



The main factors affecting somatic cell count in organic dairy farming

Inmaculada Orjales¹, Marta Lopez-Alonso², Marta Miranda¹, Ruth Rodríguez-Bermúdez², Francisco Rey-Crespo^{2,3}, and Ana Villar⁴

¹Dept. de Anatomía, Producción Animal e Ciencias Clínicas Veterinarias, Facultad de Veterinaria, Universidade de Santiago de Compostela, 27002 Lugo, Spain. ²Dept. de Patoloxía Animal, Facultad de Veterinaria, Universidade de Santiago de Compostela, 27002 Lugo, Spain. ³Centro Tecnológico Agroalimentario de Lugo (CETAL), 27003 Lugo, Spain. ⁴Centro de Investigación y Formación Agrarias (CIFA), Héroes 2 de mayo 27, 39600 Muriedas, Cantabria, Spain.

Abstract

Preventive management practices are essential for maintaining acceptable udder health status, especially in organic farming, in which the use of antimicrobials is restricted. The contribution of the following factors to somatic cell count (SCC) was assessed in 788 cows from 15 organically reared herds in northern Spain: milk production, lactation number, treatments applied, selective dry cow therapy and teat dipping routines. The data were examined by linear logistic regression. Lactation number was the main factor affecting logSCC ($\beta = 0.339$, $p < 0.001$) followed in order of importance by milk production ($\beta = -0.205$, $p < 0.001$), use of alternative treatments ($\beta = 0.153$, $p < 0.001$), selective dry cow therapy ($\beta = 0.120$, $p = 0.005$) and teat dipping routines ($\beta = -0.076$, $p = 0.028$). However, the model only explained 17.0% of the total variation in SCC. This variable depends on factors other than those considered here, amongst which udder infection is probably one of the most important. Nonetheless, the study findings enabled us to determine the contribution of the main management factors that should be taken into account to improve udder health status on organic farms.

Additional keywords: management factors; udder health; organic; dairy production; SSC.

Abbreviations used: DTR (dairy test-day records); SCC (somatic cell count).

Authors' contributions: Designed the experiments: MM and MLA. Performed the experiments: IO, RRB and FRC. Analyzed the data: IO, AV and MLA. Wrote the paper: IO.

Citation: Orjales, I.; López-Alonso, M.; Miranda, M.; Rodríguez-Bermúdez, R.; Rey-Crespo, F.; Villar, A. (2017). Short communication: The main factors affecting somatic cell count in organic dairy farming. Spanish Journal of Agricultural Research, Volume 15, Issue 4, e06SC02. <https://doi.org/10.5424/sjar/2017154-11769>

Received: 24 May 2017. **Accepted:** 21 Nov 2017.

Copyright © 2017 INIA. This is an open access article distributed under the terms of the Creative Commons Attribution (CC-by) Spain 3.0 License.

Funding: Spanish Government (AGL2010-21026); Centro Tecnológico Agroalimentario de Lugo, Spain (CETAL); IO is in receipt of a FPU fellowship (Ref. FPU14/01473) from the Spanish Ministry of Education, Culture and Sports.

Competing interests: The authors have declared that they have no competing interests.

Correspondence should be addressed to Inmaculada Orjales Galdo: inmaculada.orjales@usc.es

Introduction

Mastitis is the most frequent and costly disease for dairy producers, both in conventional and organic systems, resulting in lower milk production and poorer milk quality due to increased somatic cell count (SCC) and blood components (Roesch *et al.*, 2007). Mastitis management, particularly antimicrobial use, differs greatly in organic and conventional farming mainly as a result of the organic principles (IFOAM, 2005; EC, 2007). Thus, while udder health management is well standardized in conventional farming, and blanket dry-cow therapy and teat dipping are the mainstay of any mastitis control programme (NMC, 2006), the restrictions on the use of antibiotics to treat clinical mastitis and the explicit prohibition of blanket dry-

cow therapy in organic farming make preventive management practices essential in order to maintain udder health (Cicconi-Hogan *et al.*, 2013). In fact without hygiene or without an adequate maintenance of milking machine, antibiotic dry therapy and teat dipping are insufficient measures to prevent mammary infections and to achieve low SCC. Recent studies in northern Spain have indicated higher SCC in organically reared herds than in conventionally reared herds (Villar & López-alonso, 2015; Orjales *et al.*, 2016). This is mainly associated with a higher prevalence of chronic subclinical mastitis in organic herds (Villar *et al.*, 2016), although the higher SCC may be partly explained by the higher number of parturitions and the lower production rates on organic farms.

