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RESEARCH ARTICLE

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Udder health in organic dairy cattle in Northern Spain

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Abstract

This paper presents first data on the udder health status of organic dairy farms in Northern Spain and analyses some management and productive characteristics related to milk production comparing with the conventional sector. Five certified organic farms from the Cantabrian Region were monitored monthly from February 2006 to January 2008 and individual samples of all lactating cows were taken from parturition to the end of lactation. Although organic farms in our study showed a great individual variability, overall these were small (<50 lactating cows) traditional farms, with a high degree of pasture (66-82% dry matter intake) and a milk production (average milk yield: 5950 L) 23% lower compared with the reference conventional sector (<50 cow farms). The organic farms had higher (p<0.05) average number of calves per cow (3.93) and a lower number of first-lactation cows (16.9%) than the comparable conventional farms (2.47 calves per cow and 33.1% first-lactation cows). Organic farms showed higher (p<0.05) somatic cell counts (SCC) than the reference conventional farms (mean $\log_{10}$±SD for all cows: 5.25±0.49 and 5.06±0.59, respectively). Detailed analysis of the SCC depending on the number of lactation and % of monthly SCC tests with linear scores indicative of udder infection suggest that while the heifers' sanitary condition at the beginning of their productive cycle was similar in both types of farms, this seems to become worse along the productive cycle in the organics. This could be related to a low use of antibiotics for prophylaxis and treatment of udder infections and merits further investigation.

Additional key words: somatic cell count; mastitis; homeopathic treatments.

Abbreviations used: DCR (Dairy Control Record); DMI (Dry Matter Intake); LS (Linear Score); SCC (Somatic Cell Count).

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Introduction

Organic farming promotes a combination of providing good-quality feedstuffs, no use of chemical products, appropriate livestock husbandry systems and correct management practices to deal with the principles of health, ecology, fairness and care (IFOAM, 2014).

However, it seems that the standards associated with organic farming cannot *per se* to ensure either higher levels of animal health and welfare or safe livestock food products (Vaarst *et al*., 2006; Fall *et al*., 2008). European organic producers are subject to EC (2008) regulation but there is a lack of uniformity of standards because countries differ in characteristics such as climate, availability of resources, herd structures, economic conditions and disease prevalence, cultural differences in the perception of problems and expertise to deal with them (Vaarst *et al*., 2006). This makes that development in organic farming practice has to be set — and consequently their results to be analysed — in a national, regional or even local context. For example, the analysis of the udder health, the main sanitary problem in dairy cattle both in conventional and organic systems, shows highly variable results depending on the study (Fall *et al*., 2008; Haskell *et al*., 2009; Sundberg *et al*., 2009). EC (2008) regulation has a main focus on animal health and welfare based on the prevention of disease through regular exercise, access to the open air and grasslands, the maintenance of appropriate stocking densities, and the careful control of hygiene in animal housing. However, the restrictions on the use of antibiotics for the treatment of clinical mastitis as well as the explicit prohibition of blanket dry-cow therapy (the mainstay of any mastitis control program in conventional farming) in favor of alternative therapies as homeopathy can difficult the mastitis control.

Organic cow milk production in Spain is small but growing fast in recent years due to high consumer demand. Most organic milk production (78%) is located in Northern Spain, where organic dairy farms come from non-technological and unprofitable conventional farms where organic production was perceived as a way to increase the value of their product without increasing the herd size. The nutritional management of these organic dairy farms based on pasture, is clearly different from most of the conventional farms in the area (note that the Spanish dairy sector is one of the more intensive worldwide; ICAR, 2009; EUROSTAT, 2012). This, together with the own organic restrictions for the mastitis control could determine differences in the sanitary quality of milk and the dynamics of mammary disease in the organic herds compared with the conventional ones. Whereas occasional studies on mammary infections in conventional farms have been conducted in the area (Pérez-Cabal *et al*., 2008) no data are available for the dairy organic sector. This paper presents what we believe to be the first data on the udder health status of organic dairy farms in Spain. The paper also analyses (i) some management and productive characteristics related to milk production of the farms and compares them with data available for the conventional sector and (ii) the effect of type of treatment (homeopathic *vs* homeopathic combined with conventional) on the somatic cell count (SCC) in the studied organic farms.

