Pasture quality and *cheese traceability* index of Ragusano PDO cheese

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Abstract

In the Iblei plateau (Sicily, Southern Italy) the native dairy cattle breed Modicana during the spring season grazes exclusively on natural pastures for the production of the Ragusano protected denomination of origin cheese. Along the grazing season, herbage undergoes to changes on protein, fibre and moisture content, affecting quality parameters such as plant carotenoids concentration, involved in the colour and nutritional characteristics of dairy products and potential biomarkers for authenticating fed green pasture-based diets. The aim of this work was to assess whether the cheese traceability index, based on the carotenoids spectra data elaboration, could be related to seasonal variations of floral composition and pasture quality. Four herbage and cheese samples were collected every two weeks in two representative farms of this area, from March to May 2013. Pasture characteristics as pastoral vegetation composition and pastoral value were analysed using the methodology developed for pastoral resources studies. Traceability index showed a significant positive correlation with pasture moisture and crude protein content (r=0.729* and 0.853**, respectively), while it was negatively correlated with fibre content (r=–0.719*).

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Introduction

The Iblei plateau (Sicily, Southern Italy) is characterised by an altitude between 120 and 830 m asl, a very shallow calcareous soil and a typical Mediterranean climate with hot-dry summer and rainy autumn-winter period (Gresta *et al*., 2003). Animal husbandry is widespread within this district area where the autochthonous *Modicana* dairy cattle is traditionally reared for *Ragusano* protected denomination of origin (PDO) cheese production. Natural pastures in this area are strongly influenced by changes in weather trend with higher yield especially in spring (Cosentino and Litrico, 1992). During this season, animals graze on these pastures characterised by high plant species diversity, including several self-reseeding legumes (Patanè and Bradford, 1993). This traditional feeding system confers a characteristic aroma and colour to dairy products (Noziére *et al*., 2006), able to transmit biologically active molecules (β-carotene) having beneficial effects on human health due to powerful antioxidants protecting against oxidative stress (Marino *et al*., 2012).

Throughout the grazing season soil water availability and plant phenological stage influence plant carotenoids concentration, and, in turn, milk and cheese colour (Nozière *et al*., 2006). As reported by Carpino *et al.* (2004), cheese yellow index, related to carotenoids content, resulted higher in Ragusano produced from cows fed with natural pasture and total mixed ration (TMR) compared to exclusively TMR-fed ones. In order to trace the type of animal feeding system, Prache and Theriez (1999) developed the *traceability index*, based on the carotenoids spectra data elaboration. This index allows a complete discrimination between pasture-fed and stall-fed animals (Priolo *et al*., 2002) and it has been used to trace the changes of feeding systems in ruminant products (Priolo *et al*., 2003).

The aim of this study was to assess the influence of seasonal changes on pasture quality and how these variations are related with *cheese traceability index*.

Materials and methods

The study was carried out in two representative dairy farms of the Iblei plateau rearing *Modicana* breed for PDO *Ragusano* cheese production (Farm 1: 306 m asl, 36° 52' 50" N, 14° 33' 57" E, and Farm 2: 195 m asl, 36° 51' 36" N, 14° 32' 49" E).

Pastoral vegetation was characterised before grazing period. In each farm, data were recorded by applying a *Point intercept* method (Daget and Poissonet, 1969) to three transects 25 m long. Along each transect, 25 measurements were performed and vegetation data were analysed by computing single species contribution to vegetation composition (SCi) (Argenti and Lombardi, 2012) as follows:

$$SC_i = \frac{SF_i}{\sum SF_i} * 100 \quad (1)$$

being SF_i the specific frequency of each species found in the transect. The *pasture-type* (*facies*) was determined considering the most representative species reaching around 50% of the specific contribution (SCi) (Cavallero *et al*., 2002).

The pastoral value (PV) was computed, according to Daget and Poissonet (1972), using the following formula:

$$PV = 0.2 * \sum SC_i * SI_i \quad (2)$$

where SI_i is a specific index, ranging from 0 to 5, which summarises the forage value of each species (CoRFiLaC, 2001; Roggero *et al*., 2002). In each site, the herbage ground cover (%) was estimated by visual measurements.

In order to evaluate botanical and quality characteristics of the herbage, four samplings were collected during the spring season in 2013 (March 21, April 4 and May 2 and 18) inside a frame (50×50 cm) that was thrown randomly three times in the grazing area of both farms.

Herbage samples were taken back to the laboratory and sorted in *Poaceae*, *Fabaceae* and *other families*, dried at 105°C to measure moisture content. Crude protein (CP) was determined using Kjeldahl method (Latimer, 2012) to measure total N that was then multiplied by 6.25 to obtain crude protein. Neutral detergent fibre (NDF) was determined using the method suggested by Van Soest *et al*. (1991).

