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WORLD BREWING CONGRESS 2016

Unraveling the complexity of Belgian beer

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Summary

The diversity of Belgian beer styles can be daunting to the uninitiated beer drinker. This project set out to chart the first 'map' of Belgian beers. Our objective was to generate a resource that would help understand the differences and similarities between Belgian beer styles in an objective way. To achieve this we have chemically and sensorially analyzed over 200 Belgian beers. The sample is representative of all Belgian beer styles available in the market. We quantified a large number of relevant beer attributes (e.g. bitterness, carbonation, protein content), fermentation-derived volatiles (esters, higher alcohols) and common beer faults (4VG, sulfur off-flavors). Additionally, the beers were assessed by an in-house trained sensory panel. Principal component analysis and hierarchical clustering were used to analyze the data.

Results show that certain beer styles have unique chemical signatures. For example, pilsner beers are characterized by high levels of sulfur dioxide and relative low levels of volatile compounds, wit and saisons by the presence of 4VG, and beers with spontaneous fermentation (geuezes, krieks and brett beers) by higher levels of ethyl 2-methyl-butyrate and ethyl isovalerate, as well as lactic and acetic acid.

In the sensory analysis, there is a clear segregation of the main beer attributes. The variables with the largest loadings in PCA analysis were used to create reference plot for each beer. These plots reveal unique sensory profiles for many beer styles.

Methods

Chemical analysis

The chemical composition of beers was analyzed using a Thermo Fischer Scientific Gallery Plus™ Beer Master robot. The volatile fraction was analyzed by GC-FID (esters, higher alcohols), and GC-FPD (sulfur compounds).

Data was normalized across compounds to obtain Z-scores. Hierarchical clustering was done using 1-Pearson correlation matrix.

Sensory analysis

An in-house panel (n=16) was selected and trained using the Quantitative Descriptive Analysis (QDA, Stone et al., 1974). The panel developed a terminology to describe the various sensory aspects of beer (malt, hops, esters) and was also trained to quantify the principal beer characteristics (e.g. bitterness, carbonation, sweetness). Tastings were blind in black tinted glasses. Data was normalized for each panel member.

Conclusion

We find that certain beer styles have unique chemical and sensory profiles and we have identified which compounds and attributes define these profiles. Other beer styles, however, occupy a broader chemical spectrum and are not so easy to define.

The dataset presented here is the first of its kind for Belgian beers. It should be a valuable resource for brewers and beer enthusiasts who wish to better understand Belgian beers.

Results: chemical analysis

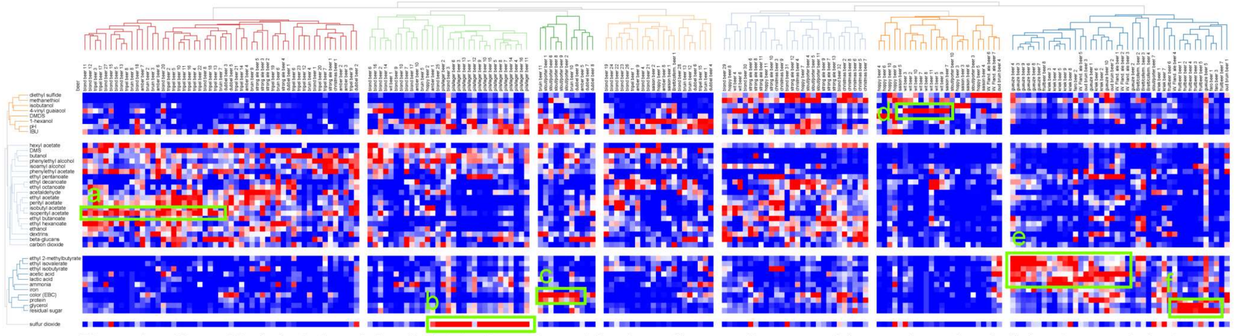

Figure 1. Hierarchical clustering of chemical data. Some beer styles (e.g. pilsners, wit or geuzes) have unique chemical signatures and cluster together. Other styles, such as blond or amber beers, have a wider chemical spectrum.

