

Sergey Konstantinov

BEER: A LECTURE



*(tasting
included)*

Sergey Konstantinov. Beer: A Lecture (Tasting Included).

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Beer. The most modest and unassuming beverage, a filler for supermarket shelves. At the same time — a staple of the economies of many nations for millennia. Egyptian pyramid builders were paid with it, polar explorers took it to the North Pole as a life-sustaining product, workers of Brussels once rioted because its price was up by two centimes.

In this book, a centuries-long beer history is told in a comprehensive, interesting, and *practical* manner. You will learn which beer styles were popular in each epoch, from Bronze Age to the 21st century, understand the reasons behind this popularity, and most importantly, explore the history by taste.

Illustrations & inspiration by Maria Konstantinova · art.mari.ka



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Source code available at github.com/twirl/Beer-Lecture

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PREFACE

Chapter 1. Author's Note

The history of beer and brewing was always a practical study for me. I was always keen to try something new — and not just try, but learn from it: when this beverage occurred and why it tastes like this. Gradually, I involved myself in studying beer history and soon found that brewing was one of the hottest topics of historical science.

For many centuries in northern parts of Europe beer was if not the first sector of economics then at least second — the fact that both Medieval chroniclers and contemporary scholars turn a blind eye to. Up until the 1980s, the researchers were interested in the history of alcohol only in the context of consumption effects on personal and public health¹. But as we all well know, alcohol, this ‘social lubricant’, plays a much greater role in society! Gradually, this fact reached academic studies. In the case of beer, it happened even later, at the beginning of the 21st century. It turns out that beer, an ordinary and democratic beverage, allows us to poke our noses into the most interesting and least documented part of the past: the daily routine of common folk.

Making one's way through beer history is incredibly fascinating — and equally challenging. Eyewitnesses didn't care about writing down such obvious and mundane things as beer brewing. Historical science made huge progress over many mysteries last years, and craft beer reenactors recreated lots of historical beers

for everyone to taste. But our knowledge is still miserably sparse regarding many aspects and events, even quite novel ones.

While writing this book I hadn't pursued the goal of compiling some short beer history. First, it's impossible; second, I'm no scholar but a beer enthusiast. All I want is just acquaint you, dear reader, with good beer, and tell an interesting story along the way. Let us begin!

An important remark

This book is written in a form of lecture-tasting. In each chapter, we're proposing to try a specific kind of beer matching the historical period described. Full description of how to read classifications and where to learn about suitable beer styles you might find in the Appendix.

References

¹ Dietler, M. (2006), p. 230

Chapter 2. What is Beer

Before starting our dive into the history of beer, we need to define what ‘beer’ is. Natural alcoholic beverages are a result of the biochemical process of alcoholic fermentation: various microorganisms (primarily yeasts, but not only them) are capable to extract carbohydrates (first of all, sugars) from an aqueous solution and break them down, producing ethyl alcohol and carbon dioxide, as well as some other organic compounds. Carbon dioxide makes the resulting drink sparkling; ethyl alcohol, interesting to humans.

Depending on what raw materials were used and what kind of sugar was fermented, the resulting beverages are called differently:

- if the raw material was grapes (or other fruit), juice of which contains a large amount of glucose, then the result of fermentation is called wine;
- if the raw material was apple (or pear) juice containing glucose and malic acid, then we get cider (or perry);
- if milk sugar lactose was fermented, then we get kumis;
- if we took honey rich in fructose saccharide as raw material, we get mead.

It's interesting

Sugar cane juice, which consists mostly of sucrose dissolved in water, also quite fits for manufacturing of low-alcohol beverages, but humanity started to cultivate it for this purpose quite recently. At that moment the distillation technology was already known, and just strong drinks were produced, rum

and cachaça for instance. The product of natural, without the use of distillation, fermentation of sugar cane is known in some countries under the name ‘guarapo’, being in very limited demand.

Finally, if sugars extracted from cereals were used for fermentation (first of all, we are talking about the disaccharide maltose), then the resulting low-alcohol drink is called ‘beer’. The grain of many cultivated plants, such as wheat, barley, maize, rice, rye, oats, millet, buckwheat, and others is suitable for beer production. Thus, such drinks made from cereals as Russian kvass, Finnish sahti, and traditional Japanese sake should also be considered ‘beer’.

Our distant ancestors, presumably, discovered the fermentation process by accident: it was enough to leave the water with grain in the open air for the wind to inoculate it with wild yeast. A few days at the right temperature — and you will get a refreshing low-alcohol drink.

The age of the known remains of fermented sugars is steadily moving further into the past. At the moment, the oldest such finding dates back to about the eleventh millennium BCE¹. Thus, beer and mammoths were there at the same time for at least nine thousand years! Some researchers believe that beer may be older than bread: brewing is easier than baking. But we would disagree with them, for two reasons.

First, cereals themselves contain little to no low-molecular carbohydrates: the main component of grain is starch. To get maltose or glucose out of it, you need to somehow activate the processes of converting starches into saccharides. For example, you can chew rice: the enzymes in saliva help to start the processes of

converting starch into glucose. This is how traditional Japanese sake *kuchikamizake* is prepared (not to be confused with modern sake, the production technology of which we will explain in the chapter ‘At the dawn of civilization’). If you have wondered why the heroine of the ‘Your Name’ movie is chewing rice, that’s it: she is producing traditional sake.

It is believed that the *kuchikamizake* technology (which was used not only by the Japanese but also by South American Indians, for example) is about 2.5 thousand years old (although we have not seen credible studies on this topic). Therefore the oldest beer was prepared somehow differently, and some other mechanism was employed to ‘activate’ the cereals. For example, bread was baked or *malt* was prepared. The latter is a product of controlled sprouting: during the germination of grain, enzymes are produced. These chemical compounds are capable of converting starches into maltose under the right conditions, and such grain becomes suitable for the production of a beverage, which we call ‘beer’.

Another problem of beer production is the necessity to somehow introduce yeast into the solution. You can, of course, rely on sheer luck, but this method is poorly applicable for large-scale production. In order for fermentation to begin, a ‘starter culture’ is needed. It can be fruits (such as grapes or dates), on the surface of which yeast lives in the wild, baked bread, or yeast sediment from a previous cooking.

Based on this, we strongly doubt that ancient beer was produced by accident: ‘accidental’ beer should have been obtained too rarely and being too weak, unlike, for example, fermented milk or fruit juices. Brewing was exactly a *technology*, one of the first mastered by mankind².

References

¹ Liu, L., Wang J., Rosenberg, D., Zhao, H., Lengyel, G., Nadel D. (2018) *Fermented beverage and food storage in 13,000 y-old stone mortars at Raqefet Cave, Israel: Investigating Natufian ritual feasting*. Journal of Archaeological Science: Reports. Volume 21, October 2018, Pages 783-793

<https://www.sciencedirect.com/science/article/abs/pii/S2352409X18303468>

² Meussdoerffer, F.G. (2009), p. 4

PART I. FROM SUMERIANS TO SADI CARNOT

Chapter 3. At the Dawn of Civilization

Historical period: from the 10th millennium BCE to the 2nd century CE

Scene of action: Mesopotamia, Egypt, China, the Mediterranean

The Sumerians are widely regarded as the first civilization in human history. It was likely Sumerians who invented writing. And — what a coincidence! — they were also huge beer lovers. In the oldest clay tablets, dated 30-32 centuries BCE, beer is already mentioned as a staple product, manufacturing of which was controlled by the state¹.

Sumerians loved beer so much that they have a separate beer goddess: Ninkasi. ‘A Hymn to Ninkasi’², dedicated to the goddess, is itself an allegorical beer recipe, according to scholars³. The Hymn was written down circa 18th century BCE, but researchers suggest it’s much older than that⁴. Apart from the Hymn, beer is also mentioned in one of the oldest Sumerian legends, ‘Inana and Enki’⁵.

There are many surviving images of people drinking beer (supposedly) from mugs or large vessels by the means of tubes⁶. Furthermore, it’s the oldest known depiction of cocktail straws⁷, so it’s quite probable they were invented specifically to drink beer.



Two sitting figures drinking from vessels by means of straw. 2600–2350 BCE

Image Credit: The University of Chicago

Babylonians, Akkadians, Ancient Egyptians — all these peoples adopted a taste for beer from Sumerians⁸. In the oldest of surviving epics, namely 'Epic of Gilgamesh', beer is mentioned in a very peculiar aspect. According to the myth, goddess Aruru created a 'wild man' Enkidu to confront Gilgamesh. But then Shamhat, a sacred temple prostitute, seduces Enkidu and civilizes him. To do so, she makes him eat bread and drink beer: the symbols of civilization, unknown to wild men⁹.

Then, beer is mentioned in the Epic once more¹⁰: goddess Siduri advises Gilgamesh to abolish his quest of seeking the meaning of life, and just enjoy small wonders — like beer. This character, Siduri, is considered to be the first written mention of 'alewife', e.g. a female brewer — bartender — tavern keeper¹¹.

One of the first codes of law in human history, the Babylonian Code of Hammurabi, refers to beer four times¹²:

- §108: if a tavern keeper pours short of the paid amount of beer (or refuses to take grain as a payment), then she shall be drowned to death;
- §109: if a tavern keeper fails to report the powers about the planned coup which was discussed in her tavern, she shall be put to death (a method of which remains unspecified);
- §110: if a ‘Sister of God’ (e.g. the high priestess) runs a tavern or just enters one to drink beer, then, as you should have guessed, she shall be executed;
- §110: if a tavern keeper donates sixty *ka* of beer in the time of famine, then she shall be awarded fifty *ka* of grain afterward.

Let us point out that the Code refers to tavern keepers as females, and all the corresponding goddesses and legendary characters are females either. From the beginning of civilization up to the industrial revolution preparation of alcoholic beverages as a whole, and brewing beer in particular, was predominantly women's job¹³, with an exception of Christian male monasteries¹⁴. It appears that brewing and baking were not decoupled from each other, it was essentially the same occupation.



Model bakery and brewery from the tomb of Meketre, an Egyptian noble, chancellor to Pharaoh Mentuhotep II and several of his successors. Circa 1981–1975 BCE

Image Credit: The Metropolitan Museum of Art

In Ancient Mesopotamia, beer was something like a currency¹⁵. Daily workers (builders of the Giza pyramids, in particular) were paid in beer — something like 4-5 liters per person per day¹⁶.

How to Try

The distinguished researcher of ancient civilizations' cuisine, prof. Patrick McGovern, managed to find traces of Egyptian beer and recreate it¹⁷. In collaboration with Dogfish Head Brewery the 'Midas Touch' beer, based on the recipe, was prepared. This is not the only attempt: another brewer, Fritz Maytag (of whom we will tell much more later) considers the procedure described in 'A

Hymn to Ninkasi' so obvious that he brewed beer based on it and presented it at the annual meeting of American Homebrewers Association in 1991. Maytag hasn't released it commercially, since the technology doesn't preclude using preserving agents; other brewers are not so picky. Today, beers brewed according to ancient recipes (Sumerian, Egyptian, Celtic, Etruscan, etc.) are available in numbers. The most famous examples are:

- abovementioned Dogfish Head Midas Touch;
- Williams Bros. Fraoch, possibly the most widespread brand based on an ancient Celtic recipe (might be found as a part of the 'Historical Ales of Scotland' set);
- Thornbridge Hall Bracia, analogous Celtic beer from the neighboring brewery;
- another ale prepared by McGovern & Dogfish Head, Kvasir (recreated using the remains of 15th century BCE beer found on the territory of nowadays Denmark);
- Posca Rustica by Brasserie Dupont, based on 1st century CE Roman recipe;
- Birra del Borgo Etrusca, after Etruscans.

There is no specific name for such 'elder' beer; look into 'Ancient Herbed Beer' and 'Traditional' categories.

Nevertheless, we consider these reconstructions being a bit deceiving; in many cases, just a wild fantasy on historical themes. Let us name three reasons which make us think so.

Let's start with the Sumerians. The situation there looks paradoxical: we are well aware of many kinds of Sumerian beer (clay tablets mention 'Gold', 'Dark', 'Sweet Dark', 'Red', and other types), and we knew all ingredients of these beverages. But have

totally no idea what these ingredients actually were, and how these beers tasted¹⁸.

Writing (cuneiforms on clay tablets) was expensive, so it was used for *important* things, like every kind of administrative order: deliver these amounts of those ingredients from point A to point B to make that amount of beer¹⁹. It went without saying that the receiver totally knew how she would brew the requested beverage, so nothing like precise recipes or brewery blueprints survived²⁰.

Even basic facts are actually a set of assumptions. There are two main ingredients mentioned in all listings: *bappir* and *munu*. The former probably means barley bread (though it's measured in volume units, like something which might be poured), the latter should be barley malt²¹. That's actually all we know more or less reliably.

The oldest surviving beer recipe was written down by an Egyptian alchemist Zosimus in the 4th century CE (which is several thousand years after the heyday of ancient brewing), and, possibly, not by Zosimus himself, but by an unknown later scribe. The recipe prescribes soaking then drying barley, preparing a half-baked bread from it, soaking it again and leaving liquids to ferment²². No other details like amounts and types of ingredients or further actions are provided. It's also vexing that Zosimus recipe contradicts archeological evidence, so considering it genuine is a bit of an overstatement²³. That's the first reason why authentic beer reconstructions are not possible.