Material and methods

Data on which this paper is based were collected within a research project to evaluate the dynamics of mammary infection on organic dairy cattle in the Region of Cantabria, Northern Spain. Five certified organic farms from the Cantabrian Region were recruited for this study. They were selected from the whole population (n=17) on the basis of being representative of the sector (size, Holstein-Friesian breed, feeding and management practices, etc.), being in the organic system for more than 2 years and agreeing to participate in the study. Table 1 summarizes general information of these farms. Overall all the farms were small (<50 cows in lactation), practiced grazing with a low concentrate intake and used homeopathic treatments to some degree.

The farms were monitored monthly from February 2006 to January 2008. During each monthly visit, single-quarter foremilk and cow composite milk samples were collected from all lactating cows, even though for this paper only data of cow composite milk samples during the first complete lactation after the beginning of the project for each cow were considered. Before milk collection, the teat ends were cleaned by the farmers in their usual manner; then they were disinfected by a technician with cotton swabs soaked in 70% ethanol and the single-quarter foremilk samples collected. Afterwards, each cow was completely milked and a composite milk sample was taken. SCC was performed in all the collected samples at the Dairy Interprofessional Laboratory (Guarnizo, Cantabria) using a MilkoScan FC 6000 apparatus.

Information of the veterinary treatments during the study was recorded (Table 2). Farm #1 and farm #4 used nearly exclusively homeopathy (>97%); on the contrary the use of homeopathy was lower in farm #2 (60%) and farm #3 (63.3%), or at least combined with antibiotics for mastitis control (farm #5). In all the farms the homeopathic treatments were set up by the same homeopathic specialist veterinarian, except in farm#3, although in all cases the Repertory of the Ho-

Table 1. Details of the organic farms in our study

Variable	Farm				
	1	2	3	4	5
Number of cows	47	19	21	31	20
Type of farm	Old tie stall barn	Old tie stall barn	Free-stall barn	Old tie stall barn	Old tie stall barn
Milked in a parlour	Yes	No	Yes	Yes	No
Belongs to DCR [1]	No	No	Yes	Yes	Yes
Teat dipping after milking	No	No [2]	No [2]	No	No
Blanket or selective antibiotic dry cow therapy [3]	No	No	No [3]	No	No
Forage intake (% total DMI) [4]	75.8±13.7	80.6±4.8	66.1±5.0	82±2.5	67.4±3.6
Grazing time (hours/day) [5]	10±7.1	7.6 ±4.5	13.8±9.0	5.0 ±5.7	18.3 ±7.8

(1) DCR: dairy control records. (2) Only for a short period of time. (3) One conventional dry treatment against *Staphylococcus aureus*. (4) DMI: dry matter intake. (5) Annual average (mean ± SD).

Table 2. Veterinary treatments by farm during the study (2 years) expressed in number and percentage over the total (in brackets)

	Farm				
	1	**2**	**3**	**4**	**5**
Homeopathic treatments	63 (96.9%)	3 (60.0%)	19 (63.3%)	88 (98.9%)	45 (84.9%)
Intramammary	0	0	1	0	9
Parenteral	0	0	0	0	0
Oral	63	3	18	88	36
Conventional treatments	2 (3.1%)	2 (40.0%)	11 (36.7%)	1 (1.1%)	8 (15.1%)
Intramammary	0	1	10	0	8
Parenteral	0	1	1	0	0
Oral	2	0	0	1	0
Total	65	5	30	89	53
Herd homeopathic treatments in drinking water	16	9	4	4	3

meopathic Materia Medica (Kent, 2015) was followed. Mastitis was treated by using Nosodes and other homeopathic remedies (mainly *Phytolaca, Pulsatilla pratensis, Phosphorus, Lycopodium clavatum* and *Calcarea carbonica*). In relation to antibiotics, no dry-cow therapy was used in any farm — the only exception being a cow suffering from a severe mastitis by *Staphylococcus aureus* in farm #3 treated with Mamyzin ® dry-off (Table 1) — although 1, 10 and 8 clinical mastitis treatments (mainly cephalosporin and penicillin-streptomycin) were registered during lactation in farms #2, #3 and #5, respectively.

