



# Data-fusion for multiplatform characterization of an Italian craft beer aimed at its authentication



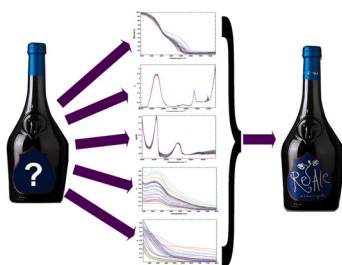
Alessandra Biancolillo, Remo Bucci, Antonio L. Magrì, Andrea D. Magrì, Federico Marini\*

Department of Chemistry, University of Rome "La Sapienza", Rome, Italy

## HIGHLIGHTS

- Characterization of beer samples by five different fingerprinting techniques.
- Chemometric discriminant and class-modeling techniques used for their authentication.
- Mid-level data fusion allowed correct classification of all samples.

## GRAPHICAL ABSTRACT



## ARTICLE INFO

### Article history:

Received 16 November 2013  
 Received in revised form 10 February 2014  
 Accepted 17 February 2014  
 Available online 20 February 2014

### Keywords:

Craft beers  
 Chemometrics  
 Classification  
 Partial least squares-discriminant analysis (PLS-DA)  
 Soft independent modeling of class analogies (SIMCA)  
 Data fusion

## ABSTRACT

Five different instrumental techniques: thermogravimetry, mid-infrared, near-infrared, ultra-violet and visible spectroscopies, have been used to characterize a high quality beer (Reale) from an Italian craft brewery (Birra del Borgo) and to differentiate it from other competing and lower quality products. Chemometric classification models were built on the separate blocks using soft independent modeling of class analogies (SIMCA) and partial least squares-discriminant analysis (PLS-DA) obtaining good predictive ability on an external test set (75% or higher depending on the technique). The use of data fusion strategies – in particular, the mid-level one – to integrate the data from the different platforms allowed the correct classification of all the training and validation samples.

© 2014 Elsevier B.V. All rights reserved.

## 1. Introduction

Beer is a rather popular drink and represents the most widely consumed alcoholic beverage in the world [1]. When looking at its global production, the largest portion of the market is dominated by a few multinational companies, but especially in the last years,

a flourishing of independent craft breweries was observed, also in countries where there wasn't an established beer making tradition – a phenomenon which is often referred to as "Beer Renaissance". Together with being smaller scale and independent, the main characteristic of craft breweries is to put the emphasis on flavor and brewing techniques [2]. In this context, Italy has a relatively young craft brewing tradition, but the quality of its production is becoming more and more unanimously recognized worldwide [3]. Salient features of Italian artisanal beer-making are the care in valorizing highly regional products, like seasonal produce, local honeys and heritage grains, and the integration of elements coming from the traditional wine production, such as the use of grape must and wine barrels. These characteristics are very well exemplified by the joint

\* Corresponding author at: Department of Chemistry, University of Rome "La Sapienza", P.le Aldo Moro 5 I-00185, Rome, Italy. Tel.: +39 6 4991 3680; fax: +39 6 4457 050.

E-mail addresses: [fmmmonet@hotmail.com](mailto:fmmmonet@hotmail.com), [federico.marini@uniroma1.it](mailto:federico.marini@uniroma1.it) (F. Marini).

agreement stipulated by eight microbreweries and two malting factories in Lazio (central Italy) to produce beers with all raw materials coming from that region, defining the product specification and the associated mark (“Birra del Lazio”).

Due to their quality standards, craft beers are high value-added products (the term indicating commodities whose economic value is increased through particular production processes, which result in a higher quality and a greater appeal for consumers), and their authentication (i.e., the verification of the compliance with their label description [4] which, at the same time, can entail brand protection) and traceability represent an important issue for both the producers and the consumers. From the analytical standpoint, the possibility of authenticating beer samples was only rarely considered in the literature [5,6] until the recent years, where a large number of beers were analyzed and characterized by different instrumental techniques in the framework of the EU-funded project TRACE (<http://www.trace.eu.org>), aiming at differentiating Trappist from non-Trappist ones, and within Trappist, Rochefort 8 against others [7–10]. In particular, Cajka et al. [7] focused their attention on the volatile profile, fingerprinted by headspace solid-phase micro-extraction coupled to gas chromatography–mass spectrometry (HS-SPME-GC–MS), while Mattarucchi et al. used liquid chromatography–mass spectrometry (LC–MS) to characterize the beer samples [8]. On the other hand, the possibility of using vibrational spectroscopy as a cheaper and potentially non-destructive alternative to chromatographic methods was addressed first by Di Egidio et al. [9], who investigated the near infrared range (NIR), and then by Engel et al. [10], who focused on mid infrared (MIR). Raman spectroscopy was also used for the purpose [11]. In general, it was shown that, at least for some classes of beers, all these instrumental techniques coupled to chemometrics could provide a reliable authentication with a relatively low classification error.

