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COMPARATIVE STUDY REGARDING THE QUALITY OF DIFFERENT TYPES OF UNPASTEURIZED BEER

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Abstract

The main purpose of this study was to compare the quality of the different types of unpasteurized beer from a profile unit in Bucharest area and samples coming from the market. The material was represented by 12 unpasteurized blonde beer samples divided in 4 batches. The samples were submitted to physico-chemical and microbiological analysis determining: alcohol concentration, original, apparent and real extract, density, limpidity, colour, pH, RDF (real fermentation degree) and microbial loading in order to verify the efficiency of pasteurization using microfiltration. pH is one of the most important parameters regarding the taste and beer stability, the values obtained were between 4.24-4.63. Another important parameter was the microbial loading, which was negative both in aerobic and anaerobic media. After analyzing all the results obtained, it is concluded that these products comply with the quality standards imposed by the legislation in force.

Key words: *unpasteurized beer, physico-chemical analyse, microbial loading, food safety.*

INTRODUCTION

Over time, beer has been defined as a low-alcohol beverage that can be obtained from malted and unmalted cereals, water, hop and yeast (Muste S. et al., 2005; Masschelein C.A. et al., 2008; Banu C., 2009; Branyik T., 2012; Hlatky M., 2013; Ghimpețeanu, M., 2017; Petcu C.D. et al., 2019).

Nowadays, on the Romanian market, there are countless types of beer obtained from different types of malt and hop, through ingenious technological processes, followed, tested and verified constantly, to make a finished product as tasty as possible, which aims to satisfy as many consumers as possible by taste, aroma, flavour and colour (SR 13355-1:1997; Cercel C., 2008; Mihaiu M. et al., 2013).

The beer contains the nutritional components of the cereals from which it is obtained and new products resulting from the alcoholic fermentation: organic acids, aldehydes, higher alcohols, water-soluble vitamins (B_1, B_2, B_6, B_{12}, PP, H), but also mineral substances (potassium, magnesium, calcium, phosphorus, iodine) (Berzescu., 1981; Banu, 2001; 2009; Banu et al., 2010; Tăpăloagă., 2013; Petcu et al., 2019).

Consumed in moderation, this drink can be beneficial to health, due to the natural ingredients from which it is obtained. Barley is an important source of proteins, fibers and vitamins, and hop is a source of antioxidants (Banu et al., 2001; 2009).

All raw materials and ingredients used to obtain beer assortments must comply with the applicable legal requirements regarding the possible presence of contaminants (Goran et al., 2012a; 2012b; Murariu O.C. et al., 2019; Murariu F. et al., 2019).

Due to the development of micro-breweries and the mass marketing of "craft" beers, all the major brands from Romania, but also from all over the world, have developed a technological system that can manufacture a product able to compete with "craft" beer, in industrial quantities, and so in the years of 2016 and 2017, the production and distribution of unpasteurized beer began in Romania.

MATERIALS AND METHODS

The study took place in a brewery, located in the Bucharest area. The general purpose of the paper is to evaluate the different types of unpasteurized beer in correlation with food safety, in order to find the physico-chemical differences between the brands.

In order to identify the different particularities regarding the beer obtaining technology, the technological flow of beer manufacturing was followed within the processing unit.

The factory is equipped with the latest technology, in terms of machinery, which are periodically checked, so that the results would reach the required level of market demands.

The technological stages take place in a completely automated stainless steel closed system. The employees at the control points can follow a series of essential parameters for the safety of the finished product (Petcu C.D., 2006). Monitoring can be done throughout the technological process of obtaining beer through several display monitors, and in case of an error, the operators are alerted visually, but also by sound to be able to solve the problem as soon as possible.

To increase the shelf life, the beer goes through a preservation process made with the help of pasteurizers or pasteurization tunnel, but for unpasteurized beer, preservation is done by cold pasteurization, meaning microfiltration of all microorganisms and enzymes using filter cartridges and avoiding contamination of beer at bottling by creating a sterile, tightly sealed environment around the bottling machine (Petcu C.D., 2014a; Petcu C.D., 2014b).

