Does the tapping dispenser system influence the aroma of beer?

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Abstract

Beer is one of the most consumed alcoholic beverage in the world. The fresh aroma is one of the main characteristics for consumers and it is strongly affected by microorganisms growing in the dispensing system. A patent for a new tapping dispenser system has been recently filed. Here, the results of the headspace analysis of lager beer taken from barrel and dispensed through traditional and the new dispenser system are reported.

Introduction

The term “beer” refers to very wide range of fermented beverages produced from different malts, brewing water, varieties of hops and two species of yeast top- and bottom-fermenting (*Saccharomyces cerevisiae* and *Saccharomyces pastorianus*, respectively) [1].
The most appreciated sensory characteristics by consumers is fresh flavor [2], therefore flavor stability is an important quality feature and a concern for the brewing industry [3, 4, 5].
The tapping dispenser system and thus, the cleaning of the dispense tap, has a major impact on the aroma perception of beer [6, 7].
Quaglia and collaborators of SQC Systems S.r.l. filed in 2017 an Italian patent application and in 2018 an international one on a new tapping dispenser system with a related procedure for the treatment of the tapping tubes [8, 9]. The patented dispenser system, Titazero, consists of a sensor, which informs the control unit that the beer barrel is finished. Then, the central unit starts the cleaning process, using water only, avoiding any kind of chemical or mechanical cleaning agent. The automatic cleaning process is followed by the manual substitution of the new beer barrel.
PTR-MS has been largely used in the monitoring of food processes involving aroma release in beverages, such as wine and vodka [10], but very little has been published on beer.
Here, the headspace of lager beer samples from beer barrels and dispensed through traditional and the new, Titazero, dispensing systems are analyzed by PTR-QMS.

Experimental Methods

PTR-QMS Headspace Analysis

Lager beer samples from beer barrels and dispensed through traditional and Titazero dispensing systems were provided by SQC Systems S.r.l.. Samples were labeled with “F” (beer barrel), “N” (traditional dispensing system) and “T” (Titazero dispensing system). A number was added after the letter N or T, indicating the number of months passed since the last mandatory sanitation by Italian law. Samples were kept at -20 °C until the analysis.
The headspace of beer samples was measured by PTR-QMS (Ionicon Analytik GmbH, Innsbruck, Austria). To avoid saturation of the mass spectrometer and the consequent depletion of the primary ion, 100 µL of beer samples were placed to equilibrate in 40-mL glass vials at 25 °C for

15 min. The instrumental conditions were the following: drift voltage 600 V, drift temperature 70 ºC, inlet temperature 70 ºC and drift pressure 2.20 mbar, affording an E/N value of 141 Townsend (1 Td = $10^{-17} cm^2 V^{-1} s^{-1}$).

Five replicates for each samples were analyzed. The measurement order was randomized to avoid possible memory effect. Four empty vials were analyzed and considered as blanks. The signal intensities were corrected and normalized as previously described [11], with the following equation:

$$ncps\left(RH^{+}\right) = \frac{cps\left(RH^{+}\right)\cdot 10^{7}\cdot \text{trasmission rate}}{500\cdot cps\left(H_3{}^{18}O^{+}\right) + cps\left(H_2O\cdot H_3O^{+}\right)} \quad (1)$$

Where ncps(RH^+) is the normalized count rate for each ion intensity, cps(RH^+) is the counts per second of each ionized molecule, cps $\left(H_3{}^{18}O^{+}\right)$ is related to the primary ion (m/z 21) and cps $\left(H_2O\cdot H_3O^{+}\right)$ to water cluster (m/z 37).

Statistical Analysis

Fingerprints obtained by the five replicates were averaged. Afterwards, one way - Analysis of Variance (ANOVA) was performed on PTR-QMS dataset. The differences among samples were visualized performing a Principal Component Analysis (PCA) of the masses selected by ANOVA. All the statistical analysis were performed using XLSTAT 2017: Data Analysis and Statistical Solution for Microsoft Excel (Addinsoft, Paris, France, 2017).

Results and Discussion

Figure 1 shows the results of the PCA performed on the masses selected by the ANOVA ($p < 0.05$). Beer sample from barrel (F) is characterized by high negative values for both PCs. Samples dispensed by the traditional dispensing system (N0, N1 and N2) are on the opposite site of the graphic; on the contrary, samples dispensed by the Titazero system (T0, T1 and T2) can be found near the sample F. It is possible to detect a clear separation among the samples N and T. Moreover, a trend due to timing is observable in both groups. Samples dispensed just after the sanitation mandatory by law (T0 and N0) are the one closer to the barrel sample. After 1 and 2 months, the samples are characterized by less negative values for PC1. Thus, PC1 is probably related to time, while PC2 to differences due to the dispensing system.

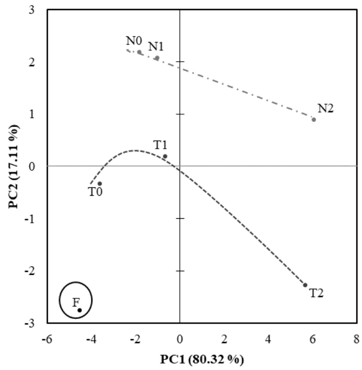

Figure 1: PC2 vs. *PC1 plot of the masses selected by the ANOVA*

Figure 2 shows the counts per second of some of the ion fragments selected by the ANOVA. All ion fragments, with the exception of m/z 45 and 61 (tentatively identified as acetaldehyde and acetic acid, respectively) show the same trend: low counts in the barrel sample and increasing counts during time in both the N and the T samples. It is interesting to point out that the amount found in the T1 samples is often lower that the one found in the N0 samples. This trend suggests that the beer dispensed through the Titazero system undergoes the spoiling process at a lower rate, compared with the beer dispensed through the traditional system.

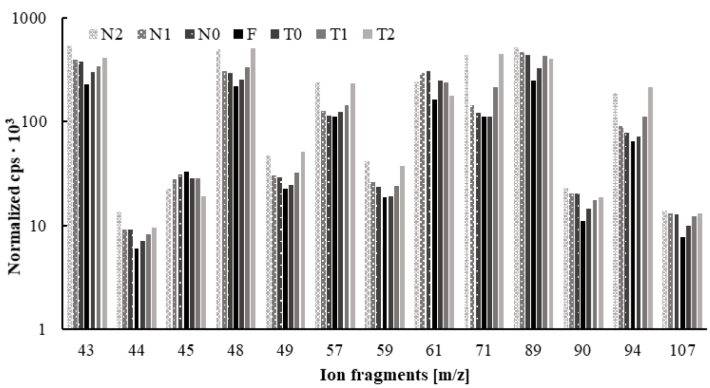

Figure 2: Normalized cps (· 10^3) of some ion fragments selected by ANOVA

Most of the selected masses (m/z 43, 44, 57, 61, 71 and 89) are related to acids [12] produced by the metabolism of microorganisms typically found in the dispenser systems (*Lactobacillus*, enterobacteria, *Pectinatus*, *Megasphaera*) [7]. M/z 90 (tentatively identified as ethyl carbamate) is a group 2A carcinogen; it has been detected in yeast-fermented beverage as a result of the reaction of ethanol with urea, a product of the metabolism of yeast [13]. Acetaldehyde (m/z 45) is the precursor of ethanol during fermentation. Afterwards, bacterial metabolism and oxidation can reduce acetaldehyde to acetic acid [14]. Benzaldehyde (m/z 107) is a typical off-flavor found in beer due to oxidation and aging processes. Samples dispensed through the Titazero system show a slower spoiling process compared to the beer samples dispensed though traditional the tapping system.

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