RESEARCH

MILKING MACHINES ON CHILEAN DAIRY FARMS AND THEIR EFFECTS ON SOMATIC CELL COUNT AND MILK YIELD: A FIELD STUDY

Máquinas de ordeña en lecherías chilenas y sus efectos sobre el recuento de células somáticas y la producción de leche: Estudio de campo

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ABSTRACT

Thirty-four dairy farms in the south central zone of Chile were evaluated in order to describe the functioning of the milking machines with respect to vacuum, pulsators, milklines and cluster characteristics and their relationship with somatic cell count (SCC) and milk yield (MY). An inadequate nominal vacuum level (NVL) was one factor that influenced negatively SCC. The increase of SCC was more accentuated in those milking machines with high-lines than mid- and low-lines. MY was also negatively influenced by an inadequate high NVL. Higher MY value was found in those farms which had < 44 kPa NVL. In all cases, effective vacuum reserve deficit (EVRD) produced SCC above international recommendations. The EVRD effect was not significant (P > 0.05) on MY. There was no influence of the pulsation type on SCC and MY, but in all cases the association pulsation-pulsator produced an SCC above international recommendations. A highly significant positive correlation between milkline height and SCC was found (r = 0.41; P < 0.01). Only low-lines presented SCC within recommended international levels. Milking machines with a small capacity cluster volume showed higher SCC. Low-lines with a large claw (300-350 mL) had lower SCC (P < 0.05) compared with mid-lines. No significant influence of claw capacity on MY was found. Cows with a high SCC level produced below the optimal level. Good milking machine functioning and maintenance might be the only solution in order to obtain maximum benefits at the studied farms.

Key words: milking machine, dairy, milk yield.

RESUMEN

Se evaluaron treinta y cuatro lecherías de la zona centro sur de Chile para describir el funcionamiento de las máquinas de ordeña con respecto al vacío, pulsadores, líneas de leche y características de la unidad de ordeño y su relación con el recuento de células somáticas (SCC) y la producción de leche (MY). Un nivel de vacío inadecuado (NVL) influyó negativamente en el SCC. El aumento de SCC fue más acentuado en máquinas de ordeño con líneas altas que con líneas medias y bajas. MY también fue influida negativamente por un alto NVL inadecuado. Mayores niveles de MY fueron encontrados en lecherías que tenían < 44 kPa NVL. En todos casos una deficiencia de la reserva de vacío efectivo (EVRD) produjo SCC sobre las recomendaciones internacionales. El efecto EVRD no fue muy significativo (P > 0.05) en MY. No hubo influencia del tipo de pulsación en SCC y MY, pero en todos casos la asociación pulsación-pulsador produjo un SCC sobre las recomendaciones internacionales. Una correlación positiva altamente significativa entre la altura de la línea de leche y SCC fue encontrado (r = 0.41; P < 0.01). Sólo las líneas bajas presentaron SCC dentro de los niveles recomendados internacionalmente. Las máquinas de ordeñav con unidades de ordeño que tenían un vaso colector de volumen pequeño mostraron SCC más altos. Las líneas bajas con un vaso colector grande (300-350 ml) tenían SCC más bajos (P < 0.05) comparadas con las líneas medias. Una influencia significativa de la capacidad del vaso colector de las pezoneras en MY no fue encontrada. Vacas con un alto nivel de SCC produjeron bajo el nivel óptimo. El buen funcionamiento y mantenimiento de máquinas de ordeña podrían ser la única solución para obtener beneficios máximos en lo predios estudiados.

Palabras claves: máquina de ordeña, lechería, producción de leche.

† Dedicated to the memory of Prof. Dr. Juan Luis López F. (1953- 2004).

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Recibido: 3 de febrero de 2005. Aceptado: 19 de abril de 2005.

INTRODUCTION

Machine milking implicates a higher risk for milk quality than hand milking, especially for the milk produced by small farmers (Boonbrahm *et al*., 2002). A milking machine is a complete installation for milking, usually comprising vacuum and pulsation systems, one or more milking units and other components, and it must fulfill construction and performance standards and mechanical tests (ISO, 1996b; ISO, 1996c) for achieving proper milking performance, maintaining udder health (Hillerton *et al*., 2000; Rasmussen and Madsen, 2000) and milk quality as well (Judge *et al*., 1977). The main objective of this study was to investigate the installation conditions and functioning of the milking machines, and to find the probable causes that could indicate the constant increase of somatic cell count (SCC) and milk yield decrease observed in some dairy farms located in the south central zone of Chile.