Microfiltration will be performed using a composite filtration system (BSF Alfa Laval) consisting of two sets of filter cartridges:

- 0.65 μm cartridge - used for retaining yeasts and various coarse particles;
- 0.45 μm cartridge - used to retain 1,000,000 bacteria/cm^2.

The factory has two microfiltration lines that can continuously filter 200 hl/h of beer each, and their sanitization is made with the help of a special internal cleaning system, which uses a NaOH-based sanitizer.

In the sterile sealed room in which the bottling of unpasteurized beer takes place, the temperature and humidity level are permanently controlled. An air purification system is installed to prevent the development of other microorganisms. In addition to these verification systems, the sterile chamber is equipped with a microparticle sensor that can stop the bottling if the microparticle limit in the air exceeds the set value.

During the study, 12 samples were examined. Beers come from 4 different brands, including beer produced by the study unit.

The 12 samples were divided into 4 batches by brand, so batch number 1 consists of unpasteurized beer produced in the study unit, and the other beer brands make up batches 2, 3 and 4.

In order to find out the potential differences between the beer brands studied, in the laboratory of physico-chemical analysis of the study unit, using the Alcolyzer Beer Anton Paar Analyzing System (Figure 1), the following determinations were made: percentage of alcohol, original extract, apparent extract, real extract, RDF (actual fermentation degree) and density. With the Haze-meter, the degree of limpidity was determined (Figure 2), while the pH was determined using the pH-meter (Figure 2), and the colour, using the spectrophotometer (Figure 3).

Figure 1. Alcolzyer Beer Anton Paar Analyzing System

Figure 2. Haze-meter and pH-meter with electrode

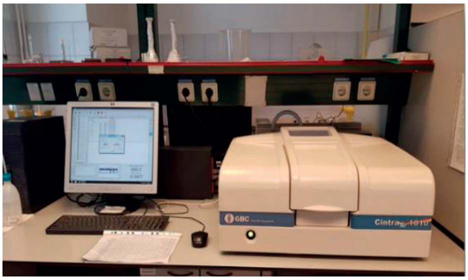


Figure 3. Spectrophotometer

In addition to to these, microbiological analyses carried out in the microbiology laboratory, were also performed, through which the microbiological load of the beer samples analysed, was determined.

Given that beer is a fermentative drink, in addition to beneficial microorganisms that transform carbohydrates into ethyl alcohol and carbon dioxide, due to minor accidents, like incorrect filtration, incorrect pasteurization or, in the case of unpasteurized beer, incorrect microfiltration, different microorganisms which could destroy the beer, can develop.

After the 10-day incubation period at 20-27°C, 100 ml of beer is filtered through a filter membrane, which is then placed in the Petri dish with the UBA or WLN culture medium. Next, the samples are incubated inside an aerobic enviroment for 3 days, respectively 7 days in anaerobic environment at 27°C, after which the counting of the colonies under the microscope is carried out.

RESULTS AND DISCUSSIONS

Results and discussions regarding the alcohol concentration determination

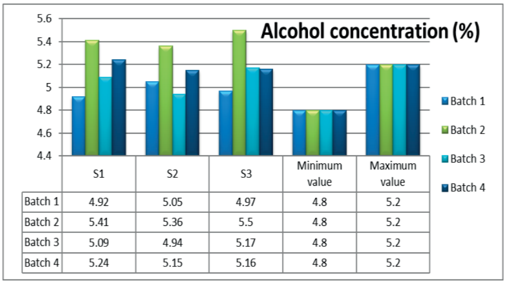
From the analysis of the obtained values it can be observed that in batch 1 all the results fall within the desired limits of 4.8-5.2%, these being the reference values.

In the case of batch number 2, all values exceed the reference values, but without distorting the product.

The alcoholic concentration of 5.3% is recorded on the label of the products that form batch 2, in correlation with the values of the determined parameters.

