COMPARATIVE STUDY REGARDING THE CHEMICAL COMPOSITION OF CRAFT BEER

LIVIU GIURGIULESCU, IOAN RADU ŞUGAR, MIHAI BANICA, LUCIAN BUTNAR

Keywords: beer, acidity, CO_2, esters.

ABSTRACT

Since the Middle Ages, after the settlement of the Saxons in Transylvania, the beer arrives first timidly and later by force in the Romanian countries. This paper`s aim is to presenta study on how to prepare homemade beer and its chemical composition.

.

INTRODUCTION

Due to the fact that beer is a very popular beverage, numerous studies and analyzes have been done on commercial beers. This is the reason why we chose to prepare two different beer recipes and a third one, obtained by combining the two recipes and diluting the outcomewith water at the end of fermentation. The three beer samples were coded as: B1, B2 and B3. The recipes are distinguished by the quantities of raw material, the brewing process at different temperatures and the fermentation time.

Beer is a low-alcohol, non-distilled beverage obtained by fermenting stum. The raw materials used in brewing are barley malt, water, hops and yeast. Homemade beer contains many nutrients, which are generally lost in industrially prepared beers due to long processing, intense filtration and pasteurization. A disadvantage that appears during the preparation process of homemade beer is the loss of CO2.

MATERIALS AND METHODS

2.1. Materials

2.1.1. Samples

The beer used in this case study was prepared according to two different beer recipes and a third one, obtained by combining the two and diluting the outcome with water at the end of fermentation. The three beer samples were coded with names such as: B1, B2 and B3. For the first recipe, B1, 2 kg of malt, 10 l of water, 6 g of hops and 3 g of yeast were used. For the second recipe, namely B2, 0.5 kg of malt, 4 l of water, 5 g of hops and 2 g of yeast were used. The last sample, B3, resulted from the combination of the first two recipes.

2.1.2. The determination of carbon dioxide

The carbon dioxide in the beer is absorbed into a 0.05 n excess sodium carbonate solution, and the excess alkaline solution is titrated with a 0.1 n hydrochloric acid solution in the presence of phenolphthalein. The reactions that take place are the following:

$H_2CO_3 + Na_2CO_3 \rightarrow 2\ NaHCO_3$; ~$Na_2CO_3 + 2HCl \rightarrow 2\ NaCl + H2O + CO_2$.

A bottle of beer is cooled and frozen with salt at 0◦C. We put 50 ml of 0.05 n sodium carbonate solution in a 600ml beaker and add by using a pipette, 25 ml of cooled beer, holding the tip of the pipette in the alkaline solution. We add another 400 ml of distilled water, homogenize, add 1 ml of phenolphthalein

solution and titrate with a 0.1 n hydrochloric acid solution until the solution discolors. In another identical beaker, take 25 ml of cooled beer, add 100 ml of distilled water and bring to the boil, stirring constantly to remove the carbon dioxide. When the liquid starts to boil, remove the flame in order to avoid the loss of volatile acids, then cool it in a mixture of ice and salt. Add 400 ml of boiled and cooled water and titrate with 0.05 n sodium carbonate solution, in the presence of phenolphthalein, until it turns pink.

2.1.3. The determination of esters

We take 250 ml of cold non-carbonated beer at a temperature of 2-5° C, place it in a distillation facility and start distillation. The process of distillation is continued until 235 ml of distillate is captured in a flask immersed in an ice bath. The distillate is brought to a volume of 250 ml, mixed well and 200 ml are taken aside and placed in a titration vessel. In order to neutralize the acids, the solution is titrated with a 0.05 n sodium hydroxide solution to pH 8.2 in the presence of phenolphthalein. 5 ml of 0.05 N sodium hydroxide are added for saponification and the solution is quantitatively transferred to a 500 ml flask fitted with an ascending refrigerant with water. We place the flask in a water bath and boil for 2 hours to saponify the esters. The content of the flask is cooled, placed in a vessel and titrated with a solution of 0.05 n sulfuric acid to a pH of 8.2 in order to neutralize the excess sodium hydroxide.

3. Results and discussions

3.1. Determination of total acidity

After the removal of carbon dioxide, the three samples of beer are titrated with sodium hydroxide until two drops of phenolphthalein reddened with sodium hydroxide, placed on a porcelain plate and mixed with 4 drops of the sample,used to be analyzed, no longer discolor. After calculating the total acidity, the results obtained are measured in g H_2SO_4 / l, and the samples vary between 1.28-1.92. The largest amount of H_2SO_4 / L expressed in grams is sample B2, followed by B1, and the smallest amount is B3. The 3 beer samples fall within the allowed limit of H_2SO_4 / l, the maximum limit being 3.3 g H_2SO_4 / l.