Of course, we can still brew *some* beer based on this recipe or archeological findings. But there are also second and third reasons.

Modern beer is basically brewed using four components: grain, water, yeast, and hops. As we will explain in the next chapters, none of these ingredients existed before the High Middle Ages. Yeast was strictly airborne, e.g. 'wild', and we don't know the exact species. Cereals that were prevalent in Ancient Mesopotamia and Egypt, namely emmer, spelt, and einkorn, were half-domesticated ancestors of modern wheat; ancient barley was a distant relative to modern barley either. Beer was sweetened and spiced with some flavor additives which we know nothing of. Finally, water in Mesopotamia was a rare commodity being very far from crystal clarity. Some reenactors choose similar (as they think) modern ingredients; some of them try authentic cereals. But no attempt to precisely reconstruct all four components has ever been made, as far as we know²⁴.

And there is also a third reason, probably more important than the two previous ones. For industrial beer production, the technical parameters must be controlled with extreme precision, right up to degrees and per mills. Until the 18th century when the thermometer and the hydrometer were invented, brewer's control over the processes of mashing, cooling, and fermenting was quite limited. Many factors, like weather or microorganisms, were totally out of their control. So ancient beer hasn't had 'a taste': each batch brewed under some specific conditions had its own specific taste. Master brewers were probably able to produce the more or less consistent product; less skilled ones were preparing totally unique beverages each time, but constantly sour and cloudy. We can only agree that, according to the big numbers law, sometimes they must have brewed something close to a liquid we have just filled our glass with.

The Decline of Ancient Beer

During the Bronze Age, beer was the most common beverage for almost every civilization, from the Sumerians to the Chinese. But in the 1st millennium BCE, the situation changed dramatically.

In China, supposedly under the rule of the Shang dynasty, circa 15–16th century BCE, a new method of producing alcoholic beverages from rice was discovered. A complex mixture of molds, yeast, and bacteria, known as ‘qū’ (麴 in traditional Chinese), cultured on a starch-rich substrate, is able to convert cereal starches to alcohol directly. The result is a rather strong beverage containing 8 to 20 percent alcohol by volume (ABV). Many traditional Eastern alcoholic beverages, such as Chinese ‘rice wine’ *huangjiu*, Korean and Japanese *sake* and *shochu*, are produced using *qū*²⁵. This technology superseded beer brewing in the East, but for obvious reasons (the secrecy and lack of rice) were not adopted in the West.

But the West — Ancient Greece and, later, Ancient Rome — had their own technological know-how: grape wine. Archeological evidence indicates that it was already produced in 6–7 millennium BCE on the territory of nowadays Georgia (and probably in China either), but it was Phoenicians who spread the taste for wine through all the Mediterranean²⁶.

Some scholars believe that late Bronze Age Greeks (Mycenaeans) inherited brewing traditions from their Minoan predecessors, and therefore drank beer or at least tolerated beer; maybe Dionysius was a god of beer and mead as well as wine²⁷. However, starting from the 10th century BCE beer completely disappears from the Greeks' diet and is mentioned in written sources as a ‘foreign beverage’ — of Thracians, Phrygians, or Egyptians. To Ancient Greeks beer was a beverage of northern ‘barbarians’ Thracians and Peons²⁸. In the 5th century BCE, Aeschylus in his plays

counterposes ‘Dionysius beverage’ (e.g. wine) against ‘Thracian beverage’ (e.g. beer). Many other Greek dramatists had started to despise beer after Aeschylus²⁹. Greeks believed that beer as a result of ‘decay’ of grain, in turn, makes humans decay, and also effemulates men. This opinion, voiced by Theophrastus³⁰, is to be repeated constantly in the Ancient Greek and Roman literature. Beer was associated with excessive alcohol consumption attributed to Scythians and Thracians, while Greeks themselves were (of course!) considered inherently modest and temperate.

As a result, with the growth of Ancient Greece then Ancient Rome's influence, beer was universally dislodged³¹. Peoples living on the territory of nowadays France, Spain, Northern Italy, Germany had been drinking beer for millennia before wine and viniculture arrived on their soil³², but during the 2nd and 1st centuries BCE, Romans progressively defeated all beer-drinking nations: Celtsiberians, Gaul, Carthaginians, Ligurians, Egyptians. Even Celts started to prefer wine over beer under Roman influence³³. Wine prominence was also enforced by the swiftly spreading Christianity, which gave it a very special position in its rituals and sacred books. At the beginning of the Common Era, the only keepers of beer tradition in the world were the ‘barbarians’ on the outskirts of the Roman Empire.

References

¹ Damerow, P. (2001), pp. 1-2

² A Hymn to Ninkasi.

³ Meussdoerffer, F. G. (2009), p. 5

⁴ <https://www.worldhistory.org/Beer/>

⁵ Inana and Enki

<https://etcsl.orinst.ox.ac.uk/section1/tr131.htm>

⁶ Meussdoerffer, F.G. (2009), p. 5

⁷ Thompson, D. (2011) *The Amazing History and the Strange Invention of the Bendy Straw*

[https://www.theatlantic.com/business/archive/2011/11/the-amazing-history-and-the-strange-i
nvention-of-the-bendy-straw/248923/](https://www.theatlantic.com/business/archive/2011/11/the-amazing-history-and-the-strange-invention-of-the-bendy-straw/248923/)

⁸ Paulette, T. (2020) *Brewing Mesopotamian beer brings a sip of this vibrant ancient drinking culture back to life*

[https://theconversation.com/brewing-mesopotamian-beer-brings-a-sip-of-this-vibrant-ancie
nt-drinking-culture-back-to-life-142215](https://theconversation.com/brewing-mesopotamian-beer-brings-a-sip-of-this-vibrant-ancient-drinking-culture-back-to-life-142215)

⁹ George, A. (1999), p. 14

¹⁰ ibid, p. 76

¹¹ <https://en.wikipedia.org/wiki/Siduri>

¹² Johns, C. H. W. (1904), p. 52

¹³ Dietler, M. (2006), pp. 236, 238

¹⁴ Poelmans, E., Swinnen, J.F.M. (2016), p. 6

¹⁵ Swinnen, J., Briski, D. (2017), p. 8

¹⁶ Marks, T. (2018) *A sip of history: ancient Egyptian beer*. The British Museum Blog

<https://blog.britishmuseum.org/a-sip-of-history-ancient-egyptian-beer/>

¹⁷ https://en.wikipedia.org/wiki/Patrick_Edward_McGovern

¹⁸ Damerow, P. (2001), pp. 6-20

¹⁹ ibid, p. 2

²⁰ Meussdoerffer, F.G. (2009), p. 5

²¹ Damerow, P. (2001), pp. 6-8

²² Hornsey, I.S. (2008), p. 49

²³ Nelson, M. (2001), pp. 124-126

²⁴ Schwartz, G. (2013) *A pint of the past: assessing authenticity in modern versions of ancient and historic ales*. *Brewery History*, 154

<http://www.breweryhistory.com/journal/archive/154/index.html>

²⁵ <https://en.wikipedia.org/wiki/Q%C5%AB>

²⁶ <https://en.wikipedia.org/wiki/Wine#History>

²⁷ Nelson, M. (2005), p. 14

²⁸ ibid, pp. 15-16

²⁹ ibid, p. 25

³⁰ ibid, p. 36

³¹ Poelmans, E., Swinnen, J.F.M. (2012), p. 2

³² ibid

³³ Nelson, M. (2005), pp. 52-53

Chapter 4. The Barbarian Booze

Historical period: the 2nd — 10th centuries CE

Scene of action: Europe north of the Apennines and the Pyrenees

Paradoxically, it was Romans who left a lot of material evidence related to beer production. At the outskirts of the Empire, brewing continued on, both for locals and the Roman legions they hosted — and therefore some administrative correspondence was preserved. Particularly, the letter on the wooden tablet found in the remains of Vindolanda (a Roman outpost in England), in which Masculus, a decurion (head of a cavalry platoon), tells Flavius Cerialis, a prefect, that the soldiers have no beer (*ceruesam*) and asks for sending some¹.

On the territory of nowadays Germany, Great Britain, and Belgium a number of Antic breweries were found. One of the oldest is located near Regensburg and dates back to the 1st-2nd centuries CE. It is notable not only for being the first known Roman brewery but also as the earliest evidence of using *kilns* for malting².

Remember that barley itself doesn't suit brewing purposes well since it lacks fermentable sugars, so grain undergoes *malting* procedure: it's soaked, then allowed to germinate. The result of this operation, known as 'green malt', might be used for brewing directly, but it perishes very quickly. So green malt is usually dried, and in this form, it might be kept well-preserved for a long time.

In Mesopotamia and Egypt, malt was presumably dried in the sun, since it's quite hot and sunny there. In the Northern Europe conditions, drying malt in the sun was not an option. Alternatively, malt might be wind-dried, but that requires specific conditions either. So, in Europe, they started heating germinated grain in large ovens named *kilns*. A kiln was usually a stone chamber with a hearth in it. The malt was spread on the floor, and then the fire was kept low for several days.

How to Try

How this late Antic beer tasted is very hard to say because no written sources survived. Several Roman writers mentioned beer (most notably, Pliny the Elder in his ‘Natural History’), but they probably didn't know anything about brewing in detail and weren't actually interested. Technically, the Zosimus recipe we mentioned in the previous chapter falls into the discussed period of time, but it describes Egyptian technology. As for European beer recipes of late Antiquity and early Middle Ages, we know almost nothing³.

However, the mere fact of using early kilns gives us an opportunity to taste the past, so to say. Nowadays the same technology of smoking malt over beech wood is used to produce a special style of German beer called ‘Rauchbier’ (also, ‘island’ whiskeys). Rauchbier is totally not authentic from all other points of view, as modern barley, yeast, and hops are used to produce it. But as you instantly understand after the very first sip, it's a hell of a taste, hardly manageable to get rid of. So from the tasting perspective, *Rauchbier* is the best approximation of late Antic ‘barbarian’ booze. (Conversely, modern reenactors that restored Celtic kiln of the

4th-5th centuries CE say that it was naturally a Rauchbier clone they've got from it⁴.)

Widely known beer in this style is produced by the Schlenkerla company (there are several distinct brands, any of them will fit). Also, a few craft breweries produce 'smoked' beer, for example, Dutch 'De Molen' ('Bloed, Zweet & Tranen' and 'Rook & Vuur' beers).

The Time of the Cathedrals

A significant part in spreading brewing in Europe was played by Christian monks and priests. Beer 'promotion' already started in the time of the Roman Empire in Ireland, which wasn't under Roman rule. In the 5th century CE, Saint Brigid of Ireland was already converting water to beer, according to legends⁵.

Monks' interest in beer was quite understandable in those regions where cultivating grapes wasn't possible. Because of numerous strict fasts, they needed an additional source of calories like no others did⁶. Beer popularity in monasteries was additionally promoted by Louis the Pius who started enforcing so-called 'St. Benedict's Rule' on the territories he controlled, in accordance to the will of his late father, King Charlemagne⁷. The 'Rule' is a set of regulations for monks created in the 6th century CE by Benedict of Nursia. The Rule prescribed monasteries to be self-sufficient and therefore to produce everything their residents needed in place. Furthermore, monks were obliged to provide meals and shelter for travelers.

It's frequently stated that monasteries produced the largest share of beer in the Early Middle Ages, but it's highly likely not true. Brewing beer was a regular activity for Middle Age households, something quite similar to baking bread. But common people haven't left any written evidence of their everyday life while monasteries were documenting their operations extensively⁸.

How to Brew Beer

Let us describe the technological process of brewing beer as it was developed in Medieval Europe and has reached our days almost unchanged.

1. First, the raw materials (e.g. malt) need to be crushed. The grinding must be rather coarse, not flour-like fine.
2. Ground malt is mixed up with water (the process known as 'mashing') and is heated up to approx. 70 degrees Celsius. At this temperature, enzymes that are present in malt convert starches to sugars. Then the solution is filtered out, and pure malt liquor called *wort* is prepared.
3. If beer is brewed with hops (see the 'Word on Hops' chapter), then the wort after mashing needs to be boiled down with an addition of hop cones for an hour or two. Sometimes wort is boiled longer to achieve a specific taste according to a recipe.
4. Then fermentation starts. Some starter is added to wort (which is often additionally filtered), or it just gathers the microbiota from the air. Depending on the microorganisms type and external conditions (like temperature or oxygen access) fermenting lasts from 2-3 days up to several weeks

and more. During this time yeasts break down sugars and produce lots of chemical compounds — notably, ethyl alcohol and complex ethers. Which substances in which proportions are left after the fermentation defines the taste of beer. Other microorganisms compete with the yeast for edible sugars, first of all, *Pediococcus* and *Lactobacillus*. If they oust yeast, beer will sour.

5. Technically, beer is ready for consumption at any moment, though usually brewers wait until the fermentation ends. High-quality beers are usually left to mature for an extended period of time, up to several months or even years.
6. Some beers continue fermenting in barrels or bottles. To enforce this process, fresh yeast and additional sugar source are added.

