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OBTAINING CRAFT GINGER BEER IN THE LABORATORY PHASE AND SENSORY, PHYSICO-CHEMICAL CHARACTERISTICS

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ABSTRACT

The purpose of this paper is the sensory and physico-chemical characterization of craft ginger beer obtained under laboratory conditions.

For this paper we prepared blonde beer (Indian Pale Ale - IPA) with ginger, the Ginger Beer assortment through the one-stage brewing method, in an amount of approximately 2 liters. The preparation resulted in a craft ginger beer with some insignificant defects (insufficient foaming, slightly high relative density, high acidity), defects explained by the too high temperature during primary fermentation and the continuation of secondary fermentation in bottles. On the other hand, the craft beer obtained has well-defined sensory qualities and is appreciated by the tasters (appearance, smell and taste), as well as a high alcoholic concentration, which qualitatively distinguishes it, compared to other commercial beers.

Once these deficiencies are identified and rectified, the craft beer recipe experimented in the laboratory can be successfully replicated in any micro-enterprise, which has as its profile the production of craft beer and opens the way for experimentation and innovation of other recipes.

1. Introduction

Craft beer is a beverage with a moderate percentage of alcohol, undistilled, which can be obtained by the fermentation process of malt juice boiled with hops (other aroma compounds may be used optionally) with the help of the brewer's yeast, in quantities restricted by independent producers.

Generally, craft beer drinkers prefer beers prepared from local varieties of malt and hops by brewery masters' products with a good knowledge of the local ingredients, as compared to the production obtained in large and medium-sized breweries (Baiano, 2021; Adams, 2006). This implies that breweries must be small in size and craft brewers must customise their brewing according to the tastes of consumers. According to a survey conducted by Alltech and The Journal of Brewers in 2016, the world number of breweries was 19000 and approximately 17700 (94%) of them were considered craft breweries (Zenith, 2017). Regarding the distribution of craft beer producers worldwide, the United States and Europe have a percentage share of 46% and 43%, respectively, followed at a distance by Canada (4.5%), South Africa (4.5%), Australia (3%), Japan (1.6%) and New Zealand (1%) (Callejo et al., 2019).

In the EU, the UK has the largest number of breweries (2430), followed by Germany (1492), France (1100) and Italy (868) (Baiano, 2021). Surprisingly, in countries with a tradition of producing beer in large breweries such as the Czech Republic, the number of craft breweries reached 480 in 2019 and have an encouraging market share of 2% (Brezinová, 2021).

For several years in Romania, the production of craft beer has started to grow, at the moment, with more than 40 microbreweries, no less than 17 opened in 2018.

As regards the ingredients used in the preparation of craft beers, the innovation of the recipe often refers to the use of new cereal mixtures or the rediscovery of old cereals, new varieties of hops, new yeast crops, fruits, vegetables and spices used to improve the sensory characteristics of the finished product (Donadini and Porretta, 2017; Li et al., 2017).

Craft beer can be classified according to its products and ingredients in several important types:

- Indian Pale Ale (IPA) tends to have a more bitter aroma, having more hops in its composition; this type of beer can be combined with ginger or other spices;
- Brown Ale, this beer has a high level of malt, which makes it softer and less bitter;
- Stout, it tastes similar to coffee because malt-free roasted barley portions are often used; it is a creamy beer rich in extract;
- Baltic Porter has a black texture, it is a dark beer with superior fermentation and has aromas of dried fruits (Hughes, 2020).

To meet consumer demands, craft beer producers have chosen to use distinct ingredients such as rice, honey, fruit, manioc, pumpkin, ginger, to induce positive sensory changes to the finished product (Tozetto et al., 2019; Pinto et al., 2015; Rio, 2013; Brunelli and Venturini Filfo, 2013; Brunelli et al., 2014; Matsubara et al., 2016).

The distinct aroma of ginger comes from the presence of volatile compounds such as camphene, borneol, geraniol, limonene, gingerol and other terpenes, while non-volatile molecules are responsible for the sharp, hot sensation in the mouth (Haniadka et al., 2013; Peter, 2006).

The production of craft beer is also an opportunity for local producers of raw materials to capitalize on their crops. Some studies have positively assessed the quality of the Romanian varieties of hops that are appropriate for the manufacture of craft beers (Mudura et al., 2010; Mudura et al., 2015; Mudura et al., 2016; Salanţă et al., 2012; Salanţă et al., 2015; Salanţă et al., 2016).

While craft brewers seek answers regarding possible new trends in beer consumption, many independent studies are directed towards assessing the quality of craft beer (Passaghe et al., 2015; Aquilani et al., 2015; Giovenzana et al., 2014).

In this context, our study aims to characterize from a sensory and physico-chemical point of view the craft beer with ginger obtained under laboratory conditions and to identify any defects that can be remedied in a future experiment.

