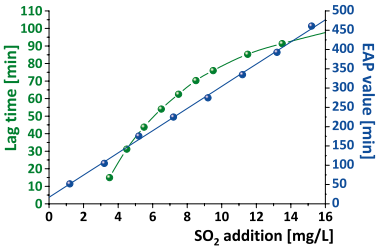

Fig. 4: Correlation between lag time/EAP value and SO_2 content.