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REGULAR ARTICLE

EFFECT OF ADDITION OF SACCHAROSE TO THE SENSORY PROPERTIES OF BEER

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ABSTRACT

The aim of this article was the evaluation of physicochemical (pH value, ethanol content and initial worth extract) and sensory properties of beer samples. The basic sensory properties are: color, limpidity, foaming (foam stability), followed by smell and taste beer. Beer of pilsner type with various concentration of saccharose was produced. The range of pH values varied from 5.36 (sample no. 4) to 5.51 (sample no. 2). Sample no. 1 without saccharose had pH value 4.98. The initial wort extract for light beers from 11.00 to 12.99 % in samples no. 1 and 2. Sample with 50 % saccharose and sample no. 3 did not meet the requirements of legislation. The lowest content of ethanol was in sample no. 4 (4.2 %) with 50 % addition of saccharose. The highest content of ethanol was in sample no. 1 (5.12). Sensory properties were evaluated as bad in sample no. 4 in several parameters. Addition of saccharose has a negative impact on the sensory properties of beer.

Keywords: beer, adulteration, saccharose, sensory evaluation, quality of beer

INTRODUCTION

Food authenticity is very important from economic and qualitative perspective. It is very important for food industry **(Nollet, 2004).**

Beer, one of the oldest known alcoholic beverages, is produced by the yeast fermentation of cereals germinated in water and flavored and stabilized with hops, this being the ingredient responsible for the bitter taste of this beverage (**Polshin *et al*., 2010**; **Vera *et al*., 2011**).

Brewing is a complex process demanding the control of many parameters to ensure reproducibility of the quality of the finished product: a very complex mixture of constituents varying widely in nature and concentration levels. Mechanical, physical, chemical, biochemical and enzymatic processes have a function in beer production. Beer quality depends on 4 basic ingredients: barley malt, hops, yeast and water **(Bamforth, 2003)**.

There are several chemical parameters related to the quality of beer. One of the parameters that needs to be controlled is pH, which has a great influence on the taste, prevents the growth of microorganisms and is a key factor influencing beer ageing and its stability (**Bamforth, 2001; Guyot-Declerck *et al*., 2005**).

Adulterated food are those whose appearance, taste, composition or other characteristics have been changed to reduce their value, and which offer the consumer as full name or the usual other false means (**Council regulation no. 152/1995**).

Change the appearance, taste, composition, or other characteristics usually occurs consequence of the voluntary addition of certain substances, either to increase in volume or weight of the product, further partial or complete restriction of certain securities ingredients or fewer confusion valuable raw materials or components **(Suhaj and Kováč, 1998)**.

Adulterated beer is beer which is produced from other than the declared ingredients, beer with substitute of malt over 30 %, beer produced from other kind of beer by colored, neutralized beer (**Hamr and Cuhra, 2004**).

Substitutes of malt are divided to sugar malt substitutes (saccharose, invert sugar, dextrose, fructose, glucose syrup) and starch (barley, wheat, corn, rice, transformed form of substitution) (**Basářová *et al*., 2010**).

Beer contains a huge number of organic compounds, such as proteins, amino acids, polyphenols and sugars, which come mainly from the brewing materials and as by-products of yeast metabolism during the fermentation. These compounds are responsible for most of the organoleptic characteristics of beer and they are related to its stability (**Araujo *et al*., 2005**)

Beer is obtained by the brewing and fermentation of starch (mainly derived from malted barley) germinated in water in the presence of yeast. Cones of hop (*Humulus lupulus*) are used in the brewing process to add bitterness which comes from α-acids (humulones), that are contained in the hop cone. During wort boil, six iso-α-acids which impart about 80% of the beer bitter taste are formed from the hop α-acids. Iso-α-acids are also of interest due to their influence on foam stability (**Blanco *et al*., 2006**) and their bacteriostatic effects (**Blanco *et al*., 2007**).