The aim of this study was to consider how different management-related factors (use of antibiotic, selective-dry cow therapy and teat dipping) contribute to the SCC on organic dairy farms in northern Spain in order to improve udder health management.

Material and methods

All organic dairy farms in northern Spain enrolled in the Dairy Test-day Records (DTR) system were invited to participate in this study, and 15 of the 28 farms accepted the invitation. Briefly, farms had a mean of 55 lactating cows and the predominant breed was Holstein Friesian (>85%). The mean of lactations was 3.23, the mean of 305-d milk production was 6720 kg and geometric mean of logSCC was 5.04.

Somatic cell count and milk production (obtained from monthly DTRs) were determined in a total of 788 cows during one complete lactation period. All farms were visited and farmers were administered a questionnaire including questions on each of the following themes: lactation number, milking and other routine procedures and mastitis treatment for all individual cows included in the study.

All statistical analyses were implemented using SPSS for Windows (V.20.0). The SCC was transformed to base-10 logarithmic scale before statistical analysis. The geometric mean of all control values (10 values per animal) was calculated for each cow to produce a representative SCC value per lactation period. Multivariate linear regression analysis was applied using a step-wise method. LogSCC was introduced as a dependent variable. Regarding the predictor variables, number of parturitions (from 1st to 12th) and standardized 305d milk production (from 2684 to 15494 kg) were included as continuous variables. The use of alternative (mainly phytotherapy and homeopathy) or antibiotic treatments (conventional treatments=0, alternative treatments=1), teat dipping (no=0, yes=1) and selective-

dry cow therapy (no=0, yes=1) were considered dichotomous variables. All variables were collected at individual level. For comparisons, differences were considered significant at $p \leq 0.05$.

The general form of the linear model used for the total herd model was as follows:

$$\text{LogSCC} = \beta_0 + \beta_1 \text{ lactation number} + \beta_2 \text{ milk production} + \beta_k X_k + \varepsilon,$$

where β_0 = intercept term, β_i = regression coefficient, X_k = predictor variable, and ε = error term.

Both B coefficients (unstandardized) and β coefficients (standardized) were calculated. Standard coefficients ignore the independent variable's scale of units (because the variances of dependent and independent variables are 1), which makes possible comparisons between variables.

Results and discussion

Results of the linear regression used to evaluate how udder health management (use of antibiotic treatments, selective-dry cow therapy and teat dipping) as well as lactation number and milk production affect logSCC in organic dairy farming are shown in Table 1. Although all of these factors were significant in the analysis ($p < 0.05$), the model only explained 17.0% of the total variation in logSCC on the organic dairy farms under study. The low variance explained by the statistical model is due to the fact that there are several main factors influencing SCC variation that have not been collected. Thus, cow milking order (in function of SCC), milking machine maintenance, herd size, chronic mastitis culling, staphylococcal vaccination, and infection status are also important factors influencing SCC variation. In fact, udder infection is generally the main factor affecting SCC, which is routinely used as a marker of udder health. The SCC increases greatly (up to 50

Table 1. Summarized data of the multivariate linear regression model.

	Unstandardized coefficients		Standardized coefficients	t	p
	B	SE	β		
Intercept term	5.289	0.093	-	57.118	<0.001
Number of lactations	0.075	0.007	0.339	10.061	<0.001
Milk production	-6.9 · 10 ⁻⁵	0.000	-0.205	-6.223	<0.001
Treatments used	0.210	0.053	0.153	3.952	<0.001
Dry cow therapy	0.119	0.039	0.120	3.044	0.005
Teat dipping	-0.114	0.051	-0.076	-2.234	0.028

Dependent variable: log SCC

times) in acute clinical mastitis in which macroscopic changes of milk also are evident. When no macroscopic milk alterations are visible, SCC values $> 200,000$ are highly suggestive of subclinical infection, and the SCC thus represents an essential tool for identifying affected animals (Ruegg & Reinemann, 2002). Pathogens were not isolated in this study, but previous research in organic dairy farming in northern Spain has indicated that the presence and the type of pathogen are the main factors affecting foremilk SCC and are responsible for 70% of the variation explained by the model (Villar *et al.*, 2016). Although management factors were not included in the aforementioned study, lactation number and stage of lactation were significant and explained 18 and 8 % of the total variability respectively.

