Prevalence subclinical mastitis in small-scale dairy farms under grazing or in total confinement in the central highlands of Mexico

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Abstract: Mastitis is the most frequent disease in dairy farms worldwide, causing severe economic loss; being subclinical mastitis the most important as it is a silent disease. The objective of this work was to compare the udder health status in cows under limited grazing against cows in total confinement in small-scale dairy systems. Ten small-scale dairy farms participated in the study, with five farms that had implemented grazing of their pastures and five farms that continued the conventional management of total confinement of their herds and feeding based in cut-and-carry pasture, straws, agricultural by products, and concentrates. The highest yielding five cows from each farm were selected for the study. The California Mastitis Test (CMT) performed every 2 weeks, from June 17 to July 15 on all participating cows, and Somatic cell counts (SCC) was determined on the farm pooled milk. Results for CMT were subjected to a Chi-squared test, and SCC to analysis of variance after log$_{10}$ transformation. There were significant differences both for CMT and SCC with lower values for cows under restricted grazing than in total confinement. Restricted grazing of dairy cows in small-scale dairy systems result in better udder health, and therefore better quality milk.

Keywords: California Mastitis Test; highlands; Mexico; Somatic Cell Count; Subclinical mastitis; Small-scale dairy systems,

Introduction

Dairy production farming in Mexico is carried out under diverse agro-ecological conditions in three main production systems, large scale intensive farms, dual purpose dairy production in the tropical lowlands and small-scale family dairy systems that takes place in all the temperate, arid and semi-arid regions of the country.

Small-scale dairy systems are farms with limited land endowments and herds between 3 and 35 cows plus replacements (Fadul-Pacheco et al. 2013) that rely mostly on family labour (Posadas-Domínguez et al. 2014); providing occupation and incomes that enable dairy families to overcome poverty (Espinoza-Ortega et al. 2007).

Conventional feeding of herds in these farms is heterogeneous, comprising maize straw, purchased lucerne hay, irrigated pastures under cut-and-carry, and large amounts of commercial concentrates (Martínez-García et al. 2015) that result in high production costs that jeopardize the economic viability of these farms (Fadul-Pacheco et al. 2013).

An alternative promoted is grazing of pastures that has been successful in reducing feeding costs and improving the profitability of farms (Prospero-Bernal et al. 2017). Grazing may also reduce the incidence of some diseases such as mastitis since the cows can maintain clean udders (Abramsén et al. 2014).

Mastitis is the inflammation of the mammary glands, a common ailment in dairy cows all over the world, of which subclinical mastitis is of utmost importance (Bangar et al. 2015) as it is a ‘silent disease’ without evident external signs, that causes a reduction in milk yields and therefore it affects incomes. Subclinical mastitis is caused mainly by pathogens in the herd environment or as a result of an injury.

The high prevalence of subclinical mastitis makes it the most important disease affecting dairy production, causing severe economic losses, representing up to 30% of total expenditures in
dairy farms all over the world (Abrahmsén et al. 2002; Wellenberg et al. 2002; Manjarrez-López et al. 2012; Frössling et al. 2017; Hachana and Tibbini., 2018).

There are reports in Mexico of an incidence of subclinical mastitis due to type of milking up to 57% (Manjarrez-López et al. 2012), but prevalence results are also affected by the hygienic conditions during milking (Ávila-Tellez et al. 2002).

Some reports mention a higher incidence of subclinical mastitis in cows under confinement compared to cows under grazing (Carrasco-Rodriguez et al. 2014); although these authors report inadequate management at dry-off and a lack of disinfection of teats after milkings. Also, Abramsén et al. (2014) report a higher incidence of subclinical mastitis in confined cows compared to grazing cows.

The objective of this work was to assess subclinical mastitis in small-scale dairy farms under conventional total confinement on concrete floors, in comparison with cows from farms that have implemented grazing of their herds for 8 h a day.

Materials and Methods

Study area

The study was undertaken in the municipality of Aculco in the central highlands of Mexico, located between coordinates 20° 06’ and 20° 17’ N and at 99° 40’ and 100° 00’ W; with a sub-humid temperate climate and mean altitude of 2440 m (Celis-Alvarez et al. 2016). Mean temperature is 13.2 °C with frosts in winter and rainfall is between 800 and 1000 mm with rains in summer (May to October) and a dry season from November to April.