At stages 4-6, beer might be additionally spiced with flavor additives, including hops (so-called 'dry hopping').

Until the 20th century, the raw materials were used several times, e.g. after the first mash is complete and the wort is filtered out, the malt remains were mixed with a new portion of water and mashed again and again, up to five times. The first wort was used to produce the best and strongest beer, while secondary worts were used to make cheap and weak 'small' or 'table' beer.

The most important parameter of wort, directly affecting beer qualities, is its original gravity. It's usually measured as wort to water density ratio and is denoted with the 'OG' abbreviation. The thicker the wort is, the more alcohol could the resulting beer contain (approximately 1% ABV per 1% of density, e.g. wort with OG=1.05 might be used to produce 5% ABV beer). Another

important parameter is final gravity (FG): not all wort components are fermentable, and fermentation might be incomplete. The higher FG, the more sweet and thick the resulting beer. And vice versa: the closer to 1 FG is, the fewer non-fermented compounds remain. The ratio (the share of dissolved organics that was fermented into alcohol) is called *attenuation*. The higher the attenuation, the more effective conversion of sugars (and the less the final gravity).

It's interesting

The final gravity might be less than 1 because alcohol is lighter in weight than water. To produce such 'very dry' beer, either yeast and bacteria should be allowed to consume all the organics in the wort, or (more plausibly) the brew should be chemically filtered.

The easiest way to raise alcohol volume in the beverage is to increase the proportion of sugars. In pre-industrial times, honey or fruits were used; later, sugar cane syrup or, in the case of cheap beer, molasses or other residues of sugar production.

The alcohol produced by yeast acts as a preservative since competing microorganisms do not tolerate its presence. However, the yeast itself can endure it up to a certain threshold: brewing beer containing more than 8% ABV requires selecting specific alcohol-tolerable yeast strains.

References

¹ Correspondence of Flavius Cerialis. *Roman Inscriptions of Britain, ab Vindol. 628*

<https://romaninscriptionsofbritain.org/inscriptions/TabVindol628>

² Nelson, M. (2001), pp. 163-166

³ ibid, pp. 12-17

⁴ Stika, H.-P. (2011) *Early Iron Age and Late Mediaeval malt finds from Germany—attempts at reconstruction of early Celtic brewing and the taste of Celtic beer*. Archaeological and Anthropological Sciences, 3(1):41-48, p. 46

https://www.researchgate.net/publication/225682712_Early_Iron_Age_and_Late_Mediaeval_malt_finds_from_Germany-attempts_at_reconstruction_of_early_Celtic_brewing_and_the_taste_of_Celtic_beer

⁵ Meussdoerffer, F. G. (2009), p. 10

⁶ Poelmans, E., Swinnen, J.F.M. (2012), p. 4

⁷ Nelson, M. (2005), pp. 100-101

⁸ Unger, R. W. (2004), p. 27

Chapter 5. Bog Myrtle

Historical period: the 10th-14th centuries CE

Scene of action: Low Lands and the northern parts of nowadays Germany

The fall of the Roman Empire entailed lots of consequences, including those to the beer history. The pressure that 'civilized' Romans put on the brewing industry has ended. New powers of Ireland and Britain as well as Merovingian and Carolingian kingdoms were drinking beer with great pleasure. The Anglo-Saxons were using beer as a 'currency' for natural exchange: all kinds of duties and wages were paid with it¹.

Medieval suzerains soon began attempting to control the production of this 'currency', just like any regular state would do in their place. The taxation mechanism was soon found: Emperor Charlemagne proclaimed brewing a state monopoly and started selling it to lords and bishops, who, in their turn, monetized their brewing rights by producing beer ingredients and selling them to local brewers. After Charlmagne's death, the Empire weakened, but the monopoly persisted in German and Low States lands².

Those ingredients, or rather semi-products, were called *fermentum* in Latin, and *gruit* (*grut*, *grout* and other variants) in local languages. *Fermentum* means 'starter', e.g. some additive that makes bread and beer 'raise' (we now learned that starters contain yeasts, but in the Middle Ages nobody knew that). *Gruit* means 'grind', which looks totally unrelated. And nowadays we use the word *gruit* for a selection of aromatic herbs. This contradiction is resolved easily: medieval gruit was all of that at once.

Beer spoiling was the brewers' main problem. There were two main ways of avoiding it: increase alcohol content or add preservatives. Medieval *fermentum/gruit* helped with both. The preparation process included grinding the malt, cooking kind of a porridge, and evaporating it. The resulting malt concentrate was either a solid or a paste-like substance depending on whether cereal residues were filtered out or not. This malt porridge could have been used for making pastries, which explains using the *fermentum* and *gruit* words to denote baked goods³. Additionally, some flavor additives, mostly herbal, were mixed in.

This malt concentrate was sold to brewers, and it was indeed quite useful: adding this gruit to the wort will cause yeast to proliferate quickly and produce a large amount of alcohol, thus suppressing the growth of competing microorganisms — which for an observer would look like if gruit indeed leavens the wort. Modern reenactors managed to achieve quite considerable shelf life for such gruit beer, more than three weeks⁴.

Flavor additives also played a major role. First, they had some antiseptic effect; second, helped to conceal an unpleasant taste and smell; third, because of them, beer was considered healthy and even curative. Different sources mention more than 40 distinct additives, and 14 more were added for medicinal reasons⁵: wild rosemary, yarrow, juniper, sage, ground ivy, anise, caraway, laurel berries; pine resins were also used. In fact, every town possessed its own unique gruit recipe depending on the local flora. However, there was one most important component: bog myrtle (*Myrica gale*), which was traditionally used as both sedative and antiseptic compound. In addition, bog myrtle is rather capricious and grows (surprise!) mostly in bogs, and was a convenient subject for the state monopoly⁶.

For medieval suzerains (barons and bishops) and, later, for city magistrates gruit was a handy and understandable method of collecting taxes⁷. Towns were buying the privilege (*gruitrecht*) from their seignors and opening the 'gruit houses' (*gruithuis*)⁸. Often, instead of buying gruit in the gruit house, brewers were paying their duties in money; such a levy was called *gruitgeld* (literally, 'gruit gold')⁹.

However, the significance of centralized starter production was gradually declining. Later records indicate that in the 13th century, gruit houses were purchasing much more herbs in proportion to malt than needed¹⁰. Some scholars believe that brewers were bringing malt to the gruit houses to be mashed with gruit there (and therefore the exact recipe was kept a secret)¹¹. Since nobody cared about writing down such obvious things as gruit usage (just like any other detail regarding brewing), later researchers were convinced that gruit was just a mix of herbs to flavor beer¹².

Beer in the Middle Ages

Let us stress that beer consumption was viewed in the Middle Ages quite differently than in other epochs. Medieval beer — which was either thick, sweet, and low-alcohol, or thin, refreshing, and almost alcohol-free, depending on which wort was used for its preparation — was a regular product on tables, just like, let's say, bread or dairy products. Medieval rations were far from being nutritious and balanced, and beer, which was considered healthy and curative, was a valuable addition to everyday meals. Some scholars claim that peasants were brewing beer more often than baking bread¹³. As brewing was rather labor-intensive, there was something like an unspoken schedule, which household brews beer

which week. In England, for example, one-third to one-half of all households was occasionally brewing beer for selling¹⁴.

Of course, alcoholic intoxication was condemned by moralists; but they were condemning it using exactly the same wording as they used for condemning gluttony. Medieval beer rarely had significant ABV: to produce strong beer a lot of grain was needed, which made it luxurious and unavailable to an average person. It looks like common folk weren't consuming beer to get intoxicated; it was rather an ordinary drink meaning to get essential carbohydrates¹⁵.

Beer Myth

Many popular sources claim that Medieval people preferred beer over water, the quality of which was poor. It's a kind of manipulation: yes, they were, in that sense that given the choice whether drink beer or water they would likely choose beer — just like a contemporary person would! In the Middle Ages, people were well aware of water quality — related problems and knew quite well that the best water was that of rain or snowmelt, avoiding polluted water if they can. Some social groups like monks, sailors, or grandees, might have actually drunk beer instead of water, but that definitely wasn't a ubiquitous practice¹⁶.

How to taste

Some breweries continue using gruit nowadays. These beers might be found by 'gruit beer' or 'herbed beer' keywords. The most notable examples are:

- Belgian Steenbrugge and Gentse Gruut;
- Dutch Jopen Koyt.

The ‘historical ales’ by Williams Bros. we have mentioned in the ‘At the Dawn of Civilization’ chapter in fact fall into the same category.

It's important to understand that these beers are just using bog myrtle and other herbs instead of hops. They are totally not authentic in any other sense; it's interesting mostly as a possibility to check the real sweet taste of beer which we in the 21st century are totally unfamiliar with.

However, we might still get a real medieval *gruitbeer*. One of the most popular beer varieties from those days called ‘mumme’ (aka *mum* or *mumm*), which emerged in the 14th century, was so popular that persisted almost unchanged until the 17th century. The recipe was written down several times, and comprised wheat malt with an addition of oats and beans, fir and birch tree-tops, elderberry, cardamom seeds, bay leaf, a lot of herbs — thistle, dewdrop, burnet, betony, marjoram, gravilat, marsh mint, thyme, — and fresh eggs¹⁷.

The beer enthusiasts had reconstructed *mumme* based on those recipes, and the style now enjoys some demand. Known examples are:

- Mumm by Scratch Brewing Company;
- Hansa Mumme brewed in collaboration by 7 Fjell and Vaat Alte;
- Schiøtz Mørk Mumme by Albani Bryggerierne;

- Kongens Bryghus Julemumme by Husbryggeriet Jacobsen.

Just don't get it mixed up: the real *mumme* must be dark, thick, alcoholic, and possess quite a peculiar taste closer to a coke than beer. Thin light beer proudly produced in Braunschweig under this name (as well as an energy drink and a sweet paste) is directly related to the former glory of the Braunschweig Mumme, but totally lost any resemblance to the original recipe over all those years.

Etymological

All this confusion with the word *gruit* switching its meaning from 'starter' or 'pastry' to 'a set of herbs for beer-making' is quite a characteristical one. Almost every term related to brewing lost its original meaning, sometimes changing to quite the opposite one.

Romans and Greeks have different words for beer depending on the region of its origin: Phracian beer was called *brytos*; Spanish, *cervisia*; Egyptian, *zythos*. *Brytos* was possibly borrowed by the German tribes and became *breuwan* (or both these words derived from proto-Indo-European *bher*, to boil), which later gave birth to English *brew*, German *brauen*, and Dutch *brouwen*, and also *broth*, *bread*, and corresponding words in German, Dutch, and other European languages.

It's interesting

Words 'Brazil' and 'bride' derived from the same root as well. The former, through Old French *bresil* (to burn) that became *brasil*, meaning 'red wood' in Spanish and Portuguese (probably, because of the wood color, resembling smoldering

embers); the territory of nowadays Brazil was called ‘terra de brasil’ ('the land of redwood') by the Portuguese. As for the latter, brewing beer was one of the many bride's duties, which is quite obvious in German: Braut stands for ‘bride'; Brauer, for ‘brewer'.

Cervisia became Spanish *cerveza* and Portuguese *cerveja*, beer. It's interesting that Romans borrowed the word *cervisia* from the Celtic tribes that lived in nowadays Spain, and its origin is proto-Indo-European ‘kerm’, making it of the same root as Slavic ‘korm’, forage.

Finally, *zythos* is nowadays widely used in modern craft subculture. For example, Martin Cornell, a well-known journalist and book author, writes on the [Zythophile](#) blog.

The simplest and clearest situation is with the word ‘pivo’ that stands for ‘beer’ in Russian and other Slavic languages. It derives simply from the verb ‘piti’, to drink. From proto-Indo-European it came to the Greek language (*pinein*, to drink); from Greek to Latin (*bibere*), from Latin to Spanish (*bebida*) and Old French (*potion*), from Old French to English (*potion*, *poison*, and *potable*). Interestingly, another English word for something drinkable — ‘beverage’ — is likely derived from the same *bibere*, though the direct connection remains unclear.

Germans enriched our vocabulary with two more roots: *beer* and *ale*. The etymology of both is quite foggy; the former probably meant mead or cider initially (and therefore shares the same root with ‘bee’) as the Germans made no distinction between various sources of sugar for their beverages; or boringly derived from the very same *bibere*. As for *ale*, it influenced Scandinavian and Baltic

languages (probably, independently from English) where its derivatives (*øl*, *olut*) are still in use.

Sumerians, as we mentioned, used a lot of different words for different kinds of beer. One of them, *sikaru*, made it into Semitic languages for denoting any alcoholic beverage and was used in the Bible in this sense. Later, it entered Old French and became *cide*.

Finally, the Latin word for a starter, *fermentum*, transformed into the scientific term ‘ferment’ and in this capacity entered dictionaries of most of the world languages.

