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**Alcoholic Beverages: Production, Trends, Innovations**

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**Introduction**

Alcoholic beverages have a very long history of production and consumption. Their production by humans can be traced back to about 7,000 BC, but it is very likely that prehistoric humans had unknowingly consumed alcohol in overripe berries and fruits for many thousands of years before that (Philipps, 2014). For the production of alcohol, two things are required: a reasonable amount of sugar, and yeast. Ethanol is one of the end products of “alcoholic” fermentation by yeast. Yeast are small single-cell microorganisms, which are classified as members of the fungus kingdom. *Saccharomyces cerevisiae* is the most well-known and commonly used yeast species for alcoholic fermentations. It has been harnessed as a trustworthy workhorse for alcoholic fermentations since ancient times, and has since been domesticated for its use in brewing, distilling, winemaking and baking. If a beverage contains alcohol, it is the product of alcoholic fermentation by yeast, which turn sugars into ethanol and carbon dioxide as part of their metabolism.

The three most common classifications for alcoholic beverages are beer, wine and spirits. In beer brewing, the substrate is a sugary extract from malted grains, mostly barley, which is boiled with hops and then inoculated with yeast. In winemaking, grapes must be used as the substrate, and the fermentation usually involves several yeast strains. Spirits are an indirect product of alcoholic fermentation by yeast, which turn sugars into ethanol and carbon dioxide as part of their metabolism.

**Beer**

**Production Method and Styles**

Only four ingredients are required to produce beer: water, barley malt, hops and yeast. Beer brewing is a multi-step process (Figure 3.1). First, barley malt is crushed and mixed with water in the mash tun. During mashing, the so-called “mash” is led through different temperature rests to release the sugars and nutrients from the malt via the action of its endogenous enzymes. After mashing, a filtration step is needed to separate the liquid sugary extract from the remaining grain particles. To achieve separation, different techniques can be applied; in a lauter tun, the grain particles build their own filter bed by sedimentation on a false bottom, which acts as a sieve, and the clear extract, now called “wort”, can be separated from the leftover grain particles. This leftover grain is the so-called “brewers’ spent grain” (BSG). Alternatively, a mash filter separates the wort from the BSG in a pressurized, membrane-based process. During boiling to sterilize the wort, hops are added to give beer its distinct aroma and bitterness and to introduce hop-derived anti-microbial compounds into the wort. After boiling, hop leftovers and denatured proteins (“hot trub”) are removed physically in a “whirlpool” and the wort is cooled and transferred into a fermentation tank. During fermentation, after the addition of yeast, the yeast metabolizes the wort sugars into ethanol and CO₂, which can take between one and three weeks. After fermentation and subsequent maturation, the beer is usually filtered again and is then ready for filling and sale.

Through the almost infinite combinations of ingredients, there is no limit to the brewer’s fantasy and creativity in creating different beers. Brewers can choose from over 270 hop varieties, over 80 malt varieties and over 200 different brewing yeast strains (Deutscher Brauer-Bund e.V., 2016; Stempfl, 2016; IHGC, 2018). In addition, in compliance with their countries’ legislation, brewers can add adjuncts such as sugars, unmalted grains, fruits and spices to further individualize their beers. However, the brewers’ creativity is not only limited to ingredients but also includes variations in brewing practices. All process steps, from mashing to fermentation and even maturation, can be altered to influence the beers’ characteristics. Generally, beers are classified into two main styles: lagers and ales. These come with many different sub-styles, based on the use of ingredients and yeast, and brewing practices. Lager beer, the most popular beer worldwide, is brewed using *Saccharomyces pastorianus*, a hybrid sister of *S. cerevisiae*. It is generally fermented and matured at lower temperatures compared with ales, which are brewed using *S. cerevisiae*. Commonly used parameters to define beer styles, besides lager and ale, are original and final gravity, bitterness, alcohol content and colour.

**Home Brewing**

Home brewing, the brewing of beer on a small scale for personal, non-commercial purposes, has its roots in the very beginnings of beer brewing. Historians believe that in the early days of brewing...
in the Mesopotamian and Egyptian cultures, beers were first brewed at home. Only when towns developed did brewing grow from a household enterprise to larger scales (Papazian, 2003).

Today, home brewing is practiced all over the world by beer enthusiasts who want to live out their experimental and creative spirit or simply save money on their beer consumption. While the early home brewers had to build their equipment themselves, today home brewing kits exist in all varieties and sizes. A standard home brewing kit is shown in Figure 3.2. Alongside the standard home brewing kits, brewing equipment manufacturers have developed high-quality home brewing equipment, designed for high functionality and convenience. The degree of automation of such equipment can reach from temperature control and programming to a fully automated system. Ingredients and equipment can easily be sourced from local or online home brewing shops.

