

The Beer's Journey from grain to the table, from the view of the economic and food safety of the value chain, through in-depth interviews

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Keywords: craft beer; food safety; sustainability; food technology

Abstract: The global craft beer market has seen a surge in consumer interest in recent years. Despite this trend, the technological challenges faced by small-scale brewery operators remain an under-explored area of research. This study aims to address this gap by examining the potential for operational failures through the perspectives of small-scale brewery managers. The research aims to provide insight into the complexities of supply chain management and the intricacies of economic processes within the craft beer industry. Additionally, the study seeks to evaluate the possibilities for sustainability within small-scale beer production. Given the exploratory nature of the study, a qualitative research design, specifically the constructivist approach of Grounded Theory Methodology, will be employed. The study will consist of in-depth interviews with the leaders of ten domestic and international small-scale breweries, focusing on market development opportunities, technological advancements, and sustainability. Small-scale breweries can be divided into three main components, which are closely related. Excessive losses during brewing, low automation and resulting food safety issues. The craft beer industry works with a loss ratio of at least 20%, which needs to be solved. The ultimate goal of this research is to propose innovative technological solutions that can improve the economic and food safety outcomes of small-scale beer production.

1. Introduction

According to the latest surveys of the Central Statistical Office, the average weekly beer consumption of Hungarians aged 15 and over was 2.6 liters in 2019 (ksh.hu, 2021). However, beer consumption still takes precedence over wine in Hungary (Cselényi, 2018). As a result of the coronavirus, the output of beer production fell by 13 percent in 2020, which was caused by the loss of consumption due to the epidemic (ksh.hu, 2021).

In 2008, Major wrote that small-scale beers are at a disadvantage because they are not well-known and their quality fluctuates (Major, 2008). According to Garavaglia and Swinnen (2018), the Hungarian breweries were able to survive by developing technology, changing their attitude towards consumers, investing capital in their institutions and creating mergers in order to gradually eliminate all the mistakes they made 10 years ago. This is the main reason why domestic breweries were able to develop and grow to such an extent and achieve a growing market share.

This development continues to this day, in which the CLXIV of 2005 on trade, also referred to as the beer law, plays a major role. CXL of 2020 on the amendment of the Act. law. Until now, a very important hindering factor in their further development was the legal barrier. Multinational companies had exclusive contracts with catering units, which prevented small businesses from expanding further (Molnár et al., 2017). From

August 2021, however, with the help of this law, small-brewery products will be available in several places, as catering units are obliged to have small-brewery beer on 20 percent of the beer taps, and exclusive contracts with the 3 largest domestic beer producers have been terminated (Magyar Közlöny, 2020). In addition, the small business tax reduction implemented in 2012 also benefited breweries, as their profitability curve began to rise after the measure (Jantyik et al., 2021). The basic task of food production and distribution is to ensure that safe food reaches consumers in the right quantity and quality. This is an economic activity of great importance, because food produced in inadequate quality can cause illness or even death (Süllős, 2010). Proper nutrition increases the feeling of well-being, which is psychologically important for us. Food free of microbiological, chemical and physical contamination is extremely important to be able to ensure this, so the issue of food safety needs to be handled comprehensively with a "farm to table" approach (Sarkadi, 2019). Food quality and safety are regulated by legislation, as the market alone cannot always ensure the level expected by society. Two types of regulation can be distinguished from the point of view of food safety, one is market regulation with the tools of agricultural and trade policy, the other is food safety regulation through hygiene and technical regulations (Uzgonyi et al, 2007). The terms craft, microbrewery, or microbrewery are used to refer to breweries that have recently started brewing new specialty beers in small quantities (Garavaglia & Swinnen, 2017).

Microbreweries use different strategies. Some use local sales channels or sell directly to nearby pubs. Others only deliver to major cities and the capital, and produce large quantities of few types of beer. On the other hand, new-wave microbreweries produce smaller quantities, but top-category premium products for paying consumers (Fertő et. al., 2018). We mainly examined breweries belonging to the third category. Due to their production method, composition, sensory and other properties, special quality beers have special properties for consumers and represent additional added value. Therefore, the Hungarian Food Code No. 2-96 concerning beer. directive had to be amended, and directive 2-702 of the Hungarian Food Code now applies instead. The amendment was necessary in order to make it clear to consumers exactly what quality product they are dealing with, as misleading indications made it difficult to make a responsible and conscious choice. It also includes food safety regulations and new regulations (Szilágyi, 2013). The five most prominent features that matter most to craft beer consumers are taste, quality, uniqueness, uniqueness and diversity (Borza, 2018). The goal of our current research is to promote these features with innovations that meet the highest quality expectations.