Lactation number was the main factor positively affecting (increasing) logSCC (β standardized coefficient= 0.339, $p<0.001$). The SCC increased progressively with lactation number from a mean logSCC value of 4.85 (first lactation) to 5.35 (≥ 7 lactations) (Fig. 1). The SCC has been reported to increase significantly with lactation number on organic dairy farms in northern Spain, particularly farms on which antibiotic therapy is not used (Orjales *et al.*, 2016) and has been related to chronic infection after several lactation periods (Villar & López-Alonso, 2015).

It is also generally agreed that SCC increases with lactation number on conventional dairy farms (Busato *et al.*, 2000; Hardeng & Edge, 2001), although the increase is higher in the organic dairy sector. Hardeng & Edge (2001) found that SCC was statistically significant lower in cows in organic herds during the first two lactations, higher counts that in conventional herds were observed in cows that had completed six lactations. Moreover, as organic cows usually remain on the farm for longer than conventionally-reared cows, milk from old cows has a greater influence on bulk tank SCC (Reneau, 1986; Busato *et al.*, 2000).

Milk production was the second most important factor in the model ($\beta = -0.205$, $p<0.001$). Overall, SCC decreased as mean milk yield increased (Fig. 1): mean logSCCs were higher (5.34) in cows with low milk yields (<4000 litres/305d lactation) and increased at the highest level of production (logSCC generally <5 for milk yields ≥ 7000 litres/305d lactation). Increased milk production on farms has been associated with a slight decrease in the SCC due to a dilution effect (Green *et al.*, 2006), although the effect was weak. Organic farms are low-input systems based on grazing with a low level of concentrate intake that leads to lower levels of milk production than on conventional farms. On the other hand, this situation could also be associated to the effect

