Sensory characteristics of Bitto, a PDO italian cheese, by NIR spectroscopy

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Introduction

Bitto cheese is a semi-hard cheese very appreciated and known among cheese produced in Valtellina (Lombardy, Italy). It is a cheese of Protected Designation of Origin (PDO) which owes its reputation to traditional production techniques used in that defined geographical area. Many authors have demonstrated that cheese flavour is a function of the type of pasture given to the herd: a relationship between grass quality and quality of cheese occurs.[1–4] Every year, the best Bitto moulds are classified by a trained panel of experts and awarded during the Bitto Show, held in Morbegno (Sondrio, Italy). The "Total Sensory" score concerns both the aspect and the taste attributes, and it is expressed in percentage (40÷100). The attribute "Taste and Flavour" is evaluated on a score scale from 8 to 20.

The aim of this work was to study the relationship between sensory scores and NIR data, in order to verify the ability of near infrared (NIR) spectroscopy to predict sensory characteristics, as a progress report of a Regional project funded by Lombardy Region, with the qualification and standardisation of Bitto cheese production as main objective.

Materials and methods

Eighty three Bitto moulds were analysed in the whole NIR range by a FT-NIR spectrometer (NIRFlex FT500, Büchi, Flavil, Switzerland). Grated cheese spectra were recorded in reflectance mode (32 scans; resolution = 8 cm^{-1}), sampling moulds four times each (332 spectra) and using Petri caps (ID: 100 mm; sample thickness: 10 mm). An example of the recorded spectra is reported in Figure 1.

PLS1 (partial least squares) was applied after using both MC (mean centering), ensuring that all results will be interpretable in terms of variation around the mean, and EMSC (Enhanced multiple scattering correction), in minimising scattering contribution to the absorption, as pretreatments. "Total sensory" score and "Taste and Flavour" score were calibrated using a full cross-validation procedure using all replicates. Samples were also grouped into 3 classes on the basis of their sensory scores. In particular, class 1, class 2 and class 3 grouped samples with a "Total Sensory" score less than 61, between 61 and 70 and higher than 70, respectively. Considering the "Taste and

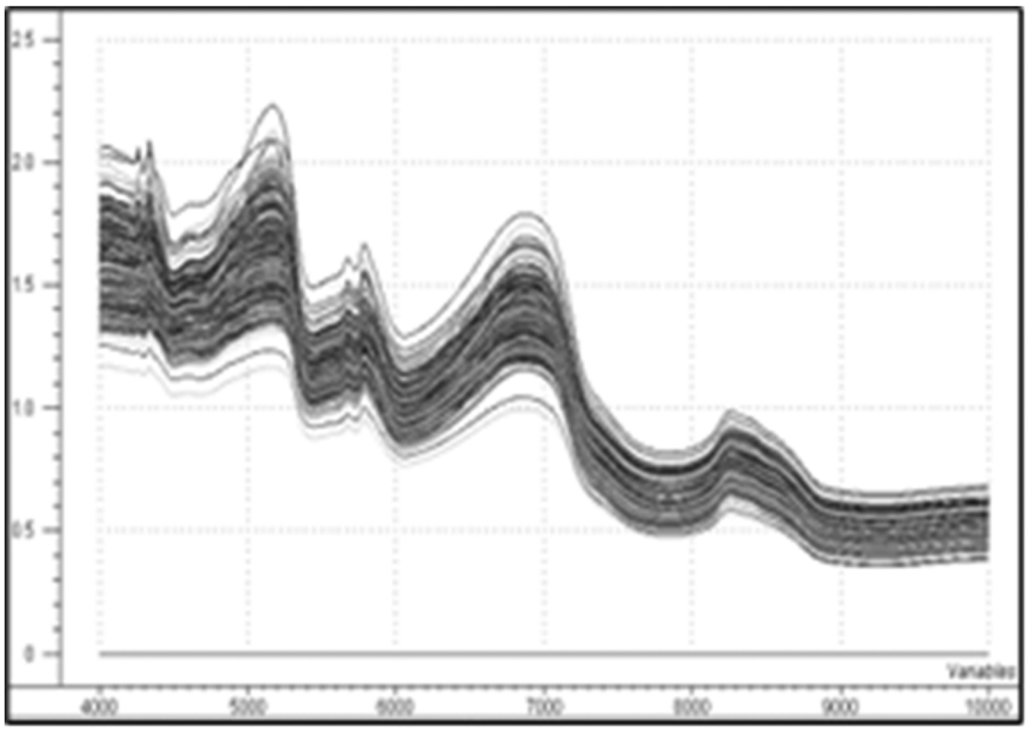

Figure 1. Examples of FT-NIR spectra of Bitto moulds.

Flavour" attribute, the same classes were formed by samples with scores from 8 to 10 (class 1), from 11 to 13 (class 2), and higher than 13 (class 3) respectively. These classes are already used by the producers in establishing price differences at the market. Leverage correction was used as preliminary test for an explorative PLSD (partial least squares discriminant; $LV = 13$) analysis (Unscrambler 9.2, Camo Inc., OSLO, Norway).

The percentage of correct classification was calculated and expressed as

$$S_p/n$$

where S_p = number of samples correctly predicted
n = number of total samples (# = 83).

Results and discussion

PLS1 results reported in Table 1 showed an acceptable capacity in predicting both the "Total Sensory" score (slope = 0.537, bias = 0.037) and the "Taste and Flavour" score (slope = 0.479, bias = −0.006).

