Comparison of mastitis prevalence between an organic and a conventional dairy herd from 2004 to 2006

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ABSTRACT

This study compared mastitis bacteriology and somatic cell counts (SCC) between an organic and a conventional dairy herd, each managed as a pastoral-based system, in the 2004/05 and 2005/06 seasons. Single quarter foremilk samples taken from both herds at calving, 14 days post-calving, mid-lactation and dry-off were cultured for bacteriological analysis. Individual cow SCC were obtained from monthly herd tests. The percentage of cows infected with *Staphylococcus aureus* and *Streptococcus uberis* was generally higher in the organic herd than the conventional herd. However, these differences were only significant for *S. aureus* at mid-lactation 2005/06, when 56% of the organic herd was infected compared to 23% of the conventional herd ($P < 0.05$), and for *Str. uberis* at dry-off 2005/06, when 7% of the organic herd was infected but none of the conventional herd ($P < 0.001$). The organic herd had a significantly higher mean lactation back transformed SCC than the conventional herd, in 2004/05 (96,921 vs. 75,608 cells/mL, $P < 0.05$) and 2005/06 (103,968 vs. 63,096 cells/mL, $P < 0.0001$). The 2004/05 season was the first time that a significant difference in mean SCC between the organic and conventional herds had been measured, since the organic and conventional dairy systems comparison trial was established in 2001.

Keywords: organic dairy system; conventional dairy system; mastitis.

INTRODUCTION

Globally there is growing demand for organic dairy products. This is due to rising public concerns regarding food safety, animal welfare and the environmental impact of intensive livestock systems (Sato *et al.*, 2005). The major New Zealand dairy cooperative, Fonterra Co-operative Group Ltd., is seeking to take advantage of this growing market and increase its suppliers of organic milk.

The impact of organic dairy systems on mastitis has been researched in Europe and the USA. However, these dairy systems are very different to New Zealand's pastoral-based systems, and the research is unlikely to accurately represent them. Little formal research has been done on organic dairy farming in New Zealand.

This study is part of a long-term trial at Massey University, Palmerston North, comparing the performance of an organic and a conventional dairy system. The goal of this part of the research was to compare mastitis prevalence in an organically and a conventionally managed pastoral-based dairy system in New Zealand. The prevalence of infection of *Staphylococcus aureus* and *Streptococcus uberis*, two of the predominant mastitis-causing bacteria in New Zealand, were identified at four critical stages of lactation. Monthly individual cow somatic cell counts (SCC) were measured throughout lactation.

In previous seasons, 2001/02, prior to organic certification, and 2003/04, post-certification, the organic herd had a higher mean lactation SCC than the conventional herd but these differences were not statistically significant (Lopez-Villalobos *et al.*, 2003; Silva *et al*., 2005). Bacteriological analysis by Silva Arteaga (2005), also found that the organic herd had a significantly higher prevalence of *S. aureus* infection per cow than the conventional herd at calving, 14 days post-calving, and mid-lactation in 2003/04. In contrast, prevalence of *Str. uberis* infection per cow was never significantly different between the organic and conventional herd. The information obtained from this research will add to the limited local knowledge about organic cow udder health in New Zealand.

MATERIALS AND METHODS

The farmlets

The study was undertaken at the Dairy Cattle Research Unit, Massey University, Palmerston North, New Zealand. In 2001, two neighbouring 20 ha farmlets were developed, one managed conventionally and the other organically. An organic and a conventional herd were developed. Each was balanced for breeding worth, production worth, live weight, age, SCC and production. The trial consisted of an average of 45 organic and 49 conventional cows in 2004/05 and 49 organic and 53 conventional cows in 2005/06. AgriQuality organic certification was obtained in 2003. In 2006, the United States Department of Agriculture organic regulations were adopted, prohibiting antibiotic use in the organic system. Homeopathic remedies were used

to address health issues in the organic herd. At dry-off, the conventional cows received dry cow therapy according to the Seasonal Approach to Managing Mastitis (SAMM) plan. The United States Department of Agriculture regulations prohibited the use of dry cow therapy or teatseal on the organic cows. The culling policy for both herds was based on empty rates, available heifer replacements, udder condition, age, milk production and SCC.