In terms of the choice of ingredients and the level of skill, home brewers can choose between extract brewing and all-grain brewing. While the beginner would start with liquid or dry malt extract, the more sophisticated home brewer will opt for all-grain brewing.

For all-grain brewing, mashing is performed in a heated vessel or by mixing the crushed grain with hot water. Temperature control of some sort during mashing is necessary to lead the mash through the desired temperature rests. Subsequently, a filtering step (lautering) is required to separate the spent grain from the sugary extract. With the “brew-in-a-bag” method, mashing is performed in what could be considered as a large tea bag. The bag can then easily be removed and drained upon completion of the mashing process, leaving behind only the sugary extract, which can subsequently be boiled in the same vessel. Extract brewing makes the whole process of mashing and lautering redundant, since the extract itself, in its dry or liquid form, is already the concentrated product of mashing. However, whether all-grain or extract, a subsequent boiling step is essential to sanitize the wort. Hops can be added in hop bags to facilitate the easy removal of

FIGURE 3.1 Illustration of the beer brewing process.

FIGURE 3.2 Typical home brewing starter kit.
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hop residue after the boil. Pre-hopped malt extract eliminates the necessity of adding hops during the boil.

To separate the clear wort from hop residue and “hot trub”, home brewers can create the whirlpool effect applied in commercial brewing by vigorously stirring the wort. Subsequently, the clear wort needs to cool before it can be inoculated with yeast. The sophisticated and impatient home brewer can use special cooling equipment such as an “immersion cooler”, a hollow stainless-steel spiral which can be connected to a water supply, to dissipate the heat. An option that does not require additional equipment is to fill the hot wort into the fermenter. By tumbling slightly, the hot wort can even be used to sanitize the fermenter surfaces before it is left alone to cool. Upon reaching the desired fermentation temperature, yeast is added in the form of dried or liquid yeast. Plastic buckets or glass or plastic carboys are well suited for use as fermentation vessels. The vessels are closed with a fermentation lock, which allows the escape of carbon dioxide produced during fermentation but prevents oxygen or contaminants from entering the fermentation vessel. At the end of the fermentation process, the beer can be filled into sanitized bottles. Small, calculated amounts of sugar are added, and the bottles are capped. The remaining live yeast in the beer will consume this sugar and give the homebrew its fizz in the closed bottles.

As with commercial brewing, a high standard of hygiene is essential to get a safe, good-tasting product. As well as equipment and ingredients, sanitizing agents can be sourced in any home brewing shop.

Home brewers are engaging in local home brewing clubs or online home brewing communities, which serve as platforms to share recipes and experiences, equipment and, importantly, home brewed beer!

Craft Beer

According to the Brewers Association, a craft brewery is defined as small (with an annual production <7 Mio. hl), independent (< 25% owned by a non-craft brewer) and traditional (with beer flavours derived from traditional or innovative brewing ingredients and their fermentation) (Brewers Association, 2019b). Born in America in the 1970s, craft beer has developed into a global phenomenon. Its primary concentration is in America and Europe, with the United States being the largest craft beer producer, followed by the United Kingdom. Since the turn of the millennium, craft beer has been growing four times faster than total beer production, a trend that is forecast to continue (Technavio, 2017).

In 2017, the number of breweries worldwide surpassed 19,000, with 17,732, or 94%, being defined as craft breweries (Brewers Journal, 2017). Such strong growth, fuelled by consumers’ desire for exclusive, small-scale, premium products, gave rise to the emergence of new and old rediscovered beer styles (Baker, 2018).

In recent years, craft beer has been dominated by hop-focused beer styles such as India pale ales (IPA) and other pale ales. These beer styles use an elevated amount of hops during boiling to create a more pronounced bitterness. Additionally, in a process called “dry-hopping”, hops are added during the cold stages of brewing (mostly lagering/maturation), which gives the beers their distinctly fruity, floral hop aroma. Another beer style, which has actually been around for hundreds of years, has recently attracted increasing attention; sour beers, such as “Berliner Weisse”, “gose”, “lambic” and “Wild ales”, are celebrating their revival among craft brewers who are looking beyond how hoppy a beer can taste. To brew a sour beer, brewers harness lactic acid bacteria, which produce lactic acid, in addition to the alcohol-producing yeast, giving the beers their characteristically tart taste. Also, unconventional yeast (i.e., Brettanomyces) may be used for co-, or secondary, fermentations. Sour beers are sometimes infused with fruits or brewed using fruit juice as an adjunct. Craft brewers have succeeded in establishing high levels of quality, consistency and innovation, expanding the minds of the beer consumers and creating the most diverse brewing culture in the world. Beer is not just an alcoholic beverage; for many consumers, craft beer has become a lifestyle.

