

# Fundamentals of beer and hop chemistry(photochem ) report example

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## Article Review

In this paper, I review the article Fundamentals of Beer and Hop Chemistry, authored by Keukeliere, D. (2010).

In his article, Keukeliere (2010) begins by indicating that beer, an aqueous fermented drink, is based on starch, but flavored by hops. Keukelie (2010) notes that, barley, and most specifically barley malt, is the main body of beer. In order to produce one liter of beer, a few hundred grams of barley malt are needed. However, Keukeliere (2010) indicates that in the absence of barley malt, starch-rich adjuncts such as wheat, corn or rice can be used. Keukeliere (2010) notifies us that brewing water (mash) and a slurry of barley malt must be heated at a temperature of 60°C, and at this time, malt enzymes (amylases and proteases) break down starch and proteins respectively, producing sugars and amino acids. In line with this, Keukeliere (2010) recommends that barley ought to be subjected to a controlled germination before mashing; this step leads to the formation of enzymes in the grains. Barley malt represents germinated barley. Heating helps in the stoppage of the conversion of starch to sugars. During the brewing process, Keukeliere (2010) notes that amber or pale colored, as well as dark malts, are obtained, but such colors are hugely dependent on the color of malt used and time and temperature. It is evident, as Keukeliere (2010) highlights, that colored malts have a distinctive taste that is unique in dark beers. Such colors are as a result of Maillard-type reactions and the caramelization of sugars.

The process of brewing, according to Keukeliere (2010) begins by mashing of starch-rich adjuncts and barley malt with brewing water. After that, the next

step involves enzymatic breakdown of starch and proteins. This step is followed by the first filtration process. At this stage, wort (sugar solution in brewers' jargon) is transferred to the brewing kettle where it is subjected to heating for an hour. On top of that, *Humulus lupulus* L. (hops) are added. Hops' quantity is insignificant when compared to the quantity of barley malt.

However, hops are essential in the stabilization of the wort solution ensuring that the bacteriological stability of beer is achieved. Besides, hops allow for the attainment of the bitter taste of beer, as well as the light struck flavor.

Cooling is done and allows for the removal of spent hops leading to the formation of hopped wort that is pumped into the fermentation vessels. At the same time, yeast is added under aeration to trigger growth, but during the anaerobic growth, yeast converts sugar to ethanol and CO<sub>2</sub>.

Temperature and the process of yeast collection after the completion of the fermentation process determine the quality of beer: top or bottom

fermentation. In addition, *Saccharomyces carlsbergensis* strain is essential for bottom fermented beers. This strain work well at temperatures below 50C, and produce 5 percent ethanol.

On the other hand, *Saccharomyces cerevisiae* work optimally at an ambient temperature and are essential for the production of top fermented beers.

Thus, the strain leads to the production of ethanol of up to 12 percent.

Fermentation takes place within a week, and yields young beer. Young beer is not drinkable because it contains unwanted components formed during fermentation and thus has a bad taste and smell. In line with this, young beer has to be matured, and this takes place at 00C. At this stage, unwanted components are decomposed and eliminated from the final beer. In addition,

there is need to monitor for the presence of pentane-2-3 diones and diacetyl especially in larger beers. These components must diminish to significantly low critical values before the final product is packaged. Pasteurization may be done to enhance the half-life of beer. At times, a second fermentation that takes place in oak kegs is conducted for several months in order to attain sour flavors; this step is used only in special flavored beers.

In a snapshot, the process of brewing, according to Keukeliere (2010) begins by mashing of starch-rich adjuncts and barley malt with brewing water. After that, the next step involves enzymatic breakdown of starch and proteins.

Filtration then follows leading to WORT. Thereafter, wort is boiled, and there is the addition of whole hops at this stage. Second filtration yields hopped wort. Fermentation then follows, but ends with yeast removal resulting into green/young beer. Young beer is then subjected to the maturation process. At this stage, filtration is done for the third time leading to the production of the final beer that is packaged ready for the market.

Up to now, the underpinnings governing the hop chemistry in beer have not been defined, especially those that govern the production of hoppy flavor in beer. However, brewing experts have agreed that this flavor is as a result of multifactorial sensory impressions that stem from a host of volatile compounds acting at synergy, in low concentrations. It has been suggested that hop oil and hop polyphenolic fraction contribute to a full mouth-feel during beer tasting.

The composition of hop oil and hop polyphenolic fractions is very complex owing to their minute concentrations. During the boiling process, these hop components are volatilized or oxidized. Nowadays, in an attempt to preserve

the original flavor of the beer, a host of brewers add aroma hops only at the end of the brewing process. This technique, which is known as late hopping, can be combined with dry hopping at the end of the brewing process. Thus, this technique is vital in the generation of unique hop flavors and aromas. Furthermore, the better profiles in beer have been well-documented. This feature is, as a result of, the bacteriostatic activity of hop acid. These acids kill gram-positive bacteria that may be present during the fermentation process and this activity yields sterile and bitter beer. Moreover, iso-alpha-acids, as well as phenolic compounds contribute to the light-struck beer flavors. They not only enhance beer stability, but also account for cupboard, stale and off flavors. This activity is attributed to the vulnerability of iso-alpha-acids to light. Their decomposition leads to the production of a light-struck flavor.

In summary, Keukeliere, D. (2010) has shown that beer is a complex drink containing hundreds of constituents. Hops influence the organoleptic qualities of beer, flavor and taste. In addition, the brewing process subjects these hops to a host of complex modifications that are yet to be well-understood. However, the bitter taste of beers has been well-documented, and it is attributed to the bacteriostatic activity of hop acid. Hop acids kill gram-positive bacteria that may be present during the fermentation process and this activity yields sterile and bitter beer. Lastly, *Saccharomyces carlsbergensis* strain is essential for bottom fermented beers while *Saccharomyces cerevisiae* work optimally at an ambient temperature and are essential for the production of top fermented beers.

## **Reference**

Keukeliere, D. (2010). Fundamentals of Beer and Hop Chemistry. *Química Nova*, 23(1), 108-112.