In each farm the day after herbage sampling, milk was drawn and processed to obtain cheese that was aged for 30 days, according to the PDO rules. After this period, reflectance spectrum (R) at wavelengths between 700 and 400 nm (1 value each 10 nm) and colour coordinates expressed as lightness (L*), redness (a*), and yellowness (b*) in the CIELab uniform colour space, were measured on 2 cheese sub-samples (approximately 10 g each), using a portable spectro-colorimeter (MINOLTA CM2022) set to use the illuminant D65 and 10° standard observer. The *traceability index* was calculated according to Prache and Theriez (1999) modified by Priolo *et al*. (2003). The reflectance spectrum (R) between 510 and 450 nm was translated to make the reflectance value at 510 nm equal zero (TR). On the translated spectrum, the integral value was calculated as follows:

$$I_{450-510}, \text{TR.nm} = [(\text{TR } 450/2) + \text{TR } 460 + \text{TR } 470 + \text{TR } 480 + \text{TR } 490 + \text{TR } 500 + (\text{TR } 510/2)] \times 10 \quad (3)$$

Variance of the data (integrals and CIELab values) was stabilised using logarithmic transformation.

Mean values and standard errors of herbage composition were calculated in each sampling date using the software packages SigmaPlot 11.0. Analysis of variance (ANOVA) of herbage quality was performed using CoHort Software (CoStat 6.003). Mean values within each sampling data followed by different lowercase letters are significantly ($P \leq 0.05$) different (S.N.K. test). Pearson coefficient was used to evaluate the correlation between cheese *traceability index* and pasture quality characteristics: moisture, CP and fibre content (NDF).

Results and discussion

Herbage ground cover at the beginning of the grazing period resulted around 90% in Farm 1 and 85% in Farm 2. In both farms the *Point*

Table 1. Characterisation of pastoral vegetation of the two dairy farms.

Farm 1		Farm 2	
Facies composition [SCi (%)]		Facies composition [SCi (%)]	
Lotus ornithopodioides L.	24.1	*Hordeum murinum* L. ssp. *leporinum*	27.5
Bromus madritensis L.	11.5	*Bromus madritensis* L.	18.8
Asphodelus fistulosus L.	9.2	*Urospermum dalechampii* (L.) Smidth	10.1
Lolium rigidum Gaud.	9.2		
Pastoral value	52.0	Pastoral value	56.0
Herbage ground cover (%)	90	Herbage ground cover (%)	85

SCi, pastoral vegetation composition.

Table 2. Herbage botanical composition (mean values±standard error), herbage quality and cheese quality parameters (mean values±standard error) recorded along the grazing season.

	21/03/2013		04/04/2013		18/04/2013		02/05/2013	
	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
Herbage composition (%)								
Poaceae	8.6±0.6	45.4±13.4	16.7±13.5	25.0±6.5	2.0±0.3	28.5±12.9	25.9±12.7	35.8±18.1
Fabaceae	45.5±4.3	15.8±6.6	12.4±7.7	10.4±3.6	40.9±9.6	15.1±5.6	9.9±5.1	3.9±1.5
Others	45.9±4.9	38.8±15.2	70.9±10.6	64.5±5.5	57.1±9.9	56.4±9.1	64.2±9.4	60.3±19.3
Herbage quality (%)								
Moisture	84.8^a	77.8^b	80.8^a	67.6^b	65.7^a	60.2^a	31.4^a	39.4^a
Crude protein	15.9^a	15.6^a	18.2^a	12.2^b	11.9^a	9.5^b	8.5^a	7.6^a
NDF	49.3^a	52.4^a	42.3^b	60.4^a	52.8^b	62.0^a	69.0^a	67.4^a
Cheese quality index								
Yellow index (b*)	20.9±0.1	21.4±0.3	22.6±0.5	21.0±0.2	19.1±0.1	19.2±0.3	17.4±0.3	18.7±1.0
Traceability index	975.6±0.1	1102.1±14.5	1106.1±26.1	951.1±34.0	846.3±0.9	924.2±12.7	865.0±30.5	861.5±95.2

Mean values within date followed by different letters are significantly different at $P \leq 0.05$. NDF, neutral detergent fibre; b*, yellowness.

intercept method allowed to record 21 species. In Farm 1 pasture *facies* showed four species reaching 54.0% of SCi (*Lotus ornithopodioides* L., *Bromus madritensis* L., *Lolium rigidum* Gaud. and *Asphodelus fistulosus* L.); while, in Farm 2 *facies* included three species: *Hordeum murinum* L. subsp. *leporinum* (Link) Arcang., *Bromus madritensis* L. and *Urospermum dalechampii* (L.) Schmidt, reaching 56.5% of SCi. PV was equal to 52/100 in Farm 1 and 56/100 in Farm 2 (Table 1).