In particular, the bias values obtained for both attributes were improved in comparison with bias values obtained last year, when just 39 samples were analysed (old bias $_{\text{Total Sensory score}} = 1.135$; old bias $_{\text{Taste and Flavour score}} = -0.007$).[5] Also the number of PLS factors used for cross-validation was

Table 1. Sensory variables: mean values, standard deviation (*SD*), and PLS calibration and validation results.

Variable	n	Mean values	*SD*	PLS factors	Calibration		Validation	
					R	*SEC*	*R*	*SECV*
Total sensory score	300	62.66	8.01	11	0.733	4.563	0.684	4.909
Taste and Flavour score	300	10.59	2.28	9	0.692	1.283	0.649	1.355

improved, decreasing respectively from 12 to 11, and from 13 to 9 for "Total Sensory" score and "Taste and Flavour" score, respectively.

A good classification of samples into three "quality classes" was also found applying PLSD, obtaining the following values of non-error rate (*NER%*) for "Total Sensory" score:

Class 1 = 83.30%, Class 2 = 77.83%, Class 3 = 92.67%; and for "Taste and Flavour" score: Class 1 = 89.33%, Class 2 = 88.67%, Class 3 = 98.66%.), respectively. In a preliminary study,[5] made on 39 Bitto samples, the classification of different cheese into the same three classes was characterised by similar *NER%* values for "Total Sensory" score. Furthermore, the classification for "Taste and Flavour" score was now improved for Class 3, with a *NER%* increase from 94.87%[5] to 98.66%.

In general, the results obtained during the preliminary screening last year[5] were substantially confirmed.

On the basis of the results obtained, the FT-NIR technique was confirmed as a tool comparable with the sensory test usually applied for the prediction of cheese sensory characteristics in terms of "Total Sensory" score and "Taste and Flavour" score, with two main advantages: (i) to give more objective results than those related to a single panel of experts and (ii) to reduce the analytical costs. Extending calibrations by the addition of new samples allowed the addition of the variability of two years cheese production, increasing the models robustness.

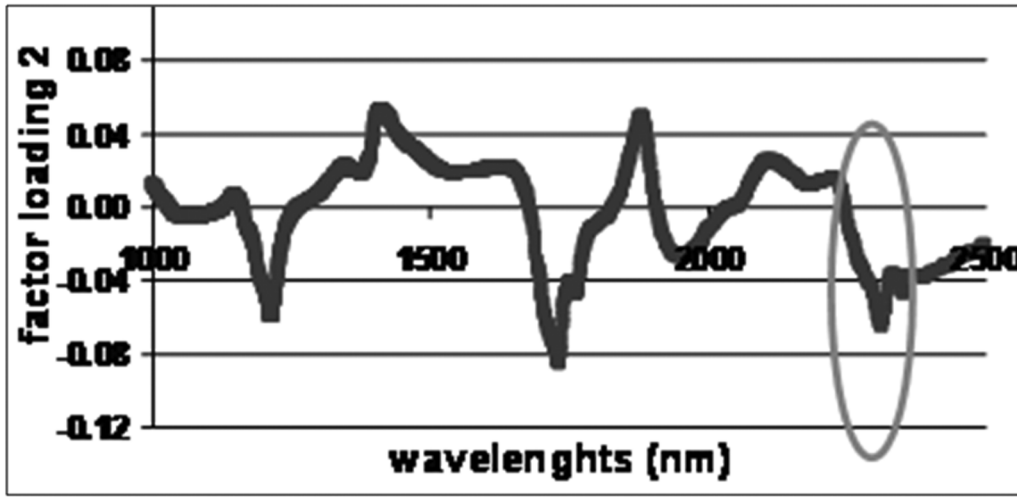

Figure 2. "Taste and Flavour" score – plot of the 2nd factor loading (FL).

The influence of both carboxylic groups of free fatty acids (FFA), and –NH groups of free amino acids (FAA) on the "Taste and Flavour" score was confirmed by both GC-MS and CE profiles, respectively.[6] These compounds contributed to the NIR absorption, in particular in the zone from 2270 nm to 2300 nm, as shown in Figure 2, where FL2 (Factor Loading 2) versus wavelengths was plotted.

Other important contributes found can be ascribable to:

- CH str. 2nd overtone (1215, 1395 nm);
- CH str. 1st overtone (1715, 1740 nm).

These results suggested that the FT-NIR technique was able to classify samples firstly on the basis of the presence of both, fat and aromatic compounds related to the aroma development, and also nitrogen compounds, responsible for piquant taste of ripened cheese. The "Taste and Flavour" attribute was confirmed to have a big influence on the final characteristics of product quality, depending on the particular technological process applied to Bitto cheese production.

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References

1. R. Lodi, M. Brasca, B. Masa, A. Tamburini, S. Erini and E. Turchetti, *Quad. SOZOOALP* **2,** 140 (2005).
2. M.A. Drake, P.D. Gerard, V.D. Truong and C.R. Daubert, *J. Texture Stud.* **30,** 451 (1999).
3. J.P. Dumont and J. Adda, *J. Agric. Food Chem.* **26,** 364 (1978).
4. R.G. Mariaca, T.F.H. Berger, R. Gauch, M.I. Imhof, B. Jeangros and J.O. Bosset, *J. Agric. Food Chem.* **45,** 4423 (1997).
5. T. Cattaneo, C. Tornielli, S. Erini and E. Panarelli, *J. Near Infrared Spectrosc.* **16,** 173 (2008).
6. S. Erinni, *First Progress report of "ValTec project*", 30 June 2009.