Data of conventional dairy farms in the region for comparison was provided by the Dairy Control Records (DCR). Approximately 51% of the conventional farms belonged to the DCR representing 80-85% of the milk production (AFCA, 2007). Conventional farms were divided in two segments since the Association of Friesian in Cantabria (AFCA) traditionally classifies the farms according to small traditional (<50), and more technological farms (≥50 lactation cows).

Statistical analysis was performed using SPSS v 20.0. SCC was transformed to base-10 logarithmic scale prior to statistical analyses. Linear scores (LS) to establish the threshold for udder health (Reneau, 1986) were calculated using the formula: LS=((LN(SCC/100,000))/0.693147)+3; LS<5 (283,000 cell/mL) was indicative of udder health; between 5 and 6 of subclinical mastitis; and >6 (1,131,000 cell/mL) of clinical mastitis. Differences between organic and conventional farm SCC and other productive variables were tested by using one-way variance analysis and post-hoc using HSD Tukey test. The influence of the mastitis treatments (homeopathic *vs* homeopathic and conventional) and the number of lactation (1, 2, 3 and >3) on the SCC was analyzed by using a repeated measures analysis.

Results

Table 3 shows the productive characteristics of organic farms in our study and the conventional dairy sector in Northern Spain. Overall, the organic farms show a great variability among them, with farms such as farm #2 having the highest replacement rate (24.9%) and the lower milk production (3800 L/lactation) and concentrate intake (2.37 kg/animal/day; Table 1), whereas farm #5 shows a very low replacement rate (9.5%) and the highest milk production (6950 L/lactation) and concentrate intake (4.98 kg/animal/day). When compared with the conventional sector, the organic farms in our study had an average number of calves/cow (3.93) statistically significantly higher than the conventional farms (2.47 and 2.70 for farms with < 50 and ≥ 50 cows in lactation respectively) and a statistically significant lower first-lactation cows compared with conventional (16.9, 33.1 and 37.5%, respectively). Milk production in the organic farms in our study was 23% and 42% lower when compared with the reference (<50 cows) and larger (≥50) conventional sector in Cantabria.

Table 4 shows the SCC in organic farms in our study and the conventional dairy sector. Overall, and for all cows, SCC was statistically significantly (p<0.05) higher in organic farms compared with conventional ones. When analyzing the data by groups of age, for primiparous cows no statistically significant differences were observed between organic and conventional farms. As expected, SCC increased with number of lactations, in all cases being statistically higher (p<0.05) in organic farms compared with small (<50) and large (≥50 cows) conventional farms. In general the higher increase was observed during the second lactation (70, 41 and 29% for organic, small and large conventional respectively; calculated from SCC geometric means) and quite

Table 3. Comparison of productive variables among the organic farms in this study and the conventional reference population

	Organic farms						Conventional farms †	
	1	2	3	4	5	Mean	<50 cows (n=378)	≥ 50 cows (n=158)
No. of calves per cow								
Mean ±SD	4.78±2.53^{a}	2.26±1.14^{d}	3.04±1.75^{c}	3.87±2.04^{b}	4.31±1.75^{b}	3.93±2.52^{A}	2.47±1.64^{C}	2.70±1.78^{B}
Range	(1-11)	(1-6)	(1-6)	(1-9)	(1-8)	(1-11)	(1-14)	(1-13)
First-lactation cows (%)	14.8	24.9	19.6	15.5	9.5	16.9^{C}	33.1^{B}	37.5^{A}
Average 305 d milk yield (L) ‡	6100	3800	6600	6300	6950	5950^{C}	7718^{B}	10200^{A}

† Records obtained from the Friesian Association of Cantabria. ‡ For farms #1 and #2 estimated average value since they did not belong to the DCR. Different superscript lowercase letters in the same row indicate statistically significantly differences between the organic farms, whereas different superscript uppercase letters indicate statistically significantly differences between the mean of the organic and the conventional farms.

