Mastitis, a Health- Related Indicator of Dairy Cow Welfare and Productivity

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Abstract

The aim of the present study was to determine the prevalence of dairy cow mastitis in the Northwest of Argentina and to estimate its validity as an animal welfare (AW) target through its relation to the cow's cleanliness, milk somatic cell counts (SCC) and productive losses. The prevalence of mastitis and the degree of udder cleanliness were observed in milking cows from 16 dairy farms in the province of Salta (Argentina) during the rainfall and dry seasons. On the other hand, records of cows with 2 or more parities with clinical mastitis (n=34) and cows without mastitis (n=27) were acquired from farms with database; in addition, cow calving to calving interval (CCI), number of services per conception and cow end (earlier culling or death-euthanized) were recorded. The annual subclinical mastitis (CMT 1, 2, 3 as positive scores) and bulk tank SCC prevalence were high: 48.5±17.9% and 558.7±238.1 respectively. A positive association between CMT prevalence (r2=0.29, p <0.002) determined from the degree of cow udder cleanliness were obtained. The total number of culling or death-euthanized cows that had mastitis (65.4%) was higher (Chi 8.3, p<0.004) than those recorded in cows without mastitis (25.9%), showing a higher probability of occurrence (OR= 5.4). Also, cows with mastitis needed higher (Chi 7.7, p <0.006) number of more than 2 services per conception (mean=4.14) than healthy ones (mean=2.2) and an OR of 7.0. A lower number (Chi 2.56, p<0.10) of cows with mastitis (mean=15.3%) had a CCI of less than 400 days than healthy cows (mean=34.6%) and with an OR of 2.9. These results demonstrate the value of mastitis as a measure target for on-farm AW assessment protocols under Argentina´s Northwest dairy systems.

Keywords: Animal welfare measure; Dairy cattle; Mastitis; Milk production; Argentina´s northwest

Abbreviations: SCC: somatic Cell Counts; CCI: Calving to Calving Interval; OR: Odds Ratio; CMT: California Mastitis Test; AW: Animal Welfare.

Introduction

Animal welfare (AW) has been defined by the World Organization for Animal Health (WOAH) as the broad term used to describe how an individual is coping with the conditions in which it lives. An animal is in a good state of welfare if it is healthy, comfortable, and well nourished, safe, able to express innate behavior and not suffering from unpleasant states such as pain, fear and distress [1].

In the last 15 years, there has been an increase in studies designed to characterize animal welfare in several animal production systems, especially those in which production systems have intensified greatly, damaging the welfare of animals, such as pigs, poultry and dairy cattle [2-5].

All these studies, as well as those that included milk cow welfare, resulted in on-farm protocols based on environmental and animal parameters to evaluate and to get better animal welfare, although in practice these protocols were criticized for how expensive it was to carry them out. From these conclusions different investigations and revisions were carried out with the purpose of simplifying the evaluation of AW [6,7]. In dairy production, one of the ways of rapid evaluation explored was to study whether the indicators taken from the data collected from the farm software served to estimate AW [8,9]. Other ways were evaluating in the field few environmental indicators or animal based measures, that by their relation with others, the only use of those welfare targets simplified the task of qualification and the costs that it implied [9].

One of those welfare targets selected was mastitis [8,10], which are recognized as the most frequent pathologies in dairy cows throughout the world [11,12]. Mastitis has a great impact on the well-being of dairy cows due to the pain and discomfort they cause, but they are also important because they cause negative effects on milk production and composition [13]. In the same sense, milk somatic cell counts (SCC) that indicates the

presence of both clinical and subclinical mastitis was reported as a good indicator of BA in the report of the European Food Safety Authority [14].

Cow cleanliness is an important animal based measure of dairy cow welfare and to ensuring udder health and hygienic milk production, beside other problems like reduce skin thermoregulation and itching [15]. For these reasons also the cleanliness degree of the cows has been selected for on farm welfare assessment protocols of dairy cow welfare [16-18].