Herbage composition showed a prevalence of *other families* (more than 50%) *versus Poaceae* and *Fabaceae*. However, on the average of sampling dates, *Poaceae* and *Fabaceae* weighted differently: 13% and 27% in Farm 1 and 33% and 11% in Farm 2, respectively (Table 2). Herbage moisture content showed a progressive decrease from 84.8% to 31.4% in Farm 1 and from 77.8% to 39.4% in Farm 2 over time. CP decreased from the first sampling (15.9% and 15.6%, respectively, in Farm 1 and 2) to the last one (8.5% and 7.6% in the same order), while fibre content (NDF) showed an opposite trend, ranging from 49.3% and 52.4% (first sampling) to 69.0% and 67.4% (last sampling), respectively in Farm 1 and Farm 2. Same results were obtained by Cosentino and Litrico (1992) in the same environment and grazing period.

Cheese yellow index (b*) showed an average value of 20.0, higher than the average value of 11.5 observed by Carpino *et al*. (2004) in *Ragusano* cheese produced by cattle fed on TMR plus pasture. Yellow index showed a decrease along grazing season ranging from 21.1 to 18.1 as average value of the two farms. Same trend was observed for *traceability index* that ranged from 1038.9 to 863.3 in the average of the two farms. This index showed a positive significant correlation with herbage CP (r=0.853**) and moisture content (r=0.729*), while a negative significant correlation was observed with fibre content (NDF) (r=-0.719*) (Figure 1).

Results are in accordance with Noziére *et al*. (2006) that showed a higher milk β-carotene levels in spring grazing compared to summer one and with Marino *et al*. (2012) that observed same trend in *Modicana* cattle reared in the South of Sicily.

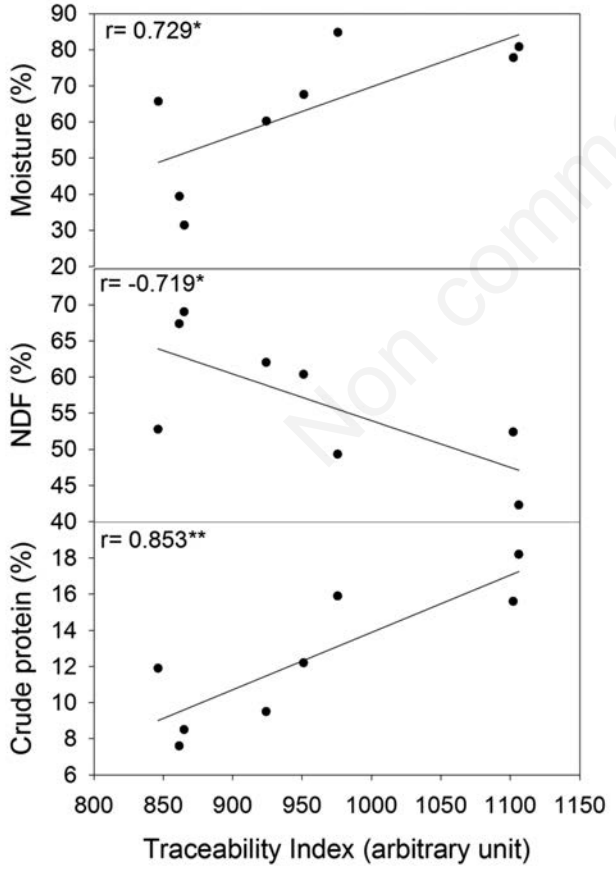

Figure 1. Correlation of *traceability index* with herbage quality characteristics recorded along the grazing season. NDF, neutral detergent fibre*Significant for P≤0.05; **Significant for P≤0.01.

Conclusions

This research shows that during spring grazing season, pasture of the Iblei plateau undergoes a typical Mediterranean spring herbaceous flush that is followed by a fast worsening of pasture quality due to changes in herbage moisture, protein and fibre content (NDF). These variations have been resulted significantly correlated with cheese *traceability index*. When animals graze a good quality pasture (high protein and moisture content), cheese will present higher *traceability index* values compared to cows grazing the same pasture later in the season.

This preliminary study indicate *traceability index* as a speedy and efficient tool to get more information about the observance of PDO rules regarding feeding system and cheese production to satisfy consumers interest about a clear food chain.

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