2. Materials and methods

2.1. Materials

For the production of craft beer we used the following equipments: electronic scale, thermometer, areometer/densimeter, stainless steel pot, glass jar (capacity 3 L), grinding and filtering utensils.

The ingredients needed to obtain 2 litres of craft ginger beer are: malt - 800 g, water - 3.2 L, hops - 4.5 g, ginger - 11.2 g, yeast - 1.5 g

The ingredients were purchased from the S.C. Brico Ideea SRL Bucharest - Romania (Malt Weyermann Vienna 7 EBC, Hops Pellet Mandarina Bavaria and Yeast Fermentis Safbrew S-33).

2.2. Samples

The assessment of the sensory quality of beer was made using the 20-point assessment system and for the assessment of the different characteristics, scales from 0...5 points are applied for each organoleptic characteristic.

The determination of the density was carried out by the pycnometer method, the determination of the alcoholic concentration based on the relative density of the distillate, the determination of the acidity by titration with 0.1 N NaOH, and the determination of the colour by titration with 0.1 N iodine solution (Diaconescu and Theiss, 2004). The real extract was determined from correlation tables based on the relative density, and the primitive extract was calculated based on the real extract, the alcoholic concentration and some empirical coefficients.

Stages of making craft ginger beer in the laboratory

Weighing

The weighing of the ingredients (malt, ginger, hops, yeast) was done with electronic scales.

Mashing

We added the amount of water required (4 times the amount of malt), then we introduced the malt gradually for a good solubilization.

Obtaining mash sugar (brewing)

We have chosen the brewing by infusion in a single phase that involves keeping the temperature constant throughout the process. The ideal temperature for brewing is 65-68°C for 60-90 minutes. We stirred it permanently with a spoon for good sugar extraction.

Figure 1. Brewing, checking of starch saccharification

After 90 minutes of brewing, it was checked the sugar stage of the starch; for this purpose it was used a porcelain capsule where a few drops of must were placed, over which 2-3 drops of iodine solution were added and the color was monitored. If the colour of the composition changes to blue, the brewing must be continued and if the colour remains brown, there is no starch remaining, that did not turn into sugar, so and the next step can be taken.

Mash filtration

The filtration process is based on the separation of the soluble fraction of the mash from the insoluble part representing the malt pulp.

Wort boiling with hops and ginger

The process of wort boiling with hops takes 90-120 minutes. At the beginning of the boiling process, we added half the amount of hops in the standard Pellet form (90) to give the beer the bitter taste, and the other half in the same form we added it 5 minutes before the boiling was completed to give the beer flavor and savour. Also at that time we added freshly grated ginger. We added 2.5 times more ginger than hops to predominate the ginger flavor over the bitter taste.

Ginger contains the pungent compound gingerol, which is similar in structure to chilli's capsaicin and pepper's piperine. Heating converts gingerol to the less pungent zingerone, palatable.

Cooling

At the end of the boiling, I cooled the wort as quickly as possible to the temperature suitable for the adding of the yeast. We placed the pot in the cold-water bath until we cooled the wort to a temperature of 25°C.

Dry yeast inoculation

Before inoculating the yeast, we poured all the liquid into a 3-liter glass jar, then added the yeast culture. The yeast was diluted with lukewarm water at 30°C and we allowed it to acclimatize for 15 minutes.

Fermentation process

After mixing the wort with the yeast, we covered the container with gauze, creating anaerobic conditions of fermentation. We left the wort to ferment for a week at a temperature of 16-18°C (room's temperature). A control sample of wort prepared under the same conditions was fermented under ideal conditions of 7-9°C for a week. After 7 days of primary fermentation, the secondary fermentation phase followed, when the yeast settled. The completion of the primary fermentation was assessed by checking the density with the areometer.

Figure 2. Fermentation process, checking the degree of fermentation

Secondary fermentation

After primary fermentation, the beer was poured in 0.33 l bottles, which were stored in the refrigerator. The bottles were previously sterilised in the oven for 60 minutes at 180°C. Refrigerated storage for 2 weeks actually simulates conditions for secondary fermentation (2-4°C) (Diaconescu and Popescu-Mitroi, 2006; Diaconescu and Popescu-Mitroi, 2011)

3. Results and discussions

Sensory analysis

The sensory analysis of craft ginger beer was carried out in accordance with the approval of the Research Ethics Committee of "Aurel Vlaicu" University of Arad. 8 tasters over the age of 18, selected by prior screening that indicated consumption of blonde beer at least once a week, and who had no aversion to ginger, participated in the experiment. The attributes assessed were appearance, color, smell, taste, impregnation with carbon dioxide, and foam using a 5-point hedonic scale for each sensory feature (Bologa and Burda, 2006).