References

¹ Nelson, M. (2005), p. 88

² Meussdoerffer, F.G. (2009), p. II

³ Ruis, F. (2016) *A Note on the Essence of Gruit*. Brewery History, 166, p. 52

<http://www.breweryhistory.com/journal/archive/166/index.html>

⁴ Verberg, S. *Reconstructing the substance gruit: an experiment*

<https://medievalmeadandbeer.wordpress.com/2021/03/29/reconstructing-the-substance-gruit-an-experiment/>

⁵ Meussdoerffer, F.G. (2009), p. 15

⁶ Unger, R. W. (2004), pp. 31-32

⁷ ibid, p. 49

⁸ ibid, p. 45

⁹ ibid, p. 64

¹⁰ Verberg, S. (2018), p. 55

¹¹ Swinnen, J., Briski, D. (2017), p. 17

¹² Verberg, S. (2018), p. 50

¹³ Unger, R. W. (2004), p. 39

¹⁴ Bennett, J. M. (1996), p. 19

¹⁵ Unger, R. W. (2004), pp. 2-3

¹⁶ Cornell, M. *Was water really regarded as dangerous to drink in the Middle Ages?*

<http://zythophile.co.uk/2014/03/04/was-water-really-regarded-as-dangerous-to-drink-in-the-middle-ages/>

¹⁷ Hornsey, I. S. (2008), pp. 388-389

Chapter 6. Word on Hops

Historical period: the 14th-16th centuries CE

Scene of action: German, Baltic, and Netherlands

Cities

Starting from the 14th century CE, gruit usage (and therefore gruit monopoly profits) begin to decline. The reason was the spread of a cheaper, more effective, and more convenient additive: hops¹.

First, hop bitterness allowed to beat unpleasant odors off. Second, hops were a way more effective preservative than herb mixture: alpha acids (or rather their isomers produced by heating wort) present in hops suppress the growth of bacteria, which prolongs the shelf life of beer up to half a year and even more. Third, and probably most important, brewing with hops allowed for using the raw materials more efficiently. English documents from that time mention that adding hops results in producing twice (!) the amount of beer from the same amount of grain²: wort might be left to ferment longer, allowing more sugars to convert into alcohol without the risk of spoiling.

The monks were probably the first who started brewing with hops, as the monasteries were the only beer producers in the early Middle ages who made enough beer to care about prolonged keeping³. The first known mention of adding hops to wort comes from 822 CE in the instructions of Adalard, the abbot of Corbie, France, written for his brothers. In the 9th-10th centuries CE, the usage of hops in monasteries was already widespread, being found both in chronicles and archeological evidence. Furthermore, hops were sometimes a part of gruit⁴. And yet, it took several hundred

years (!) for hops to dismiss gruit⁵. A few reasons were named by scholars.

1. Technological issues: hops start to work as a preservative only if boiled (which allows alpha acids to isomerize, and it's the isomers that possess anti-bacterial properties). Hops added to gruit are useless from that point of view, and they might even spoil the wort. So brewing with hops implies having an additional step of boiling wort with them for an hour or two. Hops became generally used when brewers accumulated enough capital to have separate vessels for mashing (e.g. preparing wort from ground grain and water) and boiling⁶.
2. The bitter taste of hopped beer repulsed consumers⁷. We now think that modern beer has a neutral taste, but for a 15th-century Englishman, the sweet taste of ale was so habitual that bitter beer was drunk only by Dutch ex-pats despite its production being twice more cost-effective⁸.
3. Hops undermined the monopoly on beer ingredients, so their usage was frequently opposed by local authorities, especially in the Dutch towns⁹.

One way or another hops started to supersede gruit in the 13th century, region after region. The important consequence of that (apart from bishops' and barons' whining about their incomes¹⁰) was the beginning of commercial brewing at scale. Beer became a product to deliver to other towns, not just local ones.

It's interesting

The true meaning of the word ‘gruit’ was already forgotten in the 15th century. There are surviving examples of using it as a synonym for brewing tax (sometimes even as *hoppengruit*, literally ‘the hops gruit’) and also as a verb meaning mixing something as an ingredient¹¹.

With technological advancement, the division of labor emerged. Brewing beer and selling it became different occupations. First brewers' guilds and beer trade regulating laws are known since the 13th century in English and German lands¹².

Beer, however, is a product poorly fit for transportation because of its considerable volume and weight. Moving beer by roads is suboptimal: the cost of a barrel increased by 25-70% every 100 kilometers, depending on the ground type¹³. The beer trade wasn't a luxurious one, and its margins were low. But beer was quite a convenient commodity for maritime transportation, given that it was a customary product to provide drink and calories to the sailors. First mentions of the naval beer trade began in the Viking era, circa the 11th century CE; in the 12th century, Bremen and Brugge were already dealing beer at scale. But the *real* maritime beer trade started with the development of the Hanseatic League¹⁴.

One of the two founding cities of Hansa, Hamburg, had literally become the world brewing capital in the 14th century (partly because of being one of the earliest abolishers of the *gruitgeld*). In 1369, Hamburg exported 13.3 million liters of beer and consumed probably the same amount locally¹⁵, having around 14 thousand inhabitants. At its peak, the Hanseatic League sold more than 50 million liters per year, and the League's navy drank another 25 million¹⁶. Beer gave jobs to roughly half of Hamburg's craftsmen (475 out of 1075 in 1376). Other cities of the League weren't that far

behind: there were 300 brewers in Bremen, 250 in Erfurt, 200 in Wismar and Leipzig (each), and 180 in Lubeck¹⁷. Another number is even more impressive: 25-40% of all the grain that those Medieval cities were buying was used by brewers¹⁸.

In the 15th century, however, the Hansa started to lose markets: the Dutch were forcing them out of the business as the more advanced maritime power and the more efficient beer producer alike¹⁹. During the second half of the 14th century, the Netherlands, figuratively speaking, converted from an agrarian village to an industrial city. The most important industrial sector was undoubtedly the textile one; but for sure brewing was the second-most important one²⁰.

The Delft — Gouda — Haarlem triangle became a center of the Low Lands beer industry. These three cities were producing 100 million liters of beer in the second half of the 15th century and at the beginning of the 16th century²¹, having a combined population of approximately 40 thousand people. In the heyday of beer production in the Netherlands (starting from the end of the 15th century up to the beginning of the 17th century) the beer incomes (including excise, taxes, and customs duties) of many Dutch towns comprised one to two-thirds of the total income²².

How to try

Given the ferocious competition between dozens of cities and hordes of brewers, there is no surprise that new beer trademarks were emerging, reaching heights, and disappearing into nothing *in hundreds if not thousands*. One expert, Heinrich Klaus, counted 150 types of German beer only. To denote all these beers a plethora of words with dubious etymology and ever-changing meaning was

used²³. Nevertheless, some of them gained so much popularity that they were still in use centuries after, and because of that, we may taste them today. (The longer a beer style existed, the higher the probability somebody bothered to write the recipe down was!)

The most authentic of such ‘dinosaurs’ is the modern reconstruction of one of the most popular beer styles of the 14th century, the Dutch *koyt* (also spelled *kuyt* or *kuit*). You may judge how influential this beer was by the fact that citizens of Leeuwarden revolted in 1487 because *koyt* imports from Haarlem had been banned²⁴.

The notable characteristic of *koyt* is using a large proportion of oats (more than 50%) which was the most widespread grain in the Netherlands during those times and probably allowed brewing better beer for the same money²⁵. Nowadays many microbreweries in the Netherlands (and some in the US) produce beer in this style:

- the most precise reconstruction named Klavervier Koyt; brewers from Klavervier not only produce authentic beers but also contribute to the research of brewing history;
- two Jopen brands, Padvinderskuiten and Frans Hals Bier (Jopen Koyt despite its naming *is not a koyt*);
- Oedipus Shampoo;
- Elora Windmolen Dutch Kuyt;
- Noord-Hollander Kuyt Bier;
- Grutte Pier Kuit;
- Ramses Bier Kuiter;
- Leidsch Kuitbier;
- High Oats by the Jabeerwocky-Nepomucen collaboration;
- Koyt by the Wander-Reuben's collaboration.

Another beer style originating in the 14th-16th centuries is called *bock*. It is told that its name derived from the city of Einbeck; that Martin Luther particularly loved that beer, and that he strengthened his will at the Diet of Worms of 1521 with it²⁶. However, we tend to be very skeptical regarding this story as the sources that tell it are quite far from being reliable. Nevertheless, technically speaking *bock* is quite close to the alleged pinnacle of the brewers' art of the 16th century: dark (of course) aged (therefore lacking smoky flavors) strong (means 'expensive') hopped beer. Einbeck, being a Hanseatic League member, was famous for its rigid control over beer quality²⁷.

What is called 'bock' in nowadays Germany is a totally different beer style, a dark strong lager (see the next chapter). Dutch brewers (La Trappe, Hertog Jan, Jopen) and the Belgian ones (Leute) are closer to the canonical recipe. Still, German *bockbier* (such as Ayinger Celebrator, Paulaner Salvator, Spaten Optimator, and other -or's) are quite good, though represent a later brewing tradition.

References

¹ Swinnen, J., Briski, D. (2017), p. 17

² Bennett, J.M. (1996), p. 85

³ Unger, R. W. (2001), p. 27

⁴ Nelson, M. (2005), p. 110

⁵ Unger, R. W. (2004), pp. 54-55

⁶ ibid, p. 56

⁷ ibid

⁸ Bennett, J. M. (1996), p. 60

⁹ Verberg, S. (2018), p. 56

¹⁰ ibid

¹¹ ibid, p. 57

¹² Meussdoerffer, F. G. (2009), p. 13

¹³ Unger, R. W. (2001), p. 27

¹⁴ Meussdoerffer, F. G. (2009), p. 16

¹⁵ Unger, R. W. (2004), p. 60

¹⁶ Meussdoerffer, F. G. (2009), p. 17

¹⁷ Unger, R. W. (2004), pp. 63-64

¹⁸ Meussdoerffer, F. G. (2009), p. 15

¹⁹ ibid, p. 20

²⁰ Unger, R. W. (2001), p. 55

²¹ ibid, p. 73

²² ibid, p. 69

²³ Unger, R. W. (2004), p. 185

²⁴ <https://history.stackexchange.com/questions/23532/what-exactly-happened-with-beer-and-leeuwarden-in-1487>

²⁵ Unger, R. W. (2001), p. 127

²⁶ Jackson, M. *Original Bock: the beer the doctor ordered*
<http://www.beerhunter.com/documents/19133-000034.html>

²⁷ Swinnen, J., Briski, D. (2017), p. 19

Chapter 7. The Cold of Alpine Caves

Historical period: 15 century CE

Scene of action: Bavaria

Let's now discuss another vital beer ingredient: yeasts. Without them, you can't brew beer, make wine, or bake bread — which means they were in some sense 'domesticated' several thousand years ago. That makes the fact that we actually know very little about yeast domestication even more surprising.

We are now aware of more than 1500 yeast species. And when humanity started learning brewing, wine-making, and baking, many different 'wild' yeast kinds were used for leavening.

However, at the end of the 19th century when microbiologists began to study yeasts, it turned out that winemakers and bakers were using one very specific species: *Saccharomyces cerevisiae*, or simply 'baker's yeast'. How exactly did humans isolate that specific yeast from the broad spectrum of wild species is right now quite unclear. We don't even know whether our ancestors found *S. cerevisiae* in the wild, or bred it, and when this actually happened. The latest research demonstrates that quite probably *S. cerevisiae* was first isolated during the industrial revolution in brewing, e.g. relatively recently¹.

But instead, we rather well know the history of another yeast species used by brewers, *S. pastorianus*. It was actually bred by humans as a result of the hybridization of the above-mentioned *S. cerevisiae* and 'wild' *S. eubayanus*² presumably in the 15th century CE in Bavaria. In those times brewers were struggling with

beer spoilage and unpleasant odors, and low temperature helped with both. In their determination to produce better beer Bavarian brewers (probably, monks of the secluded monasteries³) began to keep their beer in the cold of Alpine caves, just several degrees above zero Celsius — and bred new yeast species. Traditionally, beer was left to ferment at room temperature (around 20 Celsius) for several days; a new Bavarian technique implied a prolonged fermentation period (roughly 3 weeks) and then storing beer at 5-10° Celsius for an even longer period of time. This new type of beer was called ‘lager’, meaning ‘to store’ in German. A ‘lagerization’ as a specific brewers’ activity was first mentioned in 1420 CE. However, it was not widespread until the 60s years of the 19 century, because of obvious reasons: the technology required a huge amount of ice to be used⁴.

How to taste

First lagers were still dark beer (and remained as such up until the 20th century), so the most authentic ones are contemporary German dark lagers (so-called *dunkelbier*) or German *bockbier*, which is being produced utilizing the lager technology. You may take any *dunkel*: in fact, that's quite common modern dark beer. The most praised examples of the style are Ayinger and Andechser, though for a full submersion you might try to find Weltenburger (the brewery at the Weltenburg Abbey was founded in 1050 and is considered to be one of the oldest in the world) or Spaten Dunkel (which is produced since the 14th century).