Both herds were milked through a 10-bail walkthrough shed. The organic herd was always milked first, followed immediately by the conventional herd. Cows were required to be teat sprayed after milking. The plant was cleaned with organically acceptable chemicals to maintain hygiene standards and milk quality. Milk tanker compositional samples were monitored to ensure these standards were maintained.

Bacteriology and somatic cell counts

Single foremilk samples were taken from all milking quarters at the first milking or within 24 hours of calving (July to September 2005), 14 days post-calving (August to October 2005), mid-lactation (January 2006) and at the last milking before dry-off (March to April 2006). Aseptic milk sampling was undertaken in accordance with the National Mastitis Council, USA, milk-sampling protocols (Hogan *et al.*, 1999). The New Zealand Veterinary Pathology, Palmerston North undertook bacteriological analyses in accordance to with the National Mastitis Council, USA culturing protocols. Equivalent bacteriological data from the 2004/05 season and calving 2007 were obtained from records. Cows were classified as infected if they had *S. aureus* or *Str. uberis* growth in milk sampled from at least one quarter. Cows infected with two pathogens were analysed in each bacterial category.

Milk from organic and conventional cows with known clinical mastitis was withheld from the vat to avoid the financial penalties from bulk SCC exceeding 400,000 cells/mL. Due to this, individual cow SCC were obtained from monthly lactational herd tests. SCC data from the 2004/05 season were obtained from records.

STATISTICAL ANALYSIS

Due to the death of two organic cows, culling of 10 organic and nine conventional cows and the replacement of 16 organic and 13 conventional heifers, the number and identity of some cows present at some milk samplings in 2004/05 and 2005/06, were different. Data were therefore analysed separately for each sampling period using the PROC GENMOD procedure of SAS 8.02 (2001). A logit function was used to transform the data before analysis. The model considered the effect of system, season, sampling period and cow age. Models were run separately for each bacterial species.

Monthly SCC were analysed by the PROC GLM procedure of SAS 8.02 (2001) after a natural transformation to normalize variation and back transformed to the equivalent mean lactation SCC (cells/mL). The effects tested were system, season and cow age.

RESULTS

Bacteriology

The organic herd had a higher prevalence of *S. aureus* infection than the conventional herd at all sampling periods in 2004/05 and 2005/06 (Figure 1). These differences were only statistically significant at mid-lactation 2005/06, when 56% of organic and 23% of conventional cows were infected ($P < 0.05$). Generally, the prevalence of *S. aureus* infection in both the herds increased as lactation progressed. At dry-off 2006, both the organic and conventional herds had a high prevalence of *S. aureus* infection 77% and 74% of cows respectively ($P = 0.80$). Of the organic cows that were infected with *S. aureus* at dry-off 2006 and retained, 29% had a *S. aureus* infection at calving 2007. In contrast, the conventional cows infected with *S. aureus* at dry-off 2006, retained and treated with dry cow therapy, 17% had a *S. aureus* infection at calving 2007. Of the remaining retained conventional cows infected with *S. aureus*, but not treated with dry cow therapy, 27% were infected at calving 2007. System, season and sampling period all had a significant effect on the prevalence of *S. aureus* in 2004/05 and 2005/06 ($P < 0.001$).

The prevalence of *Str. uberis* infection in the organic and conventional herds was similar for the majority of 2004/05 and 2005/06. At dry-off 2004/05, the prevalence of *Str. uberis* infection in the conventional cows was elevated, with 20% of

FIGURE 1: Prevalence of *Staphylococcus aureus* infections for cows in herds managed organically or conventionally at four sampling periods in 2004/05 and 2005/06 (△ Organic 2004/05, n = 45) (▲ Conventional 2004/05, n = 49) (○ Organic 2005/06, n = 49) (● Conventional 2005/2006, n = 53).

