

CHEMICAL AND TECHNOLOGICAL CHARACTERISATION OF EWE AND GOAT CHEESES FROM PIEDMONT

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INTRODUCTION

The dairy industry is a very important sector for Piedmont (Italy) economy with ten Protected Denomination of Origin (PDO) cheeses and fifty-five cheeses classified as "Traditional". Among these "Traditional" products, the ewe and goat cheeses are very important since they are strictly connected with the Piedmont area and characterised by an high nutritional value as well as an interesting sensory characteristics.

Robiola di Roccaverano PDO and Murazzano PDO cheeses are the most important but a large number of other cheeses that can be classified in five groups (Verbano-Cusio-Ossola goat cheeses, Cevrin di Coazze, acid goat cheese, rennet goat cheese, Valsesia goat cheese) are produced. The latter might be qualified for the PDO designation but chemical information is lacking and only their gross composition is known.

AIM

The aim of this study was to characterise all the ewe and goat cheeses produced in Piedmont defining their technology, sensory characteristics and chemical composition focusing on sugars, organic acids, ketones, fatty acids and the protein degradation products obtained by the urea-PAGE.

MATERIALS and METHODS

SAMPLES - Sixty-two samples from 44 cheesemakers were collected and analyzed.

CHEMICAL ANALYSIS - Dry matter, fat and protein content were determined according to the Italian Official Methods for cheese analysis (D.M., 1986).

FATTY ACIDS - The fatty acid methyl esters were prepared by transesterification with potassium hydroxide according to ISO 5509:2000E and separated on a capillary DB-WAX column (30 m length, 0.25 mm internal diameter, 0.25 m phase thickness) by using gas chromatograph Varian, split/splitless injector and flame ionization detector (Zeppa et al., 2003).

ASSESSMENT OF PROTEOLYSIS - The pH 4.6-insoluble and -soluble extracts were prepared according to the method of Kuchroo and Fox (1982), which was slightly modified, as outlined by Hayaloglu, Guven, Fox, Hannon and McSweeney (2004). Insoluble protein fraction was electrophoresed on a Urea-polyacrylamide gel electrophoresis (Urea-PAGE) by using Protean II xi vertical slab-gel unit according to the method of Shalabi and Fox (1987). The gels were stained directly with Coomassie Brilliant Blue G-250 by the procedure of Blakesley and Boezi (1977) and destained using distilled water. After destaining, gel slabs were digitized by a scanner. Scans of the electrophoretograms were used to quantify bands, using densitometric software. Similar bands were recognised visually, as described by McSweeney, Poochet, Fox and Healy (2004) and peak volumes of corresponding bands were quantitatively determined.

MINOR COMPONENTS - Organic acids (citric, itroic, pyruvic, lactic, oxalic, hippuric, formic, acetic, propionic, butyric, isobutyric, valeric and isovaleric), sugars (lactose, glucose and galactose), diacetyl and acetoin were determined by high performance liquid chromatography according to Zeppa et al. (2001).

STATISTICAL ANALYSIS - Conventional statistical methods were used to evaluate the chemical data. Analysis of variance and Duncan's multiple mean comparison test were applied using STATISTICA for Windows Release 7.1 to determine statistical differences between the cheese varieties.



RESULTS

Table 1 - Mean values (X), standard deviation (SD), minimum (Min) and maximum (MAX) for gross composition of cheeses

