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Volatile profile differences between spontaneous and cultivated Hyblean pasture

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ABSTRACT

The Hyblean area is the major dairy producer of southeastern Sicily. This current study was undertaken to investigate the aroma-active compounds in order to detect any differences in the flavor profiles of two Hyblean pasture types of forage: cultivated vs. spontaneous. Forage samples were collected twice, at the beginning (Period I) and at the end (Period II) of April. Odor-Active Compounds (OACs) were extracted from the samples using a steam distillation technique. OACs were then detected and identified by gas chromatography/mass spectrometry/olfactometry (GC/MS/O) and grouped into 7 chemical classes: alcohol, aldehyde, ester, ketone, pyrazine, sulfur and terpene. The data was subsequently analyzed statistically by applying the Chi-square test, using a significant level of $\alpha = 0.05$. Overall, forage samples from spontaneous pasture showed a significant difference higher ($P < 0.01$) in the number of OACs compared to those from cultivated pasture. Reflecting the growth trend in natural forage, OACs were higher in Period I compared to Period II in each pasture type, but was only significantly higher ($P < 0.05$) in the spontaneous pasture samples. In both pasture types, the chemical classes of OACs found were of significant difference, ($P < 0.0001$): alcohol, aldehyde, ketone and terpene classes presented a higher number of OACs compared to pyrazine, sulfur and not identified (NI) classes similar to esters. In conclusion, analysis of samples collected from spontaneous pasture revealed a richer odor profile than those from cultivated pasture, confirming that this type of forage is an important marker tied to the high Hyblean production area and possible influence on the aroma properties of milk and dairy products.

1. Introduction

The Hyblean territory is the major dairy producer of southeastern Sicily, the area of origin of the Ragusano Protected Denomination Origin (PDO) cheese. According to the Ragusano PDO production disciplinary, cows are required to graze native pasture. Traditional Hyblean dairy cattle farms producing cheese are based mainly on semi-extensive systems, involving dairy cattle grazing on pasture. Previous studies (Licitra et al., 1997; Carpino et al., 2003, 2004a) reported that Hyblean pastures

Abbreviations: OACs, odor-active compounds; GC/MS/O, gas chromatography/mass spectrometry/olfactometry; PDO, protected denomination origin; NIRS, near infrared spectroscopy; DM, dry matter; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin; RT, retention times; RI, retention indices; MSD, mass spectrometer detector.

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Table 1
Incidence of plant families/species of fresh pasture in spring time sampling.

% Incidence	Spontaneous		Cultivated	
	I Period	II Period	I Period	II Period
Avena fatua			24.9	22.8
Avena barbata			10.5	10.8
Lolium rigidum			31.4	27.1
Hordeum leporinum			21.1	22.1
Total Poaceae			88.0	82.9
Trifolium nigrescens	–	–	1.4	4.3
Trifolium				
Vicia sativa			7.1	5.7
Total Fabaceae	–	–	8.6	10.0
Boraginaceae	1.5	6		
Compositae	12.5	25.5	2.4	5.0
Anthemis arvensis L.	7.6	16.9	0.7	3.3
Calendula arvensis L.	2.9	3.5	0.1	–
Chrysantemum seg.	2.5	3.4	0.1	–
Cichorium	–	1.7	0.7	
Other species	–	–	0.7	2.1
Brassicaceae	9.8	6.3	0.3	0.7
Euphorbiaceae	5.7	3.7	–	0.7
Geraniaceae	0.8		–	–
Poaceae	17.3	24.0	–	–
Fabaceae	37.5	29.3	–	–
Malvaceae	3.2	1.6	–	–
Oxalidaceae	1.3		–	–
Polygonaceae	3.2	1.7	0.	–
Apiaceae	7.1	2	–	0.7

produce a great variety of plant life with over 100 spontaneous plant species belonging to over 25 cataloged families with different nutritive values depending on their biological stage of growth. Among these species, *Calendula arvensis* (Compositae family) is generally the most abundant, and is, therefore, the predominant species eaten by grazing cows. It is well known that what cows are fed affects the quality of dairy products. Plant diversity also contributes to milk and cheese flavour (Carpino et al., 2004b). Several authors (Buchin et al., 1999; Viallon et al., 1999; Cornu et al., 2001) confirmed the importance of grazing on fresh pasture in the development of volatile compounds in milk and cheese, improving the traceability of dairy products. Among all plants in fresh pasture, the dicotyledon class plays an important role in the generation of volatile compounds (Viallon et al., 2000). Factors that affect animal diet diversification are changes in various growing stages of the plants, availability of the aerial part of the plant, and seasonal climatic conditions. This, in turn, might influence flavor and aroma properties of dairy products. Few studies have researched the odor profile of pasture plants. This study was conducted to investigate and detect differences in aroma-active compounds found in the forage of two Hyblean pasture types: cultivated vs. spontaneous.

2. Materials and methods

2.1. 2.1 Pasture sample collection and chemical analysis

A total of 14 farms were included in the experiment: 7 were allocated for the spontaneous pasture type and 7 for the cultivated type. Pasture samples were collected twice, 14 at the beginning of April (Period I) and 14 at the end of April (Period II) 2011. April was chosen as a reference period because this is usually the time when the most relevant plant species are present. Forage samples were hand-collected by observing the behavior of four selected cows according to the method described by Carpino et al. (2003). Sampling was performed taking into account both the eating behavior of the cows and occurrence of plants in the field. In order to mimic cows grazing, plants were collected at the flowering stage by plucking just the apical part of each plant present in the pasture area. Once collected, the plants were promptly transferred in a refrigerated box to CoRFiLaC (Ragusa, Italy) laboratory for botanical identification. The incidence ratio of each single plant species and its family was calculated using the total bulk weight of pasture samples and the weight of each single species present and expressed as a percentage value (Table 1). Samples were placed in an oven, dried at 60 °C (ISO 6498:2012), and then analyzed by Near Infrared Spectroscopy (NIRS, Foss, XDS Infrared) for Dry Matter (DM), Crude Protein (CP) and fiber fractions: Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) parameters (Coblentz et al., 2012). Fresh pasture samples were also analyzed by Gas Chromatography/Mass Spectrometry/Olfactometry (GC/MS/O) at the CoRFiLaC aroma laboratory.