Foaming is characteristic and importent property of beer. Rich, dense and durable foam usually indicates good quality beer and there is release of carbon dioxide from the beer. (**Kosař and Procházka, 2000**).

Fulness – the perception of fullness beer involved mechanoreceptors (sensors able to evaluate palpation perceptions). Fullness is influenced mainly by the content of residual extract in beer (**Čejka and Hrabák, 2007**).

The aim of this article was the evaluation of physicochemical and sensory properties of beer samples with addition of saccharose.

MATERIAL AND METHODS

The following samples were prepared and evaluated in this article:

Sample no. 1 – beer of pilsner type without saccharose

Sample no. 2 - beer of pilsner with addition 10 % of saccharose

Sample no. 3 - beer of pilsner with addition 30 % of saccharose

Sample no. 4 - beer of pilsner with addition 50 % of saccharose

Cooking of beer from malt extract is one of the possibility of beer production. Liquid malt extract arises by cooking malt and water, by crowding in an evaporator. Cooking is performed the same way as at cooking from the malt, but it begins in phase of the finished malt wort. We started to wort boiling at production of beer. Malt extract produced from Czech Pilsner malt and drinking water was used in our experiment. Properties of Pilsner type malt extract: honey consistence, average content of saccharides 76 %, dry substance 81 – 83 °Bx, proteins 5 – 7 %, mineral substances 1.2 %, pH value 5 – 5.8, shelf life 9 months).

Water (3 l), malt extract (pilsner type) (0.5 kg), 3 types of granulated hops : 5 g of variety Sladek, 5 g of variety Premiant, 1 g of variety Žatec, 0.33 g of extract one brewer's yeast BREWFERM were used to cooking each sample of beer.

Pilsner beer made from light malt should have the following characteristics: yellow to golden yellow color, medium to strong bitterness, high fullness, sweetly malt flavor, good foaming, ideal composure and good organoleptic and dietetic properties.

Brewing beer process was carried out in laboratory conditions in a mini brewery equally for each sample as follows:

1. Malt extract (0.5 kg) was added to the water (3 l). Saccharose (50 g – 10 % addition of saccharose, 150 g – 30 % addition of saccharose, 250 g – 50 % addition of saccharose) and hops extract were added to boiling water. Extract was kept in boiling for 10 minutes.
2. Hops granulates Sládek and Premiant were used after 10 minutes of boiling. Samples were boiled 15 minutes. Žatec (1 g) was added 10 minutes before end of boiling. The resulting product was hot wort.
3. Wort was pumped to the whirlpool bath tub – there was done remove of gross sludge. Wort was 35 minutes in the whirlpool tub. Wort was cooled to 18 °C.
4. Fermentation of wort was performed after cooling. This operation was performed after the addition of beer yeast BREWFERM. These yeasts are effective at temperatures 18 – 20 °C. It was a upper fermentation in an open container. Fermentation was 12 % (saccharisation).
5. The secondary fermentation was carried out in fermentation tanks at 5 °C. This activity slows the fermentation process, the beer matures and clarified. The main goal of secondary fermentation is obtain of optimal organoleptic properties, carbonation and clarifying of beer.
6. Beer can be filtered in the last phase. This operation was not performed in our experiment.

Production of standard – light beer without addition of saccharose (sample no. 1) – water (3 l), malt extract (0.5 kg), hop extract (0.33 g) and hop granulates were used.

Sensory evaluation

Sensory analyze was performed according to STN ISO 8586-2. Evaluation commission was formed from 5 members. These characteristics were evaluated: smell, taste, fullness, character of bitterness, brightness, color, foaming, total subjective impression. The total subjective impression was assessed on a scale 1-9 (very good – very bad). Other categories were assessed on a scale 1 – 5 (very weak – very strong).

Produced beer samples with a legal addition of saccharose (till 30 %) were compared with adulterated beer sample.