The taste and the temperature

Yeast kind defines not only the rapidity and the temperature of the fermentation but also how the process looks like. Baker's yeast ferments intensively, forming a think foam at the tank's surface which brewers often used as a starter for the next brew. At the same time, lager yeast behaves calmly, doesn't produce a lot of foam, and sinks to the bottom of the vessel. That's why corresponding beverages are colloquially called 'top-fermented' and 'bottom-fermented' beers respectively — though brewers had long ago developed baker's yeast strains that sank to the bottom as well. The 'high-temperature fermentation' (or 'warm-') and 'low-temperature fermentation' terms would describe the situation much more adequately but regrettfully see rare use.

For high-temperature fermented beers, the word 'ale' is now used almost universally (which has exactly zero historical justification), and the *S. cerevisiae* yeast is likewise dubbed 'ale yeast'. In this book, we use the word 'ale' only for beverages that were called ales at the time they originated, and not for denoting yeast species. If such an indication is needed, in this book it's always explicit. Other yeast species used by brewers (of *Brettanomyces* genus, for instance) are also considered 'top-fermenting'.

The difference between high-temperature fermentation and low-temperature one is that chemical reactions happen more turbulently at higher temperatures and enrich beer with complex ethers that are responsible for the flavors of bananas, raisins, berries, etc. Low-temperature beer will have a more accentuated 'bread-like' profile and comprise fewer tinges in its taste and aroma. Interestingly, lager yeast might be forced to ferment at higher temperatures; the resulting beverage is called *steambeer*.

References

¹ Gallone, B., Mertens, S., Gordon, J.L., Maere, S., Verstrepen, K., Steensels, J. (2017), p. 149

² ibid, p. 151

³ Jackson, M. *The birth of lager*
<http://www.beerhunter.com/documents/19133-000255.html>

⁴ Meussdoerffer, F.G. (2009), p. 28

Chapter 8. The Beer Purity

Historical period: the 16th-17th centuries CE

Scene of action: Bavaria

Right after the beer trade had begun, early laws regulating it emerged. Two main issues are bothering authorities of all the brewing regions: ensuring the quality of the product and taxation. It's quite possible to take some specific areas and observe how the development of the brewing industry leads to the local legislation becoming more and more strict¹.

The first laws that prescribed mandatory employing of some brewing techniques are known since the 12th century CE² and, generally speaking, were quite an ordinary thing for any brewing region. Still, one of them is outstanding: the Bavarian beer purity law of 1516, also known as *Reinheitsgebot* in German.

It's interesting

'The Beer Purity Law of 1516' is not about the beer purity, and was not adopted in 1516. However, it is widely known under that name. Such laws were in effect independently in Munich since 1487 and in the remaining parts of Bavaria since 1493. After Bavaria was united under Munich those two laws were compiled into one, and this edition of Apr 23, 1516 is called 'Reinheitsgebot'.

Contrary to other cities' magistrates that were randomly adopting and then soon canceling their beer laws, the Bavarians demonstrated truly German obstinacy and love for order. Can you imagine that adopting the *Reinheitsgebot* country-wide was the condition of Bavaria joining the united Germany state in 1871³?

Beer Myth

On the Internet, you might find the statements that the *Reinheitsgebot* was the first law regulating the quality of beer (which is not true) or even food in general (which is *absolutely* not true as those laws already existed in Ancient Rome). It is also incorrect to say that *Reinheitsgebot* is the oldest *acting* food industry law, as it was abolished by the European Court of Justice in 1987⁴ — so the Bavarian adherence to principles got rather diminished in those 100 years that passed since the Bismark times.

The law consists of several clauses that might be grouped into two categories:

- price regulation (the law sets both the maximum retail price and the maximum allowed grist for resellers);
- beer quality insurance.

It's interesting

Many beer-regulating laws prescribed the maximum price just like the *Reinheitsgebot* did. So in case of poor harvest or monetary inflation, brewers were not able to raise the price. Instead, they lowered the quality bar by using less grain.

That's why popular beer brands degraded quickly, and new ones were constantly emerging⁵.

In this law, the famous formula is stated: beer must be brewed with only three ingredients, namely water, barley, and hops. So nowadays in popular opinion, the *Reinheitsgebot* is something like a 'Silver Bullet' for ensuring the beer quality. Brewers often mention it in their commercials, and craft bars are frequently named '1516'.

In the reality, the importance of the formula was not about the ingredients it allowed, but rather ingredients it prohibited. First, *Reinheitsgebot* abolishes *gruit* and requires using hops only; second, it was meant to ensure the food security for the Bavarian burgers by prohibiting using non-forage crops for beer making, most importantly wheat.

Bavarian White

In the 15th century Bavaria a fashionable beer style occurred: the white (*weisse*) beer that was lighter than the Bavarian lagers because of some brewing tricks. One of the means of 'whitewashing' beer is using wheat (*Weizen*): wheat beer got a high white foamy head, and wheat itself might be used fully or partly unmalted. Approximately at the end of the 15th century these two words — *Weissbier* (e.g. 'white beer') and *Hefeweizen* (literally, 'yeast wheat') — started to mean exactly the same: wheat beer.

There is no consensus among scholars whether using wheat for brewing was a real food security problem, but the fact is undeniable: by introducing the 'Beer Purity Law', Wilhelm IV had legally outlawed using any grain but barley. However, Wilhelm's

son, Albrecht V, made an exception to this rule in a form of a state monopoly — presumably under the pressure of consumers that were not willing to comply. Initially, the right to brew wheat beer had been granted to Count Degenburg, but after his death returned back to the Crown. The reigning Duke, Maximilian I, had quickly learned that this monopoly might have brought considerable profits as Bavarians liked wheat bear much and were eager to pay for the ‘forbidden fruit’, especially as it was the only kind of beer allowed to be brewed in summer. Maximilian founded an entire network of state breweries, one of which — former Weisses Bräuhaus — has survived until today⁶.

Finally let us mention that beer made of wheat was produced for millennia, starting with Sumerians and Egyptians. 14th-century Hamburg was particularly praised for its wheat beer⁷. The Bavarians borrowed the technology from Bohemian brewers who had been producing wheat beers since the 12th-13th centuries CE⁸.

How to Taste

Out of the ten oldest breweries in the world, several at once are located in Bavaria.

- Weihenstephaner: the brewery at the Weihenstephan Abbey was first mentioned in 1040 (though some scholars believe that the corresponding document is a later forgery, we know for sure about cultivating hops in the monastery garden since at least 768 CE) and is generally believed to be the oldest continuously operated brewery in the world;
- Weltenburger: mentioned in the previous chapter, this abbey brewery is ten years younger than Weihenstephaner;

- Augustiner-Bräu: the brewery at the monastery of Augustine order, it was first mentioned in 1328, and was supplying beer for Bavarian dukes' households until the end of the 16th century;
- two breweries that later formed the Spaten-Franziskaner Group, unsurprisingly that of Spaten (existed since 1397) and Franziskaner (since 1363); the former, however, does not produce wheat beers and is much better known for its lagers.

There are also two slightly younger breweries:

- Staatliches Hofbräuhaus (the 'Hofbräu' trademark) — the 'state court brewery' founded by Wilhelm V himself in 1589;
- G. Schneider & Sohn (the 'Schneider Weisse' trademark) — the venture of Georg Schneider's that had eventually bought several former ducal breweries in 1924; one of them, *the Weisses Bräuhaus* in Kelheim, was established by Maximilian I at the beginning of the 17th century to implement duke's monopoly on wheat beer.



The Weissen Bräuhaus in Kelheim, Bavaria. Constructed in 1607

Image Credit: Richard Huber

There are reasonable doubts regarding the continuity of all these beer producers' traditions. For example, the Weltenburg abbey was disbanded in 1803 and reinstated only 40 years later. Still, the benchmark Bavarian wheat beers are produced by those companies, and the Weihenstephaner is considered to be the best.

As with *bock*, it's hard to tell if nowadays Bavarian *Hefeweizen* really resembles the historical *Weissbier* of the 16th century. Out of general considerations, the duke beer of that period should be closer to what we now call a 'weizenbock', e.g. relatively strong wheat dark. The reference *weizenbocks* are Mein Aventinus (AKA 'Tap 6') by Schneider Weisse and Vitus by the Weihenstephan brewery.

References

¹ Unger, R. W. (2004), p. 69

² Meussdoerffer, F. G. (2009), p. 26

³ <https://en.wikipedia.org/wiki/Reinheitsgebot>

⁴ Leonard, D.J. *10 Things You Might Not Know About the Reinheitsgebot (Beer) Purity Law of 1516*. Beer Syndicate Blog

<https://beersyndicate.com/blog/10-things-you-might-not-know-about-the-reinheitsgebot-beer-purity-law-of-1516/>

⁵ Unger, R. W. (2004), p. 187

⁶ Staudt, A. (2015) *Brewing Bavarian Weissbier – all you ever wanted to know*. brau!magazin

<https://braumagazin.de/article/brewing-bavarian-weissbier-all-you-ever-wanted-to-know/>

⁷ Unger, R. W. (2004), p. 185

⁸ The Oxford Companion to Beer (2012) *Weissbier*

Chapter 9. Barrels and Bretts

Historical period: the 16th-17th centuries CE

Scene of action: England

After the Netherlands had switched to hopped beer, Britain remained the only bastion of the sweet malt beverage (which they called ‘ale’). At the beginning of the 15th century CE, England was consuming an enormous quantity of that: a gallon of ale per day (approx. 4.5 liters) was a golden standard for provisioning soldiers, servants, monks, and even hospital inmates¹.

Quite detailed descriptions of British ale technology survived; importantly, they prescribe no boiling of wort, so ale was doomed to spoil very quickly. Furthermore, sometimes even gruit was not included in the recipe, which made the resulting product even less stable. A 1542 instruction specifically points out that ale should not be kept for more than five days². Under those conditions, wort was not allowed to ferment fully: attenuation (e.g. the share of soluble compounds that yeasts had consumed) was low. Ale was much more thick and viscous than we are accustomed to nowadays. If required to make a beer that might be kept longer, brewers had to increase alcohol content and spend a ridiculous amount of grain.

It's interesting

One of the most prized kinds of ales in the 16th-century England was a replica of German *mumme* (see the ‘Word on Hops’ chapter) — with a British accent, as some *mumme* ingredients were not growing in British isles.

Probably, that instability of ale (and therefore a lack of major producers) was one of the reasons why England resisted hops for more than 200 years. Archeologists found traces of hops in fossils dated all the way down to the 10th century CE, and the first documents mentioning hopped beer are known since the 14th century CE³. However, despite technological advancements, hops started to play a significant role in brewing only in the 16th century CE.

Initially, it was immigrants (German, Dutch, and Flemish ones) who started to brew hopped beer — to be consumed by themselves, and, ironically, to be sold to the Netherlands⁴. Englishmen even borrowed the word to denote the ‘foreign’ beverage: *bier*, which later became ‘beer’. That led to a paradoxical situation of two independent guilds — beer makers and ale makers — existing simultaneously and quite actively fighting each other⁵.

Beer Myth

Using the different words for beer and ale resulted in a common misconception, shared by many scholars, starting with the witnesses of the epoch and ending with the authors of comprehensive monographs written in the 21st century — the one that states hops were prohibited in the 16th-century England. That's not true: it was prohibited to brew *ale* with hops, but it was never prohibited to make *beer* with them. This legend was first voiced by Thomas Fuller in 1662, and since then it continues traveling from one book to another. Also, it is sometimes stated that Henry VI banished hops as a ‘pernicious and wicked weed’: this false quote originates in the same book of Fuller's⁶.

Foreigners were seemingly losing this war; however, the sheer historical inevitability forced English monarchs into supporting ‘alien’ producers. England was struggling to become a naval power, and that was impossible without beer (and not just any beer, but that one of certain quality: it must have had enough shelf life to survive several months in a voyage, and ideally be cheap). In the 15th-16th century CE, beer was a norm of life for European sailors being literally consumed instead of water. Ships were supplied with beer at the rate of 3 to 5 liters per a crewman per day universally throughout all the northern parts of Europe⁷, from Netherlands and Hansa to Russian Empire under Peter the Great⁸. English monarchs were shipping beer to their overseas garrisons since the 15th century⁹, and at the end of the 16th century Samuel Pepys, the Secretary of the Admiralty, secured a one-gallon daily ration of beer for sailors¹⁰.

The other reason why hopped beer was slowly but steadily advancing was the ability to brew stronger beverages. Because of low attenuation, English ale likely contained not more than 2.5% ABV; the elite ‘double’ (e.g. brewed with a double measure of grain) kinds of ale reached maybe 5%. Hopped ‘double’ beer might be 8-10%, and even stronger versions (so-called ‘doble-doble’, e.g. the ‘double-double’), up to 15%. In the 16th century, the English gentry was literally hunting for stronger beers, as they were a substitute for expensive imported wine and brandy. Edward VI, Mary I, and Elizabeth I were in turns fighting against the ‘doble-doble’ but had not succeeded, apparently¹¹.

It's interesting

The final victory of beer over ale happened in 1710, with the Parliament banned hop substitutes (of course, for taxation reasons)¹². The language changed as well: starting from the 17th century, the words 'ale' and 'beer' began meaning slightly and strongly hopped beer respectively. Paradoxically, the legal distinction between beer and ale persisted: for example, beer was prescribed to be sold in 36-gallon barrels, while ale was to be sold in the 32-gallon ones¹³.