The dairy basin of the Lerma Valley is characterized by a daily average production of 21.5±5.3 milk liters/cow based on Holstein cows, mostly managed under systems that complement the use of pastures with corn silage and grain supplementation [19]. Under this type of systems and within a project that contemplates the study of dairy cows welfare, in order to elaborate a simple on-farm welfare assessment protocol, precise and according to the dairy production systems of the region, is that mastitis was studied as a welfare target.

Therefore, the aim of the present study was to determine the prevalence of dairy cow mastitis in the northwest of Argentina and to estimate its validity as a welfare target through its relation to the cow's cleanliness, milk somatic cell counts and productive losses.

Material and Methods

The study was conducted at the dairy basin, located in the Lerma Valley of northwestern Argentina at 1050m a.s.l. Rainfall in this temperate valley is concentrated in the summer (rainfall season), with a dry period from April to November. Mean annual rainfall is 800mm and mean temperature is 17 °C (maximum: 36; minimum: -6), with relative humidity between 20 and 80 %.

Sixteen dairy farms (38% of the dairy basin) of a mean of 190.2±88.4 cows in milk were visited two times during 2014 and 2015. Samplings were programmed according to the climatic characteristics of the Lerma Valley, visiting the farms during the dry season (May-September 2014) and the rainfall season (January to April 2015).

During the dry and rainy seasons individual milk samples of each mammary quarter were collected to determine the prevalence of subclinical mastitis (Ms) and the somatic cell counts (SCC) level from the bulk tank milk. In addition the cleanliness degree of a sample of cows of each dairy farm was registered.

The prevalence of Ms was recorded using the California mastitis test (CMT) according to Schlam & Noorlander [20], taking a milk sample at random of 80 mammary quarters per dairy farm. With 1, 2 and 3 scores of CMT as positive, the prevalence of Ms in each dairy farm was estimated. The SCC was determined using Fossomatic- 90 equipment.

The cow cleanliness was estimated since 59 to 73 cows per farm [20] selected at random by inspection of dirt areas (faeces/

mud). One randomly selected side of the cow body and behind, only including the udders, flank and back (upper legs and lower legs, hind quarters and tail) of standing cows one to two hour before milking was visually assessed [20,21]. An overall score clean (no dirt or minor splashing) or dirty (an area of separate or continuous plaques of dirt) cow was calculated from the mean of the scores of the three sites [22] and then the farm prevalence cleanliness.

On the other hand, from the dairy management software "DIRSA" of three dairy farms (the only ones registering mastitis in their software) two groups of cows with more than two lactations were compared, a group of cows (n=34) recorded with previous cases of clinical mastitis and a group of cows (n=27) with no records of previous clinical mastitis. Beside, in the cow group that suffered mastitis, differences between control milk yield before and after the occurrence of the clinical mastitis was observed. Furthermore, cow calving to calving interval (CCI), number of services per conception and cow end whatever the cause (earlier culling or death-euthanized) were recorded and compared between WMG and NMG. The variables were analyzed using simple linear regression (Pearson), ANOVA test, chi-square and odds ratio (OR), by the Info Stat program.

Results

Table 1: Mean and standard deviation (SD) of somatic cell counts (SCC*1000), California mastitis test (CMT) with only the scoring 1, 2 and 3 and 2 and 3 sampled during dry, rainfall and total seasons.