Batch number 3 did not exceed the limits imposed, forming a lot with compliant results.

The last analysed batch registered a single minor deviation of 0.04% which does not endanger the integrity of the product (Figure 4).



	S1	S2	S3	Minimum value	Maximum value
Batch 1	4.92	5.05	4.97	4.8	5.2
Batch 2	5.41	5.36	5.5	4.8	5.2
Batch 3	5.09	4.94	5.17	4.8	5.2
Batch 4	5.24	5.15	5.16	4.8	5.2

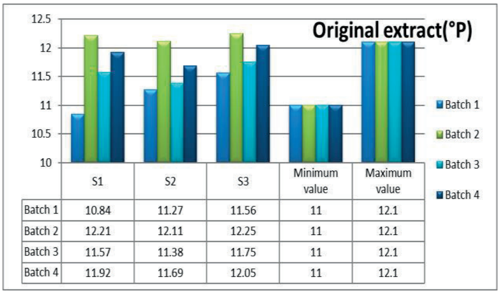
Figure 4. Evolution of the values obtained after determining the alcohol concentration (%)

Results and discussions regarding the original extract determination

The first batch analysed for the determination of the original extract started with a small deviation of the first beer sample of - 0.16°P. This deviation does not endanger the integrity of the final product.

All the results of batch 2 have exceeded the maximum limit of 12.10°P, but considering that the values are very close to this limit, the quality of the product is not jeopardized.

The values obtained from the determination of the original extract of the samples of batch 3 and batch 4 were in compliance, not exceeding the maximum and minimum values (Figure 5).



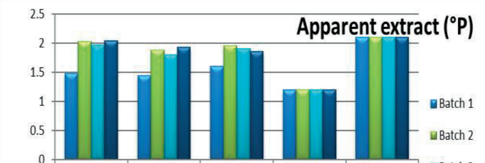
	S1	S2	S3	Minimum value	Maximum value
Batch 1	10.84	11.27	11.56	11	12.1
Batch 2	12.21	12.11	12.25	11	12.1
Batch 3	11.57	11.38	11.75	11	12.1
Batch 4	11.92	11.69	12.05	11	12.1

Figure 5. Evolution of the values obtained after determining the original extract (°P - Plato degrees)

The results obtained in the present study, regarding the original extract, were close to the ones obtained in the study conducted by Mudura E. et al. in 2006.

Results and discussions regarding the apparent extract determination

The results obtained from the determinations made for finding the apparent extract of all the samples were within the quality limits of 1.20 - 2.10ºP (Figure 6).



	S1	S2	S3	Minimum value	Maximum value
Batch 1	1.48	1.44	1.6	1.2	2.1
Batch 2	2.03	1.89	1.96	1.2	2.1
Batch 3	1.97	1.8	1.91	1.2	2.1
Batch 4	2.04	1.93	1.86	1.2	2.1

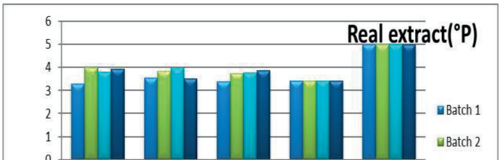
Figure 6. Evolution of the values obtained after determining the apparent extract (°P - Plato degrees)

Petcu C.D. et al., conducted in 2019 a study on a batch of 20 blond beer samples, the results of the apparent extract being close to the results obtained in the present study.

Results and discussions regarding the real extract determination

Following the determination of the real extract of the samples from batch number 1, it was found that two of the samples have values below the minimum allowed limit (sample 1, which has 0.11°P less, and sample 3 with 0.02°P less than the minimum allowed limit). Since these values are very close to the allowed limit, the quality of the beer is not considered to be altered.

Results obtained from the analysis of the samples from batches 2, 3 and 4 did not register real extract values that exceed the limits imposed, having obtained compliant values (Figure 7).

