

Characterisation of production system of Niza cheese (PDO): effect of sheep breed on milk composition and coagulation properties

Martins A.P.L., Belo A.T., Vasconcelos M.M., Fontes A.L., Pereira E.A., Belo C.

in

Pacheco F. (ed.), Morand-Fehr P. (ed.).
Changes in sheep and goat farming systems at the beginning of the 21st century :
research, tools, methods and initiatives in favour of a sustainable development

Zaragoza : CIHEAM / DRAP-Norte / FAO

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 91

2009

pages 221-225

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=801149>

To cite this article / Pour citer cet article

Martins A.P.L., Belo A.T., Vasconcelos M.M., Fontes A.L., Pereira E.A., Belo C. **Characterisation of production system of Niza cheese (PDO): effect of sheep breed on milk composition and coagulation properties.** In : Pacheco F. (ed.), Morand-Fehr P. (ed.). *Changes in sheep and goat farming systems at the beginning of the 21st century : research, tools, methods and initiatives in favour of a sustainable development* . Zaragoza : CIHEAM / DRAP-Norte / FAO, 2009. p. 221-225 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 91)



<http://www.ciheam.org/>
<http://om.ciheam.org/>

Characterisation of production system of Niza cheese (PDO): Effect of sheep breed on milk composition and coagulation properties

A.P.L. Martins*, A.T. Belo**, M.M. Vasconcelos*, A.L. Fontes*,
E.A. Pereira** and C.C. Belo**

*NTLD-DTPA, Estação Agronómica Nacional, INRB, I.P., Instituto Superior de Agronomia, Tapada da Ajuda, 1349-018 Lisboa (Portugal)

**Estação Zootécnica Nacional, INRB, I.P., Apartado 17, Fonte Boa, 2000-763 Vale de Santarém (Portugal)

Abstract. The increasing demand for traditional Portuguese cheeses has been promoting structural modifications on sheep milk production system and on traditional cheese making industry with impact on milk properties that are considered to affect cheese quality and tipicity. The objective of this study was to investigate the effect of sheep breed on milk composition and coagulation properties, both being important elements in cheese making, and consequently on cheese quality. The study included two successive winter/spring lactations and monitored three farms, using different sheep breeds, Merino, Saloia and Assaf. The milk of the two daily milkings was sampled twice a month (1st year) or monthly (2nd year), and the samples were analysed for acidity, pH, and solids non-fat, fat, protein and casein contents. The potential cheese making yield was estimated and the milk coagulation properties were assessed using the Optigraph. The milk composition showed higher solids content for Merino and Saloia breeds, resulting in a potential cheese making yield respectively 75% and 27% higher than Assaf milk. The physical and chemical characteristics contributed also to different milk coagulation behaviour, with superior clot firmness (A_{40}) for Merino breed (16.8 V) and lower values for Assaf sheep milk (13.0 V). The firming rate was also lower for Assaf milk while milk from Saloia showed the fastest clot firming. The results emphasize the different cheese making aptitude of the milk from the autochthonous breeds and suggest the need of technology modifications according to milk characteristics.

Keywords. Sheep breeds – Milk composition – Cheese making yield – Clotting aptitude – Optigraph.

Caractérisation du système de production du fromage Niza (AOP) : effet de la race ovine sur la composition du lait et les propriétés de coagulation

Résumé. La demande croissante de fromages traditionnels portugais a favorisé des modifications structurelles dans le système de production de lait de brebis et dans l'industrie fromagère traditionnelle. L'objectif de cette étude est d'analyser l'effet de la race de brebis sur la composition et l'aptitude à la coagulation du lait, deux éléments importants pour la technologie et la qualité du fromage. L'étude a inclus deux lactations successives d'hiver/printemps et trois troupeaux avec des races différentes, Merino, Saloia et Assaf. Le lait des deux traites quotidiennes a été prélevé deux fois par mois (1^{ère} année) ou mensuellement (2^{ème} année). Les échantillons ont été analysés pour l'acidité, le pH, et les teneurs en graisse, protéine et caséine. Le rendement fromager a été estimé et l'aptitude à la coagulation du lait a été évaluée avec l'Optigraph. La composition du lait a montré un contenu plus élevé de matières solides pour les races Merino et Saloia, ce qui se traduit dans un rendement fromager potentiel plus élevé respectivement de 75% et 27% que le lait de la race Assaf. Les caractéristiques physiques et chimiques ont contribué également au différent comportement du lait à la coagulation, avec une fermeté de caillé (A_{40}) supérieure pour la race Merino et une obtention de gels plus mous pour le lait d'Assaf. Le taux de raffermissement était également inférieur pour le lait d'Assaf tandis que le lait de Saloia a présenté la gélification la plus rapide. Les résultats mettent en évidence la différence d'aptitude fromagère du lait des races autochtones et suggèrent le besoin de modifications de la technologie en fonction des caractéristiques du lait.