1.1 Research Objective

In the course of my work, I would like to explore the critical points from the point of view of food safety along the beer route all the way back to the harvesting of barley. To explore error possibilities and to look for new methods. I also examine the road from an economic point of view, reveal the critical points and try to find better solutions for faulty or uneconomical operations. A complex review of the entire system is necessary, based on the information obtained from the value chain analysis, breweries can achieve development and a competitive advantage. The decline in the consumption of large-scale beers can already be seen, with my research I would like to give smaller craft breweries a competitive advantage over the oppressive big ones. In addition, one of the most important issues of our time is sustainability. Craft breweries are also increasingly striving for more sustainable operation, which they try to achieve by improving water and energy management, as well as sustainable management of the brewing process (Calvo-Porrá, 2018). In addition, environmentally conscious waste management policy is also gaining more and more importance and attention (Baiano, 2021).

1.2 Literature review

Beer is the most consumed alcoholic beverage in the world and the third most popular beverage after water and tea (Salantă et al., 2020). Interest in craft beers is increasing (Cole, 2017). In the last decade, consumer interest in craft beers has increased worldwide, especially traditional beers and lagers with a distinctive taste, unique quality value and overall special sensory properties (Humia et al., 2019). Craft brewers and consumers have transformed the global beer market (Garavaglia et al., 2017b). In Hungary, craft beers have developed both on the supply and demand side, the consumption of craft beers and the activities of small-scale breweries are also becoming more and more popular (Csapó et al., 2015). The growing role of consumers is the driving force behind the success of craft beer (Capitello et al., 2020). The craft beer revolution in the United States of America began already in the 1980s. Large-scale breweries produced homogeneous, mild beer that attracted as many customers as possible. This created a market niche that was exploited by craft beer makers (Garavaglia et al., 2017a). Especially in craft markets, new market niches can grow to the point where the modal consumer no longer identifies as an enthusiastic but rather as an ordinary participant (Pozner et al., 2021). Driven by the shared belief that a rising tide lifts all boats, craft breweries have created cooperative actions to collectively become better competitors against large-scale breweries (Mathias et al., 2018). The growth of the craft sector and the entry of an increasing number of small-scale breweries into the market has been facilitated by the increasing availability of technical equipment that enables the production of small-scale batches (Garavaglia et al., 2018). Early craft brewers used equipment from even other industries because the capacities of large-scale brewing equipment were too high for them. This has now changed, with brewers able to use smaller capacity equipment for their size, thanks to the adaptation of the technology industry (Elzinga et al., 2015). One result of globalization has been the promotion of local traditions or specific local resources through the creation and promotion of beverages such as craft beers, which are diverse, atypical and high-quality products (Wojtyra, 2020). The classic brewing process can be divided into the following steps: malting, grinding, mashing, boiling, cooling, fermentation, aging, filtering, carbonization, microbiological stabilization and packaging. However, advanced techniques have allowed brewers to create beer using more sophisticated and efficient methods (Moura et al., 2018). Craft beers and craft brewers are characterized by innovation through the development of new beer varieties (Salantă et al., 2020). While equipment and technology do not show much difference in the beer industry, craft brewers have developed new and original techniques and even try to save old techniques, such as barrel aging, to prepare their recipes (Villacreces et al., 2022). High-level standardization of the quality of craft beers also at microbreweries requirement (Villacreces et al., 2022). Industrial beer is a substrate that is sensitive to contamination by microorganisms because it contains all the essential nutrients (Villacreces et al., 2022). Processes such as filtration, low temperature storage, and pasteurization reduce contamination; however, remaining bacterial species can cause quality defects. However, some microorganisms can survive and multiply in this environment, which can cause undesirable changes in the final product (Villacreces et al., 2022). In 2014, Csapó also wrote that there are no preservatives in craft beers, no additives, and they are not pasteurized, so these beers do not last for many months and cannot be stored at 20-25 degrees Celsius on store shelves. Craft beers are fresh beers, stored at 5-10 degrees Celsius, they have a shelf life of 10-20 days (Csapó et al., 2015). Technological advances such as automated manufacturing; speeding up packaging; more automated brewing, fermentation and conditioning processes; and better distribution through a better road network led to greater economies of scale (Garavaglia et al., 2017). Microbreweries usually lack a laboratory suitable for beer quality control (Menz et al., 2010). Craft beers are usually not filtered or pasteurized in order not to compromise the quality characteristics of the beer, however, in order to achieve microbial stability, a wide range

