Development of goji berries in brewing: comparisons between analytical data and sensory.

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Abstract

Goji berries (Lycium barbarum) have been used for several centuries in the traditional Chinese medicine due to their numerous therapeutic effects such as anti-aging, immunity enhancing and liver protecting properties. The enrichment of beer with fruits may have beneficial effect on flavour properties and bioactive compounds content of the beverage. Goji berries were added to ale type beer using several method in order to define the better way which allows producing a beverage with desirable sensory characteristic and high antioxidant capacity. The obtained beers differed in terms of color and turbidity. The enrichment of ale beer with goji berries led to higher antioxidant activity of the final product. Addition of berries at the early stage of processing resulted in high extraction rate of rutin. The highest content of p-coumaric and ferulic acids was noted in beers to which goji berries were added before fermentation. At this stage, the beers were not subjected to the thermal treatment any more. The consumer preference was clearly towards the beers to which goji berries were added at the beginning of the production process. The multidimensional correlation between the sensory data of the profile and the analytic parameters is significantly positive (RV = 0.68, p-value < 0.09). In conclusion, addition of goji berries at the beginning of the beer processing allows preserving/extracting bioactives and obtaining the beer with high antioxidant activity and best sensorial characteristics.

Keywords: ale beer, goji berries, antioxidant activity, sensory properties

1. Introduction

Beer is a drink consumed around the world. It is a product rich in carbohydrates, amino acids, minerals, vitamins and phenolic compounds. These are mainly from the malt and hop. Beer consumers are always looking for new products with new flavours, new tastes. Specifically, the addition of red fruit helps bring new flavours and also increases the bioactive components and oxidative stability of the products. It is also recognized that moderate beer consumption can have a positive impact on health by reducing the risk of vascular and heart disease. In addition, Goji berries (Lycium barbarum) are recognized in Chinese culture for their therapeutic virtues. Their high content of polysaccharides, carotenoids, polyphenols, amino acids are of them "super fruit". The objective of QualFood project, funded by the healthfood program HES-SO, aims to study and propose modes of integration of Goji berries in the diet in order to promote their consumption.

2. Materials and methods

As part of this project we investigated the influence of the mode of incorporation of Goji berries on the composition and sensory analysis of red beers. The choice was focused on this type of beers because they generally have higher antioxidant capacity compared to lagers. Different variants, from beer A to beer F, have been brewed. The difference involved the incorporation of 50 g/L goji berries at different stages of the development process. Alternatively witness that no bay has been added, has also been brewed, beer F. These six products were analyzed for their physicochemical characteristics like standard analysis (color, pressure), the total polyphenols content, their content of phenolic compounds, their antioxidant activity and their bioactive content. A thorough analysis of these sensory beers was conducted. Then, the study of the relation between analytical and sensory data were analysed.

3. Results

3.1 Physicochemical analysis of beers

3.1.1 Standard analysis

Alcohol levels were comparable for the treatments A, B, C and D with 50 g/L goji berries (Table 1). It is lower for the treatment E, which contained only 11 g/L of berries and again lower for the control (F) without berries. The beers of the E treatment was different from the others by an increased CO2 pressure level (factor 2) in the bottle and a very high turbidity due to the presence of suspended berry fragments.

Beer	A	B	C	D	E	F
Color L*	56.3 ± 0.1d	55.9 ± 0.0d	66.1 ± 0.1a	65.3 ± 1.0ab	60.2 ± 0.3c	64.9 ± 0.0b
Color a*	34.8 ± 0.1b	35.5 ± 0.0a	26.7 ± 0.1d	26.6 ± 0.3d	29.7 ± 0.3c	25.9 ± 0.0e
Color b*	90.8 ± 0.1b	90.8 ± 0.1b	91.7 ± 0.0a	90.3 ± 0.9b	87.4 ± 0.1c	87.1 ± 0.0c
Alcohol (%Vol.)	7.26 ± 0.06a	7.10 ± 0.04b	7.35 ± 0.05a	7.30 ± 0.05a	5.91 ± 0.02c	5.00 ± 0.03d
Real Extract (g/L)	80.1 ± 0.2b	80.8 ± 0.2a	54.4 ± 0.1e	58.2 ± 0.4d	52.9 ± 0.1f	60.9 ± 0.1c
Pressure 4°C (bar)	1.13 ± 0.15c	1.30 ± 0.12bc	1.28 ± 0.15bc	1.68 ± 0.15b	3.00 ± 0.40a	1.40 ± 0.08bc
Turbidity (NTU)	2.8 ± 0.1c	7.9 ± 0.5c	4.4 ± 1.6c	10.6 ± 4.8c	66.5 ± 13.0a	38.1 ± 0.3b

