Bottle Conditioning – Undiscovered Territory for New Creations

AN UNDERRATED KEY TO BEER QUALITY | Until around 20 years ago, secondary fermentation in the bottle was widespread among most breweries producing Southern German-style wheat beer. However, since then, the majority of them have abandoned traditional bottle conditioning in favor of secondary fermentation in tanks. There are multiple reasons behind the move away from bottle conditioning aside from the need to simplify and standardize the production process. It was primarily the desire to avoid yeast autolysis and to achieve uniform and stable levels of turbidity which were the motivation for seeking alternatives to bottle conditioning.

UPON CLOSER EXAMINATION of the traditional method of bottle conditioning, it appears that these disadvantages actually become advantages with the right approach. Furthermore, the amount of value that consumers assign to bottle conditioning should not be underestimated either.

Many Highly Regarded Beers are Bottle-Conditioned

The craft beer movement has heightened the interest of both brewers and consumers in international beer styles. Many of the best-known beer styles are produced using bottle conditioning, including the dubbel, tripel and quadrupel styles from Belgium, not to mention the famous Trappist beers. The same applies to "Oude Gueuze" or "Bière Brut", which can be quite expensive.

The success of these beers around the world and their impressive stability in the bottle provide food for thought and also the perfect opportunity to revisit the topic of autolysis. Everyone who has ever had the chance to savor a five or even ten year old (!) glass of Orval (Belgian Trappist beer, bottle-conditioned) will marvel at the fantastic foam stability and the freshness of the beer. To be perfectly clear: after all those years, the living yeast which conditioned the beer is still in the bottle. While bottle conditioning is slowly fading away in Bavaria, many brewers around the world have embraced this technique and the advantages it brings with it. They are now applying it to many different styles of beer.

Autolysis – the Bane of Bottle Conditioning?

The general perception of the bottle conditioning process, both during and after, is based on the idea that the yeast cells undergo degradation (self-digestion, also known as autolysis) when all of the nutrients in the medium have been consumed. This, in turn, negatively affects foam and detracts

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Fig. 1 Many consumers associate bottle conditioning exclusively with Southern German-style wheat beer – but it is possible to apply this method to any beer style

from the flavor. Since the extract is consumed within several days or one week at the most, the apprehension the brewer may feel is understandable regarding what might happen to the yeast over the ensuing months until the end of the shelf life is reached. That said, the intensity of the autolysis is heavily dependent on three factors:

1. Physiological condition of the yeast
The younger and more active the yeast cell is, the less likely it is to self-digest or secrete undesirable compounds. For this reason, it is important to remove the yeast from primary fermentation to the greatest extent possible and to utilize fresh, young, active yeast cells for conditioning in the bottle. Moreover, young, fresh yeast cells are capable of taking up compounds released by yeast undergoing autolysis.

2. Yeast cell count
Since bottle conditioning usually takes place at warm temperatures (20 °C), the yeast cell count can and should be very low. Cell counts ranging from one to a maximum of five million cells per ml (depending on the yeast strain) are more than sufficient. However, the yeast cell count is considerably higher at most breweries.

In addition to a lower propensity for autolysis, smaller numbers of cells lead to the formation of significantly higher amounts of esters, which is desirable in many styles of bottle-conditioned beer. A lower concentration of yeast is also important for a uniform and stable turbidity, since the yeast always sediments out, binding to proteinaceous compounds and thus removing them from the beer. Since a cloudy appearance is desirable in these beers, the compounds responsible for haze are removed if the yeast cell count is too high. Therefore, in this case, less is more when it comes to yeast!

3. Yeast strain
Different yeast strains exhibit radical differences when it comes to autolysis. In general, top-fermenting strains tend to be significantly less likely to undergo autolysis and are therefore better suited for bottle conditioning. The practice of using bottom-fermenting yeast for bottle conditioning wheat beer (due to less sensitivity to temperature) has apparently resulted in negative experiences for many breweries and consequently has led some brewers to abandon the practice of bottle conditioning.

Bottle Conditioning and Flavor Stability

One of the most widespread problems with beer, which remains unresolved to this day, is its limited flavor stability. This is especially true of filtered beers, since naturally occurring SO_2 and several other substances, which act as antioxidants, are lacking in these beers, leaving them unprotected against the damaging effects of oxygen. Viable yeast cells are the best and longest lasting shield against oxidation.