RESULTS AND DISCUSSION

Sensory analysis is an analytical method in which the organoleptic characteristics of food are determined only by human senses. Sensory stability is considered one of the most important factors that determine the quality of the beer.

Legislation allows the use of substitution of malt, up to a 30 % **(Decree no. 2313/4/2000-100)**. Therefore, sample no. 4 is considered to be adulterated beer. This beer contained 50 % of saccharose. This sample was compared with samples with 10 and 30 % addition of saccharose and with malt beer (0 % content of saccharose).

Enzymatic processes mashing are affected by pH value. pH value affects mainly cleavage of high-molecular substances, solubility of nitrogenous bases and bitter substances (**Basařova *et al*., 2010**).

pH value of our samples varied and depended on the content of added saccharose. The range of pH values varied from 5.36 (sample no. 4) to 5.51 (sample no. 2). Sample no. 1 without saccharose had pH value 4.98.

Normal values pH for light beer are from 4.1 to 4.8 according to STN 56 6635. pH value in sample no. 1 was slightly over the legal limit. pH value at adulterated sample no. 4 was 5.36 – over the legal limit. High pH values were measured also at other samples.

Samples no. 1 and no. 2 meet the requirements of Regulation (ES) no. 510/2006, which indicates the contents of the initial wort extract for light beers from 11.00 to 12.99 %. Sample with 50 % addition of saccharose and sample no. 3 did not meet the requirements of legislation.

Quantity of extract in the initial wort can be about 0.3 percent lower than the declared, while the upper limit to the amount of the initial wort extract may not exceed the lower limit of beer with a higher amount in the initial wort extract, in special beers can be exceed declared by upper limit of 0.5 weight percent (**Decree no. 2313/4/2000-100**).

Use of the sugar substitutes causes decrease of content of nitrogenous substances, polyphenolic and growth substances and increase degree of fermentation and alcohol content in beer (**Basářová *et al*., 2010).**

Content of ethanol was also examinated in each sample. The lowest content of ethanol was in sample no. 4 (4.2 %). The highest content of ethanol was in sample no. 1 (5.12 %).

Determination of sensory parameters of beer

Complex mixture of volatile compounds varying in chemical structures and concentration levels generates the beer aroma which has a key role in beer quality. The aroma or flavor of beer can be considered to be derived from four sources: raw materials, the impact of the process, in-pack flavor changes and the ingress of taint materials (**Kosař and Procházka, 2000**).

Ultimately it is the combination of these factors that create the flavor or aroma of beer. Beer production is a complicated process, relying on three biotransformation steps - mashing, fermentation and maturation, on to which is superimposed the chemical changes that arise particularly during wort boiling and wort clarification (**Vanderhaegen *et al.*, 2006**) .

Sensory properties of beer are very important. Sensory evaluation of beer is performed by degustation commission (**Kosař and Procházka 2000).**

Sensory analysis is divided into 2 groups:

Objective sensory analysis - this is the most accurate description of the evaluator's assessment of perceptions. Evaluation can be done only by trained tasters.

Subjective sensory analysis - informs about evaluator relation to the product under consideration **(Čejka and Hrabák, 2002).**

Sample no. 1 were evaluated as good by first evaluator. Sample no. 2 was evaluated as bad and sample no. 3 was evaluated as very bad, sample no. 4 was evaluated as bad. Samples no. 1 and no. 2 were without foreign smells. Foreign fruity smell with medium intensity was detected in sample no. 3. Foreign yeast smell with medium intensity was detected in sample no. 4.

The sensory indicator „fullness of beer“ was characterized as strong in sample no. 1 and weak in sample no. 2. Fullness of beer was evaluated like very weak in sample no. 3 and 4. Another sensory property was evaluated "limpidity of beer“. The best evaluation was in sample no. 1. The moderate limpidity was in sample no. 2. Limpidity was weak in samples no. 3 and 4. Foam stability was detected as medium in sample no. 1. Weak foam stability was detected in sample no. 2 and 3 by first evaluator. Foam stability was very weak in sample no. 4.