Small-scale dairy systems have herds between 3 and 35 cows plus replacements, small land holdings, and rely on family labour (Fadul-Pacheco et al. 2013).

Selection of dairy farms

The study followed a participatory livestock research approach (Conroy, 2005) with 10 participating farmers, of whom five keep their herds under conventional total confinement in pens with cut-and-carry pastures, and five farms that have implemented day grazing of their pastures (between morning and afternoon milkings) for 8 h/day, and confinement overnight in similar concrete floor pens as in the total confinement herds.

A total of 10 small scale dairy farms (5 each from conventional confinement in pens with cut-and-carry pastures and grazing system) were selected from the study area, that were initially selected by a snow-ball sampling procedure in the project to which this work belongs (Prospero-Bernal et al. 2017). Table 1 shows the characteristics of participating farms.

Five cows with the higher average daily milk yield from each participating farm were selected for sampling.

Milking was by hand, between 4:00 and 6:30h in the morning and between 16:00 and 18:00 h in the afternoon. Hygiene routines were the same in all farms: farmers washed their hands before milking, and cleaned the udder with water and a cloth, and foremilk examined. Cows were milked always by the same person.

Duration of the study

The study took place for 45 days during the rainy season. Milk samples were collected thrice at fortnightly intervals at morning milking in the case of grazing herds and at evening milking in confined and stall fed herds. Since all farmers milk at similar times in the region, for logistical purposes, by random allocation, grazing farms were sampled in the morning milking, and confinement farms in the afternoon milking.

For the detection of subclinical mastitis California Mastitis test (CMT) was performed on collected milk samples. The CMT scores given were; negative, traces, 1, 2 and 3.

Pooled samples of the selected five cows from each farm were refrigerated after every milking. The samples were then homogenised and warmed to 37 °C in a water bath and somatic cell counts (SCC) were determined using a DeLaval DCC Automatic Somatic Cell Counter.

Statistical analyses

A Student “t” test for independent samples was performed to compare California Mastitis Test scores (in percentage) between the two treatments (grazing vs. confinement (Schefler, 1979).

Log10 transformation of SSC values were analysed by ANOVA under a split-plot design (Kaps and Lamberson, 2004) with the model:

\[ Y_{ijkl} = \mu + r_i + S_j + E_k + p_l + T_{pj} + e_{ijk} \]

Where:

\( \mu \) = General mean

\( r \) = Effect of replicates (farms), \( i = 5 \)

\( S \) = Effect of feeding strategy (confinement or grazing) (Main Plot) \( j = 1, 2 \)

\( E \) = Error term for Main Plots \( \{r(T)ij\} \)

\( p \) = Effect of sampling periods (split - plot) \( k = 1, ..., 3 \)

\( Sp \) = Interaction term between treatments and measurement periods
Results and Discussion

Table 2 shows the results for the analysis of CMT scores. There were 34.6% more negative cases in grazing cows than cows in confinement, although given the nature of the variable (percent of quarters with a given score), the Student "t" test could not detect significance (P>0.05).

However there was a significant trend (P<0.10) for a lower number of quarters with score 2 in grazing cows, and a significantly lower (P<0.05) proportion of cases with CMT score 3 in grazing cows compared with cows under permanent confinement.

Eighty percent of quarters of cows under day grazing had negative or trace CMT scores, compared to only 64% under confinement.

Day time grazing, even when restricted to only 8 h/day, resulted in cleaner udders and less contact with manure contaminated floors in pens which is critical in the rainy season. Besides stage of lactation, rain and dry seasons are determinant in the presence of mastitis (Bradley and Green 2004).

Lack of adequate bedding in pens in small-scale dairy systems mean difficult conditions to keep pens clean from manure, representing an infection source for cows since the main source for infections are pathogens in the cow environment (Phuektes et al. 2001).

Ávila-Téllez et al. (2002), from a study of mastitis in sub-tropical dual purpose dairy systems in Mexico also with restricted grazing, reported 57% incidence of subclinical mastitis, higher incidence than results from the work herein reported both for day grazing as for confined cows. These differences might be due to the higher ambient temperatures in the subtropics that favour microbial proliferation.

Subclinical mastitis is a worldwide problem for dairy farmers, and in line with results from this study, Abrahmsen et al. (2014) in Uganda reported 73.5% incidence of mastitis in confined cows compared with a significantly lower rate (53.8%) for grazing cows.