Table 1.

Values obtained for total acidity expressed in g H_2SO_4/ L of beer

Coded sample of beer	Vol. NaOH 0.1 N (ml)	Total acidity, g H_2SO_4/l
B1	8.2	1.64
B2	9.6	1.92
B3	6.4	1.28

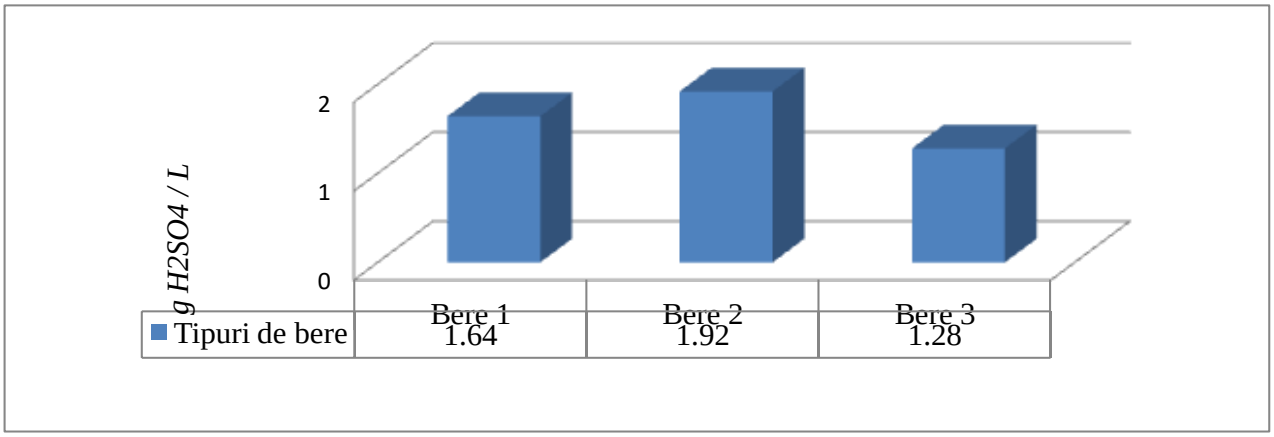

Figure 1. Total acidity, expressed in sulphuric acid (g H_2SO_4/l)

3.2. The determination of volatile acidity

Volatile acidity is calculated using the total acidity.After titration of the distillate with 1N sodium hydroxide, in the presence of phenolphthalein, a rapid coloration in pink is observed, which determines the use of a small amount of hydroxide. After performing the calculations, the results obtained are measured in g / l acetic acid.The largest amount of acetic acid is sample B2.

Table 2

H_2SO_4/ L Volatile acidity(values)

Coded samples of beer	Vol. NaOH 1N (ml)	Volatile acidity expressed in g/l acetic acid
B1	0.15	4.83
B2	0.10	5.70
B3	0.30	3.66