Intensity of bitterness was evaluated as good in sample no. 4. Intensity of bitterness was evaluated as weak in samples no. 1, 2 and 3.

Samples no. 1 and 2 were without foreign smells by second evaluator. Foreign fruity smell was detected in sample no. 3. Medium intensity of foreign yeast smell was detected in adulterated sample no. 4. Fullness of beer was the best in sample no. 1 and the worst fullness was in sample no. 2. The foreign apple taste was detected in sample no. 4 by second evaluator. The other samples were without foreign taste. Indicator "limpidity of beer“ was evaluated as best in sample no. 1, the worst limpidity was in sample no. 4. Sample no. 1 was evaluated by second evaluate as the best and sample no. 4 was evaluated as the worst.

The intensity of smell was evaluated like medium (value 3) by third evaluator. Foreign apple smell was detected in samples no. 3 and no. 4. The bitterness of beer was evaluated as weak in sample no. 1, 2 and 3. Medium intensity of bitterness was evaluated in sample no. 4. Bitterness of beer was evaluated as strong in sample no. 1. The foam stability was weak in sample no. 3 and 4. Sample no. 4 was evaluated like a poor in all sensory parameters according to third evaluator.

Smell of beer was evaluated like strong in sample no. 1 by fourth evaluator. Other samples had medium smell. Samples no. 1 and 2 were without foreign smell. Foreign apple smell with medium intensity was detected in sample no. 3. Foreign yeasty smell with medium intensity was detected in sample no. 4. Limpidity of beer was the best in sample no. 1, weak limpidity was in sample no. 2, 3 and 4. Foreign fruity taste with medium intensity was detected in sample no. 4. The medium foam stability was detected in sample no. 1. Weak foam stability was detected in samples no. 2, 3 and 4. Total subjective impression was evaluated as good in sample no. 1. Samples no. 2 and 3 were evaluated as medium good. Sample no. 4 was evaluated as the worst sample.

Total intensity of smell was evaluated by fifth evaluator as follows: sample no. 1 – strong, samples no. 2 and no. 4 – weak, sample no. 3 – medium. Foreign yeasty smell was detected in sample no. 4. Foreign apple smell was detected in sample no. 3. Bitterness of beer was evaluated as medium intensity in sample no. 1, other sample were evaluated as weak. All samples of beer were without foreign taste. Stability of foam was evaluated as medium in samples no. 1 and 3. Foaming was evaluated as weak in samples no. 2 and 4. Sample no. 1 was evaluated as best in all sensory indicators, sample no. 3 was evaluated as medium good and samples no. 2 and 4 were evaluated as bad.

Objective and reproducible results can be achieved by accreditation of laboratories, by training of evaluators, adequate methodology and by the correct application of statistical methods.

Unauthorized content of added saccharose has a negative impact on sensory and physicochemical properties of beer. Beer surrogated by crystal sugar was characterized by lighter color, weak foaming, higher alcohol content and foreign smell. Saccharides affect the organoleptic properties of food (taste, appearance, texture). Relative sweetness indicates organoleptic properties of different saccharides (**Willaert, 2001**).