Mots-clés. Races de brebis – Composition du lait – Rendement fromager – Coagulation – Optigraph.

I – Introduction

All sheep milk produced in Portugal is transformed into cheese and this is one of the oldest and characteristic activities in unfavourable regions. This tradition based on specific animal production systems and technology that characterize each region made possible the manufacture of high quality, tipicity and retail prices Protected Designation of Origin (PDO) sheep milk cheeses. However the trend throughout the last 10-20 years in sheep milk and cheese production, that include the increasing demand for traditional Portuguese cheeses, the intensification of milk production, the increasing of farm and cheese making facilities size, the introduction of new sheep breeds and cheese technology modifications, have promoted changes that are said to affect the milk characteristics and the cheese quality and tipicity (Martins and Vasconcelos, 2003).

The effect of sheep breed on milk composition is well known and the clotting properties of milk have been widely used to assess the processing performance of milk (Bencini, 2002) but the literature on sheep milk clotting properties evaluated with the Optigraph is scarce. The objective of this study was to investigate the effect of sheep breed, one of the factors involved on milk production intensification, on composition and clotting properties of milk from the PDO Nisa cheese area, both being important elements in cheese making and consequently on cheese quality.

II – Materials and methods

The milk production from three farms in the PDO Nisa cheese area was monitored throughout two successive winter/spring lactations. In all farms the ewes were allowed to graze and were supplemented with hay and concentrates according to their level of production. The major difference between farms was the breed. The sheep breeds were two autochthonous breeds - Merino (traditionally related with this type of cheese) and Saloia (related with PDO Azeitão cheese area nowadays important in the Norte Alentejo region) and Assaf (an exotic breed frequently found in Portugal). The milk from the two daily milkings was sampled twice a month (first year) or monthly (second year) throughout five months. The milk samples (200 ml) were refrigerated (2-4°C) after addition of 0.5 ml/100 ml of a sodium azide solution (0.8%, w/v) (Remeuf *et al.*, 1989) until further analysis.

The milk samples were analysed for acidity (NP-470), pH (Metrohm 713), and solids non-fat (NP-475), fat (NP-469), crude protein (NP-1968 based Tecator Kjeldahl method) and casein (Rowland, 1938) contents. The evaluation of the cheese making yield was carried out according to Remeuf *et al.* (1989) throughout the first lactation. Twenty millilitres of milk were measured for a centrifuge vessel and after temperature stabilization (32°C) 1 ml of rennet solution (the same used in Optigraph trials) was added. After homogenisation, the milk was let at clotting temperature for one hour, and further centrifuged (3500 g, 15 m; Sigma 4K10, Germany) without previous curd cutting. After centrifugation the whey volume and the crude cheese making yield on a fresh or dry matter basis were evaluated.

The milk clotting aptitude was assessed with the Optigraph (Ysebaert, France), according to previous work (Alves *et al.*, 2004, 2004a). After setting the milk clotting temperature to stabilized at 32 °C, 1 ml of rennet solution was added to 10 ml of milk. A 0.08% aqueous solution (m/v) of rennet powder containing $96 \pm 2\%$ of chymosin (Granday[®] 6000, Gist Brocades) was used for milk coagulation trials. All tests were run for 50 minutes and the studied parameters were R (clotting time, min), firmness measures (Volt) after 20 minutes (A_{20}) or 40 minutes (A_{40}) of trial, and after a 2R (AR) or 3R (A2R) period, representing suitable cutting time in respectively soft and hard cheese technologies (Mahaut *et al.*, 2000), and OK20 (rate of firming, min) representing the time to reach a standard curd firmness related with a firmness suitable for cutting, equivalent to a 20 mm distance between the two parabola branches of the Formagraph type output (McMahon and Brown, 1982; Delacroix-Buchet *et al.*, 1994), substituted in the Optigraph by a standard consistency equivalent to 6.5 V. All analysis was made in duplicate.

The analytical data was analysed by ANOVA, using the Scheffe comparison test with a significance level of 5% (Statistica 99 Edition®).