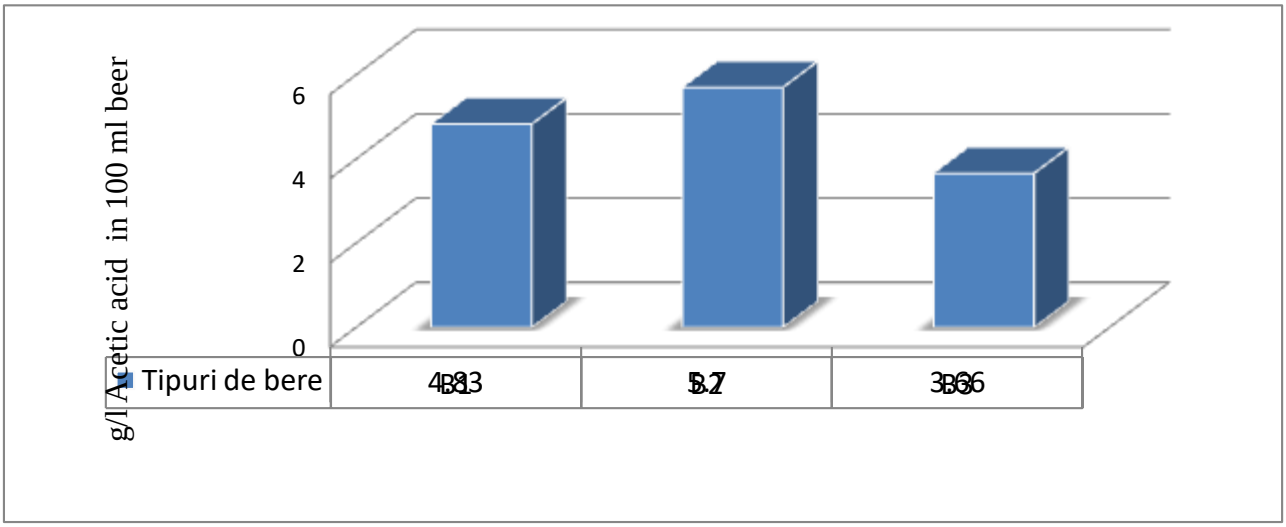

Figure 2. Volatile acidity, in g/l acetic acid

3.3. The determination of carbon dioxide

After determining the carbon dioxide, differences can be spotted between the 3 samples. The strongest presence of CO2 is in sample B2, which underwent a longer process fermentation. B1 has a smaller amount of CO2 than B2, and B3, being the diluted sample, has the smallest amount of CO2. The CO2 values are low due to the CO2 losses that appeared during the filtration process.

Table 3

CO2 content

Coded samples of beer	Volum HCl 0.1 N (ml)	Volum Na2CO3 0.05 N (ml)	CO2 g/100 ml beer
B1	21.5	1.5	0.0968
B2	19.2	1.9	0.1707
B3	23.1	2.2	0.0282

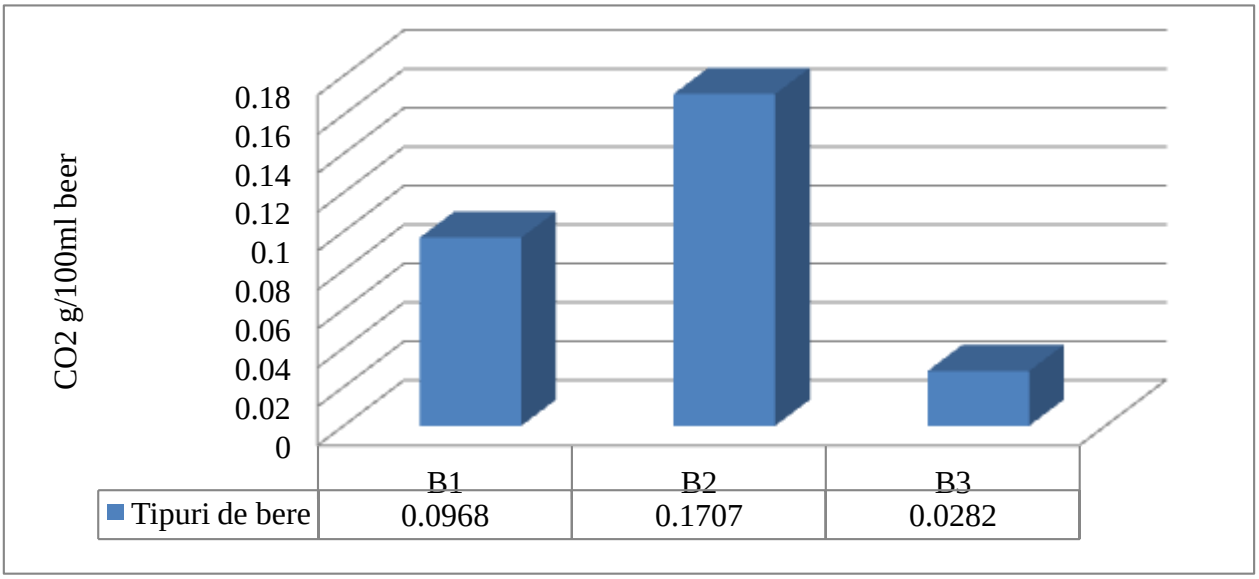

Figure 3. Content of CO_2/100 ml beer

3.4. The determination of esters

The smallest amount of esters, expressed in mg/l of ethyl acetate appears in the sample of beer coded B1, followed closely by the B2 sample and the smallest amount of ethyl acetate appears in the B3 sample of beer.

Table 4.

Values obtained at the determination of esters

Coded samples of beer	NaOH 0.05 N (ml)	Ethyl acetate (mg/l)
B1	9.5	41.80
B2	8.9	39.16
B3	7.7	33.88

