Discrimination of milk from different animal species using FTIR features

Lemonia-Christina Fengou, Panagiotis Tsakanikas, Evanthia Manthou, Anastasios Stamatiou, George-John E. Nychas

Laboratory of Microbiology and Biotechnology of Foods, Department of Food Science and Human Nutrition, School of Food and Nutritional Sciences, Agricultural University of Athens, Iera Odos 75, Athens 11855, Greece

INTRODUCTION

There is a trend for spectroscopic instruments to be miniaturized for integrating them across the food supply chain enabling continuous monitoring of quality, safety, and fraudulent practices. Feature selection limits the needed spectral span, enabling the instrumental simplification both in size and cost.

OBJECTIVE

Features were selected from FTIR spectra to discriminate raw milk from different animal species.

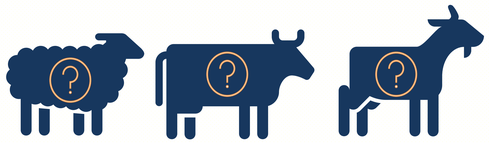


Table 1. Confusion matrices for SVM model classification for the external validation (n= 54) using FTIR data.

True class	Predicted class			
All features	**cow**	**goat**	**sheep**	**Recall (%)**
cow	6	3	0	67
goat	0	22	0	100
sheep	1	1	21	91
Precision (%)	86	85	100	**Accuracy** 91 %
Selected features	**cow**	**goat**	**sheep**	**Recall (%)**
cow	8	1	0	89
goat	1	21	0	95
sheep	3	1	19	83
Precision (%)	67	91	100	**Accuracy** 89 %

RESULTS

In Table 1 are shown the results for the external validation.

Accuracy in the case of

- all features was 91%, while for
- the selected features the accuracy was 89%.

Thus, while the accuracy scores are similar,

the wavenumbers used in the latter case are the 25% of the total.

METHODS

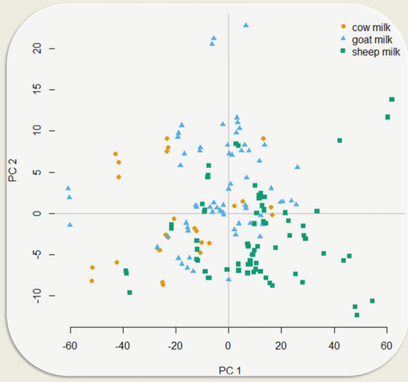
In total 73 samples were analyzed in triplicates (n=219) using FTIR sensor (**4000 to 400cm^{-1}**), but just the **3100 to 900 cm^{-1}** range was used, excluding the noisy signal at the edges of the spectrum and the water peak.

Afterwards, stratified was applied, so as 75-25% of the datasets to be used for development (n=165) and external validation (n=54) of the models.

Feature selection was performed by exploring the distributions of mean values and standard deviations of goat, sheep, and cow milk. Those wavenumbers exhibiting a significant amount of deviation (> std) across the 3 classes of milk were considered as important while the rest were excluded.

The models were (SVM classifiers) developed and externally validated using all features, for a base efficiency of the models,

and then with the selected ones (**1750 to 1194 cm^{-1}**).



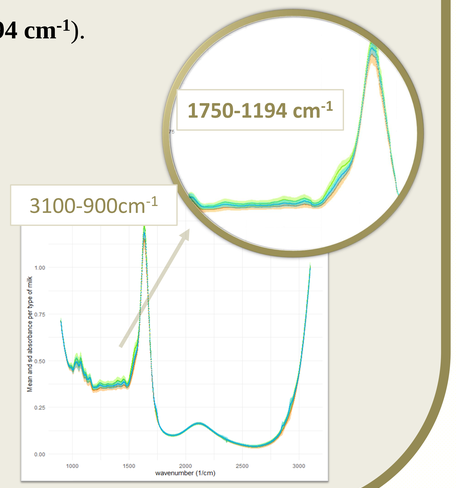


Figure 1. Principal component analysis for FTIR data. Scores plots for PC1 and PC2.

CONCLUSIONS

FTIR coupled with SVM showed potential for milk discrimination in the region 1750-1194 cm^{-1} with similar results when all features were used. Further analysis is important to be applied using milks from other animal species (e.g., buffalo, donkey) and adulteration scenarios.

European Union's Horizon 2020 research and innovation programme with the acronym "DiTECT" under grant agreement No 861915.