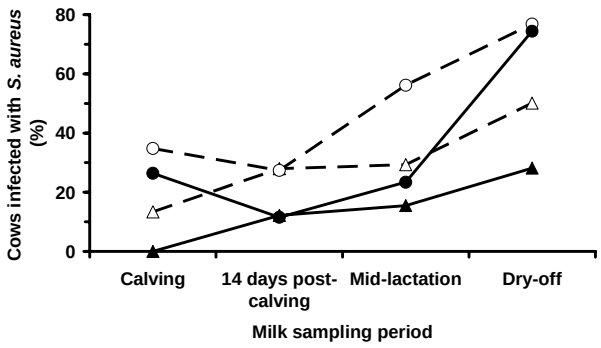
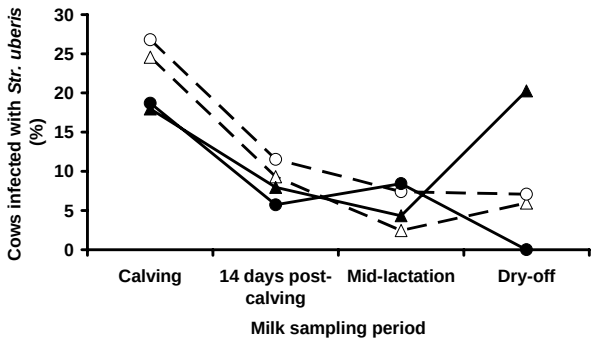


FIGURE 2: Prevalence of *Streptococcus uberis* infections for cows in herds managed organically or conventionally at four sampling periods in 2004/05 and 2005/06 (△ organic 2004/05, n = 45) (▲ conventional 2004/05, n = 49) (○ organic 2005/06, n = 49) (● conventional 2005/2006, n = 53).



conventional cows infected compared to 4% at mid-lactation (Figure 2). However, the difference between the conventional and organic herds at dry-off 2004/05 was not statistically significant (P = 0.09). The only significant difference in *Str. uberis* prevalence was measured at dry-off 2005/06, when 7% of the organic cows were infected but none of the conventional cows (P <0.001). Prevalence of *Str. uberis* tended to be highest at the beginning of lactation, with the exception of the conventional herd at dry-off 2004/05. The effect of system on the prevalence of *Str. uberis* infection was not significant (P = 0.428), however the effect of season and sampling period were (P <0.001).

Somatic cell counts

Least square mean SCC was significantly higher in the organic herd than the conventional herd in both seasons (Table 1). In 2005/06, the organic herd's mean SCC increased from that of 2004/05, but in contrast the conventional herd's mean SCC was reduced, creating a large significant difference in mean SCC between the two herds (P <0.001) (Table 1).

DISCUSSION

The aim of this research was to compare the prevalence of mastitis in organically and conventionally managed dairy cows during the 2004/05 and 2005/06 seasons. In 2004/05 and 2005/06 the organic herd always had a higher prevalence of *S. aureus* infection per cow than the conventional herd, but this difference was only significant at mid-lactation 2005/06 (Figure 1). Silva Arteaga (2005) also reported that the organic herd had a higher prevalence of *S. aureus* infection per cow than the conventional herd in 2003/04. Overall, prevalence of *S. aureus* infection per cow in both herds has increased as the trial has progressed.

TABLE 1: Back transformed mean somatic cell count (SCC) averaged across monthly herd tests for all cows in two herds managed organically or conventionally during lactation in 2004/05 and 2005/06.

Season	System	SCC (cells/mL)	P value
2004/05	Organic	96,921	0.023
	Conventional	75,608	
2005/06	Organic	103,968	<0.001
	Conventional	63,096	

The prevalence of *S. aureus* infection in the organic and conventional cows increased as lactation progressed in both seasons (Figure 1). This prevalence pattern agrees with that previously described for conventional New Zealand herds (McDougall, 1998) and organic Danish herds (Vaarst & Enevoldsen, 1997). The high prevalence of *S. aureus* infection during late lactation is due to the contagious nature of *S. aureus*. As days in milk increases, so does the risk of *S. aureus* transmission and new intramammary infections. In late lactation, there is also reduced milk yield, thus less milk to flush bacteria out of the gland (Silva Arteaga, 2005).

At dry-off 2005/06, *S. aureus* infection rates were unacceptably high with 77% of the organic and 74% of the conventional cows infected (P = 0.80). This was a concern as *S. aureus* infections are particularly difficult to eliminate once established, even with the use of antibiotics (Silva *et al.,* 2005). This was demonstrated in the relatively high percentage of cows that were infected with *S. aureus* at dry-off 2006, and still infected at calving 2007. Preventative measures are essential to avoid the spreading of *S. aureus* infections between cows and herds, especially in an organic system where antibiotic treatments are prohibited.

