TOPIC: BEER CATEGORY

PART 2: BEER'S CONTRIBUTIONS TO HUMANITY: A CATALYST FOR SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

8 min read

In the grand tapestry of human history, few foods or beverages have woven themselves as intricately into the fabric of society as has beer. In the second of our three-part series on the multifaceted world of beer's influence on humanity, we explore beer's role as a catalyst for scientific and technological progress

Beer has held a pivotal position in society throughout the ages. It has served as facilitator of social interaction, ceremonial drink, and subject of artistic expression, all of which is to not even mention its significant and widespread economic impact, which has propelled development in numerous quarters worldwide.

Furthermore, and in stark contrast to its common characterization as a mere thirst-quencher, beer has also actively contributed to noteworthy scientific and technological progress.

It Starts on the Farms

Agriculturally, beer is thought to have spurred numerous advancements, as its brewing required the domestication of grains and the establishment of irrigation systems, innovations central to fostering stability and permanence among human communities. A 2018 research study led by Professor Li Liu at Stanford University focused on residues found in 13,000-year-old stone mortars from the Raqefet Cave in Israel, a burial site of the Natufian people. Such residues, it is thought, provide evidence of the earliest known beer brewing, predating the farming of brewing grains and other cereals in the eastern Mediterranean region by several thousand years. According to the study's authors, these findings support the hypothesis that beer brewing may have been a reason for, rather than a consequence of, the early domestication of cereals.

By motivating the controlled cultivation of grains, the study suggests that beer might have led to the advancements in agriculture that ultimately fueled the development of settled societies, highlighting the deep historical significance of beer as a catalyst for the progress of human civilization.

Science and technology's golden age

While beer has held a prominent position throughout human history, it was during the industrial revolution that it made some of its most remarkable contributions to scientific progress. During the 18th and 19th centuries, the brewing industry emerged as an early adopter of numerous innovative technologies, driving progress and facilitating their development for the benefit of the general public and other sectors.

"The Scottish doctor and scientist Joseph Black, experimenting in an unnamed Edinburgh brewery, discovered in 1757 that the gas given off by fermenting wort was the same gas given off if you pour acid on chalk, and would snuff out a flame," says author and beer history specialist Martyn Cornell, explaining how an 18th-century Scottish brewery was instrumental to the understanding of carbon dioxide. "Black strongly influenced Joseph Priestley, who made his own experiments into the gas given off as beer ferments in the Meadow Lane brewery, Leeds, around 1770. This was the start of the scientific revolution that led to the understanding of matter being made up of elements, although it was several more decades before it was discovered what this gas consisted of."

The brewing industry was also instrumental to the development of artificial refrigeration as a commercially viable technology. In the late 19th century, the groundbreaking work of German engineer Carl von Linde – particularly his invention of a continuous process for liquefying gases in significant quantities – laid the foundation for modern refrigeration technology.

"As with steam power, brewers were very early adopters of the technology pioneered by Carl von Linde in the 1880s, particularly lager breweries," says Cornell, hinting at the Bavarian brewing industry's instrumental role within the successful progress of von Linde's work.

"It was however an order from Guinness for a carbon dioxide liquefaction plant in 1892 that inspired him to research low-temperature refrigeration, and the liquefaction of air. By 1895, this led to a process to obtain pure oxygen, which in turn led to the development in 1903 of the oxyacetylene torch, used in everything from welding ships to building skyscrapers."

While the brewing industry's early adoption of innovative technologies led directly to numerous advancements made outside of the industry, noteworthy developments also emerged from within beer's own sphere.

In the early 20th century, statistician William Sealy Gosset (publishing under the pseudonym "Student") developed the t-test, a statistical comparison of the means of two samples, while working on quality control at Dublin's Guinness brewery. The t-test is now commonly employed in hypothesis testing, and has had wide applications in everything from sociology to medicine, engineering to biology.

Among all scientific discoveries owed to the beer industry, the development of the pH scale stands out as particularly noteworthy. In 1909, Danish chemist Søren Sørensen, while working at the Carlsberg Laboratory in Denmark, was investigating the acidity of beer and recognized the need for a standardized measurement system. To this end, he introduced the concept of pH [power of hydrogen] to quantify acidity and alkalinity.

“The ability to measure pH is crucial in the brewing process. Monitoring the pH allows brewers to control various aspects of brewing, such as enzyme activity, yeast performance, and flavor development. By understanding and adjusting the pH levels during mashing, fermentation, and other stages, brewers can optimize the brewing conditions, resulting in consistent and high-quality beer,” explains Carlsberg director of research Birgitte Skadhauge. “But the pH scale and the concept of pH have found applications in numerous industries and scientific fields beyond brewing.” Indeed, pH measurement is used in agriculture, water treatment, food production, pharmaceuticals, and environmental monitoring, and is also a fundamental tool in the production of other alcoholic beverages, above all wine.