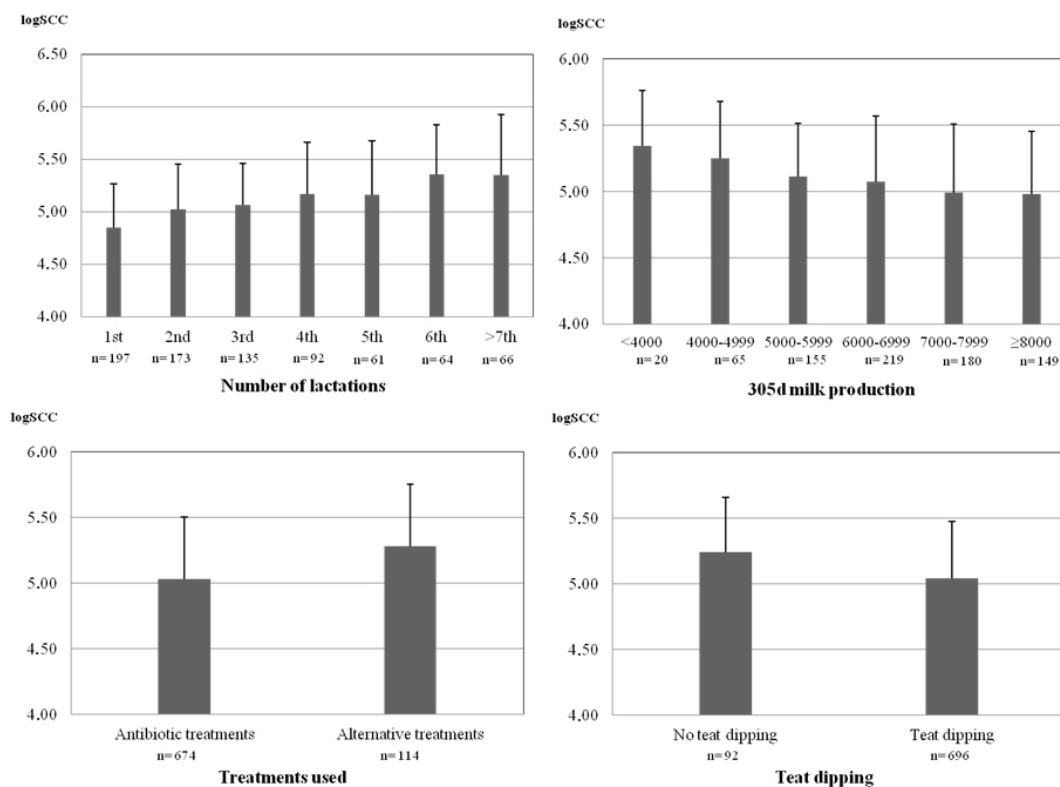


Figure 1. Effect of lactation number, milk production (305d milk production), treatments used and udder hygiene procedures (teat dipping) on logSCC in organic farms.

that subclinical mastitis (with the consequently higher SCC) has on milk production.

All of the management-related factors considered in the present study had a significant effect on SCC. The use of alternative treatments increased the SCC and was the third most important factor in the model ($\beta=0.153$, $p<0.001$). This indicates that udder health status is poorer on farms that use alternative therapies (mean $\log\text{SCC}=5.28$) than on farms that use antibiotic therapies (mean $\log\text{SCC}=5.03$; Fig. 1). Previous studies in Spain have indicated poorer udder health status on organic farms that favour the use of alternative therapies over use of antibiotics, especially in older cows (Orjales *et al.*, 2016); indeed, the same study concluded that although organic farming aims to reduce the use of antibiotics, treatment must be used in older cows to maintain udder health status. As already mentioned, older cows on organic farms are at a greater risk of suffering chronic subclinical mastitis, which is very difficult to control unless antibiotic therapy is used. Indeed, dry cow therapy is one of the most effective measures used in conventional farming to control mastitis (Cicconi-Hogan *et al.*, 2013), and blanket dry cow therapy is routinely used. It may seem paradoxical that dry cow therapy had a positive effect ($\beta=0.120$, $p=0.005$) on increasing the SCC in the present study. However, only selective dry cow therapy is allowed in organic farming, so that antimicrobial treatment at the end of the lactation can only be used after assessment of the infection status of the cow. Thus, far from indicating a negative effect of dry-cow therapy on udder health, the positive association between selective dry-cow therapy and SCC is a consequence of the selective use of this antimicrobial treatment only in cows with a high SCC during lactation, which are generally those cows with a high lactation number.

Finally, the study findings indicate that udder hygiene at milking is an important factor in udder management. Routine use of teat dipping was negatively associated (decrease) with $\log\text{SCC}$ ($\beta=-0.076$, $p=0.028$). Thus mean $\log\text{SCC}$ was lower on farms that routinely used teat dipping (5.04) than on farms where this practice was not routinely performed (5.24, Fig. 1). Teat dipping is considered an effective method of reducing subclinical mastitis (Erskine & Eberhart, 1991), but it is not equally efficient against all bacteria (Pankey *et al.*, 1984; Smith & Hogan, 1993). It is more effective in preventing infection by contagious pathogens than infection by environmental streptococci (Hogan *et al.*, 1989). As contagious pathogens are usually more important than environmental pathogens in organic dairy farming (because of the prohibition of use of blanket dry

cow therapy; Villar *et al.*, 2016), teat dipping may represent an effective means of control.

In summary, as antibiotic treatments are highly restricted in organic dairy farming, prevention becomes essential to control udder infection. This study enabled us to analyze the main management factors that should be considered to improve the udder health status on organic farms: 1) elimination of older cows with high SCC; 2) use of antibiotic treatments at least in cows with high SCC indicating clinical mastitis; and 3) establishment of an appropriate milking routine including teat dipping.

Acknowledgements

The authors thank all farmers who participated in the study.