MATERIALS AND METHODS

Data collection

Thirty-four dairy farms in the south central zone of Chile were randomly selected in order to describe and evaluate which parameters of milking machines have an important influence on milk yield and milk quality. Data were collected in a 35 km radius. 36°35' S lat and 72°05' W long was considered as the starting point. All cows kept at farms were of the Holstein Friesian breed (98-100%). Average number of lactating cows was 90.15 ± 9.97 (mean ± standard error). Of 34 farms, 14 (41.2%) had between 61 and 120 cows milked, followed by herds with < 60 (38.2%) and > 120 (20.6%) lactating cows. All cows were milked twice daily. Milk yield average at visiting day was 16.65 ± 0.67 L cow^{-1} (mean ± standard error). During the visit to the dairy farms, a visual inspection of the milking parlour, milking room and stables took place and to allow a standardized investigation and assessment of dairy farms by different persons a checklist was made and the personnel in charge on the farm were interviewed.

Milk sampling and analysis

One sample was taken from the bulk milk tank after evening milking was completely finished (17:00-18:00 h). The tank contained also milk from the morning milking. For determination of somatic cell count (SCC), bulk milk samples were preserved with 0.05% potassium dichromate after sample collection and analyzed using a Fossomatic cell counter (Foss Electric Ltd., Hillerod, Denmark).

Milklines inspection

A visual inspection of milking parlour in order to examine milklines and clusters took place. A steel metric tape (Stanley, Tools Product Group, New Britain, USA) to measure height and length of milklines was used. The ranking of milkline heights was made according to ISO (1996a). Milkline diameter was recorded in inches (in) with a stainless steel 6" dial caliper (Tools Plus, Meadow St. Waterbury, Connecticut, USA). Only for descriptive and statistical reasons, claw volumes were ranked as small (120 mL), medium (180-200 mL) and large (300-350 mL).

Milking machine testing

A dry or static test was performed in accordance with ISO (1996c). During testing the machine was running but not milking, i.e., only air was flowing through the machine. A vacuum recorder - pulsator tester (Fullwood-Pulscript, Fullwood Ltd., Ellesmere Shropshire, England) was used for measuring the pulsator and nominal vacuum level (NVL). Effective vacuum reserve (EVR) was measured with an air flow meter (SAC 0-3000, Christensen & Co., Kolding, Denmark) and a manometer (Wika, Alexander Wiegand GmbH & Co., Rastatt, Germany). An effective vacuum reserve deficit (EVRD) level was calculated as follow:

EVRD (L min^{-1}) = EVRS – EVRM.

where EVRS: EVR suggested by ISO 5707 (ISO, 1996b) and EVRM : EVR measured.

The pulsator test was performed with milking units connected to the milkline, pulsators operating and liners fitted with teat cup plugs. A total of six pulsation cycles for each unit were recorded. Each individual phase of the pulsation cycle was analyzed as a percentage.

Statistical analysis

In the present study, the general linear model (GLM) multivariate of SPSS V.11.0 (SPSS, 2001) was carried out. Milk yield (MY) controlled at visiting day and SCC were considered as dependent variables. In all cases, SCC data were $\log_{10}$-transformed (Ali and Shook, 1980) before analysis because SCC were not normally distributed. The results are based on a field study, and due to high diversity of farm structures, between 28 and 250 lactating cows, the lactating cows number was used as covariate. Fixed factors were: nominal vacuum level [NVL (< 44; 44-51; > 51 kPa)], effective reserve vacuum deficit [ERVD (< 200; 200-300, > 300 free air L min^{-1})], pulsation and pulsator type [2x2-E, 2x2-V, 4x0-E, 4x0-V (2x2: alternating pulsation, 4x0: simultaneous pulsation, E: electrically operated pulsator, V: vacuum operated pulsator)], milkline height (low-line, mid-line, and high-line; according ISO, 1996a) and claw capacity (small: 120 mL; medium: 180-200 mL; large: 300-350 mL). Significance level (P) for fixed factors, their interactions, evaluated statistical estimations with respect to the covariate (lactating cows) and pairwise comparison based on estimated marginal means were obtained with the GLM procedure, full factorial. The Bonferroni test was carried out for adjustment of multiple-comparisons.

Other antecedents

Total average NVL measured was 48.78 ± 0.45 kPa (mean ± standard error) and 70.6% of dairy farms had 44-51 kPa. EVR average was 122.79 ± 10.63 L free air min^{-1} (mean ± standard error). None of the milking machines fulfilled EVR standards. ERVD average was 277.50 ± 12.36 L min^{-1} (mean ± standard error). The b phase represented 41.8% of the pulsation curve, while the c phase was 15.7%. With respect to rate, 64.8% of dairy farms had between 55-64 cycles min^{-1}. The most frequent pulsation ratio was 60:40 (58.8% of farms).