of product-specific tools are now available to craft breweries (Villacreces et al., 2022). The primary goal of the plants is to minimize the amount of waste generated during production. The waste produced in craft beer production can be used widely, even as a raw material in other industries (Albert, 2021). There is no commonly accepted definition of sustainability (Gatrell et al., 2018). The three pillars of sustainability are: environment, economy and capital or people, planet, profit (Elkington, 2012). Craft brewers seem to focus their efforts mainly on sustainable production processes, such as reducing water consumption, introducing green energy and redistributing used grain to farmers (Capitello et al., 2020). Breweries have a high demand for water, not only for beer production, but also for cleaning (Morgan et al., 2020). In the United States of America, although craft breweries strive to increase sustainability, the volume of waste water generated is seven times that of production (Withers, 2017). After the fermentation process, the yeast can be reused for a new batch of fresh beer, saving resources for all breweries (Bühligen et al., 2014). The ecological footprint of craft beers occurs mostly in the transportation of the finished product. The method of transport is the critical point, the footprint can be reduced by increasing the quantity transported (Morgan et al., 2020). Embracing sustainability is an important opportunity for the craft beer industry, not only for the in terms of reducing the environmental footprint and increasing efficiency, but also contemporary also meeting the expectations of the consumer, who increasingly sees sustainability as an integral component of beer quality (Carley et al., 2018). The small available supply and the high price of craft beer are currently a sales problem (Villacreces et al., 2022). In the craft beer industry, a locally made product makes it more attractive to consumers, but the use of local ingredients is not always profitable (Atallah et al., 2021). The capacity increase that ensures the satisfaction of traffic growth is the characteristic that makes such a product most similar to mass products produced on a large scale (Hoffman et al., 2016). For consumers, artisanal production comes with a guarantee of higher quality (Hoffman et al., 2016). The higher income of consumers not only stimulates the increase in demand for more expensive products, but also the demand for a greater selection. In addition to higher incomes, consumer demand becomes more sophisticated and renewable, looking for greater variety, through which the consumer can communicate meanings that go beyond mere physical consumption (Garavaglia et al., 2017a). A brewer's main task is to satisfy the wishes and needs of consumers while keeping them safe and satisfied (Salanta et al., 2020). Craft beer now permeates social scenes from hipster to hippie, popping up everywhere from music festivals to yoga studios (Withers, 2017). According to Csapó, the number of restaurants and shops selling craft beer should definitely be increased (Csapó et al., 2015). On the other hand, according to Csörögi, wide availability has a negative effect on the choice of craft beers (Csötögi et al., 2018). Beer-related events are extremely popular, beer-themed events are key factors in the choice of craft beers and their consumption experience (Csörögi et al., 2018). Food tourism is undoubtedly a major component of the tourist's itinerary and is at the heart of destination strategies. Craft breweries are currently favored in beer tourism. Passengers motivated by beer (so-called "beer tourists" or "beer travelers") can be considered a separate market segment (Gajić et al., 2021).

2. Materials and methods

Through qualitative research, we can explore a wide range of dimensions of the social world, including the texture and fabric of everyday life, the understandings, experiences and ideas of our research participants, the way social processes, institutions, discourses or relationships operate and the significance of the meanings they generate (Mason, 2002). "The in-depth interview tool, with which we achieve that we have asked verbally, is mapped orally, without "extraneous additions"(Heltai et al., 2006). In general, the questioner is a foreign addition. In an in-depth interview, two people take part, two people express themselves. Only one of them is interesting, the interviewer is just a

tool. A tool that must be extracted from the material during processing so that it can be purely itself" (Heltai et al., 2006). Due to the exploratory nature of the study, I chose a qualitative descriptive design. This design may be considered appropriate when knowledge of the phenomenon of interest is limited and a deeper understanding is needed, as in this study. I considered open-ended interviews to be a suitable data collection method related to the goal, since the interview, questioning and answering represent a personal encounter in which the interviewer tries to understand the interviewee's point of view and experiences (Andersson et al., 2010). In order to get to know the experiences and opinions of the managers of the breweries, an in-depth interviewing technique will be needed. This allows us to gain insight into the operation of technological and economic processes, which is essential for uncovering errors and problems. I will carry out the investigation at 5 domestic and 3 foreign breweries, so I can not only get to know the domestic situation, but also compare it with international trends.