References

- Busato A, Trachsel P, Schallibaum M, Blum JW, 2000. Udder health and risk factors for subclinical mastitis in organic dairy farms in Switzerland. *Prev Vet Med* 44: 205-220. [https://doi.org/10.1016/S0167-5877\(00\)00104-5](https://doi.org/10.1016/S0167-5877(00)00104-5)
- Cicconi-Hogan KM, Gamroth M, Richert R, Ruegg PL, Stiglbauer KE, Schukken YH, 2013. Associations of risk factors with somatic cell count in bulk tank milk on organic and conventional dairy farms in the United States. *J Dairy Sci* 96: 3689-3702. <https://doi.org/10.3168/jds.2012-6271>
- EC, 2007. Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91. 28 of June 2007. <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32007R0834>
- Erskine RJ, Eberhart RJ, 1991. Post-milking teat dip use in dairy herds with high or low somatic cell counts. *J Am Vet Med Assoc* 199: 1734-1736.
- Green MJ, Bradley AJ, Newton H, Browne WJ, 2006. Seasonal variation of bulk milk somatic cell counts in UK dairy herds: Investigations of the summer rise. *Prev Vet Med* 74: 293-308. <https://doi.org/10.1016/j.prevetmed.2005.12.005>
- Hardeng F, Edge VL, 2001. Mastitis, ketosis, and milk fever in 31 organic and 93 conventional Norwegian dairy herds. *J Dairy Sci* 84: 2673-2679. [https://doi.org/10.3168/jds.S0022-0302\(01\)74721-2](https://doi.org/10.3168/jds.S0022-0302(01)74721-2)
- Hogan JS, Smith KL, Hoblet KH, Schoenberger PS, Todhunter D, Hueston WD, Pritchard DE, Bowman GL, Heider LE, Brockett BL, Conrad HR, 1989. Field survey of clinical mastitis in low somatic cell count herds. *J Dairy Sci* 72: 1547-1556. [https://doi.org/10.3168/jds.S0022-0302\(89\)79266-3](https://doi.org/10.3168/jds.S0022-0302(89)79266-3)

- IFOAM, 2005. The IFOAM basic standards for organic production and processing. International Federation of Organic Agricultural Movements, Germany.
- NMC, 2006. Dry cow therapy. National Mastitis Council, USA. <http://nmconline.org/drycow.htm>
- Orjales I, López-Alonso M, Rodríguez-Bermúdez R, Rey-Crespo F, Villar A, Miranda M, 2016. Is lack of antibiotic usage affecting udder health status of organic dairy cattle? *J Dairy Res* 83: 464-467. <https://doi.org/10.1017/S0022029916000601>
- Pankey JW, Eberhart RJ, Cuming AL, Daggett RD, Farnsworth RJ, McDuff CK, 1984. Uptake on postmilking teat antisepsis. *J Dairy Sci* 67: 1336-1353. [https://doi.org/10.3168/jds.S0022-0302\(84\)81443-5](https://doi.org/10.3168/jds.S0022-0302(84)81443-5)
- Reneau JK, 1986. Effective use of dairy herd improvement somatic cell counts in mastitis control. *J Dairy Sci* 69: 1708-1720. [https://doi.org/10.3168/jds.S0022-0302\(86\)80590-2](https://doi.org/10.3168/jds.S0022-0302(86)80590-2)
- Roesch M, Doherr MG, Scharen W, Schallibaum M, Blum JW, 2007. Subclinical mastitis in dairy cows in Swiss organic and conventional production systems. *J Dairy Res* 74: 86-92. <https://doi.org/10.1017/S002202990600210X>
- Ruegg PL, Reinemann DJ, 2002. Milk quality and mastitis test. *Bovine Practitioner* 36: 41-54.
- Smith K, Hogan JS, 1993. Environmental mastitis. *Vet Clin North Am Food Anim Pract* 9: 489-498. [https://doi.org/10.1016/S0749-0720\(15\)30616-2](https://doi.org/10.1016/S0749-0720(15)30616-2)
- Villar A, López-Alonso M, 2015. Udder health in organic dairy cattle in Northern Spain. *Span J Agric Res* 13 (3): e0503. <https://doi.org/10.5424/sjar/2015133-6610>
- Villar A, Gradillas G, Fernández-Ruiz C, Rodríguez-Bermúdez R, Alonso ML, 2016. Dynamics of mammary infections in organic dairy farms in Northern Spain. *Span J Agric Res* 14 (2): e0502. <https://doi.org/10.5424/sjar/2016142-7626>