Summing up the scores

Depending on the importance of each characteristic in the formation of the quality of the beer, weighting factors are used:

Table 1. Sensory characteristic and weighting factor

Sensory characteristic	Weighting factor
Appearance	0.6
Color	0.8
Smell	0.2
Taste	1.4
Impregnation with CO_2	0.6
Foam	0.4

The result is calculated as an average, using the formula*:* $P_{mp}=P_{mnp}*F_p$

P_{mp} - weighted average score for each characteristic;

P_{mnp} - the unweighted average score of each characteristic, as the arithmetic average of the individual scores;

F_p - the weighting factor for the characteristic to be assessed.

Table 2. The centralization sheet of the results obtained in the sensory analysis of craft ginger beer

Current number	Taster code	Individual scoring					
		Appearance	Color	Smell	Taste	Impregnation with CO_2	Foam
1.	01	5	3	5	5	4	0
2.	02	5	4	5	5	3	1
3.	03	5	3	5	5	3	1
4.	04	5	3	5	5	3	1
5.	05	5	4	5	5	4	1
6.	06	5	4	5	5	4	0
7.	07	5	4	5	5	4	1
8.	08	5	4	5	5	3	1
Unweighted average score		5	3.6	5	5	3.5	0.75
Weighted average score		3	2.88	1	7	2.1	0.3
Total average score		16.28					

The score obtained in sensory analysis is 16.28 points, receiving the rating "Good", the product having specific positive qualities quite well outlined, the defects being insignificant. The appearance of the liquid is clear, without sediment or impurities, yellow-brown color, pleasant smell and taste specific to beer, without foreign smell and taste, harmonious combination between the taste of hops, malt and ginger. It is worth mentioning that for sensory characteristics, appearance, smell and taste, the analyzed product obtained maximum scores unanimously from the tasters.

However, following the evaluation carried out by 8 different tasters, the same sensory defect was identified: insufficient foaming, which is the consequence of poor impregnation with carbon dioxide during fermentation.

Table 3.Results of physico-chemical measurements for craft ginger beer

Physico-chemical measurements for craft ginger beer	**Medium values**	**Commercial ginger beer „Crabbie's"**	**Limits according to SR 4230:2004 for superior blond beer**
Density ($g*cm^{-3}$)	1.019±0.01	1.018	1.018
Real extract (%)	4.83±0.01	2.16	3-5
Primitive extract (%)	12±0.01	10	10-12
Alcoholic concentration (%)	5.85±0.03	4.0	Minimum 4.3
Color (mL iodine solution)	1.10±0.10	1.4	Maximum 1.2
Total acidity ($g*L^{-1}$)	5.70±0.08	3.78	2.8
pH	3.6±0.10	4	3.9-4.6

Physico-chemical measurements

For craft ginger beer, the following physico-chemical parameters were determined: density, real extract, primitive extract, alcoholic concentration, color, pH and total acidity. All physico-chemical measurements were performed 3 times and mean values were taken into account.

The results showed a higher alcoholic content of craft beer compared to commercial beer, a fact confirmed by other studies (Zhao et al., 2010). The high concentration of alcohol in craft ginger beer seems to be a parameter with a positive impact on the preferences of consumers. In addition, the ginger flavor induces positive sensory changes in the finished product, being highly appreciated by consumers.

The high alcohol content is correlated with the increase in total acidity, the same trend being reported in the other studies (Mascia et al., 2014).

Usually, unfiltered and unpasteurized craft beers tend to ferment again in bottles, in this way the increase in total acidity can also be explained (Marongiu et al., 2015).

Comparing craft ginger beer to commercial ginger beer (assortment „Crabbie's") it can be seen that the parameters alcohol concentration, color, real extract are clearly superior for craft ginger beer.

In the absence of a standard for craft ginger beer, the results were compared with the standard for superior blonde beer SR 4230 (2004).

4. Conclusions

The main advantages that personalize the product obtained are its appearance, smell, taste, but also the high alcoholic concentration.

The main defect identified in the sensory analysis (insufficient foaming) can be explained by the fact that the primary fermentation was carried out at a much too high temperature (16-18°C), the ideal temperature being 7-9°C. This defect can be remedied by driving the primary fermentation at lower temperatures.

The deficiencies identified by the physical-chemical examination are: higher density than normal, due to the presence of the suspended yeast - the cause being insufficient filtration and the total acidity higher than normal, but without the occurrence of the souring defect - the cause being the continuation of the secondary fermentation in bottles.

The results of the experiment carried out by us in the laboratory show that the preparation of craft beer by the method of single-phase brewing is not such an easy thing, resulting in some unpleasant surprises, materialized in small defects. Once these defects have been identified and remedied by "laboratory microprobes", it opens the way for experimentation and innovation of other recipes, initially at the laboratory phase, then at the pilot station and finally at the industrial phase (craft beer micro-enterprise).

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