Grounded Theory is a qualitative methodology whose goal is to identify a concept through the understanding of problems and possible solutions (Kelemen-Erdős, 2014). The foundations of the methodology were formulated and described by Barney Glaser and Anselm Strauss more than fifty years ago, in 1967 (Glaser, 1992). To begin analyzing the data, Glaser and Strauss suggested comparing and coding the data (Strauss et al., 2008). Line-by-line coding helps researchers understand the experiences and perspectives of their research participants (Charmaz & Thornberg, 2020). However, the authors defined their analysis technique in different ways, Glaser was an inductive positivist, while Strauss sought a deductive analysis technique (Kelemen-Erdős, 2014). Over time, countless trends have emerged. Classical Grounded Theory is an analytical method that does not impose strictness or rules on data collection procedures (Timonen et al., 2018). Analysis software also appeared in the 21st century, but not everyone considers it a good idea to use them to apply the method (Bryant & Charmaz 2019). In our research, we use a constructivist approach, which was introduced by Charmaz in 2006, since it is inevitable to apply and incorporate previous knowledge and experience into the research, and we also consider the preliminary literature review to be of prime importance. According to the constructivist point of view, Grounded Theory is a flexible, heuristic strategy that is not rigid and prescriptive, rather it supports interpretive understanding, and it can be applied even without a positivist approach (Mitev, 2012).

The main research questions: What technological innovations support the operation of small-scale breweries? What are the food safety issues and critical points in small-scale breweries? How can food safety be improved in small-scale breweries? Which factors contribute to the sustainability of small-scale beer production?

3. Results

With the help of a set of questions based on Grounded Theory, we talked to the managers of 10 small-scale breweries about the market, technology, and sustainability. The image is well characterized by the following quote: ". So, we are talking about a small plant here, which should have the same equipment as a large plant. The difference is that here people really do it with all their heart and soul, and put in the ingredients that are needed." – Interviewee 7. Figure 1 presents the main problems of the craft beer industry and their solution options as a result of the analysis of the in-depth interviews based on the Grounded Theory methodology.