The beer production had been constantly increasing all over the 17th century, reaching its peak in 1691: London had brewed more than 2 million barrels, e.g. approximately 300 million liters, having a population of 600 thousand — that's five liters of beer per day per each inhabitant, including children.

The technology advancement impacted English beer bars (*alehouses*, taverns, or since the 17th century 'pubs' — short for a 'public house'): if ale was to be sold short after it's brewed, beer might be kept for a prolonged time, so new terms occurred: 'mild ale' or 'running ale' for fresh beer, and 'keeping ale' or 'stale ale' for aged beer — or rather aged beer actually came into being as a mass product. (Unhopped ales could be kept for a prolonged time as well, but only the strongest and most expensive ones¹⁴).

While producing those keeping ales, English brewers had created and developed a new technology (initially by accident, presumably). Beer stored in a barrel for a long time continued to slowly ferment: barrel planks gave shelter to yeasts, initially being inoculated by accident, and later simply absorbing remains of the previous brew. 'Wild' yeasts, unlike the baker's and the lager ones, are much more resilient (it was impossible to purge them from barrels) and are capable of fermenting under little oxygen supply,

breaking down complex sugars (maltodextrins) that are present in abundance in thick wort and normally are not consumed by regular baker's yeasts — but they did it very slowly, for many months.

So, finally, after a year or two, the beverage in the barrel will be quite different compared to the initial one. First, beer loses its carbonation. Second, it becomes stronger in alcohol content and extremely dry: during the prolonged keeping time yeasts will break down all fermentable sugars. Third, the look and the taste change: beer becomes more clean and clear, the hop bitterness ceases, and the characteristic acidity (or even tartness) is added up alongside the taste of the barrel itself. As a result, tavern keepers got new work to do: mixing up a high-quality but stale aged ale with a fresh one to get some better-tasting beer to sell.

These aged beers were called 'stale' (from 'stall'¹⁵), 'keeping', 'old', and starting from the 17th century — 'stock'. Typically, they had 6% alcohol by volume, though stronger beers having 10% or even more were also produced to please the respected gentlemen's tastes (such strong beers since the 19th century are known as 'barleywines').

British stock ales were aged sometimes for 5, 10 and more years (*much more: there is a batch of Bass No. 1 strong ale brewed in 1869, and it's still drinkable*¹⁶).

How to taste

'Real' English ale can't be bought because of its short shelf life, but you might try brewing it yourself¹⁷.

Stock barrel-aged ales are not being produced for a long time now, but there are several craft reconstructions, most notably — Greene King Strong Suffolk / Olde Suffolk, which is being prepared as a mixture of fresh ale and the stale one, aged for two years.

Apart from authentic stock ales, there is a lot of ‘old ales’ being produced nowadays. However, ‘old ale’ is an umbrella term for several different beer styles of different ages. The closest to the 17th-century ales are dark barrel-aged beers. The classics are English Robinson Old Tom, Theakston Old Peculier, Adnams Tally Ho!, and Scottish Harviestoun Ola Dubh. Stock ales were quite popular in the US, so many American brewers produce them as well — for example, Alesmith Olde Ale or Founders Curmudgeon Old Ale.

As for beers that are called ‘mild ales’ today, it is a much more contemporary invention, having nothing in common with the 17th-century ones.

It's all about yeasts

In the beginning of the 20th century, Niels Claussen, a Carlsberg Labs employee, found a new species of yeasts in British stock ale that were responsible for adding the famous ‘British taste’ to beer. Claussen named the new kind of microorganisms ‘*Brettanomyces*’, e.g. ‘The British fungus’, literally¹⁸ (which is totally correct in Latin; however, somehow a variant with a typo became normative: *Brettanomyces*, with ‘e’). *Brettanomyces* (or ‘bretts’ in the brewers’ slang) today are the third choice of yeasts for a brewer (after the lager and the bakers’ ones). Some breweries specialize in ‘bretts’, and also some wineries employ them as well.

Almost every style of the 17th-18th century aged beers — stock ales, porters, pale ales as well, as we will tell in the next chapters — were passing a phase of secondary fermentation driven by ‘bretts’, simply because it was impossible to get rid of them. Nowadays, ‘wild’ yeasts are considered to be brewers’ worst enemies, and all the equipment is sterilized to avoid inoculating wort with unwanted microorganisms. That’s why contemporary ‘old ales’ have nothing to do with the original technology: except for craft restorations, only Belgian *saisons* and brown ales (which we will describe in detail in the second section of this book) preserved the original taste of those beers.

It's interesting

Also, *Brettanomyces* are notable because of being the first patented microorganisms in human history, as Claussen was granted a patent No. GB190328184 for his discovery.

References

¹ Bennett, J.M. (1996), p. 17

² Hornsey, I.S. (2008), p. 324

³ ibid, pp. 309-312

⁴ Bennett, J.M. (1996), p. 80

⁵ Hornsey, I.S. (2008), p. 323

⁶ Cornell, M. Myth 2: Hops were forbidden by Henry VI

<https://zythophile.co.uk/false-ale-quotes/myth-two-hops-were-forbidden-by-henry-vi/>

⁷ Unger, R.W. (2004), p. 129

⁸ Дурлов, И.Г.(2014.)

⁹ Krenzke, J.R.(2014), p. 39

¹⁰ Meussdoerffer, F.G.(2009), p. 22

¹¹ Cornell, M.(2010), pp. 157-158

¹² Cornell, M. *A short history of hops*

<https://zythophile.co.uk/2009/11/20/a-short-history-of-hops/>

¹³ Cornell, M.(2010), p. 28

¹⁴ Krenzke, J.R.(2014), p. 22

¹⁵ Cornell, M.(2010), p. 26

¹⁶ ibid, p. 160

¹⁷ Kerthjalfadsson, T. (1998). *Recreating Medieval English Ales (a recreation of late 13th - 14th c. unhopped English ales)*

https://www.cs.cmu.edu/~pwp/tofi/medieval_english_ale.html

¹⁸ Cornell, M.(2010), p. 161

Chapter 10. The Beer of the Industrial Revolution

Historical period: the 18th century CE

Scene of action: London

At the end of the 17th century CE, all the prerequisites for the industrialization of brewing in England were in place. Chaotic and semi-professional ale producers were superseded by organized, commercially-minded beer brewers. There were more than 17 thousand licensed drinking premises in the country (one per 183 inhabitants)¹, and the beer business comprised 28% per of GDP² — however, no real *industry* existed: beer was consumed on-premise in those thousands of alehouses.

The impetus that catalyzed the industrialization came in a form of an excise tax turmoil. England entered the Nine Years' War of 1688-1697 and in a search of additional funding the government, exquisitely as hell, created a total mess with taxation, raising beer levies dramatically³. Brewers were forced to seek 'optimizing' the taxes and soon found the loophole: from the legal point of view, there were 'strong' and 'weak' beers, but the exact alcoholic content was not prescribed. So to ease the tax burden, one could brew a batch of very strong beer, pay the levies, and then dilute it with weak beer. This beverage prepared for future blending was called 'double', 'three-threads', or 'stout' (meaning 'hard') beer. As a result, clandestine mixing of the semi-products to get a ready-to-use consumer product became a widespread practice among tavern keepers⁴.

Beer Myth

It's often said that the 'three-thread' beer was a blend of three kinds of beer: stale, fresh, and pale. This is probably just an urban myth: 'three-threads' was just a mix of keeping and running ales⁵. Still, mixing up just two threads was nevertheless hard (and dangerous) job for tavern keepers.

In the end, the beer production dropped, and the collected tax sums became even smaller than before (partially, that was because of 'gray' schemes, of course, but the overall beer consumption still decreased significantly). In order to overcome the illicit stout blending, lawmakers introduced an additional levy on malt itself, which led to further degradation of the industry⁶.

These hide-and-seek games with the government were finally resolved at the beginning of the 18th century in the most progressive manner: some nameless innovators started to brew a beverage called 'entire-butt' (or rather 'intire-butt' as they spelled it those days), e.g. 'the full barrel'. To make this beer, all four or five worts prepared from one batch of grain (in this case, the cheapest 'brown' malt) were mixed back, intensively hopped, and then aged for some time in a large barrel (which was called 'butt').



Paul Sandby, 'The encampment in Hyde Park', 1781. The sign states: 'Pooles / Intire Butt Beer / Fine Ale & Amber'
Public Domain

There were other innovations: the inventors of that new beer were the first who approached the beer production with an engineer's pedantry to control *precisely* how the product is prepared. In particular, they started drying malt implying a specific temperature profile instead of just leaving it in a kiln for several days: the heat was gradually increasing, giving the sharp rise at the very end of the process, to make malt 'pop' like popcorn (this type of malt was conversely called 'blown'⁷). Wort made from this malt might ferment at a higher temperature meaning it was less likely to turn sour and was fit to be brewed in summer. As this beer got spoiled less frequently and generally became less capricious, the sizes of 'butt'-barrels began to increase thus allowing for scaling the production. This product was ready-to-use, no need to mix it with anything, and — the most important part! — it cost half-penny less than analogous blended beers⁸.

Interestingly, first 80 or so years this beer was called just ‘entire-butts’, but finally another naming prevailed: *porter*. This beverage was so enormously popular among port workers that *porter* (initially just a euphemism) superseded other names. One scholar claims that porter consumption provided 2000 calories per day for an average London port worker in the 18th century^{9!}

Basically, the earliest porters were pseudo-‘keeping ales’ made from the cheapest malt with the lack of alcohol (typical ‘old ale’ was stronger) being compensated by adding hops in abundance. The scheme worked because lawmakers somehow overlooked the possibility of putting excises on hops as well¹⁰. Brown malt was cheap because it was dried in a wood kiln (thus absorbing smoky flavors) while quality malts were dried over more expensive straw. Even in the 1890s, some porters were advertised as having ‘the flavor of the wood’¹¹, so the consumers had probably developed something like a Stockholm syndrome towards that smell and taste.

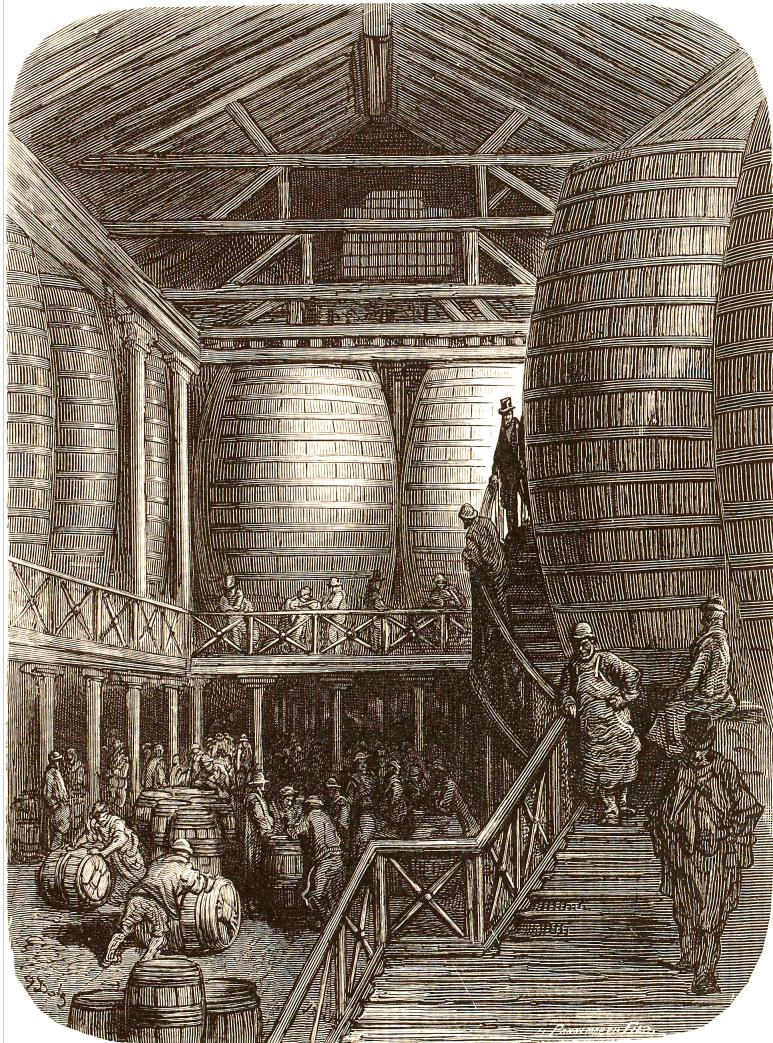
It's interesting

Later, in the middle 18th century, brewers started to keep porter for maturing, thus giving birth to terms ‘mild porter’ and ‘stale porter’, so tavern keepers were not enjoying abolishing beer blending for long. The word ‘stout’ had not rested in peace as well: it soon became a designation for the thickest and heaviest porters. Also, the porter itself was always a ‘beer’, not ‘ale’: up until the middle 20th century you would have got a pint of porter if you had asked for a ‘beer’ in a British pub.