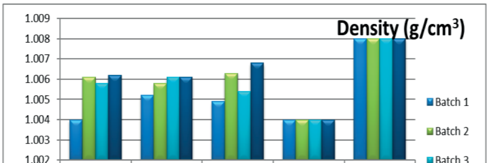


	S1	S2	S3	Minimum value	Maximum value
Batch 1	3.29	3.53	3.38	3.4	5
Batch 2	3.99	3.82	3.75	3.4	5
Batch 3	3.81	3.98	3.77	3.4	5
Batch 4	3.94	3.51	3.86	3.4	5

Figure 7. Evolution of the values obtained after determining the real extract (°P - Plato degrees)

Results and discussions regarding the density determination

The beer samples from all analysed batches obtained density results that do not exceed the limits imposed by 1.0040-1.0080 g/cm^3 (Figure 8).

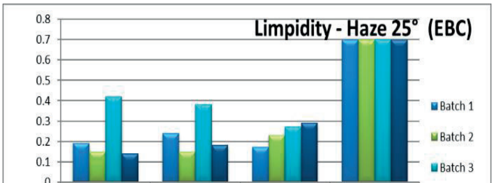


	S1	S2	S3	Minimum value	Maximum value
Batch 1	1.004	1.0052	1.0049	1.004	1.008
Batch 2	1.0061	1.0058	1.0063	1.004	1.008
Batch 3	1.0058	1.0061	1.0054	1.004	1.008
Batch 4	1.0062	1.0061	1.0068	1.004	1.008

Figure 8. Evolution of the values obtained after determining the density (g/cm^3)

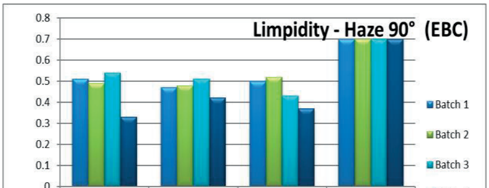
Results and discussions regarding the limpidity determination

The degree of limpidity of all the examined batches did not exceed the limit of 0.70 EBC units, neither in the case of the Haze at an angle of 25°, nor in the case of the Haze at an angle of 90° (Figures 9 and 10).



	S1	S2	S3	Maximum value
Batch 1	0.19	0.24	0.17	0.7
Batch 2	0.15	0.15	0.23	0.7
Batch 3	0.42	0.38	0.27	0.7
Batch 4	0.14	0.18	0.29	0.7

Figure 9. Evolution of the values obtained after determining the limpidity - Haze 25º (EBC)



	S1	S2	S3	Maximum value
Batch 1	0.51	0.47	0.5	0.7
Batch 2	0.49	0.48	0.52	0.7
Batch 3	0.54	0.51	0.43	0.7
Batch 4	0.33	0.42	0.37	0.7

Figure 10. Evolution of the values obtained after determining the limpidity - Haze 90º (EBC)

Results and discussions regarding the colour determination

After determining the colour of the beer for the samples from batch 1 and batch 2, it was found that the results fall within the imposed limits (4.5-8.5 EBC).

The results of the samples from batch 3 registered the exceeding of the maximum limit, but these do not influence the quality of the beer.

All the samples of batch 4 have exceeded the maximum limit, but the result does not influence the quality of the beer, but the colour difference between the beer analysed in this batch and the samples analysed in the other batches is very visible, as the producers may have used a darker type of malt (Figure 11).

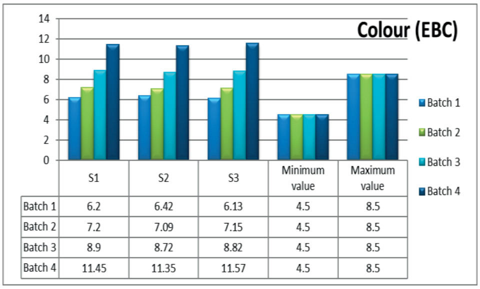


Figure 11. Evolution of the values obtained after determining the colour (EBC)

Results and discussions regarding the pH determination

The values recorded after the determination of the pH of the beer samples from batch 1 and batch 3 were within the limits of 4.10-4.50.