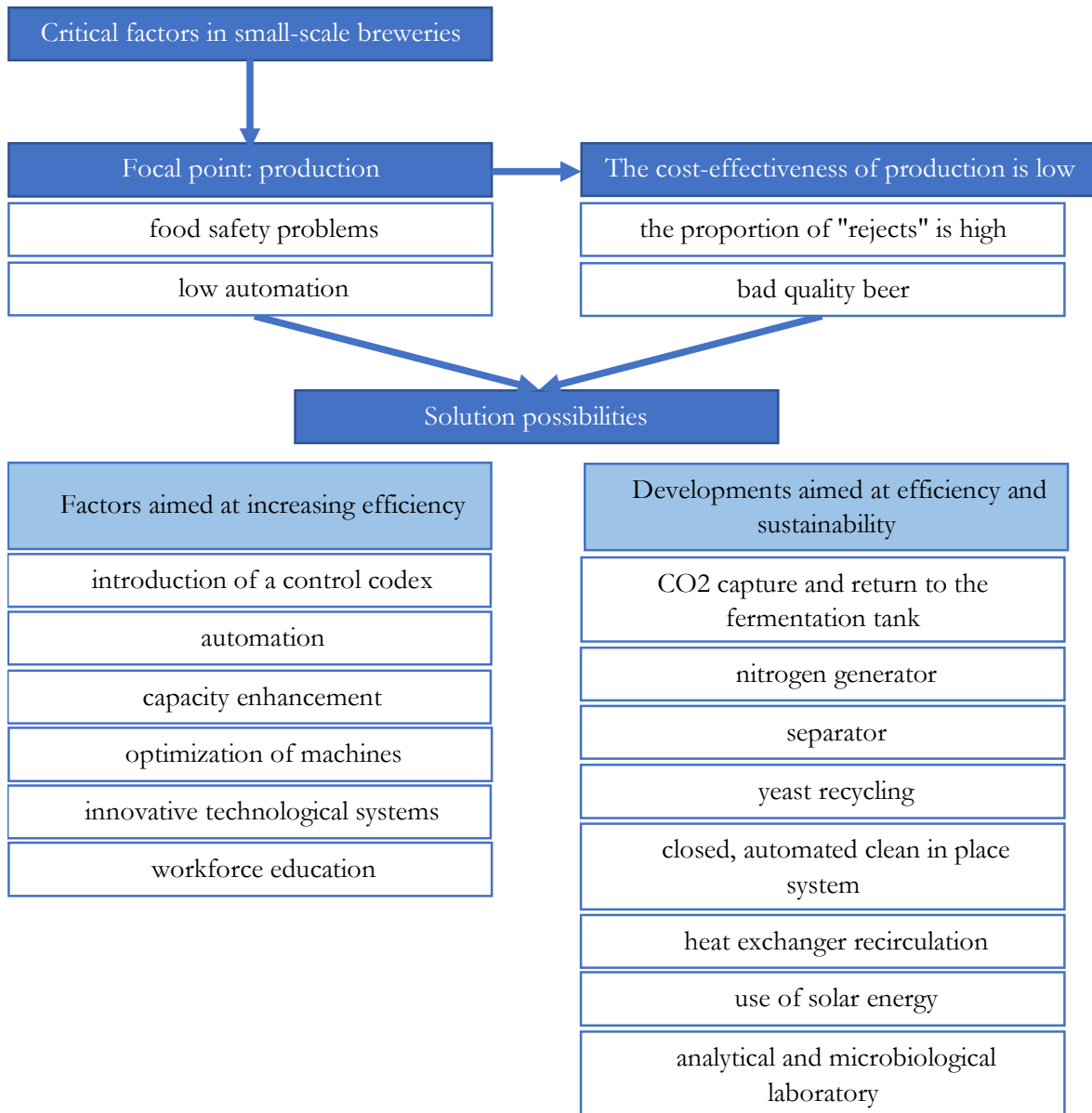


Figure 1. Critical areas and opportunities of small-scale beer production

The main goal of the research is to find out how small-scale beer production could be made more economical, cost-effective and sustainable. This is justified by the fact that we can get craft beers at a significantly higher price than large-scale beers, and moreover, they are not always of the right quality. One of the main influencing factors of the price is how much losses occur during production. Based on the interviews, it turned out that in most cases this is at least 20% during production. It is clear that the output could be increased by reducing the losses. We believe that the best solution for this is if brewers use a separator during brewing, which helps to reduce losses, and the finished beer will be much more stable in terms of food safety. Another solution would be for brewmasters to reduce losses by optimizing the settings of the machines. In addition, it would be not only a cost-effective, but environmentally friendly solution to capture the carbon dioxide produced and recycle it back into the finished wort. From an economic point of view, it is clear that capacity expansion would be the solution, economies of scale are a fundamental condition for efficient production. Using a nitrogen generator is also a cost-effective way to replace carbon dioxide, and it is more ideal from

