



Identifying the critical control points in beer production

Attila Albert

Óbuda University Doctoral School of Safety and Security Sciences, Budapest, Hungary, albert.attila@phd.uni-obuda.hu

Abstract: The aim of the research is to reveal the critical points from the point of view of food safety during the classical brewing technology process. In order to explore these critical points, it is important to know what technological steps we are going through in the brewing process. By examining each technological step, the points of infection can be explored, which I make suggestions for prevention. Even before starting the brewing technology process, the suitability of the ingredients should be checked and it is worth paying attention to the source of supply. Replacing the now obsolete technological solutions used in each technology step can greatly increase the level of food safety, ie reduce or even eliminate the possibility of infection. From a food safety point of view, packaging is also a critical point after the product has been made, which carries a high risk. Environmental and sustainability considerations must not be overlooked when choosing packaging. If we pay close attention to the small details, we can be sure that our brewed beer will be impeccable from a food safety point of view, and we can enjoy the liquid gold under the foam without danger.

keywords: beer, technology, brewing, food safety

1 Introduction

In order to explore the critical points, it is important to know what technological steps we are going through in the brewing process. These processes must take place at a specific temperature and within a specific time frame. The following picture contains the time and temperature steps, what are needed through the process of the brewing:



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Process	Action	Objectives	Time	Temperature (°C)
Malting				
Steeping	Moistening and aeration of barley	Preparation for the germination process	48 h	12–22
Germination	Barley germination	Enzyme production, chemical structure modification	3–5 days	22
Kilning	Kilning of the green malt	Ending of germination and modification, production of flavoring and coloring substances	24–48 h	22–110
Milling	Grain crushing without disintegrating the husks	Enzyme release and increase of surface area	1–2 h	22
Mashing + wort separation	Addition of warm/hot water	Stimulation of enzyme action, extraction and dissolution of compounds, wort filtration, to obtain the desired fermentable extract as quickly as possible	1–2 h	30–72
Wort boiling	Boiling of wort and hops	Extraction and isomerization of hop components, hot break formation, wort sterilization, enzyme inactivation, formation of reducing, aromatic and coloring compounds, removal of undesired volatile aroma compounds, wort acidification, evaporation of water	0.5–1.5 h	>98
Wort clarification	Sedimentation or centrifugation	Removal of spent hops, clarification (whirlpool, centrifuge, settling tank)	<1 h	100–80
Wort cooling and aeration	Use of heat exchanger, injection of air bubbles	Preparing the wort for yeast growth	<1 h	12–18
Fermentation	Adding yeast, controlling the specific gravity, removal of yeast	Production of green beer, to obtain yeast for subsequent fermentations, carbon dioxide recovery	2–7 days	12–22 (ale) 4–15 (lager)
Maturation and conditioning	Beer storage in oxygen-free tank, beer cooling, adding processing aids	Beer maturation, adjustment of the taste, adjustment of CO ₂ content, sedimentation of yeast and cold trub, beer stabilization	7–21 h	–1–0
Beer clarification	Centrifugation, filtration	Removal of yeast and cold trub	1–2 h	–1–0
Biological stabilization	Pasteurization of sterile filtration	Killing or removing of microorganisms	1–2 h	62–72 (past.) –1–0 (filtr.)
Packaging	Filling of bottles, cans, casks, and kegs; pasteurization of small volumes in packings	Production of packaged beer according to specifications	0.5–1.5 h	–1 to room temperature

Figure 1
The Beer Brewing Process: Wort Production and Beer Fermentation
Source: Willaert, 2007



The aim of this research is to explore critical points for food safety in the classical brewing technology process. Once these points of infection have been identified, a solution must be found for prevention and new methods must be used to find alternatives. The use of the right technology, impeccable hygiene and careful attention not only minimizes the risk from the point of view of food safety, but also increases the enjoyment value of the finished product. Large food companies operate under strict rules. In the case of small-scale breweries, although they produce small quantities, they must also apply certain standards and rules in order to produce products of the right quality.

2 Content Analysis - Exploring critical points in technology processes

The main component of this Beer is water. In most cases, this is added to the ground malt by treating it with the right ingredients, thus ensuring consistent quality. In contrast, malt can pose many dangers. A common raw material defect is high mycotoxin content, such as fusarium fungi (Tadei et al., 2020). High concentrations of these mycotoxins pose a serious health risk (Antonissen et al., 2014). Fortunately, European Union legislation sets maximum levels for these toxins in food (portal.nebih.gov.hu, 2020). In most cases, malt enters breweries when it is ready. If it has not been possible to prevent the appearance of the fungus during production, a critical point is to control the quality of the raw material entering the factory (Mastanjevic et al., 2018).

The destruction of unwanted microorganisms is an important task during brewing. This is why the observance of technological temperatures during cooking, but especially during hop cooking, must be constantly monitored (Vaughan et al., 2005).

Nowadays, the use of closed fermentation tanks during main fermentation is also becoming more common, but open fermentation vats are still in use. In addition to being much more difficult to control temperature and pressure, the risk of infection is much higher. Microorganisms in the air can easily enter the uncovered liquid, thus not only changing the microbiological composition of beer, but also posing a major hazard to the entry of hazardous substances into fermenting beer (Kunze, 2014). Today, it is almost unthinkable to hear stories from the beer-drinking layer of the 80s in which a mouse was found in a beer bottle in Kőbánya, even though a separate person was employed in the factory, to keep unwanted rodents away from open fermentation vats. remove specimens that are already intoxicated.

