

Authentication of milk from buffaloes fed with hydroponic barley forage using E-nose

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The use of fresh forage in the animals' diet improves the nutritional composition of milk and, hence, of dairy products [1]. Grazing or fresh forage cultivation may become less feasible as Mediterranean agriculture is threatened by climate change, drought and scarcity of natural resources such as water and arable land [2]. Recently, hydroponic cultivation system has emerged as a new soilless cultivation method for growing quality-constant fresh forage, offering advantages such as better environmental sustainability, reduced labour costs, lower resource and space requirements [3]. The evaluation of the best nutritional composition of the milk, to avoid possible frauds, has focused on time consuming and laborious analyses such as chromatographic ones. This study aimed to use an E-nose to differentiate raw milk samples from buffaloes fed on maize silage or hydroponic barley forage. 108 samples of raw milk were taken on three different days, from three groups of twelve buffaloes (Italian Mediterranean breed). The control group (C) was fed maize silage and concentrate (60:40). In the first experimental group maize silage was replaced at 50% (LH) by hydroponic barley forage, while in the second group at 100% (HH). The E-nose, equipped with ten metal oxide semiconductor sensors (MOS), was used in combination with statistical data analysis (LDA and PCA) to classify the milk samples. In order to obtain information on the volatile compounds that characterised the milk samples, a SPME-GC/MS analysis was also performed. The confusion matrix for the cross-validation results, obtained from LDA performed on the E-nose data vectors, showed a correct classification rate of 84.3%. Furthermore, the PCA observation plot of the resulting 10-dimensional patterns corroborates the LDA findings, showing good discrimination of the three types of milk samples (Figure 1).

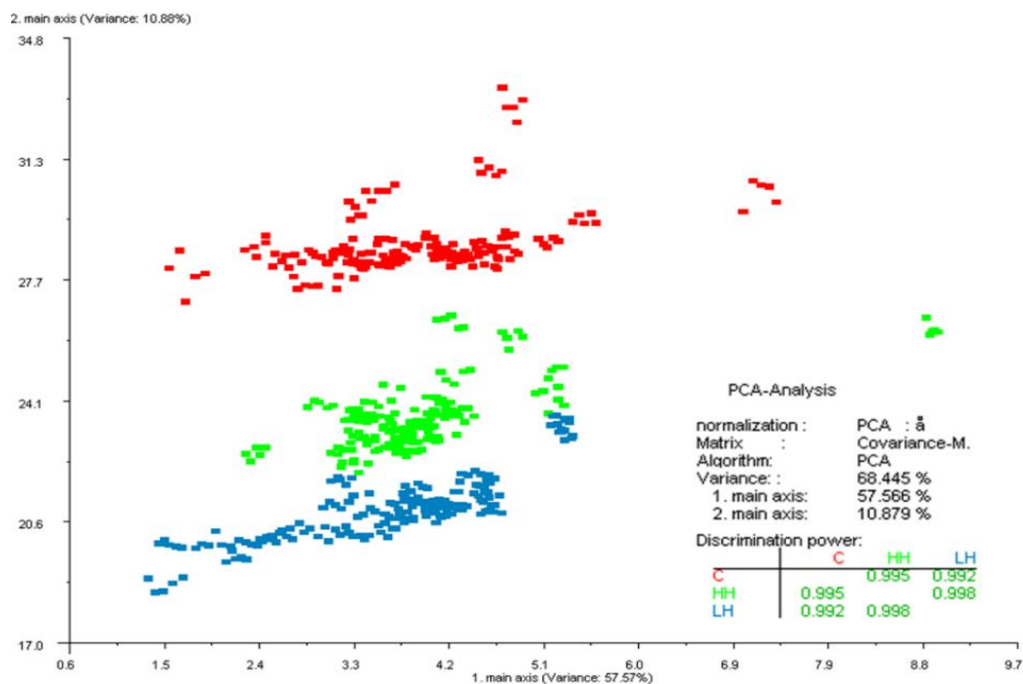


Figure 2 PCA results of electronic nose data vectors of 108 milk samples obtained from maize silage-fed buffaloes (control group, C, in red) and hydroponic forage-fed buffaloes, with 50% (LH, in blue) and 100% (HH, in green) silage replacement percentage. Data were extrapolated in the time range 55-59 s and processed with Winmuster v.1.6 software (Airsense Analytics GmbH, Schwerin, Germany).

This different response of MOS sensors to samples is due to quantitative differences of some volatile compounds. In fact, C milk samples had a higher overall abundance of volatile compounds, particularly for esters and ketones. In conclusion, the evidence from this study implies that E-nose can be a portable, solvent free and relatively inexpensive device for the rapid control of the authenticity of raw milk to protect producers and consumers of dairy products from potential fraud.

References

- [1] Balivo A, Sacchi R, Genovese A (2023) The Noble Method in the dairy sector as a sustainable production system to improve the nutritional composition of dairy products: A review. *International Journal of Dairy Technology*, **in Press**, DOI:10.1111.1471-0307.12941.
- [2] Aguilera E, Diaz-Gaona C, Garcia-Laureano R, Reyes-Palomo C, Guzmán G I, Ortolani L, Sánchez-Rodríguez M, Rodríguez-Estevéz V (2020) Agroecology for adaptation to climate change and resource depletion in the Mediterranean region. A review. *Agricultural Systems*, **181**, 102809.
- [3] Agius A, Pastorelli G, Attard E (2019). Cows fed hydroponic fodder and conventional diet: effects on milk quality. *Archives Animal Breeding*, **62**, 517-525.