A high CMT score indicates a high incidence of infected quarters; directly related with somatic cell counts as shown in Table 3. Cows in confinement had 70% more somatic cells/ml of milk than cows under day grazing, again due to cleaner udder conditions in cows under day grazing compared with soiled floors under confinement. Inadequate hygienic conditions are known as risk factors that enable mammary gland infections (Manjarrez-López et al. 2012).

On the contrary, Carrasco-Rodríguez et al. (2014) studying mastitis in cows from the Carora breed in Venezuela under grazing and total confinement reported a higher incidence of mastitis (32.7%)

Table 1 Characteristics of participating farms

| Pasture management Strategy | Grazing | Cut-and-carry |
|----------------------------|---------|---------------|
| Farm                       | 1       | 2             | 3     | 4     | 5     | Mean | 1 | 2 | 3 | 4 | 5 | Mean |
| Farm size (ha)             | 6.3     | 7.8           | 13.0  | 9.0   | 12.5  | 9.7  | 4.5| 2.0| 3.5| 2.5| 7.8| 4.1   |
| Total pastures (ha)        | 1.5     | 3.0           | 4.0   | 2.0   | 2.5   | 2.6  | 1.5| 1.0| 1.5| 1.0| 3.0| 1.6   |
| Milking cows               | 7.0     | 7.0           | 8.0   | 6.0   | 17.0  | 9.0  | 17.0| 10.0| 8.0| 13.0| 7.0| 11.0 |
| Dry cows                   | 1.0     | 1.0           | 2.0   | 2.0   | 5.0   | 2.2  | 3.0| 1.0| 1.0| 2.0| 1.0| 1.6   |
| Milk yield (L/cow/day)     | 15.3    | 13.9          | 17.0  | 14.9  | 16.4  | 15.5 | 13.8| 18.0| 11.0| 14.9| 13.9| 14.3 |
| Milk fat (g/kg milk)       | 33.0    | 38.0          | 35.0  | 34.0  | 34.0  | 34.8 | 35.0| 33.0| 32.0| 35.0| 38.0| 34.6 |
| Protein (g/kg milk)        | 32.0    | 32.0          | 33.0  | 33.0  | 32.5  | 32.5 | 32.0| 33.0| 32.0| 33.0| 32.0| 32.0 |

Table 2 Incidence of subclinical mastitis (%) in small-scale dairy farms under day grazing or total confinement

| Variable       | Negative | Traces | 1     | 2     | 3     |
|----------------|----------|--------|-------|-------|-------|
| Grazing        | 67.7     | 18.7   | 13    | 4.6   | 2.0*  |
| Confinement    | 50.3     | 14.3   | 16.3  | 11.7  | 7.3b  |
| SEM            | 6.09     | 3.25   | 2.93  | 8.6   | 2     |
| P-value        | 0.187    | 0.34   | 0.147 | 0.067 | 0.043 |

SEM= Estándar error of the mean, a,b (P<0.05)

Table 3 Somatic cell counts (SCC) for different feeding strategy (cells/ml milk)

| Grazing    | Confinement | SEMₐ   | SEMₙ   |
|------------|-------------|--------|--------|
| 4,40,000   | 7,43,000    | 261.82**| 51.80**|

SEMₘ = Standard error for housing management (Main Plots), EEMₜ= Standard error for sampling periods (split-plots) **P<0.01
in cows under grazing that on permanent confinement (19.9%). Authors discuss that differences were mainly due to adequate milking practices in confinement farms, while in grazing farms hygiene at milking was deficient.

Table 3 shows the results for somatic cell counts, with highly significant differences (P<0.05) between housing managements with higher SCC for cows under permanent confinement compared with lower cell counts for cows under day grazing.

Mean SSC in cows from grazing farms were 440,000 cells/ml, a value near the 400,000 cells/ml required by the intensive dairy industry for large farms; even though small-scale dairy farmers milk by hand and with deficient hygiene practices. These results mean that day grazing of dairy cows may be an option, not only to reduce feeding costs and increase profitability, but also to improve the quality of milk and the health and welfare of dairy cows in these small-scale dairy systems.

Conclusions

In conclusion, results indicated that even under restricted grazing for 8 h/day reduce the incidence and severity of subclinical mastitis in small-scale dairy systems. CMT scores showed a larger number of negative and trace scores and lower CMT scores 1, 2, and 3 under grazing than under confinement.

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