Comparison between Two Fermentation Methods for the Obtaining of Beer with Strawberries

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Abstract
For the obtaining of various types of beer, brewers use diverse adjuvant or modify the fermentation parameters of beer. For example, Belgian brewers offer to the consumers a large variety of quality beers made after old recipes. One of the aromatization methods consists in adding fruits or fruit aroma before the fermentation starts. The wort used for these beers is specially treated and Belgian brewers usually use gueuze beer. They add sugar and fruits and obtain after fermentation a special beer with fruit aroma. In this paper we compare two methods for the obtaining of beer with strawberries aroma concerning the main aroma substances found in this beer (diacetyl, 2,3 pentadione, acetaldehyde, etylacetate, propanol, isobutanol, isoamyl alcohol, isoamyl acetate). For the fermentation we used ordinary wort, strawberries and sugar for one sample and wort and strawberries for the second sample.

Keywords: Special beers, fermentation, flavour, strawberry

1. Introduction

Market saturation with “Pils” beers bring to the development of new products by Belgian brewers, products called special beers. These special beers are characterized by an unconventional sensorial perception of the consumer, respectively they have a different appearance, smell and taste (Derdelinckx, Hopulele et all).

Certain Belgian beers have a typical character given by the major parameters which influence beer’s physico-chemical properties and organoleptic characteristics. For the characterization of a special beer all sensory aspects must be taken into account: view, touch, odour and taste (Derdelinckx, et all).

Special beers represent about 30% of the beer market in Belgium and are in general produced by small and medium sized breweries. However, the success of some special beers catches the interest of larger breweries which now seek participation in the activities of special beer breweries or they tend to develop new special brands (Derdelinckx, et. all).

The quality of these beers depends on the consistency and quality of each step of the process. One of the best known types of special Belgian beer is guéuze, obtained by bottle refermentation of lambic. Using gueuze as raw material, Belgian brewers may obtain kriek beer by adding fruits before bottle refermentation. The main characteristic of these beers is the use of top fermentation. Some of these beers are considered as luxury types and the presence of yeast in the bottle, giving visible sediment and eventually turbidity, is considered as an excellent item for the flavour description of these types of beers (Derdelinckx, Brent et all).

If we compare the added value generated by diverse brewing processes we observe that most food and beverages technologies generate more benefits than beer production.

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For the increasing of the added value of a beer we create a special beer with fruits (strawberries) using a regular wort. In this way, we developed a new product and we must agree that some findings are applied successfully. We tried to improve the bouquet of the beer by natural treatments applied during beer fermentation.

We hope that the introduction of new flavoring agents will improve the satisfaction level of the actual consumer and convince non-beer lovers to become consumers.

For the obtaining of new special beer with fruits we added natural flavoring agents (strawberries) and sometimes sugar in the wort and realized a fermentation process at 20°C. The beer obtained has a specific color given by the fruits and a specific taste.

2. Materials and methods

The fermentation process was conducted in 2 liter flasks. For the experiment industrial wort was used having next properties: original extract 8.53°P, pH - 5.28, colour – 9.3 EBC units, bitterness – 42.8 BU, FAN – 111.3 ppm. The wort was pasteurized at 85°C for 5 minutes.

The fruits used for fermentation were Romanian strawberries having the following characteristics: dry matter 9.1 g/100g, water 90.9g/100g, sugar 4.7g/100g. In one sample we added sugar.

The wort was pitched with industrial slurry brewing yeast with a viability of 94.9%, consistency of 67.3% and pH of 5.27. The pitching rate was 15×10⁶ cells/ml and the yeast was introduced at the beginning of the assay.

The laboratory apparatus used were:
- Karl Zeiss Jena Microscope – for cell counting,
- Analytical balance Owalabor type 750.05 – for weighing the samples,
- Shimadzu gas-cromatograph with capillary column Chromopack 7773, length 50 m, detectors FID and ECD, mobile phase N₂/H₂ – for the determination of aroma compounds,
- Anton Paar DSA 5000 – for alcohol content and extract determination,
- Spectrophotometer for free amino nitrogen content, color and bitterness determination,
- pH-meter for pH measurements.

The methods used were:
- Direct counting of microorganisms with Thomas camera,
- Vitality staining of yeast with methylene blue according to EBC method,
- Head space by gas-cromatography for aroma compounds using EBC method,
- Ethanol determination using standardized method SR 13355-3/1999,
- Free amino nitrogen content using ninhydrin method,
- Color, bitterness and polyphenols were determined according to EBC methods.