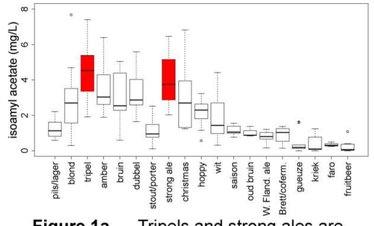

Figure 1a. Tripels and strong ales are characterized by higher levels of esters (IA shown here)

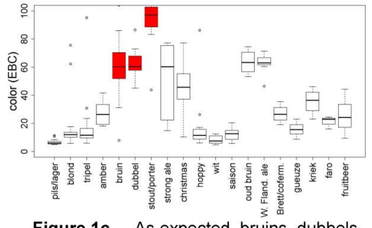

Figure 1c. As expected, bruins, dubbels and stouts have the highest EBC values

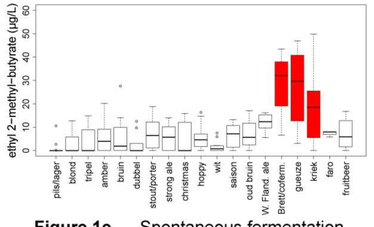

Figure 1e. Spontaneous fermentation and Brettanomyces beers have the highest levels of ethyl 2-methyl-butyrate

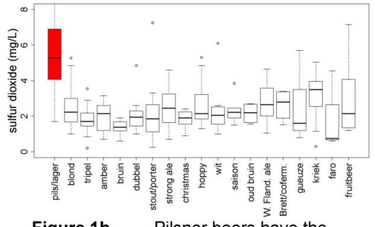

Figure 1b. Pilsner beers have the highest sulfur dioxide levels

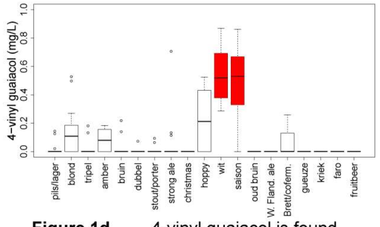

Figure 1d. 4-vinyl guaiacol is found almost exclusively on wit and saison beers

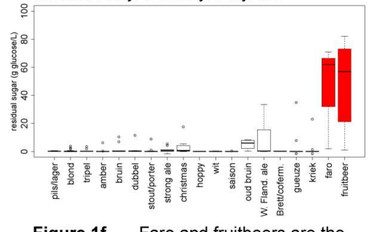

Figure 1f. Faro and fruitbeers are the sweetest of the examined beers

Results: sensory analysis

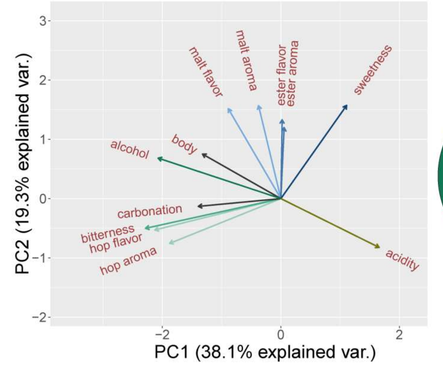

Figure 2a. Principal Component Analysis of sensory data. Variables with the highest loadings were used to create the fan plot on the right

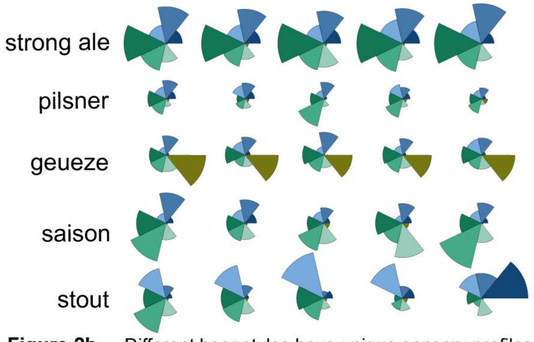

Figure 2b. Different beer styles have unique sensory profiles: strong ales are dominated by alcohol and ester aromas; pils beers score low on most aromas; gueze beers are the most acidic; saisons are mostly hoppy and bitter and stouts have strong malt aromas.