III – Results and discussion

1. Milk composition and cheese making yield

The mean values for physical and chemical parameters (not shown) were in general agreement with those expected for sheep milk (Alichanidis and Polychroniadou, 1997), with a variation within a range according with the frequent variability of small ruminants milk composition. This variation came from animal production factors (e.g. breed, production year, lactation period, feeding; some of them, year/lactation and sheep breed, are present in this study), or related with some deficient production or milk preservation conditions. The production year revealed a significant effect ($P < 0.05$) on milk composition and on milk freshness parameters, with a higher acidity level and a lower pH in the second year, probably reflecting worst weather or milk handling conditions for milk production. The milk composition (Table 1) was not so different between the two lactations with higher fat ($P > 0.05$) and protein ($P < 0.05$) contents in the second year, which may reflect changes in the weather, feeding and other production conditions. The breed and the interaction with the year had significant effects ($P < 0.05$) mainly on the milk composition with higher non-fat solids, fat and protein mean contents for the Portuguese breeds. In fact, Merino breed showed the highest protein content (6.75 and 7.16%) and the Assaf milk had lower protein contents (5.13 and 5.83%). The composition of Saloia milk was intermediate between the other two breeds, showing a quite interesting protein level for cheese making (6.07 and 6.27%).

Table 1. Effect of breed and year of production on chemical composition of sheep milk

	Acidity (ml NaOH N/l)	pH	Solids non-fat (% w/w)	Fat (% w/v)	Crude protein (% w/w)	Casein (% w/w)
Saloia 1 st year	27.1 ^b	6.54 ^{ac}	11.60 ^{ab}	8.7 ^a	6.07 ^b	4.73 ^c
Assaf 1 st year	25.8 ^b	6.55 ^{ab}	10.76 ^c	6.6 ^b	5.13 ^c	3.95 ^d
Merino 1 st year	27.0 ^{bc}	6.62 ^a	12.14 ^{ab}	9.3 ^a	6.75 ^a	5.23 ^b
Saloia 2 nd year	32.4 ^{ac}	6.46 ^{bc}	11.28 ^{bc}	8.7 ^a	6.27 ^b	4.82 ^c
Assaf 2 nd year	37.5 ^a	6.35 ^b	11.27 ^{ac}	7.4 ^{ab}	5.83 ^{bc}	4.39 ^{cd}
Merino 2 nd year	33.5 ^a	6.52 ^{ab}	12.41 ^a	9.7 ^a	7.16 ^a	5.70 ^a

Note: In each column, different letters mean significant differences ($P < 0.05$).

As expected, the milk composition had a significant effect ($P < 0.05$) on cheese making yield. The milk from Merino breed reached potential crude yield levels 27% and 75% higher than those obtained for Saloia (52.8%, w/w) or Assaf (38.48%, w/w) milk respectively. On a dry matter basis, the yield mean value for Merino breed was 17% and 49% higher than those obtained for Saloia (15.9%, w/w) and Assaf (12.4%, w/w) milk respectively.

2. Milk clotting properties

The previous results express the influence of milk composition, influenced either by environmental or animal factors, on the milk technological quality, although inadequate cheese making practices or poor coagulation properties can contradict this trend. As referred by Alichanidis and Polychroniadou (1997), sheep milk coagulation is quicker than that usually found for cow's milk, leading to more firm curds and faster micellar aggregation. In spite of its wide variation, the results obtained for the milk clotting properties show significant effects ($P < 0.05$) for the year and the breed, as well as for the interaction of both factors, especially for curd firmness and firming rate. On the first year, certainly related with a lower protein content, a

lower mean clotting time (R) and curd firmness (either A₂₀, A₄₀, AR or A2R) was observed, which is in agreement with Pellegrini *et al.* (1994) (Table 2).

Table 2. Effect of sheep breed and year on milk clotting properties

	R (min.)	AR (V)	A2R (V)	A ₂₀ (V)	A ₄₀ (V)	0K20 (min.)
Saloia 1 st year	10.08 ^a	9.13 ^b	13.18 ^{bc}	8.92 ^{ab}	15.56 ^{ab}	5.18 ^{ab}
Assaf 1 st year	9.85 ^a	8.21 ^b	10.75 ^c	7.77 ^b	14.11 ^b	6.18 ^a
Merino 1 st year	9.74 ^a	10.52 ^{ab}	15.06 ^{abc}	10.87 ^{ab}	17.60 ^{ab}	4.58 ^{ab}
Saloia 2 nd year	9.02 ^a	10.96 ^{ab}	15.41 ^{ab}	12.10 ^a	18.36 ^{ab}	4.35 ^b
Assaf 2 nd year	10.95 ^a	10.31 ^{ab}	15.09 ^{abc}	8.94 ^{ab}	17.71 ^{ab}	5.03 ^{ab}
Merino 2 nd year	12.61 ^a	13.91 ^a	19.20 ^a	9.63 ^{ab}	20.08 ^a	4.38 ^b

Note: In each column, different letters mean significant differences ($P < 0.05$)