3. Results and discussions

The fermentation process was conducted in two flasks with capacity of 2.0 liters; each flask was filled with 1.5 l of boiled wort with the properties above-mentioned and strawberries. In one flask we added sugar and in the other we didn’t, trying to determine if between the two samples major differences are concerning beer’s aroma.
The wort was pitched with $15 \times 10^{6}$ cells of *Saccharomyces carlsbergensis* per milliliter. The fermentation process was conducted at a constant temperature of 20°C. The fermentation lasted for 7 days. In the end the samples were analyzed for aroma compounds content, color, pH, apparent extract, alcohol content.

There weren’t major differences between the samples depending of the original gravity of the sample.

The two samples were: ZK – the sample with sugar and FZK – the sample without sugar.

The original extract and apparent extract are showed in the figures 1 and 2. The original extract for the sample without sugar is $8.3^\circ$P, lower than the wort’s, because of the dilution with strawberries. For the sample with sugar the original extract is $8.76^\circ$P. The differences between apparent extract of the samples wasn’t major, as it can be seen in figure 2.

![Figure 1](image1.png)

Figure 1. The original extract for the samples without sugar (FZK) and with sugar (ZK).

![Figure 2](image2.png)

Figure 2. The apparent extract for the samples without sugar (FZK) and with sugar (ZK).
The alcohol content is according with apparent extract variation (figure 3).

The same variations have the pH and the color of the beer.

Regarding the aroma profile of the samples, it can be observed from the following figures that there aren’t differences between the samples in the ester content, but there are some differences concerning the other aroma substances determined. The acetaldehyde content of the sample ZK is higher because of the sugar added and the alcohol content of this sample. The approximate flavour threshold for acetaldehyde is 5-15 ppm and this compound is responsible for the green apples aroma in beer.

The typical concentration of acetaldehyde in beer is 2-15 ppm. As it can be observed in figure 4 the acetaldehyde content for the FZK sample is normal, 8.1 ppm, but the acetaldehyde content for the ZK sample is higher, respectively 24.7 ppm, due probably of the sugar added.

The diacetyl which imparts a buttery aroma and flavour is one of the vicinal diketones. Its presence is recognized down to 50 ppb, but is identified at 150 ppb. In our samples the diacetyl content is lower in the ZK sample and higher in the sample without sugar (figure 5).
The 2, 3-pentandione content is low, but together with diacetyl is over the sensorial threshold for vicinal diketones (figure 6). The vicinal diketones imparts in beer an unpleasant and sweet aroma of butter and milk.

The higher alcohols content in beer is varying a lot between 60-150 ppm and affects the aroma, taste and smell of the beer.

We determined the n-propanol content, isobutanol content and 1-amylic alcohol content. The higher alcohol content is different for the two samples as it can be seen from the figures below.

The propanol content is lower than the sensorial threshold (100 ppm) and it isn’t dangerous for the final beer’s aroma and flavour (figure 7).

The isobutanol content is over the sensorial threshold (12-15 ppm) and imparts in beer an unpleasant bitter taste (figure 8).

The 1-amylic alcohol content is very high, over the sensorial threshold (60-65 ppm) – figure 9.
The higher superior alcohols content found in our samples may be due to the raised temperature used for fermentation.

The ester content in beer may achieve 80 ppm in final beer. Esters are compounds responsible for the fruity aroma of beer. In our samples the both esters determined (ethyl acetate and isoamyl acetate) are below the sensorial thresholds (50 ppm for ethyl acetate and 5 ppm for isoamyl acetate). Both esters are in the same amount for the FZK and ZK samples. Ethyl acetate is 28.7 ppm and isoamyl acetate is 1.7 ppm. There are no differences in fruity aroma of the samples regarding the two esters determined.

But, using fruits for beer fermentation brings in beer a specific pleasant flavour given by the specific esters found in these fruits.

4. Conclusions

The aroma profile of the analyzed samples is different due to the different content in diacetyl, 2, 3 pentanedione, acetaldehyde and higher alcohols.

As it could be observed from the anterior data, the best fermentation method for strawberries beer is the method that doesn’t use sugar. For the FZK samples the acetaldehyde content and higher alcohols content, except n-propanol, is lower.

This beer needs a longer maturation time for the diminution of vicinal diketones content and a lower fermentation temperature. In literature we didn’t find aroma profiles for special beers, so we couldn’t compare our samples with similar beers on the market but more studies can be made for the characterization of these types of beers.
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