Table 1: Color parameters (L*: lightness, a*: greenness/redness and b*: blueness/yellowness), alcohol content, real extract, in bottle pressure and turbidity of six types of beer

3.1.2 Antioxidant capacity of beers

The TEAC for beer samples ranged from 2.26 to 3.82 mmol/L, whereas ORAC from 8.87 to 16.84 mmol/L (Table 2). The addition of 50 g/L of goji berries resulted in a significant increase in antioxidant capacity of a beer. ORAC values showed an increase of more than 40%. Treatments A and B showed the highest antioxidant capacity, based on the results of both assays.

Beer	A	B	C	D	E	F
TEAC by ABTS (mmol/L)	3.82 ± 0.25a	3.70 ± 0.27a	2.87 ± 0.22bc	2.95 ± 0.25b	2.40 ± 0.23cd	2.26 ± 0.11d
ORAC (mmol/L)	16.81 ± 0.42a	16.84 ± 0.86a	15.04 ± 1.71ab	13.13 ± 0.82b	10.03 ± 0.44c	8.87 ± 1.15c
TPC (mg GAE/L)	609 ± 44a	623 ± 16a	373 ± 19bc	415 ± 17b	357 ± 14c	335 ± 11d
AA analog (mg/L)	111.1 ± 0.8a	111.2 ± 1.9a	75.3 ± 0.5b	68.3 ± 0.7c	22.9 ± 0.4d	n.d.
p-coumaric acid (mg/L)	3.75 ± 0.29a	3.86 ± 0.12b	7.98 ± 0.11a	7.81 ± 0.13a	1.38 ± 0.31c	0.38 ± 0.01d
ferulic acid (mg/L)	4.60 ± 0.47b	4.56 ± 0.34b	7.09 ± 0.22a	7.58 ± 0.26a	2.05 ± 0.23c	1.10 ± 0.04d
Rutin (mg/L)	23.13 ± 0.36a	22.44 ± 0.09b	n.d.	n.d.	1.38 ± 0.27c	n.d.

Table 2. Trolox Equivalent Antioxidant Capacity (TEAC), Oxygen Radical Absorbance Capacity (ORAC), total polyphenol content (TPC), ascorbic acid (AA) analog, p-coumaric, ferulic acids and rutin content in six types of beer. Different letters within columns indicate significant differences between the values.

The results ranged from 335 mg GAE/L for the standard amber ale beer (F) to 623 mg GAE/L for the beer B. Numerous studies were done on antioxidant capacities and TPC of commercial beers[1–2]. The published results report large differences between different beer types, but also between the same types of beers. In general, ale beer has a much higher antioxidant capacity than lager beer[3]. Antioxidant activity in beer is attributed mainly to their phenolic compound contents[4].

3.1.3 Phenolic compounds content

In order to identify the main phenolic compounds, the beer samples were analysed by HPLC. The obtained results are presented in Table 2. Ferulic acid (1.54 mg/mL) was by far the most abundant free phenolic acid in ale beer followed by vanillic (0.61 mg/mL) and p-coumaric (0.58 mg/mL) [3]. The addition of goji berries increased substantially the content of both phenolic acids, at almost 8 mg/L. The highest content of p-coumaric and ferulic acids was noted in beer C and D, to which goji berries were added before fermentation. The addition of goji berries incorporated a substantial quantity of rutin to beer A and B, a compound not detected in the standard beer. They contained 23.12 and 22.44 mg/L of rutin, respectively.

3.1.4 2-O-β-D-glucopyranosyl-L-ascorbic acid content

The content of ascorbic acid analog for the beers with 50 g of goji berries added, ranged from 68.3 to 111.2 mg/L of beer (Table 2). Very high content of this compound was noted for beer A and B, the extraction rate exceeded the one used in the analytical procedure. In beer C and D, much lower contents than in A or B were noticed. Very good extraction rates were also noticed for beer E (11 g of goji/L of beer).

3.2 Sensory analysis of the beers

Free sorting tasks allow to build groups of similar products based on their organoleptic characteristics. Three different free sorting task were carried out to obtain similarity groups between beers on appearance, odour and taste characteristics. These first stages allowed to generate descriptors used for the sensory profile. The sensory profile indicated that 11 of the 18 descriptors used were significant at the 5% level.