London brewers took a pedantic approach not only towards brewing procedures but to the beer business as a whole, being very rigorous about the statistics: when the beer was prepared, whom it was sold to, what was the price, etc. It was probably the first time in history when the accountants became more important than master brewers themselves¹². Later, in the 1770s, the Londoners were first to start using the measuring tools (namely, thermometers and hydrometers) for brewing, and it was them who installed the first steam engines in breweries as well¹³.

The combination of these three factors — effectiveness, cheapness, and readiness for immediate use — had made a revolution in the brewing industry, or rather *had created* the industry. ‘Entire-butts’ took over London alehouses with a lightning speed, and after them, the entire world. This beer style had quickly become truly global, being shipped to the New World, Australia, the Russian Empire, India, and every other corner of the globe.

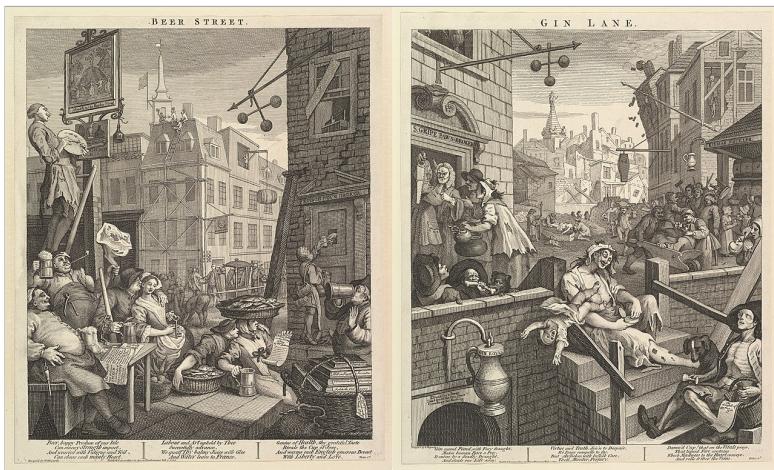
The vat sizes were growing even faster. In 1736, Humphrey Parsons installed new barrels of a record 200 thousand liters each in his brewery; six decades later, the largest vat could hold quite close to three million liters of beer¹⁴ with iron staples alone weighing 80 tons. In 1814, a relatively small 600 thousand liters barrel exploded and caused a real beer flood that killed eight people¹⁵.



Gustave Doré, Blanchard Jerrold, 'London, a pilgrimage. Chapter XVI, The town of malt. The great vats.', 1873
Public Domain

The production scale and the level of monopolization were increasing as well. Law favored large-scale brewers and in the middle 18th century just two of them — Calvert and Thrale — were controlling more than 40% of beer production in the city¹⁶.

In 1751, painter William Hogarth created a pair of prints named 'Beer Street' and 'Gin Lane'. The former depicts urban porter connoisseurs — cheerful, buoyant, and healthy. (The latter, as you might have guessed, portrays exhausted and insane lovers of that god-awful gin.)



William Hogarth, 'Beer Street and Gin Lane', 1751

Public Domain

How to Taste

Sounds weird, but the first truly global beer style (e.g., porter) had eventually gone into decay and was not produced at all in the United Kingdom from the beginning of the 1950s till 1978. Stouts were luckier, as they were (and are) brewed by plenty of companies, starting with an international giant, Guinness. But you should take into account that contemporary porters and stouts are brewed using more modern technology, that of the second half of the 19th century (see the ‘Age of Empires’ chapter), which has nothing to do with an original ‘entire-butts’ porter. Several reconstructions exist, namely ‘Entire Butt English Porter’ by Salopian Brewery, but it’s rather hard to find them. The best approximation of the early English porter is actually the brown ale of Flanders, the story of which we will tell in Section II of this book.

If we talk about modern porters, the most heralded ones are English Fuller’s London Porter and Samuel Smith Taddy Porter and Scottish Harviestoun Old Engine Oil.

The trust that went bust

The Hogarth’s diptych graphically outlines the processes that were brewing in 18th-century England. Being one of the most potent locomotives of the Industrial revolution and accumulation of capital, beer production was finally pushed back by more advanced technologies. The tea, coffee, soft drinks, and strong alcohol industries were blooming and had soon become competitive powers (partly because of the re-investment of capital made on brewing). Wealthy social stratum still preferred prestigious grape wine over beer; less prosperous common folk had switched to cheap gin¹⁷.

As the world population has been growing, the absolute beer industry numbers have also grown manifold since the 18th century. But the importance of brewing for the economy as well as average consumption had never reached those mind-blowing figures of early-industrial times.

References

¹ Meussdoerffer, F.G. (2009), p. 22

² Steele, M. (2012), see chapter 2

³ Krenzke, J.R. (2014), p. 194

⁴ ibid, pp. 219-226

⁵ Cornell, M. *The three-threads mystery and the birth of porter: the answer is ...*

[https://zythophile.co.uk/2015/06/05/the-three-threads-mystery-and-the-birth-of-porter-the-a
nswer-is/](https://zythophile.co.uk/2015/06/05/the-three-threads-mystery-and-the-birth-of-porter-the-answer-is/)

⁶ Krenzke, J.R. (2014), p. 228

⁷ [https://brewingbeerthehardway.wordpress.com/2017/12/27/blow
n-vs-brown-malt/](https://brewingbeerthehardway.wordpress.com/2017/12/27/blow-n-vs-brown-malt/)

⁸ Cornell, M. (2010), p. 55

⁹ Cornell, M. *The forgotten story of London's porters*

<http://zythophile.co.uk/2007/11/02/the-forgotten-story-of-londons-porters/>

¹⁰ Anderson, R. (2003) *Microbes and the Origins of Porter*. Brewery History, 113, pp. 27-30

<http://www.breweryhistory.com/journal/archive/113/bh-113-o27.html>

¹¹ Cornell, M. (2010), p. 55

¹² Swinnen, J., Briski, D. (2017), p. 31

¹³ Meussdoerffer, F.G. (2009), p. 24

¹⁴ Hornsey, I.S. (2008), pp. 449-450

¹⁵ https://en.wikipedia.org/wiki/London_Beer_Flood

¹⁶ Krenzke, J.R. (2014), pp. 237, 248

¹⁷ ibid, pp. 252-253

Chapter 11. It's All About Water

Historical period: the 18th century CE

Scene of Action: Burton upon Trent

In the beginning of the 18th century, London was the world's brewing capital by a vast margin. Hansa hadn't recovered after the Thirty Years' War of 1618-1648; the Netherlands, which was severed by the wars of religion even stronger than the League, at the end of the 17th century had rebuilt its economics, but not the brewing industry — because of multiple reasons, from high taxes to the grape wine and strong alcohol expansion throughout Northern Europe. The growing popularity of porter strengthened London's superiority even further.

However, closer to the end of the 18th century, Londoners got an unexpected (and initially barely visible) competitor: the small town of Burton located on the banks of the Trent river, which population was mere 1800 citizens in 1710. Burton was well-known for its beer since the Middle Ages, but since it was quite far from trade routes, this popularity never exceeded its direct vicinity. The situation changed in 1712 when the Parliament extended the navigation on Trent from the port of Hull down to Burton.

The first commercial (e.g. not related to some local pub) brewery was opened in Burton by Benjamin Printon in 1708. With the trade possibilities expansion, other establishments emerged, including those by Benjamin Wilson (which later passed to Wilson's great-nephew, Samuel Allsopp), William Worthington, and William Bass¹.

The opening of the river trade coincided with another important factor: the growing interest in English beer from the Baltic states, namely Poland and the Russian Empire. It is said that Peter the Great of Russia had brought from England that he visited at the end of the 17th century the love for English beer. No reliable source on the matter survived, and Peter in his own vigorous way had, first of all, established the beer industry in Russia itself. However, the maritime trade was growing, accelerating further towards the end of the century. Imports to Russia, the majority of which were controlled by Burton, comprised 100 thousand liters in 1750 and more than 1.5 million liters in 1775².

Burtoners owed this expansion to water: first, the River Trent that gave access to British ports; second, the unique qualities of local water sources. Burton's water was hard and rich in calcium and magnesium sulfates. It turned out that this water suited brewing exceptionally well, stimulating the growth of yeasts and allowing for intensive hopping. Burton beer was more carbonated and much more clear than the London one (and it also got the unique 'Burton snatch' — the fleeting 'aroma' of sulfur that occurred shortly after pouring).

It's interesting

London brewers were struggling to solve the puzzle of Burton water, and finally developed the 'burtonisation' process of enriching water with sulfates.

Yet another factor that contributed to the development of the brewing industry as a whole (and the Burton one in particular) was the spread of pale malts. England had been struggling with the wood shortage for decades and had converted to using coal quite early. One problem: coal might be used for heating wort, but not for kilning as the sulfur smell of burning coal was considered unacceptable³. As a result, malt was dried over expensive wood, even more expensive straw, or the best Wales anthracite, the supply of which was limited.

In 1603, Hugh Plat got a patent for his invention of producing coke from coal, analogous to the production of charcoal from wood. For some time, the invention remained unnoticed until the malt makers employed it in 1640s. Coke demonstrated extraordinary qualities: first, it produces no fumes; second, it burns in a much more controllable manner in terms of fire temperature. Because of those, in controllable low-temperature conditions, brewers were able to produce malt that was not ‘smoked’⁴; this malt was called ‘pale’, and the resulting beer, ‘pale ale’.

Pale malt has a huge advantage over darker malts: it contains more sugars, which allows for more effective beer production (and the taste of the resulting beverage is much clearer as yeasts might break down a higher proportion of chemical compounds dissolved in wort). This fact was likely not known to brewers until the saccharometer (e.g. the sugar concentration measuring device) was invented; and if it was known, it would still make a little impact as coke initially was too expensive for commercial brewing. Pale ales were mostly produced in the households of wealthy gentry in Northern England.

Let us stress out that malt will be ‘dark’ or ‘pale’ depending on the temperature it was dried at. Technically, it’s possible to produce ‘pale’ malt in a wooden kiln (though it would still be ‘smoked’, e.g. dark in color). Making pale (and even non-smoked) malt was very much possible before the invention of coke, but required much more effort. Let’s just say that making brown malt required thrice less time⁵.

It's interesting

The Netherlands started suffering from the lack of wood even earlier than England. However, instead of inventing coke, the Dutch just switched to using peat. You might imagine the taste of Dutch beer in the 16th century.

Those two factors, namely hard water and pale malt, led to the birth of the ‘Burton Ale’, which was a thick, strong, intensively hopped sweet beer. It was not literally pale: malt was additionally roasted or caramelized. Today, we would call this beer ‘amber’.

The history of Burton Ale consists of rises and falls, half a century in-between each. The period of prosperity based on the Baltic trade did not last long. In 1783, Russian authorities imposed a 300 percent tax on beer imports; then went the continental blockade of Napoleonic time and the annexation of Poland by Russia, which had closed the Polish market for English brewers. Finally, in 1822, a new Russian customs tariff was introduced that effectively banned all sorts of imports (including beer) from Britain. As a result, at the beginning of the 19th century, the Burton brewing industry deteriorated (four out of 15 breweries were closed, several others

sold⁶) — just to make the rebirth from the ashes (story of which we will tell in the next chapter) even more spectacular.

After the sales were rerouted to other markets, Burton Ale of the middle-to-end 19th century became exquisitely pale (it's hard to tell what was the difference between 'Burton Ale', 'old ale', and 'barleywine' of that period), but in the early 20th century the pendulum swung in the opposite direction: the public adored dark caramel beers once again, and Burton Ale (in its original dark sweet form) gained its popularity anew. It was so popular that in the British Air Force there was a euphemism for those who had not returned from the mission — 'gone for Burton'⁷.

The 1960s proved to be disastrous for Burton Ale: it disappeared almost overnight.

How to taste

The only Burton Ale that survived the 20th century is 'Winter Warmer' by Young. Other renowned examples of the style are '1845' by Fuller's and Ballantine Burton Ale, production of which was restored based on the surviving recipes, and also Marston's Owd Rodger and Theakston's Old Peculier. And of course, there are craft versions.

References

¹ Webster, I. (2018), pp. 7-9, 19

² ibid, pp. 9-10

³ <https://www.beeretseq.com/where-theres-smoke-theres-pale-ale/>

⁴ Cornell, M. *Burton: NOT the first place in the world to brew pale beers*
<https://zythophile.co.uk/2009/11/26/burton-not-the-first-place-in-the-world-to-brew-pale-beers/>

⁵ Pattinson, R. *Mid-18th Century Malting*
<http://barclayperkins.blogspot.com/2009/09/mid-18th-century-malting.html>

⁶ Webster, I. (2018), p. 29

⁷ Cornell, M. (2010), p. 43

Chapter 12. The Red Triangle

Historical period: the 19th century CE

Scene of action: Burton upon Trent

While the beer trade in the Baltics was stagnating, another prospective market was growing at a faster pace: ‘The Jewel in the Crown’, e.g. India. First beer shipments to Madras and other colonies were already mentioned at the beginning of the 18th century. Closer to the end of the century, however, all the trade was monopolized by a single London brewer named Hodgson. The brewery he owned, called ‘Bow Brewery’, which was not even on the London top-ten beer producers list, was quite fortunately located next to East India Trading Company headquarters. Hodgson pulled some strings, offered Company’s captains an 18-months credit line — and became an exclusive beer supplier for India¹. The trade volumes grew fivefold from 1775 to 1800 — from 240 thousand liters to 1.3 million.