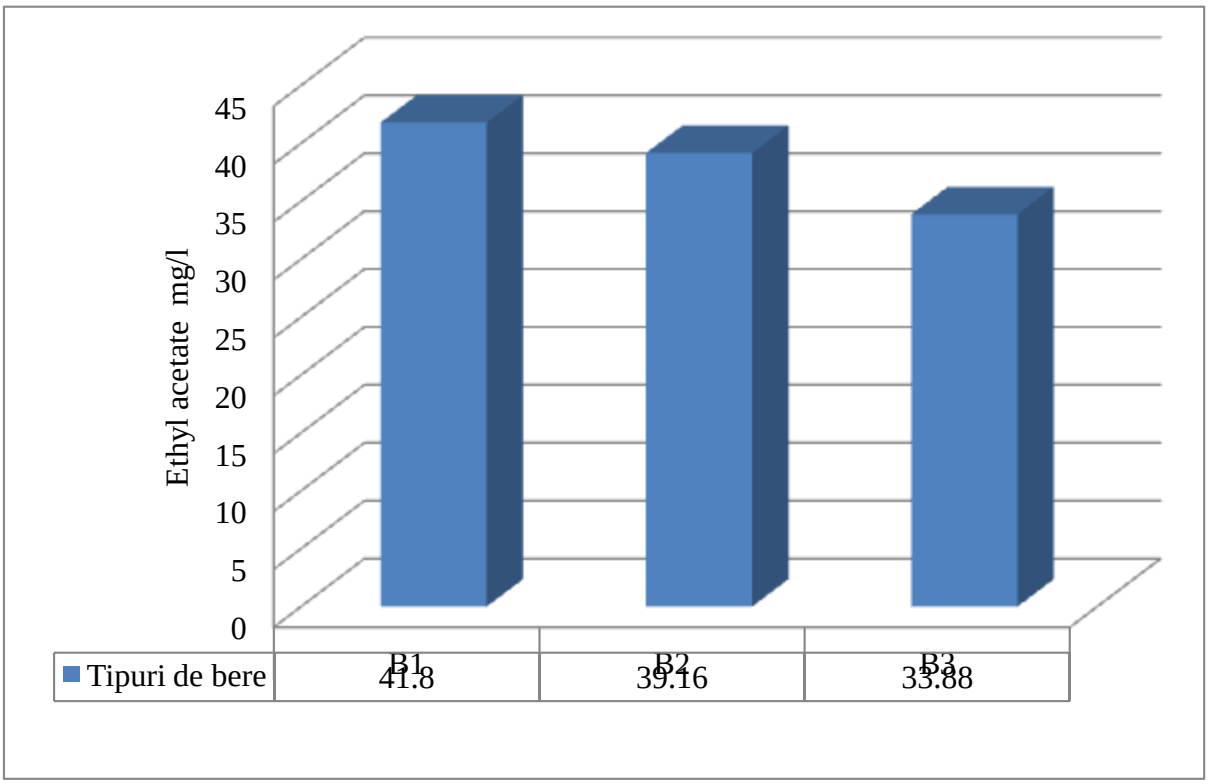

Figure 4. Amount of ethy acetate (mg/l)

CONCLUSIONS

Following the research, made on the three types of beer, coded B1, B2 and B3, we find that the recipes presented above, in terms of the amount of raw materials, brewing at different temperatures and fermentation time, fall within the quality standards of beer. Thus, after determining the quality of the foam, samples B1 and B2 have a good, respectivelygood foaming, and the diluted sample has an insufficient foaming. Following the determination of the total acidity, expressed in g H2SO4 / l, it we may conclude that the beers B1, B2 and B3 fall within the allowed limit, the limit being of 3.3 g H2SO4 / l. Following the determination of the volatile acidity, expressed in g / l acetic acid, we can observe that the beer coded B2 has the highest amount. Following the determination of carbon dioxide,we can notice a loss of CO2, the outcome of the process being small amounts of carbon dioxide.

BIBLIOGRAPHY

1. **Adrian A.,** *Berea preparată în gospodărie*, Editura Alex-Alex, 2001
2. Banu C.,*Manualul inginerului de industrie alimentară*, vol.II, EdituraTehnică, Bucureşti, 2002
3. Banu C., *Tratat de industrie alimentară*, EdituraAsab, Bucureşti, 2008
4. Berzescu P., ş.a., *Utilaje şi instalaţii în industria berii şi a malţului*, Editura Ceres, Bucureşti, 1985
5. Borcean I., David G., Borcean A., *Tehnici de cultură şi protecţie a plantelor tehnice*, Editura de Vest, Timişoara, 2006
6. Borcean si colab, *Tehnologia culturilor de camp*, Ed. Agroprint, Timisoara, 1997
7. Filimon N., Predescu T., *Tehnologia industriilor fermentative,* Editura didactică şi pedagogică, Bucureşti, 1973
8. http://proalimente.com/tehnologia-berii-fabrica-berea
9. https://www.scribd.com/document/370728991/Determinarea-Calităţii-Spumei-Berii
10. https://ro.scribd.com/doc/141128009/Implementarea-Haccp-La-Bere