Table 4. Comparison of somatic cell count (SCC) and % monthly SCC samples with different linear scores (LS) between the organic farms in this study and the conventional reference population

	Organic farms						Conventional farms†	
	1	2	3	4	5	Mean	< 50 cows (n=378)	≥ 50 cows (n=158)
SCC (mean log_{10}±SD)								
All cows	5.28± 0.45^{a}	5.06± 0.57^{b}	5.13± 0.51^{b}	5.30± 0.49^{a}	5.30± 0.45^{a}	5.25±0.49^{A}	5.06±0.59^{B}	5.01±0.57^{C}
Primiparous heifer	5.06± 0.50^{ab}	4.84± 0.52^{b}	4.84± 0.45^{b}	5.34± 0.37^{a}	4.97± 0.58^{ab}	4.96±0.51	4.89±0.54	4.88±0.52
Cows 2 lactation	5.25± 0.42^{ab}	5.16± 0.64^{ab}	5.07± 0.43^{b}	5.36± 0.33^{a}	5.25± 0.28^{ab}	5.19±0.47^{A}	5.04±0.57^{B}	4.99±0.55^{C}
Cows 3 lactation	5.24± 0.39^{ab}	5.02± 0.47^{ab}	5.05± 0.49^{b}	5.24± 0.51^{ab}	5.41± 0.44^{a}	5.26±0.47^{A}	5.11±0.59^{B}	5.07±0.57^{C}
Cows > 3 lactation	5.29± 0.43^{a}	5.43± 0.23^{a}	5.46± 0.5^{a}	5.41± 0.54^{a}	5.29± 0.45^{a}	5.33±0.47^{A}	5.21±0.60^{B}	5.17±0.60^{C}
LS (% monthly SCC test)								
<5	69.8^{ab}	72.5^{a}	70.7^{ab}	62.0^{b}	64.2^{ab}	67.7^{C}	76.7^{B}	80.0^{A}
5-6	24.7	23.3	26.3	30.3	30.0	26.8^{A}	17.1^{B}	14.5^{C}
>6	5.5^{ab}	4.2^{ab}	3.0^{b}	7.7^{a}	5.8^{ab}	5.5^{AB}	6.2^{A}	5.5^{B}

† Records obtained from the Friesian Association of Cantabria. Different superscript lowercase letters in the same row indicate statistically significantly differences between the organic farms, whereas different superscript uppercase letters indicate statistically significantly differences between the mean of the organic and the conventional farms.

constant (~20%) for the other cases. In addition, for all the animals the proportion of milk samples with low LSs (<5), threshold for mastitis control applications according to Reneau (1986), was significantly lower (p<0.05) in organic (67.7%) compared with small (76.7%) and large (80.0%) conventional farms; the higher differences between organic and conventional farms were found for LSs between 5-6 (26.8, 17.1 and 14.5% for organic, small and large conventional farms, respectively) whereas no statistically significant differences between organic and conventional farms were found for animals with LS >6 (5.5, 6.2 and 5.5%, respectively). When the proportion of milk samples within different LSs were detailed analyzed by number of parturition (Fig. 1) it was observed that there were not differences (p>0.05) between the organic and the reference conventional herd (< 50 cows) for primiparous cows. Afterwards the proportion of samples with LSs indicative of subclinical udder disease increased and statistically differed between groups (organic>small conventional>large conventional). No statistical significant differences were observed between organic and conventional farms for LS indicating clinical mastitis.