Starting from these considerations, aim of the present study was to try to extend the idea of a multi-platform characterization to the authentication of a high valued craft beer produced in the Lazio region of Italy, Reale from Birra del Borgo. Birra del Borgo is one of the leading Italian craft breweries, and one of the most deeply involved in the quest for high quality products with regional traceability; Reale represents their flagship beer. In particular, in order to

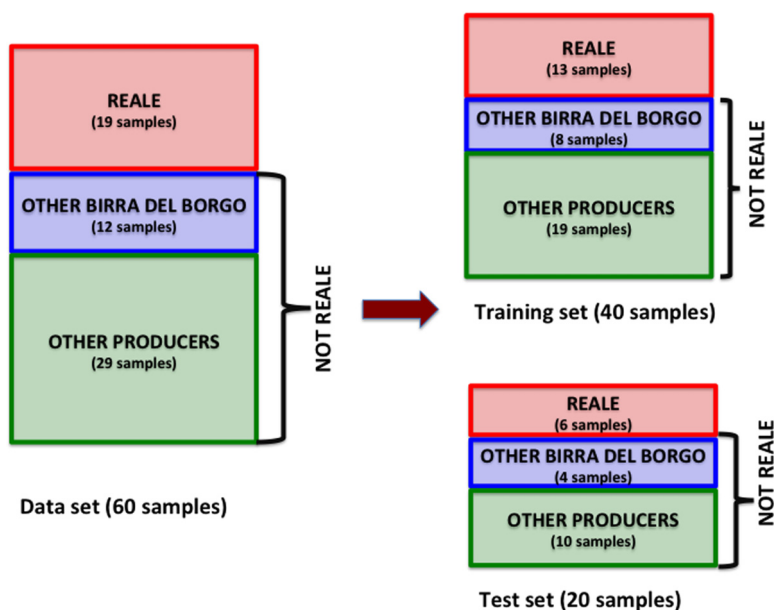
keep the costs of analysis as low as possible, at the same time have a fast determination requiring little or no sample pretreatment, and try to obtain as complementary information as possible from the different instruments, five fingerprinting techniques – almost all spectroscopic (near-infrared, mid-infrared, ultra-violet and visible), the only exception being thermogravimetry – have been used to characterize each sample. Chemometric classification methods have then been applied to the collected profiles to built models which could allow differentiating Reale beers from all the others; at first, fingerprints from the individual instrumental techniques have been considered separately, but in a second stage, in order to take advantage of the complementary information carried by the different profiles, low- and mid-level fusion strategies were used to integrate the data from the various blocks into a single model.

## 2. Materials and methods

### 2.1. Samples

60 beer samples from different producers were collected for the study. In particular, 31 samples came from Birra del Borgo (Borghese, Italy), the craft brewery of interest and the remaining 29 were representative of different producers in Italy and the rest of Europe. Of the 31 beers from Birra del Borgo, 19 samples were from “Reale”, which is considered the flagship beer of the brewery and whose authentication is the main object of the present study, while the remaining 12 were representative of the rest of their production. As Reale is a beer brewed in the style of real ales (top-fermented), and in particular, it is an American pale ale, almost all the beers from other breweries were ales, the majority of them being pale ales. As far as the other beers from Birra del Borgo are concerned, most of them share the same raw materials (malt types, hop cultivars and yeast strain) with Reale, but are brewed according to different styles, the large part of them being ales as well. The samples came from different batches, which were produced and collected in different periods. A graphical representation of the composition of the data set is displayed in Scheme 1.

All the beers were analyzed immediately after collection; prior to the analysis, a degassing step was necessary to avoid contributions from dissolved CO<sub>2</sub> to the signals.



Scheme 1. Graphical representation of the data set.

Download English Version:

<https://daneshyari.com/en/article/1164196>

Download Persian Version:

<https://daneshyari.com/article/1164196>

[Daneshyari.com](https://daneshyari.com)