The 11 significant descriptors at the 5% level were maintained to carry out a Principal Components Analysis (PCA). The treatments were then grouped according to their common characteristics using a classification (figure 1). It was noted that all products with goji berries added early in the development process (at the beginning of cooking for beers A and B, at the first fermentation for beer C) were different from the two beers whose berries were added later. The latter two beers, E and D, also showed more variability, and each one forming a separate group. Similarly, when the berries were added at the beginning of the process, the fact that they were whole (beer B) changed little in the sensory perception compared to the control (beer F).

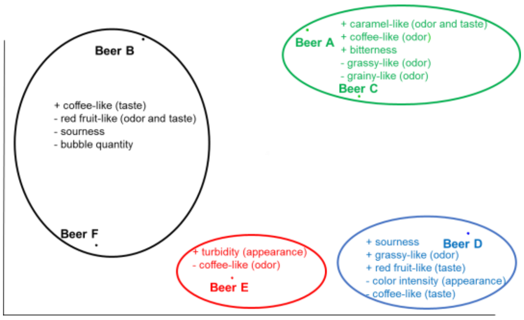
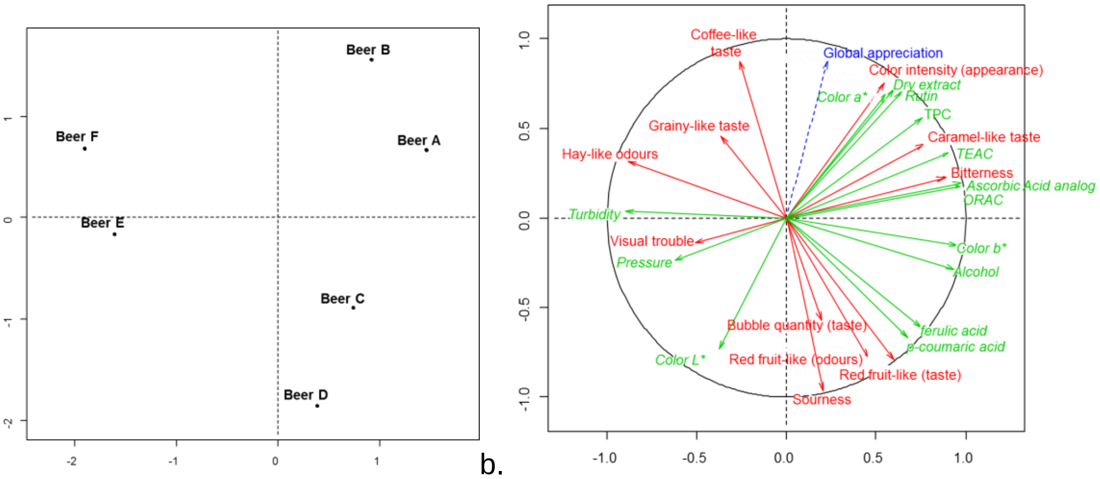


Figure 1. Product map issued of PCA with significant attributes at 5 %. Characterisation of products using a classification with significant descriptors at 20%.

Finally, the consumer test showed significant differences of appreciation between the beers (test of ANOVA with significant product effect ($F (5,420) = 9.86$, p-value < 0.001)). The differences between the beers were identified by a Tukey's test at the 5% level. The products A, B and F were preferred by the consumers.

The relationship between the sensory and analytic data was investigated using Multiple Factor Analysis (MFA) (figure 2a and 2b). In figure 2b, the red coloured descriptors represent the significance of the sensory profile at 5% (ANOVA), the analytical data are green coloured, and the global consumer appreciation (blue coloured) is projected as illustrative variable.



a. b.

Figure 2a and 2b. Figure 2a represents the 6 beers. Figure 2b represents the correlation circle of the sensory descriptors, in red, and the analytic parameters, in green and in italic. Global appreciation of consumers is presented as illustrative variable, in blue.

The first dimension placed the beers according to a temporal gradient where goji berries have been introduced in the development process. The second dimension opposed the beers with coffee-like taste like the beer B, to the beers C and D with odours and red fruit-like taste.

4. Conclusion

The multidimensional correlation between the sensory data of the profile and the analytic parameters is significantly positive ($RV = 0.68$, p-value < 0.09). Therefore, the sensory data and the analytical parameters are positively correlated, which confirms the results of previous studies [5, 6]. The present study showed that a certain temperature at the beginning of the process allowed a better extraction of polysaccharides and antioxidant.

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