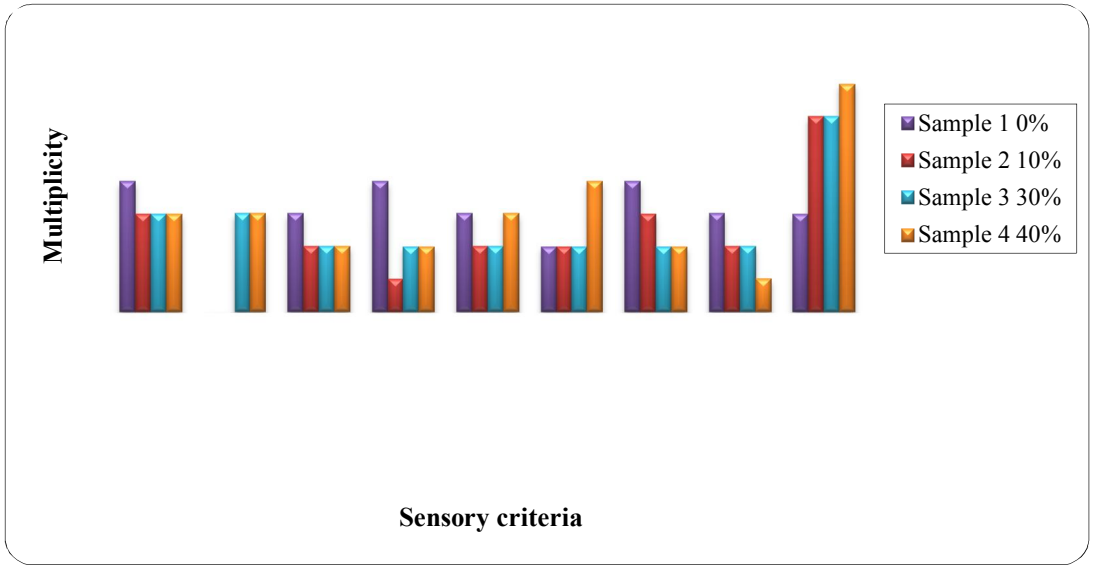

Figure 1 Evaluation of sensory characteristics of all samples

Figure 1 shows the results of sensory evaluation of all samples of beer.

Beer should have the following sensory characteristics: pleasant the characteristic smell, good fullness, bitterness quality, absence of foreign smells and tastes (**Čejka and Hrabák, 2007**).

Figure 2 shows results of sensory analyze of sample no. 1 and sample no. 4.

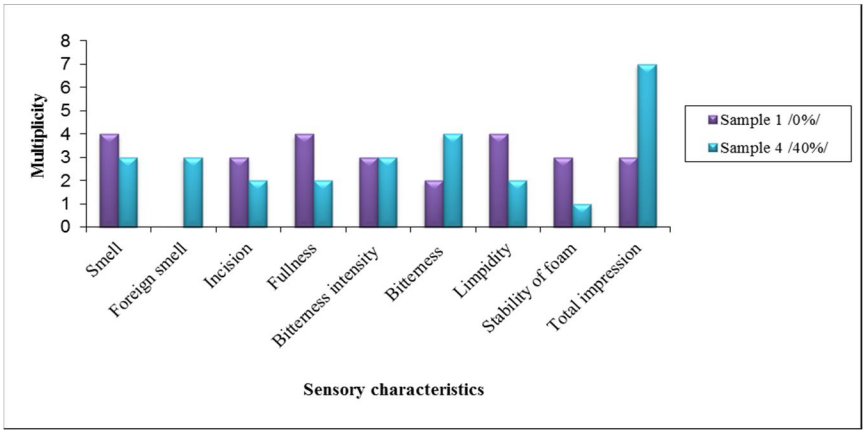

Figure 2 Compare of sensory characteristics of samples

The foam of beer is one of basic characteristic of beer (**Kosař and Procházka, 2000**). The foam in sample no. 1 was evaluated as medium. The foam in adulterated beer (sample no. 4) was evaluated as low, instability and weak.

Total smell beer of Czech type should be low to medium (**Kosař and Procházka, 2000).** Malt beer had stronger smell in compare with adulterated beer. Foreign yeast smell was detected in adulterated sample of beer.

Beer incision was good in sample no. 1, weak incision was in samples no. 2, 3 and 4. Incision of beer is caused by the release of bubbles of carbon dioxide in the mouth.

CONCLUSION

Significant differences were detected between compared samples of beer. High molecular proteins and some other high-molecular substances are involved in the fullness of beer. Fruity apple taste was detected at adulterated beer, increased amount of esters causes a foreign taste. Addition of saccharose and higher temperature of fermentation supports the formation of esters.

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