The values recorded from the analyses for determining the pH of the beer samples from batch 2 exceeded the maximum limit of 4.50. The pH value may be influenced by yeast that has not been removed by microfiltration or by high alcohol concentration.

In the case of beer samples comprising batch number 4, only one of them exceeded the limit imposed with 0.13 units on the pH scale. Since the values of the other samples were within the limits imposed, the integrity of the batch is not affected (Figure 12).

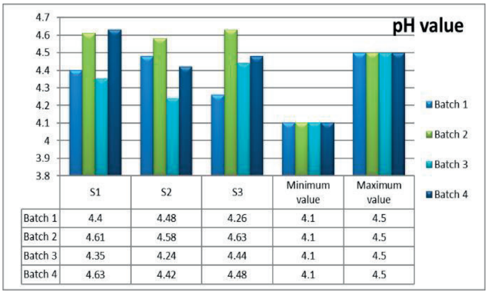


Figure 12. Evolution of the values obtained after determining the pH value

Comparing the results obtained in the present study regarding the pH value, with the results obtained by Petcu C.D. et al. in 2019, it is found that the accepted reference range is 4.35-4.8, a range in which the current study fits.

Results and discussions regarding the RDF (real fermentation degree) determination

The values recorded after the analysis of all beer samples for the determination of RDF do not exceed the maximum value of 73% (Figure 13).

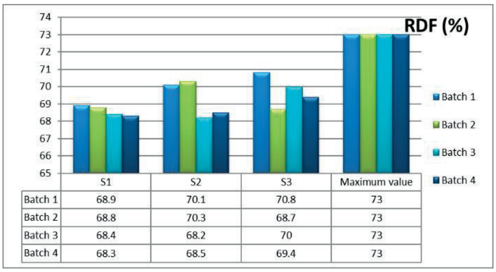


Figure 13. Evolution of the values obtained after determining the RDF (real fermentation degree)

The results of these determinations recorded similar values of the RDF (real fermentation degree) with the results obtained in the study conducted by Mudura E. et al. in 2006.

Results and discussions regarding the determination of microorganisms using filter membranes

After the incubation period of 3 days in an aerobic environment, respectively 7 days in anaerobic environment at 27°C, the samples are removed from the incubator. It is noted that no microorganisms were developed on any culture medium used (UBA or WLN), so we can say that microfiltration was effective for each type of beer (Figure 14).

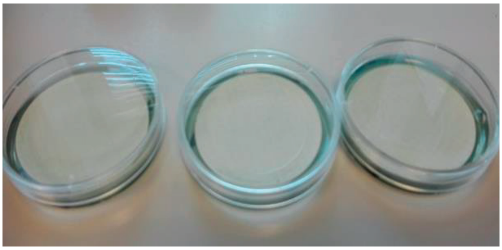


Figure 14. Representative samples of the batches of beer after incubation

CONCLUSIONS

The results were compared with the quality standards for pasteurized beer, and some samples show minor differences from the applicable standard.

Four of the analysed parameters namely: the apparent extract, the density, the limpidity and the RDF (real fermentation degree) recorded corresponding values for all the analysed samples.

On the other hand, after the determination of the real extract, deviations were recorded for 2 samples, the values obtained being with 0.11°P, respectively 0.02°P lower than the minimum allowed limit, although the quality of the beer is not considered to be altered.

In the case of the alcohol concentration determination, the exceedence of the reference values by 0.16%, 0.21% and 0.30% for the 3 samples of batch 2, is not considered a deviation from the beer quality standard.

Regarding the values obtained after the colour determination, half of the samples were within the reference range, and the results of two batches exceeded the maximum allowed limit for blonde beer. The colour difference from the other samples is clearly visible, which most likely correlates with the darker hue of the type of malt used by the processor unit.

With the help of the results obtained from the analyses carried out on each batch, we can say that most of the unpasteurized beer samples comply with the legal quality standards.

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