For the organic cows, an analysis of repeated measures along the lactation, with type of treatment as main factor (homeopathic: farms #1 and #4 or homeopathic and conventional: farms #2, #3 and #5) and number of lactation as covariate, was used to evaluate their effect on

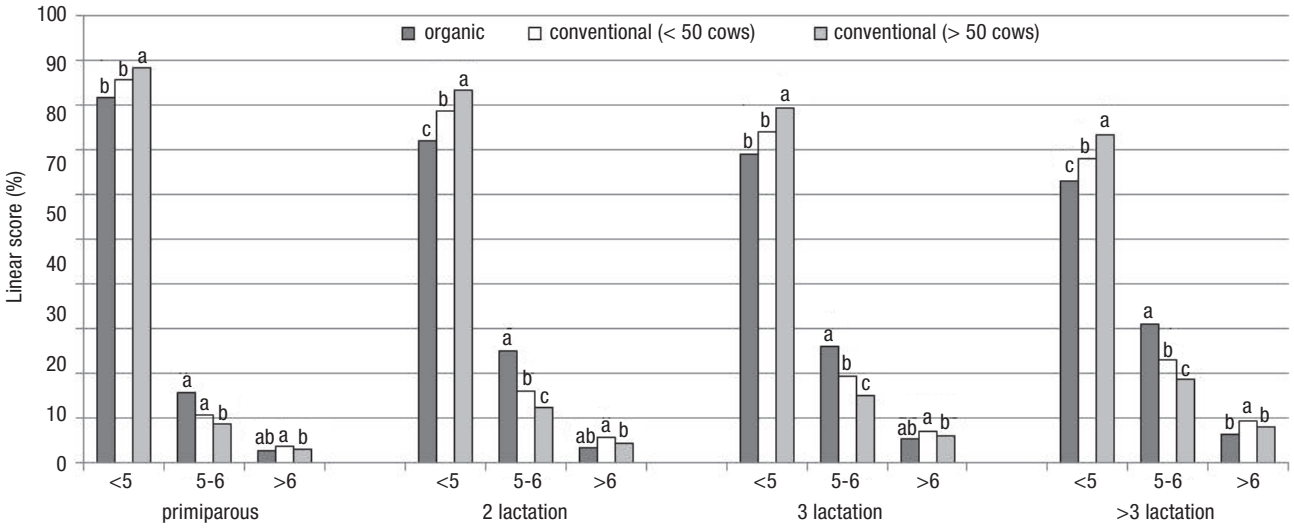

Figure 1. Comparison of percentage of monthly samples with different linear scores between organic and conventional farms considering the number of parturitions. Different letters indicate statistically significantly differences (p<0.05) between the different types of farms.

SCC. As expected, SCC significantly varied along the lactation ($F_{5.25, 567}$=7.930, p<0.001) showing an increase at the end of the lactation and tended to increase with the number of lactation ($F_{6,108}$=2.130, p=0.055) (Figs. 2 and 3). In addition, significant differences ($F_{1,108}$=7.320, p=0.008) were observed between cows from farms that treated mastitis nearly exclusively with homeopathy and those that combine homeopathy with antibiotics (Fig. 3).

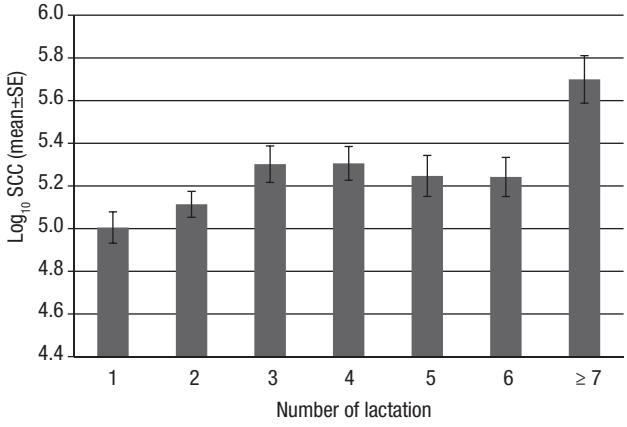

Figure 2. Somatic cell counts (SCC) in the five organic farms studied depending on the number of lactation.