Contrary to common belief, the action of yeast is not just limited to the uptake of oxygen. The deciding factor is actually the reducing power of the yeast. Yeast can reduce carbonyl compounds formed during the aging process to their corresponding alcohols. The sensory threshold for these alcohols is 100 to 1000 times higher than that of the carbonyls. Reduction has a "freshening effect" which does not stop when the extract in the bottled beer has been fermented, but remains as long as the yeast cell is alive and functioning.

Observations made with beers aged for different periods

Fig. 2 The effect of bottle conditioning on the sensory profile of beer should not be underestimated

of time have shown that some of the yeast is still alive in these beers, even many years after bottling. As noted above in the section on autolysis, younger, fresher and more active yeast cells exhibit a greater reducing power.

Binding CO_2 and Mouthfeel

If brewers can look beyond the four walls of their breweries, the close parallels to bottle conditioning performed by vintners should be immediately apparent. Bottle conditioning is well established in the wine industry and is employed in the production of premium sparkling wines such as "Champagne", "Winzersekt", "Crémant" or "Cava" – all products created using this process. Tank fermentation is utilized to produce other less expensive products, such as "Prosecco", "sparkling wine" or "Frizzante".

Along with the price and their image, the products differ markedly in mouthfeel, which is more or less brought about by the CO_2 in solution. The "Mousseux" or "Perlage", as it is known, has a great deal of influence on how the quality of sparkling wines is evaluated.

Even if mouthfeel is not the primary attribute for assessing beer, the creamy mouthfeel of properly bound CO_2 makes a significant contribution to beer quality. In addition to mouthfeel, tightly bound CO_2, such as that produced by bottle conditioning, naturally has a positive impact on the consistency and stability of foam.

And What Happens When the Extract Ferments Out?

What happens to the yeast? One must look no further than sparkling wine producers to discover another "secret": premium sparkling wines must be allowed to rest on the yeast sediment for a specified period of time. For example, champagnes bearing a vintage must be stored on yeast for a minimum of three years, with some doing so for as long as ten years.

Just as with beer, the extract is completely fermented out after several weeks. Nevertheless, the yeast cells continue to live, creating various metabolic products which contribute to the aroma of the product. In addition to classic compounds such as esters, the liberation of β-glucosidases plays an important role in sparkling wine. Aroma-active substances are formed through the cleavage of glucose from glycosidically bound compounds.

Although numerous publications are available for sparkling wine on this subject, this knowledge is almost non-existent in the beer world. Positive empirical evidence has been collected by craft brewers from all over the world for dry-hopped beers, and bottle conditioning is now poised to be the next scientific "frontier".

Many Practical Advantages

Since the final CO_2 concentration is generated during secondary fermentation in the bottle, the beer is much easier to fill due to the extremely low initial CO_2 concentration. This in turn allows higher filling speeds and more uniform fill levels. Special bottle sizes such as a magnum, double magnum or growler can be simply filled without counterpressure.

Inexpensive wine filling machines can also be utilized. This is an especially attractive option for smaller craft brewers. Another advantage emerges in the fermentation cellar: more costly bright beer tanks designed to withstand higher pressures are no longer necessary. A final positive aspect is that the maturation of the beer takes place in the bottle, thus the time spent in the fermentation cellar is very brief and there is no need for a chilled lager cellar.

A Tool for the Creative Brewer

Typically, most consider the effects of bottle conditioning to be limited to the generation of CO_2; however, the impact on the sensory profile of the beer should not be underestimated. Although only six to eight grams of fermentable sugar are fermented during bottle conditioning, depending on the strain, the yeast selected to carry out the maturation process can profoundly affect the aroma profile. For this reason, it is conceivable that different yeast strains can be employed to produce a broad range of beers using the same base beer. Yeast, therefore, joins malt and hop varieties in the brewer's creative arsenal.

Many consumers in Germany only associate bottle conditioning with wheat beer. In actuality, this method can be applied to all beer styles, opening a new world of possibility, for example, perhaps bottle-conditioned pilsner? These handcrafted, traditional brewing methods are also sanctioned under the German Purity Law.

In addition to all of the practical, sensory and technological advantages described above, bottle-conditioned beers have great marketing potential. As a result of champagne production, the level of recognition and the positive image associated with this traditional method is quite widespread. The use of bottle conditioning as a marketing tool is far from being fully realized, and given the appropriate platform for communicating its advantages, it could become much more prevalent. One must only imagine how impressed visitors to a brewery would be upon seeing bottles of beer resting in riddling racks … ■