In February 2006, there was a change of management at the Dairy Cattle Research Unit and it is suspected that the application of teat spray after milking was not strictly practiced after this time. Post-milking teat sanitization is important as it reduces bacteria on the teat end helping to control the transmission between cows. Silva *et al*. (2005) reported that teat cups were rinsed with an acid sanitizer between milking of the organic and conventional herd from August 2004, however this procedure was short lived and did not occur in 2005 or 2006. The lack of teat and cup sanitization between milking of the organic and conventional herds is suspected to have allowed the spread of *S. aureus*, from the organic to the conventional cows, resulting in the spike of *S. aureus* infections in the conventional herd between mid-lactation and dry-off 2005/06 (Figure 1). The utilisation of a hot disinfectant cup wash before the conventional herd was milked had been proposed however, organic regulations limited the disinfectant to peracetic acid,

which is difficult to handle and so the procedure was deemed impractical. Due to the results of this study, it is highly recommend that the utilisation of a hot cup wash is reinvestigated, and post-milking teat spraying better utilised in order to maintain udder health and a more accurate insight into prevalence of *S. aureus* infection, especially in the conventional cows.

The prevalence of infection of *Str. uberis* for the organic and conventional herds was relatively similar in both seasons. Only at dry-off 2005/06 was there a significant difference between the two herds, with 7% of the organic and none of conventional cows infected ($P < 0.001$). However, the effect of system on prevalence of *Str. uberis* infection was not statistically significant ($P = 0.428$), therefore this difference at dry-off 2005/06 was possibly due to a seasonal or sampling period effect ($P < 0.001$). Due to the seasonal nature of New Zealand dairy farming, the prevalence of *Str. uberis* infection usually declines as lactation progresses as seen in the prevalence pattern of *Str. uberis* infection in 2005/06 (McDougall, 1998). As lactation progresses from spring, the environment becomes drier, reducing the risk of *Str. uberis* transmission from the environment to the teat canal. However, in late lactation the environment can become moist again and prevalence of *Str. uberis* infection can increase, as seen in 2004/05 (Figure 2). Why the conventional cows had such a high prevalence of *Str. uberis* infection at dry-off 2004/05, is unknown. Prevalence of *Str. uberis* in 2004/05 and 2005/06 was relatively similar to 2003/04 and does not indicate any overall trend in prevalence (Silva Arteaga, 2005).

The SCC is an important indicator of udder inflammation and mastitis. In both the 2004/05 and 2005/06 seasons, the organic herd had a significantly higher mean SCC than the conventional herd (Table 1). In previous seasons, the organic herd also had a higher mean lactation SCC than the conventional herd but these differences were not significant. In 2001/02, pre-certification, the mean lactation SCC for the organic and conventional cows was 84,886 cells/mL and 71,091 cells/mL, respectively (Lopez-Villalobos *et al.*, 2003). In 2003/04, this had increased to 116,000 cells/mL for the organic herd and 102,000 cells/mL for the conventional herd (Silva *et al.,* 2005). Overseas research often utilises bulk milk SCC as a crude correction for milk volume. Our individual cow SCC does not correct for milk volume, therefore, direct comparisons with other studies are limited.

CONCLUSION

During this study, the organic herd had a higher prevalence of *S. aureus* infection than the conventional herd at all sampling periods, however this difference was only significant at mid-lactation 2005/06. In late lactation 2005/06, the prevalence of *S. aureus* infection in both herds rose to commercially unacceptable levels, suggesting a problem with milking procedures. This emphasises the need for a hot detergent cup wash before the conventional cows are milked and regular application of post-milking teat spray in future lactations. Overall, the prevalence of *Str. uberis* infection in the organic and conventional herd was similar. Mean lactation SCC has always been higher in the organic herd than the conventional herd. However, this difference only became significant for the first time in 2004/05 and 2005/06. This research will aid farmers in evaluating potential changes in herd mastitis status upon converting to an organic system. The New Zealand dairy industry would benefit from further research into the prevalence of mastitis and the effects on milk production from organic herds.

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