| | Lactic cheese | | | Presamico cheese | | | Valsesiano cheese | | | Verbano-Cusio-Ossola cheese | | | Cevrin di Coazze | | | Robiola di Roccaverano PDO | | | Murazzano PDO | | | | | | | | | |
|----------------------|---------------|------|------|------------------|------|------|-------------------|------|------|-----------------------------|------|------|------------------|------|------|----------------------------|------|------|---------------|------|------|------|------|------|------|------|------|------|
| | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | | | | |
| Fat (%) | 19.33 | 13.7 | 24.7 | 26.8 | 2.9 | 20 | 30.9 | 24.7 | 4.4 | 19.1 | 33.6 | 27.2 | 2.7 | 24.2 | 32.3 | 26.1 | 1.9 | 24.8 | 27.5 | 18.4 | 2.7 | 15.2 | 25.6 | 28.6 | 3.6 | 24.2 | 31.9 | |
| Dry matter (%) | 38.6 | 3.4 | 32.8 | 43.3 | 5.4 | 3.6 | 48.8 | 61.8 | 57.1 | 6.9 | 45.4 | 64.8 | 55.7 | 4.1 | 49.7 | 61.5 | 63 | 3.8 | 51.8 | 54.1 | 37.7 | 3.4 | 34.1 | 47.5 | 55 | 4.3 | 49.4 | 59.2 |
| Protein (%) | 14.5 | 1.6 | 12 | 17 | 24.3 | 19.4 | 27.6 | 27.9 | 4.7 | 20.4 | 35.1 | 24.2 | 2.3 | 21.1 | 27.5 | 22.4 | 1 | 21.7 | 23.1 | 14.5 | 1.6 | 12.6 | 17.8 | 22.3 | 1.2 | 20.6 | 23.2 | |
| Fat (g/dm) | 48.9 | 4.6 | 41.6 | 57 | 48.3 | 3.4 | 41.1 | 55.5 | 43.3 | 5.2 | 40 | 55.6 | 48.8 | 2.4 | 45 | 52.5 | 42.4 | 7.6 | 37.1 | 47.8 | 48.7 | 2.9 | 44.5 | 54.7 | 51.9 | 2.9 | 49 | 55.5 |
| Protein (g/dm) | 37.8 | 3.8 | 31.5 | 41.2 | 44.2 | 3.1 | 36.4 | 48 | 48.7 | 4.3 | 41 | 54.1 | 43.5 | 2.6 | 39.8 | 48.3 | 36.5 | 7.6 | 31.1 | 41.9 | 38.6 | 3.4 | 50.5 | 40.7 | 1.9 | 38.7 | 42.9 | |
| Water (%) | 61.4 | 3.4 | 56.7 | 67.2 | 44.6 | 3.6 | 38.2 | 51.2 | 42.9 | 6.9 | 35.2 | 54.6 | 44.3 | 4.1 | 38.5 | 50.3 | 37.1 | 15.8 | 25.9 | 48.2 | 62.3 | 3.4 | 52.5 | 65.9 | 45 | 4.3 | 48.0 | 50.6 |
| Ash (%) | 1.7 | 0.3 | 1.4 | 2 | 1.9 | 0.4 | 1.3 | 2.7 | 1.9 | 0.5 | 1.3 | 2.7 | 1.9 | 0.3 | 1.3 | 2.3 | 1.2 | 1.5 | 0.2 | 2.3 | 1.7 | 0.4 | 1 | 2.3 | 1.3 | 0.4 | 0.8 | 1.7 |
| Total nitrogen (%) | 2.3 | 0.3 | 1.9 | 2.7 | 3.9 | 0.4 | 3 | 4.3 | 4.4 | 0.7 | 3.2 | 5.5 | 3.8 | 0.4 | 3.3 | 4.3 | 3.5 | 0.2 | 3.4 | 3.6 | 2.3 | 0.3 | 2 | 2.8 | 3.5 | 0.2 | 3.2 | 3.6 |
| Soluble nitrogen (%) | 0.5 | 0.2 | 0.2 | 0.8 | 0.9 | 0.4 | 0.2 | 1.8 | 1.2 | 0.4 | 0.6 | 1.6 | 1.2 | 0.5 | 0.6 | 2 | 0.2 | 1.9 | 2.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.4 | 0.4 | 0.1 | 0.3 | 0.5 |
| pH | 4.6 | 0.2 | 4.3 | 4.8 | 5 | 0.3 | 4.4 | 5.3 | 5.3 | 0.2 | 5 | 5.7 | 5.4 | 0.4 | 4.9 | 5.8 | 5.1 | 0.2 | 5 | 5.3 | 4.2 | 0.1 | 3.9 | 4.4 | 4.7 | 0.1 | 4.6 | 4.9 |