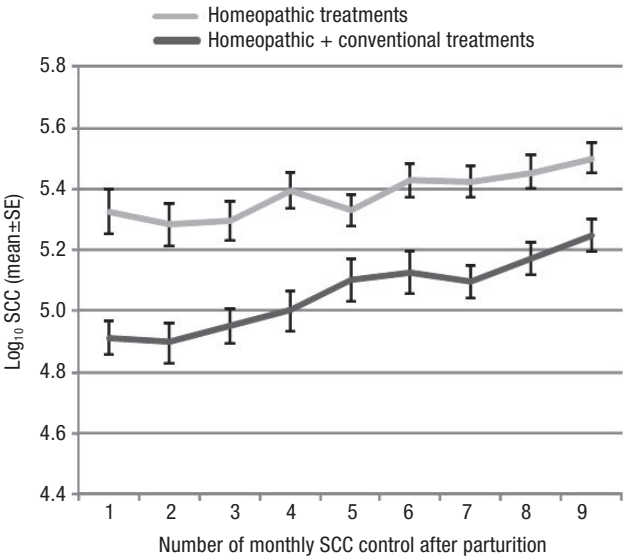

Figure 3. Evolution of the monthly SCC controls along the lactation in organic dairy cows receiving homeopathic or homeopathic+conventional treatments.

Discussion

The analysis of organic dairy farming in Northern Spain in comparison with the conventional sector in the region, and with the literature, indicates that despite the lack of uniformity of organic systems (Vaarst *et al*., 2006) there is a general agreement that milk production in organic farms is lower compared to conventional. Overall, differences between both systems seem to be related to the degree of intensification of the conventional sector, largely depending on the country; so differences can be large (~ 30%) in countries as USA (Zwald *et al*., 2004) or the Netherlands (Bloksma *et al*., 2008) with a high milk production by cow and small (~ 10%) in others, like Switzerland, (Mosimann & Suter, 2003) with a lower milk production (ICAR, 2009; EUROESTAT, 2012). The main reason for the lower production in organic farms is the lower level of

concentrate intake compared to conventional (Busato *et al*., 2000; Hardeng & Edge, 2001; Zwald *et al*., 2004; Hamilton *et al*., 2006). The monitoring of feeding management of organic farms in Cantabria (Villar *et al*., 2011) revealed that total DMI was ~ 21% lower than in conventional extensive farms and 33% lower than in intensive. Organic farms usually have a lower replacement rate compared to their conventional counterparties (Rozzi *et al*., 2007; Sundberg *et al*., 2009) which is a consequence of the lower productive pressure compared to conventional as well as the way of understanding the organic production, including ethical reasons and harnessing resource use.