Parameters		Dry Season	Rainfall Season	Total Seasons
SCC	Mean	422,0 a	695,4 b	558,7
	SD	164,3	224,7	238,1
CMT 1,2,3	Mean	38,4 a	57,9 b	48,5
	SD	16,8	13,5	17,9
CMT 1,2	Mean	23,9 a	42,4 b	33,5
	SD	13,1	12,1	15,5
Different letters indicate significant differences (p<0.05)				
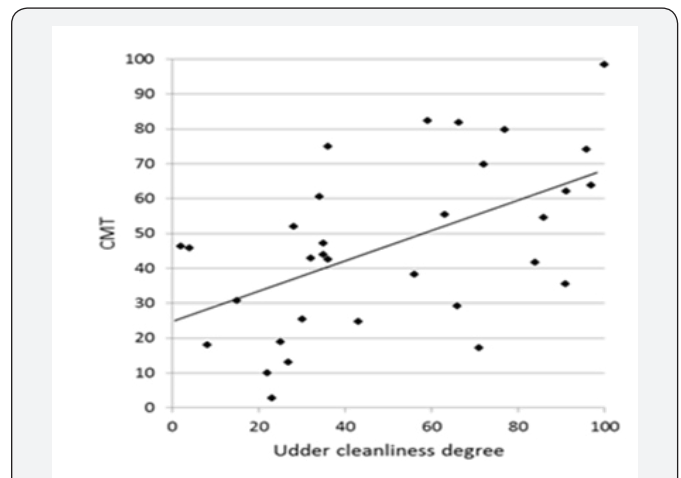
Figure 1: Lineal regression between CMT (scores 1, 2 y 3) prevalence determined by udder cleanliness prevalence degree of the cows (y=24.6+0.43*x).
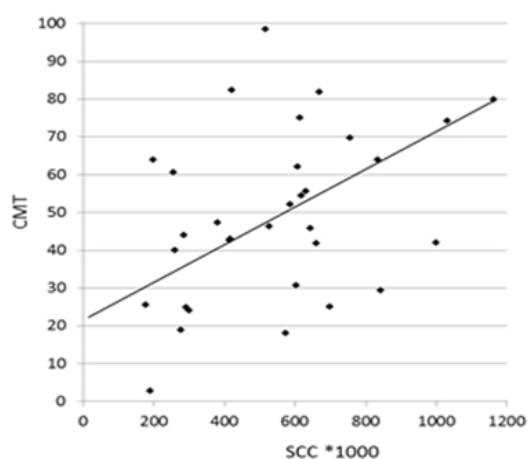
Figure 2: Lineal regression between CMT (scores 1, 2 y 3) prevalence determined by bulk somatic cell counts (y=21.0+0.05*x).

The prevalence of CMT and SCC values collected in the rainy season were significantly (p<0.006) higher than those collected in the dry season. The arithmetic mean and standard deviation of the season samples of CMT 1, 2 and 3 and 2 and 3 scores and SCC are show in Table 1. A positive association between CMT (1, 2, 3 scores) prevalence determined from the degree of cow udder cleanliness (r2=0.29, p<0.002; Figure 1) and general cleanliness average (r2=0.19, p<0.012) were obtained. Mean differences of 5.7 liters/day (p<0.12) were attained between control milk yield before and after clinical mastitis was acquired. Also, a positive association between CMT (1, 2, 3 scores) prevalence determined from the bulk somatic cell counts (r2=0.25, p <0.009) was obtained (Figure 2).

The total number of culling or death-euthanized cows that had mastitis (65.4%) was higher (Chi 8.3, p<0.004) than those recorded in cows without mastitis (25.9%), showing a higher probability of occurrence (OR= 5.4) in animals with mastitis. Also, cows with mastitis needed higher (Chi 7.7, p <0.006) number of more than 2 services per conception (mean=4.14) than healthy ones (mean=2.2), showing a higher probability of occurrence (OR=7.0) in animals with mastitis. A lower number (Chi 2.56, p <0.10) of cows with mastitis (mean=15.3%) had a CCI of less than 400 days than healthy cows (mean=34.6%) and with an OR of 2.9.

Discussion

The discipline that studies the AW must take charge in addition to its study, of its promotion and in that line develop practical and regional adapted protocols for assessing AW and then propose specific solutions to dairy farm owners and staff and finally the consumer trust. In that sense and with that purpose is CMT studied as a practical measure to evaluate the prevalence of mastitis and consequently to have an AW measure to obtain the best and simple protocol adapted to the dairy systems of the Northwest region.