More Trends and Innovations

The skyrocketing number of new craft brewery openings in the United States has gone hand in hand with the emergence of new brewpubs (i.e., restaurant-breweries selling at least 25% of volume on site) (Brewers Association, 2019a). This trend has also been observed in Europe. Brewpubs serve as a craft beer lovers’ Mecca, where they can indulge in locally produced craft beer while enjoying a meal or a snack, which is often uniquely fitted to the beers (Figure 3.3). In fact, another growing trend is food pairing, the combination of a certain beer style with a certain dish or ingredients.

With advances in production methods and a society that is more conscious about health and well-being, non-alcoholic and low-alcohol beers (NABLAB) are on the rise (Bellut and Arendt, 2018). While more and more big breweries and craft breweries are adding NABLAB to their portfolio, craft breweries focusing solely on NABLAB have started to pop up, examples being Bravus Brewing Co. and WellBeing Brewing Co. in the United States (Washington Post, 2018) and Nirvana Brewery in the United Kingdom (METRO, 2017).

In light of the global gluten-free trend, brewers have been exploring with naturally gluten-free pseudo cereals in brewing, such as millet, buckwheat and quinoa. Quinoa Italia has created...
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Wine

Production Method and Styles

As with beer, the principles of winemaking date back thousands of years. Only in the 1800s did our understanding of the microbial nature of winemaking develop. There exist major philosophical differences about whether “wine is made in the vineyard” or whether the grapes are simply the raw material in the hands of a skilled winemaker, who crafts the wine in the cellar.

Winemaking begins with the removal of the leaves and sometimes the stems from the grapes, before the grapes are crushed to yield the juice. The freshly crushed grape juice that contains the pulp, skins and seeds is called the “must”, with the solid portion being called the “pomace”. During the subsequent maceration process, nutrients, flavourants and colourants are extracted from the pomace. For white wine production, maceration is kept to a minimum, the juice and pomace are quickly separated, and the fermentation is initiated only after a few hours. For red wines, maceration is prolonged and occurs simultaneously with the alcoholic fermentation, which enhances the extraction of skin and seed phenolics that are responsible for the red wine’s flavour. Contrary to popular belief, red wine inherits its rich colour from the skin of the grapes and not its pulp. The red colour is achieved by the prolonged maceration process, leading to the extraction of anthocyanins from the grapes’ skin. In fact, most red grapes have light-coloured pulp and therefore give light-coloured juice. White wines made from red grapes are known as “blanc de noirs”. The most popular example is Champagne, the sparkling wine from the Champagne region of France.

Historically, fermentation started spontaneously due to endogenous yeasts present on the grapes and in the fermentation vessels, but today the juice is inoculated with one or more yeast strains of known characteristics. Yeast are responsible not only for the formation of alcohol but also for the creation of odorant compounds that contribute to the overall bouquet of the wine. Upon the termination of alcoholic fermentation, an optional secondary “malolactic fermentation” may be applied to reduce acidity by transformation of malic acid into lactic acid with the aid of specific lactic acid bacteria. During the maturation process, the wine bouquet develops further and the colour is stabilized. Before bottling, the wine is sometimes fined to soften or reduce its astringency and remove proteins capable of haze formation, and usually filtered to further enhance its stability and clarification (Jackson, 2014). A flow diagram of the winemaking process can be seen in Figure 3.5.

A generally accepted system to classify wines does not exist. Wines may be organized by their colour, alcohol, sugar and carbon dioxide content, or by their stylistic, varietal or geographical origin (Jackson, 2014).

Trends and Innovations

The market research organization Euromonitor analysed spending habits of consumers around the world and identified several trends in the wine industry (Euromonitor, 2018). Unlike the preceding generation of baby boomers, the generation of millennials is more interested in experiences over material goods and chooses unusual, unique wines over well-established premium brands (the drinks business, 2016). More uncommon grape varieties and styles are gaining attention, as well as wines from new, emerging geographical regions, such as China. Just as in the craft beer industry, where cans are big business, making packaging cheap, eco-friendly and stylish, canned wine is on the rise in the United States and Europe (the drinks business, 2017). In addition, wine on tap is becoming more popular, with companies like Vagabond Wines pioneering in London (Vagabond Wines Ltd, 2018). So-called “natural wines”, farmed organically and processed naturally without the addition of sulfites, are also growing in popularity.