Table 2 - Mean values (X) and standard deviation (SD) of acid, sugars and other components evaluated by HPLC analysis and results of variance analysis with Duncan's test (R - Robiola di Roccaverano PDO; M - Murazzano PDO; L - Lactic cheese; C - Cevrin di Coazze; V - Valsesiano cheese; VCO - Verbano-Cusio-Ossola cheese; P - presamico cheese)

| | M | VCO | V | P | C | L | R | SD | Signif. | | | | | | | |
|------------------|---------|-------|---------|--------|---------|-------|---------|-------|---------|--------|--------|-------|--------|-------|-------|-----|
| Oxalic acid | 0.21 | 0.093 | 0.014 | 0.027 | 0.062 | 0.064 | 0.111 | 0.034 | 0.237 | 0.042 | 0.052 | 0.28 | 0.023 | ns | | |
| Formic acid | 4.667 | 2.392 | 3.261 | 2.499 | 2.322 | 1.685 | 2.4 | 2.380 | 0.705 | 0.280 | 1.924 | 1.444 | 2.151 | 1.208 | ns | |
| Pyruvic acid | 0.167 | 0.112 | 0.087 | 0.102 | 0.189 | 0.14 | 0.131 | 0.11 | 0.067 | 0.075 | 0.129 | 0.055 | 0.182 | 0.221 | ns | |
| Lactic acid | 71.0742 | 4.007 | 10.5848 | 8.993 | 19.9402 | 5.760 | 14.5423 | 6.680 | 13.7778 | 16.748 | 6.180 | 2.162 | 6.530 | 6.25 | *** | |
| Formic acid | 10.419 | 0.51 | 1.282 | 1.48 | 0.560 | 0.222 | 0.949 | 0.960 | 0.26 | 0.324 | 0.694 | 0.520 | 0.572 | 0.811 | ns | |
| Acetic acid | 0.414 | 0.269 | 0.8305 | 0.645 | 0.7975 | 0.428 | 0.7885 | 0.691 | 0.1424 | 0.143 | 0.494 | 0.380 | 0.299 | 0.122 | *** | |
| Propionic acid | 0.0791 | 0.056 | 0.3445 | 0.428 | 0.268 | 0.323 | 0.202 | 0.238 | 0.181 | 0.061 | 0.059 | 0.071 | 0.038 | 0.043 | *** | |
| iso-butyric acid | nr | nr | 0.0464 | 0.065 | 0.0064 | 0.007 | 0.0064 | 0.011 | 0.2315 | 0.327 | 0.0064 | 0.011 | nr | nr | *** | |
| Butyric acid | 1.708 | 1.477 | 4.7 | 4.507 | 2.315 | 1.418 | 3.019 | 3.387 | 1.72 | 0.032 | 3.547 | 3.978 | 1.437 | 2.049 | ns | |
| iso-valeric acid | nr | nr | 0.098 | 0.18 | 0.2915 | 0.435 | 0.126 | 0.191 | 0.0014 | 0.001 | nr | nr | nr | 0.037 | 0.112 | *** |
| n-Valeric acid | 1.0814 | 1.148 | 7.588 | 15.978 | 4.001 | 3.854 | 2.110 | 1.72 | 4.292 | 1.138 | 0.887 | 0.711 | 1.138 | 0.867 | *** | |
| Hippuric acid | nr | nr | 0.001 | 0.001 | 0.004 | 0.013 | nr | nr | nr | nr | nr | nr | nr | 0.001 | 0.006 | ns |
| Acetoin | 0.003 | 0.002 | 0.003 | 0.002 | 0.001 | 0.003 | 0.002 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | ns | |
| Lactose | 5.161 | 3.966 | 0.038 | 0.031 | 0.062 | 0.185 | 0.820 | 3.167 | 0.017 | 0.024 | 10.720 | 7.711 | 11.930 | 6.711 | *** | |
| Glucose | 0.001 | 0.003 | 0.007 | 0.013 | 0.003 | 0.007 | 0.004 | 0.085 | nr | nr | 0.1645 | 0.148 | 0.064 | 0.044 | *** | |
| Galactose | 0.209 | 0.132 | 0.018 | 0.033 | 0.023 | 0.04 | 0.483 | 1.371 | 0.011 | 0.015 | 0.273 | 0.19 | 0.338 | 0.29 | ns | |

a, b, ... Different letters indicate significant statistical differences for p < 0.05.