A modern scientific revolution

The brewing industry continues to contribute to scientific and technological advancements in the modern era, with brewing technology and fermentation techniques being effectively utilized in a variety of industrial sectors.

Presently, there is growing focus on spent grain, which makes up approximately 85% of beer’s total solid by-products, and its potential in the production of biofuel. A recent study published in the journal *Fuel* concluded that spent grain in pelletized form could feasibly and relatively cleanly be employed as a renewable source of energy in incineration plants.

Further research led by scholars at the Department of Food Science and Technology at Virginia Tech, focused on spent grain’s high protein and fiber content, the latter of which makes it difficult for humans to digest and is why it is commonly upcycled as feed for ruminants. Using an alcalase treatment, the researchers successfully recovered and concentrated up to 83% of the protein in the spent grain, which can be then used in food manufacturing. Subsequently, the researchers employed a new species of *bacillus licheniformis* to convert the grain into 2,3-butanediol, a compound used in the production of various products such as synthetic rubber and fuel.

Extensive investigation has likewise been conducted to uncover additional applications for spent grain, capitalizing on its unique physicochemical properties. It has been used in the production of building materials and, due to its low ash content and abundant fiber, as a raw material in the paper manufacturing industry. Moreover, spent grain has been utilized in the production of charcoal bricks and tested as an adsorbent for various compounds, further demonstrating its versatility.

By leveraging the knowledge gained from brewing, researchers and engineers have been able to apply brewing principles, fermentation expertise, and analytical techniques to the production of biopharmaceuticals too. Groundbreaking discoveries, for instance, have been made about substances derived from yeast and plants that can boost the growth and productivity of cells used in biopharmaceutical production.

Green-driven innovation

The brewing industry’s commitment to enhancing sustainability goals is fueling the development of innovative technologies and solutions that prioritize resource efficiency, recycling, and carbon emission reduction.

Of particular significance are the ongoing experiments aimed at incorporating water purification into the brewing process. In May, Fox City Brewing Company, based in the U.S. state of Georgia, introduced their Revival Purified Lager, while last year, Singapore’s Brewerkz showcased their NewBrew, both made with purified wastewater.

Recently, a similar project involving Microsoft founder Bill Gates garnered significant attention. The initiative originated from a start-up called Epic Cleantec, which received funding in 2012 from the Bill and Melinda Gates Charitable Foundation to promote advancements in water reuse and conservation. Recently, a momentous milestone was reached with the creation of a test beer called Epic OneWater Brew, also made from wastewater.

In the Czech Republic, a comparable endeavor took place as the South Bohemia microbrewery Čížová partnered with ecological solutions firm Veolia to produce a beer named ERKO using recycled wastewater. In the process, prior to being introduced to the brewing environment, wastewater undergoes treatment utilizing membrane technology, after which it is transported to the brewery and turned into lager.

Efforts towards sustainability have also extended to the development of more eco-friendly packaging options, as traditional glass bottles are estimated to contribute approximately 0.97 kg of CO_2 per kg, accounting for around 49% of a beer's overall carbon footprint.

In 2021, Anheuser-Busch Inbev responded to this challenge by launching what it claimed to be the world's lightest longneck glass beer bottle for commercial production. The brewing giant reduced the weight of its standard longneck beer bottle from 180g to 150g, thereby cutting CO_2 emissions by an estimated 17% per bottle.

Meanwhile, Carlsberg has been actively engaged in the development of its own alternative beer container to replace traditional glass packaging. The current prototype consists of a bio-based and fully recyclable fiber bottle incorporating a plant-based polyethylene furanoate (PEF) polymer lining that both protects the beer and remains compatible with recycling systems. The outer shell, made from sustainably-sourced wood fiber, provides insulation to keep the beer colder for longer. Last June, the company launched a large-scale pilot of its new fiber bottle in eight European markets.

These remarkable advancements not only have a significant impact on the brewing industry, they also serve as a springboard for analogous solutions across the broader drinks and food sector, and other industries, as well. From its early role in agricultural innovation to its influence on microbiology, chemistry, and biotechnology, beer and brewing have consistently pushed the boundaries of human knowledge, and so, throughout the ages, the quest for a perfect brew has catalyzed advancements propelling societies and civilizations towards a more scientifically and technologically advanced future.

By Dr. Jacopo Mazzeo

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