In recent years, more and more “urban wineries” have started to pop up all around the globe, but mostly in the United States and Europe. The principal concept of urban wineries is the sourcing of grapes, or grape juice, from local or further-afield vineyards and processing them in the urban winery, which usually owns a central location in a big city. The offers in urban wineries are usually not limited to the wine produced in-house; they may also offer experiences and education, such as winemaking or tasting courses (American Association of Wine Economists, 2014).
Distilled Drinks

Principal Production Method and Styles

There is a limit to the amount of alcohol that can be formed by alcoholic fermentation, which is defined by the yeast strain’s maximum alcohol tolerance. The most resistant yeast strains can reach ethanol concentrations of around 20% alcohol by volume (ABV). In order to overcome the biologically defined limit, a process called distillation was developed. The principle of distillation is based upon the different boiling points of ethanol (ca. 78 °C) and water (ca. 100 °C). A basic distillation setup consists of three parts: the still pot for heating the liquid; the condenser for cooling the vapours; and the still receiver for collecting the distillate. With heating above the boiling point of ethanol but staying below the boiling point of water, the produced vapour is high in alcohol and can be condensed to recover a concentrated distillate.

The production of whisky includes production procedures similar to that of beer. A cereal-based mash, called “wash”, is fermented and distilled. The distillate is then matured in oak casks, which impart many aroma and flavour characteristics to the whiskey, before blending, bottling and selling. By law, the distillate must typically be matured for a minimum number of years before it can be called whiskey; for example, in order to be labelled as Irish whiskey, it must be matured in casks for a minimum of three years, whereas bourbon must be matured for a minimum of two. Brandy is yielded by distilling wine with subsequent maturing in casks. Rum is the distillate of fermented sugar cane juice and molasses. Tequila and mezcal are the distillates of fermented agave juice. Vodka is the distillate of fermented neutral grain like wheat, barley, rye or potato. For the production of gin, a neutral grain spirit from barley, corn, rye or wheat is macerated with botanicals like juniper berries, which contribute to its flavour as the major ingredient, and then distilled. Liqueurs and creams are drinks made from a combination of water, alcohol, sugar, fruits, and spices or herbs.

Trends and Innovations

Due to the increasing consumer demand for premium craft products, which are usually made locally with limited scale and distribution, the spirits industry is experiencing a craft spirits trend much like craft beer. Craft spirits are forecast to have enormous growth over the next few years, with whisky (whiskey in Ireland and America, whisky in Scotland) being the most sought-after variety of craft spirits. It is closely followed by gin, vodka and rum (Grand View Research, 2017).

As a part of the omnipresent health and well-being trend, alcohol-free distilled spirits have emerged in recent years. Seedlip, which was founded in 2014 in the United Kingdom, now produces three alcohol-free, distilled spirits, which are sold in over 20 international cities in their best restaurants, cocktail bars, luxury hotels and high-quality retailers (Seedlip Ltd, 2018). More companies followed in their footsteps, like Ceder’s, Stryyk, Surendran & Bownes and Whinn. In addition, Gordon’s has introduced a ready-to-drink “Ultra Low Alcohol G&T” into the market (The Spirits Business, 2018).

Category Blurring

As a result of the craft trend, consumers now expect and demand more creative offerings that allow them to experience new tastes and flavours, the potential of which may well lie between category lines. Also known as cross pollination, category blurring is happening in the whole beverage industry, but especially the alcoholic beverage industry.

In a collaboration, Irish whiskey distiller Jameson (Irish Distillers Pernod-Ricard) teamed up with a local craft beer brewery. From an exchange of barrels, the brand Jameson Caskmates was born, a blended Irish whiskey aged in wooden, stout-seasoned barrels. After this phenomenal success, an IPA edition of Caskmates was released. The craft brewery on the other end was able to serve craft beer matured in whiskey barrels (Irish Distillers Ltd, 2018).

Beer and wine hybrids are also gaining popularity. Craft breweries are adding grape must to their wort to introduce more flavour and complexity to their brews, but it is also happening the other way around. With hops at its peak in the craft beer trend, winemakers are adding hops to their wine, creating dry-hopped wine (Vinepair, 2018). Apart from grape must, various fruit juices or purées are popular ingredients in the growing sour beer trend, and harmonize with the sour and tart character of sour beers.
However, fruit juice additions are not only limited to the sour beer style but are also added to pale ale styles to go hand in hand with their fruity hop character.

**REFERENCES**