Table 3 - Mean values (X) and standard deviation (SD) of fatty acids identified on goat cheeses of Piedmont

| | Cevrin di Coazze | | | Lactic cheese | | | Murazzano PDO | | | Presamico cheese | | | Robiola di Roccaverano PDO | | | Valsesiano cheese | | | Verbano-Cusio-Ossola cheese | | | | | | |
|-------|------------------|------|-------|---------------|-------|------|---------------|------|-------|------------------|-------|------|----------------------------|------|------|-------------------|------|------|-----------------------------|------|------|------|------|------|------|
| | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | X | SD | Min | MAX | |
| C20:0 | 0.26 | 0.02 | 0.22 | 0.28 | 0.31 | 0.06 | 0.31 | 0.07 | 0.3 | 0.04 | 0.69 | 0.29 | 0.31 | 0.1 | 0.1 | 0.1 | 0.1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| C22:0 | 0.25 | 0.15 | 0.14 | 0.06 | 0.21 | 0.09 | 0.16 | 0.05 | 0.31 | 0.06 | 0.34 | 0.11 | 0.16 | 0.08 | 0.08 | 0.14 | 0.16 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| C24:0 | 1.32 | 0.11 | 1.3 | 0.94 | 1.74 | 0.97 | 0.89 | 0.8 | 1.54 | 0.68 | 1.24 | 0.73 | 1.05 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 |
| C26:0 | 0.29 | 0.07 | 0.25 | 0.25 | 0.89 | 0.27 | 0.93 | 0.44 | 0.97 | 0.4 | 0.87 | 0.48 | 1.05 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| C28:0 | 0.82 | 0.38 | 0.57 | 0.41 | 0.95 | 0.32 | 1.27 | 0.5 | 1.28 | 0.43 | 1.04 | 0.54 | 1.3 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 |
| C30:0 | 2.25 | 0.57 | 4.63 | 1.6 | 3.44 | 0.98 | 5.04 | 1.66 | 5.63 | 1.56 | 4.07 | 1.85 | 4.8 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 |
| C31:0 | 0.19 | 0.12 | 0.21 | 0.07 | 0.21 | 0.06 | 0.17 | 0.06 | 0.22 | 0.06 | 0.13 | 0.07 | 0.17 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| C32:0 | 2.5 | 1 | 2.7 | 0.89 | 2.97 | 0.62 | 2.91 | 0.62 | 3.51 | 0.71 | 2.22 | 0.89 | 2.9 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 |
| C33:0 | 0.13 | 0.05 | 0.19 | 0.06 | 0.14 | 0.03 | 0.12 | 0.03 | 0.16 | 0.05 | 0.09 | 0.05 | 0.13 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| C34:0 | 9.05 | 1.26 | 10.75 | 1.25 | 10.14 | 0.95 | 8.88 | 1.17 | 9.94 | 1.14 | 8.06 | 1.63 | 8.59 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 |
| C35:0 | 0.61 | 0.16 | 0.23 | 0.21 | 0.37 | 0.13 | 0.19 | 0.23 | 0.21 | 0.15 | 0.11 | 0.19 | 0.24 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| C36:0 | 1.19 | 0.06 | 1.11 | 0.17 | 1.23 | 0.16 | 1.05 | 0.26 | 1.11 | 0.21 | 1 | 0.19 | 0.88 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
| C37:0 | 25.32 | 3.7 | 30.50 | 2.51 | 27.94 | 0.99 | 27.28 | 2.89 | 29.48 | 4.37 | 24.84 | 2.37 | 25.48 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 |
| C38:0 | 1.73 | 0.29 | 1.3 | 0.3 | 1.7 | 0.15 | 1.18 | 0.22 | 1.54 | 0.28 | 0.86 | 0.2 | 1.1 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| C39:0 | 0.82 | 0.25 | 1.1 | 0.18 | 0.82 | 0.08 | 1.05 | 0.21 | 0.95 | 0 | | | | | | | | | | | | | | | |