Numerous studies have compared the SCC in organic and conventional farms worldwide, however no consensus has been found. Even though some studies indicate a lower SCC in organic dairy farms (Busato *et al*., 2000; Hamilton *et al*., 2006), most of them found the opposite (Hovi & Roderick, 2000; Zwald *et al*., 2004; Roesch *et al*., 2007; Rozzi *et al*., 2007; Sundberg *et al*., 2009) or very little difference between both production systems (Hardeng & Edge, 2001; Vaarst *et al*., 2006; Fall *et al*., 2008; Haskell *et al*., 2009). When SCC was higher in organic farms, this seemed to be associated to a higher prevalence of subclinical mastitis (Busato *et al*., 2000; Hovi & Roderick, 2000; Zwald *et al*., 2004; Roesch *et al*., 2007). Our results indicate that while the heifers' sanitary condition at the beginning of their productive cycle was similar in the organic and conventional farms, it seems to worsen during the productive cycle in the organics. This could be associated with a greater incidence of subclinical mastitis in the organic herd. The main reason of the high incidence of subclinical mastitis in organic farming seems to be the restrictions in the use of antibiotics for prophylaxis and treatment of udder infections (Busato *et al*., 2000; Zwald *et al*., 2004). However, it is also well assumed that factors like husbandry, management, genetics, and nutrition and associated metabolic and endocrine changes have some influence on the SCC. In this sense, the higher SCC of the organic farms could be explained in part by their lower milk production compared to the conventional ones. It is well known that SCC increases throughout lactation as milk yield decreases (Rozzi *et al*., 2007) and that in healthy cows the shape of the SCC curve is inversely related to the shape of the milk production curve, which indicates a dilution effect (Schepers *et al*., 1997). There is also a general consensus that SCC increase with lactation number both in organic and conventional dairy farms (Busato *et al*., 2000; Hardeng & Edge, 2001), while this increase could be higher for the organic sector. In this sense, Hardeng & Edge (2001) found that while cows in organic herds had statistically significant lower SCC in the two first lactations, greater counts were observed in lactations six and higher compared to conventional. As indicated, organic cows stay for more lactations at the farm, this factor possibly contributing to the higher SCC in the organic systems. So, differences in the udder health between organic and conventional herds are not necessarily only due to a direct effect of the organic management, and many other differences in management routines may exist between organic and conventional farms besides the "purely" organic and these differences might differ between studies (Fall *et al*., 2008). In fact, in studies conducted in identical experimental conditions no differences were observed between subclinical mastitis in organic and conventional managed herds (López Villalobos *et al*., 2003; Fall *et al*., 2008).

In our study, the reduction of antibiotics for prophylaxis and treatment of udder infections showed a significant effect on the SCC. Once again, there is no agreement in the scientific literature: while some authors (Zwald *et al*., 2004; Vaarst *et al*. 2006) postulate that the restrictions of antibiotics in the prophylaxis and treatment of udder infections (specially dry cow treatment) might be a reason of major problems of mastitis, it does not seem to be clearly demonstrated. Other authors, as Haskell *et al.* (2009), concluded that the control measures for SCC used on organic farms are at least as effective as those on non-organic farms in controlling SCC; however, it should be considered that in that study, unlike ours, most organic farmers treated the early stages of mastitis with alternative remedies, but they used antimicrobials when the case became clinical or took too long to clear. In addition, organic normative differs by countries. In USA, the USDA Organic Standard prohibits the use of antimicrobial drugs for organic dairy cows (USDA, 2001) and their use leads to the loss of the organic status of an animal. The organic EU legislation (EC, 2008) limits but does not prohibit the use of antibiotics although explicitly states that alternative treatments should be used in preference to antibiotics; however, within each country the situation is different: whereas in the UK the majority of organic dairy farms use homeopathy as an alternative to antibiotics (Hovi & Roderick, 2000) in Sweden, the organic regulations do not advocate alternative medicine over conventional veterinary medicine (Fall *et al*., 2008). Moreover, information on the effect of homeopathy on the SCC in experimental conditions is sparse. Results of a recent study in mild to moderate clinical mastitis indicate that cows treated with homeopathy showed significantly higher SCC that those treated with antibiotics (Werner *et al*., 2010). When efficiency of homeopathy is compared with a placebo in cows suffering subclinical mastitis, Kiarazm

et al. (2011) found a significant decrease of the SCC and a reduction of the incidence of the disease in the group receiving homeopathy, even though Holmes *et al*. (2005) did not find any significant effect of the treatment.

In summary, our results indicate that the management and productive characteristics of the organic dairy farms in Northern Spain fits within the pattern observed in other countries. Overall, organic farms are small traditional farms, with a high degree of grazing and lower milk production compared to the reference conventional sector. The SCC are higher in organic compared to conventional farms, and the detailed analysis of the data indicate that this could be related to a higher prevalence of mastitis by the low use of antibiotics for prophylaxis and treatment of udder infections and merits further investigation.

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