At this stage of production, beer encounters a lot of new surfaces compared to the past, which increases the risk of infection (Bokulich & Bamforth, 2013). Whatever unit of use the finished beer is in, it is very important to follow the rules of hygiene.



In the case of recycled packaging units (returnable glass, KEG barrels), even more attention must be paid to cleanliness. Infected beer not only loses its enjoyment value (when exposed to light and oxygen), but also carries serious food safety hazards. It is no coincidence that most large-scale beers are pasteurized before delivery. This creates microbiological stability, destroys potential pathogens, and in turn, beer loses its enjoyment value (Hoff et al., 2013). With this aspect in mind, unpasteurized tank circuits with short maturities but higher enjoyment values were created. In addition, attempts have been made to sterilize beer with microwaves, which has also proven to be reliable and even has benefits (Shi et al., 2012).

Based on this, we can conclude that it is important to select and use the right raw materials, to store, handle and use the purchased raw materials properly, to use the right technology and to use the right tools. Closed fermentation tanks should be preferred and proper hygiene should be observed during fermentation and packaging.

3 Results - Prevention options and solutions

There are breweries where a complete analytical and microbiological laboratory is available for the continuous control and monitoring of the characteristics and properties of the raw materials and the finished products. However, these opportunities are not available everywhere. In this case, it is advisable to send the incoming malt for a laboratory test in order to exclude the possibility of contamination of the grain. If an infected raw material gets into the beer without control, it can no longer be removed from it. It is much more expensive to destroy the entire finished product afterwards than to inspect it beforehand. EU limits must not be exceeded in the presence of toxic substances, and if this is the case, it is forbidden to dilute the finished product with a suitable quality. Thus, it is strongly recommended to test the raw materials before any process of brewing begins. The amount of fusarium in the grain can be detected easily and quickly with HPLC devices (Piacentini et al., 2017).

It is also worth paying attention to the sources of raw materials. If we can, we always choose our homeland. The cheaper raw material may end up being more expensive if it turns out to be infected. Always choose good quality ingredients that we would consume with a good heart.

Another way to eliminate the risk of infection in grain is to use a substitute product as a raw material. Nowadays, gluten-free beer has become very fashionable, here too a grain substitute product is used in some cases (Hager et al., 2014). It is popular to use wheat, corn, rice instead of barley malt.



It is essential to maintain the correct technological temperatures during brewing. It is an economically determining factor, as cooling and heating is a very energy-intensive process. Improper temperatures produce the wrong end product, but more importantly, boiling hops is a critical point for food safety, as raising the temperature to the wrong height will not only result in poorer hop yields, but will also kill the microorganisms left in the wort, which they can be dangerous to the human body. Not only the temperature, but also the exact observance of the technological times must be observed, because if the heat treatment does not last for the right time, we make the same mistake as with the wrong temperature. Today, the technology is so advanced that the temperature of the raw material can be controlled and standardized throughout the production process. Mechanization can eliminate this source of danger.

Although beer made in open fermentation tanks has a special taste that is impossible to achieve indoors under pressure, it unfortunately carries many dangers. No matter how carefully and prudently we try to ferment beer in open fermentation vats with maximum adherence to hygiene rules, unfortunately the risk to food safety increases. Therefore, it is advisable to use closed fermentation tanks with a modern, cylindrical design during the entire fermentation process of the beer, in which both temperature and pressure can be controlled and the entry of foreign substances into the beer can be avoided.

The fermentation of beer takes a long time, it can take up to several months. Meanwhile, microorganisms have countless opportunities to attack beer, and at the end of fermentation, beer travels a long way from tanks to packaging, where countless hazards lurk around it. The process of pasteurization, which covers heat treatment, serves to eliminate these hazards. It can be used in several ways, with instant pasteurization or tunnel pasteurization, each with its own advantages and disadvantages. It should be noted that in the tunnel paste process, the beer is already in the bottle when it enters, and due to the sudden change in temperature, the glass can easily break and shards of glass can get into the beers. If this technology is applied to the packaging line, it is advisable to set up a solid state detector after the tunnel paste, which filters out such cases.

It is important that the storage device into which the beer enters and travels to the consumer is always clean. This is especially important for recycled devices such as recyclable glass or KEG barrels. If not properly washed and cleaned, there is a risk of infection. Today, the consumption of tank beers is becoming more widespread, which means that beer is taken directly from the factory to the pubs in huge tanks, unpasteurized. Its shelf life is thus greatly reduced, but its enjoyment value is greatly increased due to the omission of heat treatment. To prevent the storage tanks from becoming dirty and having to be disinfected weekly, the factories line the inside of the tanks with a sterile bag and fill the beer directly into these bags, thus avoiding contact with metal surfaces. It can be disposed of after the bag has been emptied,



which is reassuring from a food safety point of view, but a concern from an environmental and sustainability point of view.

4 Conclusion

An adequate level of food safety is essential during brewing. With proper attention and care, most hazards can be eliminated and prevented. It is important to pay attention to the right raw material and check the conformity of the components before starting the processes. If we can control the temperatures, our decoction can also be made safer. Abandoning outdated technological solutions greatly increases the level of food safety, so it is advisable to work with the most modern technologies and in no case provide the possibility of infection with an outdated technological solution. Once our product is ready, there is a high risk in the packaging phase, so it is worth handling potential hazards with even greater care. If we pay close attention to the small details, we can be sure that our brewed beer will be impeccable from a food safety point of view, and we can enjoy the liquid gold under the foam without danger.

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