CDR Paper 1802

The aroma of butter having the name of diacetyl!

What is the diacetyl taste? It's butterscotch-like, a hard yellowish-brown sweet made from butter and brown sugar.

Dr. Emanuela Pascale
Research fellow at Department of Chemistry Università degli Studi di Firenze

Diacetyl

Diacetyl is a compound so-called vicinal diketone (VDK) because it has two C=O groups, side-by-side. It's a product of yeast metabolism and it's formed in every brewery fermentation.

Diacetyl is a volatile compound whose buttery character plays an important role in beers giving them a typical flavour.

The amount of diacetyl produced is yeast strain-dependent but wort composition and fermentation conditions, as well as temperature, are also significant parameters to overall diacetyl levels.

Homebrewed beers can have diacetyl levels from 0.05 to greater than 1.0 mg/L, but the desired level in the final beer depends on the particular flavour aimed for. In fact diacetyl concentrations above 0,05 mg/L can be perceived as a negative flavour characteristic in some "lager" (a type of beer conditioned at low temperature), while concentrations about 1 mg/L are allowed in "ale" (a type of beer brewed using a warm fermentation method), in order to balance the peculiar full-bodied and fruity taste of ale beers.

Sometimes, diacetyl can also be formed by a bacterial contamination but this is an uncommon event, since breweries have invested in cleaning and sanitization care.

Fermentation process and yeast metabolism

Diacetyl is an organic compound and it is generated as a by-product of amino acid metabolism in yeast during wort fermentation.

Yeast metabolism is a complex process which involves the formation of by-products.

In general, these by-products are used in the metabolic pathway, but sometimes, in particular conditions, they can leak out of the yeast cell and have an effect on the organoleptic profile of the finished beer.

In particular, one of the metabolic products of yeast, belonging to diacetyl synthesis is acetolactate: it is derived from pyruvates, useful for the synthesis of aminoacids. Part of the acetolactate produced becomes valine, and part leaks out of the yeast cell membrane and ends up into beer, this acetolactate is then chemically

converted to diacetyl in the beer by an oxidation reaction.

The production of acetolactate continues throughout the sugar fermentation process, until it stops.

Yeast is able to consume the diacetyl produced, and reduce it: as yeast slows down in fermentation and beer undergoes a maturation process, yeast reabsorbs diacetyl and convert it to acetoin and subsequently to 2,3-butanediol. Both acetoin and 2,3-butanediol can escape the cell, but neither contribute much in terms of flavour.

It's important to provide sufficient maturation time for diacetyl reduction in the beer which depends on the conversion speed into acetoin and 2,3-butanediol. Furthermore, the health of yeasts should be evaluated. In fact yeasts stored for a long time, at unsuitable temperatures, or yeasts that do not have adequate nutritional availability during fermentation, are less efficient in the process of diacetyl reduction compared to yeasts in optimal physiological conditions.

Temperature

At the end of fermentation, the increase in temperature of a few degrees promotes the yeast metabolic activity, as well as the diacetyl reduction: this method is commonly known as a "diacetyl rest". Depending on the yeast strain, this process can be variable in terms of time and temperature. After the "diacetyl rest", the temperature is then lowered to a conditioning temperature following diacetyl reduction. Generally, the cooling step does not start until the analytical tests indicate a diacetyl not increase thereafter, particularly during pasteurization process.

Determination of diacetyl

Performing the analysis for the determination of diacetyl is essential to achieve an improvement in the production process, management and finally the conservation of the product. It is also important that not only breweries, but also beer lovers identify and enhance the product, when peculiar organoleptic markers, such as diacetyl, can represent an element of uniqueness, rather than a real flaw.

CDR BeerLab® is an analysis system able to determine with a single instrument all the most important chemical parameters of beer, wort and water, including also diacetyl, relying on the reference method.

The sample of beer to be analyzed is previously distilled. The VDKs contained in the distillate react with a solution of alpha-naphthol and creatine to produce a colored compound which absorbs at 520 nm. The absorbance is measured, which is proportional to the analyte concentration.

The CDR BeerLab® method for the determinationd od VDKs is strongly correlated with the reference method, as established by the study carried out by the international reference laboratory Campden BRI.

CDR BeerLab® analysis system has available reagents into disposable tubes, in order to make

easier both the analytical procedures and the sample preparation, ensuring standards of accuracy are in line with the reference methods.

CDR BeerLab® can be used by anyone directly in the brewery allowing one to check the brewing process in real time and to make prompt decisions improving the quality of the finished product.

Conclusions

Monitoring VDKs during fermentation allows one to closely follow the phases of yeast metabolism and to verify the diacetyl level, which enhances the specific organoleptic characteristics for each type of beer.

Using a fast and simple system, such as the CDR BeerLab®, one is able to check the brewing process while in the brewery. Thus eliminating the need of an outside lab. Conveniently improving the quality of the finished product while saving time and money.

References

Chris White, Jamil Zainasheff, *Yeast: The Practical Guide to Beer Fermentation (Brewing Elements)*, Brewers Publications

Links

[a] Vicinal Diketones (VDKs) determination
[b] CDR BeerLab® the Beer and Wort analysis
[c] Evaluation of new features (VDK, yeast vitality) of the CDR BeerLab® Analyser – Camden BRI
[d] Campden BRI