The Table 2 also shows that the milk clotting properties followed in general the breed ranking results for milk composition. The gel consistency, which depends mainly on milk composition (Lenoir *et al.*, 1997), is higher for Portuguese breeds. The curd firmness (A₂₀, A₄₀, AR or A2R) was different ($P < 0.05$) only between some of the groups, and the year kept the relations between breeds but influenced the mean values. The breed and year interaction did not affect significantly ($P > 0.05$) the clotting time, in agreement with Lenoir *et al.* (1997). The Assaf milk had lower curd firming rate (higher 0K20) and also lower values for all curd firmness parameters within the same year, even in early firming phases (A₂₀ or AR) when the differences in clotting time have a major effect on curd firmness (Pellegrini *et al.*, 1994). The milk from Saloia breed showed an intermediate interesting behaviour pattern given the good milk production level, with A₂₀ and 0K20 values close to those of Merino milk.

Together with milk hygiene and composition, the milk clotting properties are important technological parameters as they influence the later cheese making operations such as draining and ripening. It must be emphasized that poor clotting properties can mean difficulties and yield losses in cheese making as well as poor cheese quality, requiring the adoption of technological modifications for particular type of milk, like Assaf milk when compared with Portuguese traditional breeds.

IV – Conclusions

Sheep breed significantly influenced milk composition. The milk from Portuguese breeds is richer in important components for cheese making, leading to an advantageous potential cheese making yield. In this study the production year was more related to milk characteristics dependent on microbial contamination, although some effect on milk composition was also seen. The lower solids content of Assaf milk led to lower curd firmness and the milk from Merino and Saloia breeds showed superior firming rates and reach higher final curd firmness in agreement with milk composition data. The results showed clearly better coagulation properties for the milk from the two Portuguese autochthonous breeds, which agree with cheese manufacturers general opinion. Rather than an unsuitability to reach a high traditional cheese final quality, the poor clotting aptitude of the Assaf milk indicate the need of cheese making changes to substitute traditional sheep breeds.

References

- Alichanidis E. and Polychroniadou A., 1977. Special features of dairy products from ewe and goat milk from the physicochemical and organoleptic point of view. In: *Sheep Dairy News*, 14: p. 11-18.
- Alves S.M.P., Martins A.P.L., Mourato M.P., Vasconcelos M.M. and Fontes A.M.L., 2004. Effect of clotting agent on coagulation properties of sheep milk. In: *Proceedings of the International Symposium "The Future of the Sheep and Goat Dairy Sectors"*, FIL/IDF-CIHEAM, Zaragoza (Spain), 28-30 October 2004, p. 278-279.

- Alves S.M.P., Martins A.P.L., Mourato M.P., Vasconcelos M.M. and Fontes A.M.L., 2004a.** Effect of technological parameters on coagulation properties of sheep milk. In: *Proceedings of the International Symposium "The Future of the Sheep and Goat Dairy Sectors"*, FIL/IDF-CIHEAM, Zaragoza (Spain), 28-30 October 2004, p. 279-280.
- Bencini R., 2002.** Factors affecting the clotting properties of sheep milk. In: *J. Sci. Food Agric.*, 82, p. 705-719.
- Delacroix-Buchet A., Barillet F. and Lagriffoul G., 1994.** Caractérisation de l'aptitude fromagère des laits de brebis Lacaune à l'aide d'un Formagraph. In: *Lait*, 74, p.173-186.
- Lenoir J., Remeuf F. and Schneid J.-C., 1997.** Le lait de fromagerie – l'aptitude du lait à la coagulation par la présure. In: *Le fromage. De la science à l'assurance-qualité*, Eck A. and Gillis J.-C. (eds). Paris: Lavoisier, p. 229-256.
- Mahaut M., Jeantet R. and Brulé G., 2000.** *Initiation à la technologie fromagère*. Paris: Lavoisier.
- Martins A.P.L. and Vasconcelos M.M., 2003.** A qualidade do queijo fabricado com leite cru. Efeito dos principais factores tecnológicos. In: *Pastagens e Forragens*, 24/25, p. 15-33.
- McMahon D.J. and Brown R.J., 1982.** Evaluation of Formagraph for comparing rennet solutions. In: *J. Dairy Sci.*, 65, p. 1639-1642.
- Pellegrini O., Remeuf F. and Rivemale M., 1994.** Évolution des caractéristiques physico-chimiques et des paramètres de coagulation du lait de brebis collecté dans la région de Roquefort. In: *Lait*, 74, p. 425-442.
- Remeuf F., Lenoir J. and Duby C., 1989.** Étude des relations entre les caractéristiques physico-chimiques des laits de chèvre et leur aptitude à la coagulation par la présure. In: *Lait*, 69, p. 499-518.
- Rowland S.J., 1938.** The determination of nitrogen distribution. In: *J. Dairy Res.*, 2, p. 42.