Meanwhile, Burton brewing industry at the beginning of the 19th century was stagnating. Just one brewery was opened from 1803 to 1827². However, in 1821, the wind of change reversed its direction, to Burtoners greater glory. The East India Company got tired of Hodgson and his dubious practices of doing business and brewing beer alike — and approached Burton’s leading brewer, Samuel Allsopp, offering the possibility to start Indian trade. Soon, another two Burton brewers joined Allsopp, namely Bass and Salt. Hodgson tried to counter-attack but his ale was of no quality to compete, and soon the market fell into Burtoners’ hands almost entirely³. In 1830, William Worthington also entered the market.

Initially, in the 18th century, the most common types of beer were shipped to India: pale ale, porter, Burton ale, and even ‘table beer’. Hodgson was a porter producer (and porter was actually a standard drink for soldiers and petty officers, and was supplied in great quantities to military garrisons, including those based in India⁴). However, dark beers were considered to be too heavy for a tropical climate while low-alcohol and slightly-hopped beers frequently were not surviving the long voyage. So Hodgson was shipping first of all his strongly hopped pale ale, and it was this beer that was brewed by Allsopp (according to the legend, in a teapot) when the Chairman Marjoribanks of the East India Company asked him to replicate the best Hodgson's recipe. Let us remind you about the qualities of Burton water that allowed for even more pale and sparkling pale ales.

It's interesting

Marjoribanks approached not London porter brewers but Allsopp because Burtoners had got the expertise in long-distance ale shipping. As for Burton pale ales being so good, that's a bit of pure luck for us.

During the first five decades, nobody bothered to invent a designation for this product. Up until the end of the 1830s, there was *no specific name* for India-oriented beers, it was just ‘beer’⁵. However, this style was slowly gaining such descriptions as ‘pale ale prepared for East and West India climate’, ‘pale ale brewed for Indian market’, and so on, to denote its export qualities. Starting from the 1850s, instead of these bulky constructs, the phrase ‘India Pale Ale’ prevailed. It looks like it was directly related to the extending railroad network to Burton in 1839. Bass and Allsopp

shifted their focus to domestic sales and started to advertise their product extensively. Hodgson was not lagging behind as well: in 1844, his IPA was marketed as ‘having an excellent reputation in India for more than a century’ (sic). Shortly after, the IPA sales within Britain excessed Indian exports and IPA gradually became a beer for domestic consumption, a status drink for middle and upper classes⁶.

Beer Myth

There is a beautiful legend, voiced in 1869 by Walter Molyneaux, a contemporary of the events, about a ship that wrecked near the British coast with its cargo of IPA later sold in Liverpool by the insurers; it is told that the commoners got a taste for the ale, and started seeking to buy it in large quantities. Though the part about the shipwreck turned out to be true (though Molino was mistaken about the dates), the connection of the IPA popularity growth to the event is rather doubtful⁷.

The most prominent Burton brewer, William Bass, had created the first truly global beer brand. In 1887, at the peak of its fame, the Bass Brewery produced 150 million liters of beer in a year.



Édouard Manet. A Bar at the Folies-Bergère, 1882

Public Domain

You might judge how popular Bass Pale Ale was by the fact it was depicted by several leading painters of the time, most notably in 'A Bar at the Folies-Bergère' by Édouard Manet. In this picture, there are two easily noticeable bottles with the red triangle; this is the famous logo of the Bass Brewery. Also, it's the first registered trademark in Britain: it is said that William Bass had sent the clerk overnight to be the first on the queue the day the bureau opened, as Bass' company was suffering from treacherous competitors selling low-quality beer stamped with the red triangle.⁸.

The bitter confusion

Let us note that no difference between ‘Indian Pale Ale’ and just ‘Pale Ale’ existed up until the second half of the 19th century. In particular, Bass Pale Ale was the canonical IPA that actually gave the style its fame. Many beer producers, noticing the growing popularity of ‘Ale for India’, were rebranding their most expensive pale stock ales as ‘IPA’⁹. Beer marked as ‘Pale Ale’ even in the second half of the century still had an impressive bitterness of 60-80 IBU¹⁰ (see below).

All those (I)PAs were stock ales meaning they were aged for 4-12 months or even more and secondary fermented with the *Brettanomyces*. However, with the growing popularity of the style and further technical progress, British brewers started to produce ‘mild’ (e.g. unaged) versions by adding invert sugar (also, corn flakes and other additives) to wort and additionally refining it. This ale was denoted with the abbreviation ‘AK’ (sometimes, ‘KK’) and was sold in casks as fresh as possible¹¹ — in fact, it’s exactly the thing that we now call a ‘real ale’ (see the ‘Revitalisation’ chapter).

It's interesting

Martin Cornell suggests that the letters ‘AK’ might mean ‘Ankel Koyt’ ('single koyt'), therefore being an artifact of that epoch when the Dutch expats were brewing hopped beer in Britain¹² (see the ‘Word on Hops’ and ‘Barrels and Bretts’ chapters).

Consumers, however, had adopted neither of the terms: pub patrons called these beers just ‘bitters’. As a result, four different designations of the same style emerged:

- Indian pale ale (British style);

- pale ale (British style);
- bitter;
- extra-strong bitter, or ESB.

Most classifications are currently identifying them as four different beer styles, though, in fact, they are just variations of the 'AK' beer, slightly varying in bitterness and alcohol content.

How to taste

Finding an 'AK' is not a problem, as it's just a classical British ale. Out of breweries that had made it through the 20th century we might note American Ballantine Indian Pale Ale and British Worthington's White Shield (the latter still brewed in Burton). In general, British bitters got quite a characteristic taste and are now produced in numbers by fine breweries — let us mention Fuller's, Adnams, Thornbridge, Greene King, Samuel Smith, Harviestoun, Marston's.

Tasting a 'real' IPA, the one that Hodgson and Allsopp shipped to India, is unfortunately not possible. To begin with, we have no idea what they were actually shipping. Out of four original East India Company suppliers (namely, Hodgson, Allsopp, Bass, and Salt), none have survived. The Bass trademark was bought by AB InBev, and the Bass Pale Ale continues to be produced (under the pretentious 'Bass Trademark No. 1 Ale' name) with the red triangle being redesigned beyond any recognition; however, it has nothing to do with the original Bass, and, furthermore, the beer itself is quite mediocre.

Craft brewers make some aged intensively hopped stock ales that should be very much like the real IPAs. That's for example, Brett IPA by Allagash and Enjoy After Brett IPA by Stone.

Bitterness Units

Bitterness of beer might be measured. There are two main scales: international (IBU, International Bitterness Units) and European (EBU, European Bitterness Units). Beer with less than 30 IBUs is usually considered not bitter at all (though an English man of the 15th century wouldn't agree with that). Beer with 60 or more IBUs is definitely bitter, and many people will not like it (pale ale at this level of bitterness should be called an IPA). In the 30 to 60 range, every producer is free to decide whether to mark the beer as a pale ale, a bitter, or maybe an IPA as well.

Thicker and stronger beers conceal bitterness. Imperial stouts (see the next chapter) might easily have IBU 100, but it's hard to tell they did. Reaching more than IBU 100 is possible but makes no sense as humans can't sense it.

European bitterness scale theoretically should coincide with the international one. However, because of some technicalities, it's usually slightly lower.

References

¹ Cornell, M. (2010), p. 101

² Webster, I. (2018), p. 27

³ Cornell, M. (2010), p. 107

⁴ Cornell, M. *More IPA myths that must die on #IPADay*
<https://zythophile.co.uk/2012/08/02/more-ipa-myths-that-must-die-on-ipaday/>

⁵ Steele, M. (2012), see chapter 3

⁶ Cornell, M. (2010), p. 115

⁷ Cornell, M. *The IPA shipwreck and the Night of the Big Wind*
<https://zythophile.co.uk/2015/10/12/the-ipa-shipwreck-and-the-night-of-the-big-wind/>

⁸ Cornell, M. *The Bass red triangle: things AB-InBev won't tell you*
<https://zythophile.co.uk/2013/06/28/the-bass-red-triangle-things-ab-inbev-wont-tell-you/>

⁹ Cornell, M. (2010), p. 114

¹⁰ Pattinson, R. *Defining Pale Ale*
<http://barclayperkins.blogspot.com/2021/09/defining-pale-ale.html>

¹¹ Pattinson, R. *What was AK*
<http://barclayperkins.blogspot.com/2021/06/what-was-ak.html>

¹² Cornell, M. (2010), p. 17

BIBLIOGRAPHY

A Hymn to Ninkasi

<https://etcsl.orinst.ox.ac.uk/cgi-bin/etcsl.cgi?text=t.4.23.1&display=Crit&charenc=gcirc&lineid=t4231.p1#t4231.p1>

Bennett, J. M. (1996) *Ale, Beer, and Brewsters in England: Women's Work in a Changing World, 1300-1600*. ISBN 9780195126501

Cornell, M. *Zythophile*

<https://zythophile.co.uk/>

Cornell, M. (2010) *Amber, Gold & Black. The History of Britain's Great Beers*. ISBN 9780752475943

Damerow, P. (2001) *Sumerian Beer: The Origins of Brewing Technology in Ancient Mesopotamia*. Cuneiform Digital Library Journal, 2012:002
https://cdli.ucla.edu/pubs/cdlj/2012/cdlj2012_002.html

Dietler, M. (2006) *Alcohol: Anthropological/Archaeological Perspectives*. Annual Review of Anthropology, 2006. 35:229–49:230

https://www.academia.edu/272118/Alcohol_Archaeological_Perspectives

Gallone, B., Mertens, S., Gordon, J. L., Maere, S., Verstrepen, K., Steensels, J. (2017) *Origins, evolution, domestication and diversity of Saccharomyces beer yeasts*. Current Opinion in Biotechnology, Volume 49

<https://www.sciencedirect.com/journal/current-opinion-in-biotechnology/vol/49/suppl/C>

George, A. (1999) *The Epic of Gilgamesh. A new Translation. Translated with an Introduction by Andrew George*. ISBN 0140447210

https://www.academia.edu/16568346/Epic_of_Gilgamesh_The_George_trans_Penguin_1999_

Hornsey, I. S. (2008) *A History of Beer and Brewing*. ISBN 0854046305

Jackson, M. *The Beer Hunter*

<http://www.beerhunter.com/index.html>

Johns, C. H. W. (1904) *Babylonian and Assyrian Laws, Contracts and Letters*

<https://www.gutenberg.org/ebooks/28674>

Krenzke, J. R. (2014) *Change Is Brewing: The Industrialization of the London Beer-Brewing Trade, 1400-1750*. Dissertations. 1276

https://ecommons.luc.edu/luc_diss/1276/

Meussdoerffer, F. G. (2009) *A Comprehensive History of Beer Brewing*. Handbook of Brewing: Processes, Technology, Markets. Edited by H. M. Eßlinger (2009). ISBN 9783527316748

https://www.academia.edu/4421107/1_A_Comprehensive_History_of_Beer_Brewing_1

Nelson, M. (2001) *Beer in Greco-Roman Antiquity*

https://www.academia.edu/6156225/Beer_in_Greco-Roman_Antiquity

Nelson, M. (2005) *The Barbarian's Beverage. A History of Beer in Ancient Europe*. ISBN 020330912X

Pattinson, R. *Shut up about Barclay Perkins*

<http://barclayperkins.blogspot.com/>

Poelmans, E., Swinnen, J.F.M. (2012) *From Monasteries to Multinationals (and Back): A Historical Review of the Beer Economy*. Journal of Wine Economics, Volume 6, Issue 2

Poelmans, E., Swinnen, J.F.M. (2016) *A Brief Economic History of Beer*

https://www.researchgate.net/publication/268043355_A_Brief_Economic_History_of_Beer

Steele, M. (2012) *IPA: Brewing Techniques, Recipes, and the Evolution of India Pale Ale*

Swinnen, J., Briski, D. (2017) *Beeronomics. How Beer Explains the World.* ISBN 978808305

The Oxford Companion to Beer (2012) Edited by Garrett Oliver. ISBN 97801995367138

Unger, R. W. (2001) *A History of Brewing in Holland: 900-1900. Economy, Technology and the State.* ISBN 9004120378

Unger, R. W. (2004) *Beer in the Middle Ages and the Renaissance.* ISBN 9780812219996

Verberg, S. *Medieval Mead and Beer. Experimental brewing with Medieval flair*

<https://medievalmeadandbeer.wordpress.com/>

Verberg, S. (2018) *The Rise and Fall of Gruit.* Brewery History, 174
<http://www.breweryhistory.com/journal/archive/174/index.html>

Webster, I. (2018) *Brewing in Burton upon Trent.* ISBN 9781445670553

Дуров, И.Г. (2014) *Производство и обеспечение пивом кораблей Балтийского флота при Петре Великом.* Военно-исторический журнал

<http://history.milportal.ru/proizvodstvo-i-obespechenie-pivom-korabley-baltijskogo-flota-pri-petre-velikom/>