The use of SCC of bulk milk to predict intramammary infection at dairy herd level is a useful method, where leucocytes increase in response to bacterial infection, tissue injury and stress. The individual SCC is at least less than 100,000cel/ml in a healthy cow [23] and at bulk milk SCC levels of 200,000, 500,000, 1,000,000 and 1,500,000; the corresponding percentage of infected quarters has been estimated to: 6, 16, 32 and 48% [24]. Then, the relationship obtained between bulk SCC and CMT ensures and confirms the validity of the diagnostic data on the prevalence of mastitis and confirms that it is a good methodology under our productive conditions to be incorporated in the AW assessment protocols and provide information on lost productivity for the dairy farmer. An Italian study showed a better animal welfare score with a lower bulk tank SCC and that in dairy farms, with the worst welfare score, SCC values were higher than 345,000cells/ml [25].

In the dairy basin of the Lerma Valley and in general in Argentina, CMT monitoring is not performed as a routine mastitis diagnosis and its implementation in the on-farm AW protocols would be useful information for owners and in addition to disseminating and promote its use. On the other hand, the time spent in perform the CMT of 80 mammary quarters is not important, only varying between 30-45 minutes. In addition the utility of Ms Information data by CMT in the AW protocols is potentiated since in only three dairy farms cases of clinical mastitis were recorded.

Dirtiness evaluated from soiled parts of the cows has a significant impact on AW evaluation [26] because in our systems indicate the presence of mud, which is a serious animal welfare issue during the rainfall season in Argentina´s Northwest region, affecting animal hygiene, causing stress and increasing lameness prevalence [19]. Dirt on the udder is strongly associated with the development of rates of environmental mastitis, increases the pre-milking cleaning adding time to the milking routine and increases the risk of poor milk quality. Barkema et al. [27] showed associations between bulk tank SCC and management practices, detecting in dairy farms with low SCC (<150,000) in which significantly more attention was paid to general hygiene than the higher SCC dairy farms. In the same way the present results also confirm those previous observations, showing a good relationship of the prevalence of CMT score with the cleanliness degree prevalence and giving even more validity to the need to evaluate the Ms as AW target in future protocols.

This study exposed more productive problems in that cows that had registered with clinical mastitis. In that sense the present results showed associations between cows who suffered clinical mastitis and higher probability of culling or death-euthanized cows (OR=5.4). Some previous studies concerning the association between SCC or mastitis and any of the adverse effects that produce death-euthanized, showed more risk of mortality in the first 100 days of lactation of that cows with an increase in mean SCC of 100,000cell/ml and OR=1.16 [28]. Under a Danish study evaluating the performance of register data as

predictors for dairy herds with high lameness prevalence, Otten et al. [29] identified bulk tank SCC as a significant predictor for lameness, indicating a probable association between SCC and foot disorders. Beside, at an investigation in the dairy farms of our Northwest region Suarez & Martinez [19] showed significant correlations between 1, 2 and 3 CMT score prevalence and percentage of total (r=0,43; p<0,015) and severe (r=0,50; p<0,004) lame cows.

A survey carried out in dairy farms of the center region of Argentina showed that clinical mastitis of the transition cow's result in a decrease in milk yield of about 435lt/animal during the first 3 months of lactation [30]. Also, this study showed that cows that suffered mastitis had more reproductive problems, probably caused by the close relationship between mastitis and various diseases such as metabolic and mineral deficiencies problems, reproductive failures, immunodeficiency states and chronic stress due the human-animal relationship [31,32].

Conclusion

These results demonstrate the value of the registry of subclinical (CMT) and clinical mastitis as animal measure targets for on-farm welfare assessment protocols in the Argentina´s Northwest dairy systems, since on one hand it is related to the environment parameters of the dairy farms through the degree of cow cleanliness and on the other with productive factors and general health of dairy cows.

Conflict of Interest

The authors declare that they have no conflict of interests on the writing and publishing of this manuscript.

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