a sustainability point of view, since no excess CO₂ is released into the environment. There is also the possibility of recycling yeast, as there are breweries where a batch of yeast is only used once, even though it could be used for several generations. Unfortunately, the prerequisite for this is the appropriate laboratory background, as it is essential that the live yeast cells are recycled under suitable food safety conditions. Another sustainable, environmentally friendly and cost-reducing solution is to recirculate the water used in the heat exchanger in the system and use the heated water used for cooling during the next brewing. The other main problem we have encountered in breweries is the inadequate level of automation. Unfortunately, most processes during brewing still require a lot of manual labor. Although small-scale breweries have improved a lot in recent years, an automatic system during the entire brewing process would greatly simplify and make the production process safer. The following statement put it very well: "There is only one point of infection in a brewery, so we try to keep it in a closed system as long as possible." – Interviewee 3. In this way, not only would personnel costs be reduced, but the beer being prepared would also have less contact with the air, which would reduce the food safety risk. We know that an inadequate number of germs in the air endangers the processes, so proper automation would be important. This is also important because in many cases the managers of breweries employ inadequately trained workers, which greatly increases food safety risks. If the appropriate level of automation is not available, it is worth creating a control code that everyone must follow, so that critical processes in production cannot be missed. This also makes it easier for an inadequately trained workforce to be sure to carry out the required processes. Unfortunately, carelessness and lack of thoroughness have caused food safety problems in many cases in the past. Of course, we can't ignore the solution that the factories undertake the education and proper preparation of the workforce. But all this can be omitted if automated processes are increased in production. The application and automation of CIP (Clean in Place) systems is also a cardinal issue, since it is not only worth using them economically, but also from a food safety point of view. With appropriate settings, CIP systems help to a large extent to significantly reduce the use of cleaning agents during cleaning. What's more, you can even use a single dose of detergent several times. With the help of an automatic CIP system, it is possible to avoid a food safety risk on equipment cleaned with inadequate thoroughness by live workers. However, for this it is important that the system is properly set up, otherwise we cannot avoid the risks and even the amount of cleaning agent used may increase. As in all industries, it would be important to use renewable, green energy in craft brewing. The most obvious solution is the placement of solar collectors, which can even make a building self-sufficient in terms of energy. Unfortunately, due to the characteristics of the buildings, this is not possible everywhere, but where it is, it can definitely be an initiative to be considered, both from an economic and sustainability point of view.

All in all, it can be said that small-scale beer production can be made more economical, cost-effective and sustainable with new, innovative and automated equipment, their optimal settings, the recycling of used materials and the inclusion of renewable energy sources. In addition, the optimal level of economy of scale can be achieved by expanding capacity, and the appropriate level of food safety by using an analytical and microbiological laboratory.

4. Conclusions

A complex review of the entire system of the breweries is necessary, based on the information obtained from the value chain analysis, the breweries can achieve development and a competitive advantage. Based on the results obtained, it can be concluded that the problems of small-scale breweries can be divided into three main components, which are closely related. Excessive losses during brewing, low automation and resulting food safety issues. We have established a variety of solution options for these. With the help of separator equipment, we can reduce losses and increase yield.

The equipment reduces food safety risks and increases the shelf-time of the finished product. By using a nitrogen generator, the production process can be made more economical, and carbon dioxide, which has a high environmental burden, can be replaced with an environmentally friendly solution. A similar advantage can be achieved by capturing and returning CO₂. By recycling the yeast and heat exchanger water, costs can be reduced and the ecological footprint can be reduced. Closed and automated systems provide a craft brewery with both food safety and economic benefits. A plant can be made energetically self-sufficient by using renewable energy. The most obvious and cost-effective solution for this is the use of solar collectors, but the use of geothermal energy can also be an alternative solution. The utilization of yeast recycling is a potential method in the brewing industry, as some breweries dispose of yeast after a single use, even though it can be reused for multiple cycles. However, this approach requires a laboratory infrastructure with proper food safety protocols to ensure the viability of the yeast cells during the recycling process. Another sustainable technique is the implementation of a water recirculation system in the heat exchanger, which not only reduces costs and environmental impact but also utilizes the heated water for cooling in subsequent brewing cycles. By applying these innovative technological solutions, actors in small-scale beer production can gain a competitive advantage over large-scale breweries from an economic and food safety point of view. Setting up a microbiological and analytical laboratory reduces food safety risks, but it is a costly factor. By using a CIP system, the environmental burden and the costs of cleaning agents can be reduced, and with the help of a closed automatic CIP system, food safety risks can also be reduced. By optimally setting up your machines and equipment, you can increase yield, reduce total costs and reduce food safety risks. It is important that properly trained live workers work in production, and in order to avoid mistakes, it is worth creating a control code (checklist). With capacity expansion, the optimal level of economies of scale can be achieved, which results in cost reduction. All in all, we can say that with the introduction of the appropriate level of automation, appropriate sizes and innovative technological processes, the actors of small-scale beer production can be developed economically and from a food safety point of view.

Funding: Supported by the ÚNKP-20-1 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation

Fund.”  
 NEMZETI KUTATÁSI, FEJLESZTÉSI
 ÉS INNOVÁCIÓS HIVATAL
 ÚNKP
 Új Nemzeti Kiválóság Program

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