RESULTS

As shown in Table 1, higher MY was found in those farms which had < 44 kPa NVL. There was a significant difference (P < 0.05) between < 44 kPa and > 51 kPa NVL. A tendency was observed (P > 0.05), SCC increased along with an increase of NVL. SCC tended to be higher in milking machines with > 51 kPa NVL. Results from Table 2 show that the lowest MY was reached at 301- 400 free air L min^{-1} range. A significant difference (P < 0.05) between EVRD and MY was not found. SCC remarkably increased along with an increase of EVRD. SCC was highest (P < 0.05) in 301-400 free air L min^{-1} deficit range. As shown in Table 3, there were no significant differences (P > 0.05) between different pulsation-pulsator groups with respect to MY and SCC. The 4x0 pulsators showed lowest SCC (5.619 ± 0.047 and 5.660 ± 0.038 cells mL^{-1}, electronic and vacuum operated respectively) and showed a higher milk yield as compared with 2x2 pulsation-pulsator groups. As shown in Table 4, higher MY was found in those farms which had a low-line. There was a significant difference (P < 0.05) between low- and high-line. Low-lines had the lowest SCC (P < 0.05) compared with mid- and high-lines. SCC values of 5.404 ± 0.046, 5.664 ± 0.018 and 5.773 ± 0.043 (in low-, medium- and high-line, respectively) were reached. A highly significant positive correlation between milkline height and SCC was found (r = 0.41; P < 0.01). Table 5 shows that there was no significant difference (P > 0.05) between different claw sizes with respect to MY. An increasing claw capacity caused decreasing SCC, and it was remarkably more accentuated (P < 0.05) in large than small and medium capacity.

Table 1. Effects of nominal vacuum level (NVL) on milk yield (MY) controlled at visit day and som atic cell count (Log_{10}SCC).

Cuadro 1.-Efectos del nivel de vacío nominal (NVL) sobre la producción de leche (MY) registrada el día de visita y el recuento de células somáticas (Log_{10}SCC)

	NVL (kPa)	Means ± SEM	Confidence interval 95%	
			Min.	Max.
MY,L	< 44	1850 ± 204 a	1435	2267
	44-51	1630 ± 72 ab	1456	1750
	> 51	1219 ± 133 b	947	1492
SCC, cells mL^{-1}	< 44	5.536 ± 0.067 a	5.390	5.670
	44-51	5.659 ± 0.024 a	5.610	5.700
	> 51	5.707 ± 0.040 a	5.610	5.790

Test for multiple-comparison: Bonferroni´s t-test.
Means ± SEM in the same column without common letters differ (P > 0.05).
Min.: minimum; Max.: maximum.

As shown in Figure 1, an increasing in NVL produced a more accentuated increase of SCC in low- and high-lines. Mid-lines presented a wide range of NVL (< 44 to > 51 kPa). This wide variation of NVL didn't produce a wide variation on SCC. At different milkline height with the same recorded NVL (44 to 51 kPa), SCC increased according to increases in height of milklines. The highest value for SCC was identified in high-lines with > 51 kPa NVL. The clearest NVL effect on SCC could be observed in low-lines. Milklines with low heights had the lowest

NVL compared with those with mid- and high-lines. This difference was significant ($P < 0.05$) for levels of 44 ± 0.50, 48.7 ± 0.44 and 50.4 ± 0.5 kPa in low-line, mid-line and high-line respectively. A significant Pearson's correlation ($r = -0.67$; $P < 0.001$) between NVL and EVRD was determined. With higher ERVD, milking machines presented lower working NVL. In the first subgroup (301-400 L min^{-1} EVRD) milking machines worked at 46.4 ± 0.7 kPa, and in the second subgroup (200-300 and < 200 L min^{-1} EVRD) worked at 49.4 ± 0.5 and 51.2 ± 1.0 kPa, respectively. As shown in Figure 2, highest MY was found at low-line with large claw capacity. Lowest MY was found at high-line with small claw capacity. At the same milkline height (mid-line) with different claw capacities, it was observed that the lowest MY was reached with a small claw. No significant differences ($P > 0.05$) between claw capacity with respect to MY were found. Figure 3 shows that at same milkline height (mid-line), SCC increased according to decreasing claw capacity, and it is remarkably more accentuated in large than small and medium capacity ($P < 0.01$). When the same claw capacity was available at different milkline heights, an inverse-proportional relation between SCC and claw capacity was observed. Low-lines with large claw (300-350 mL) had the lowest SCC ($P < 0.05$) compared with mid-lines. Highest SCC values were found in those high-lines which had a small claw. A highly significant negative correlation was demonstrated between cluster capacity and SCC ($r = -0.497$; $P < 0.01$), and a highly significant positive correlation between milkline height and SCC was demonstrated ($r = 0.41$; $P < 0.01$). As shown in Figure 4, milk yield controlled at visiting day decreased with increasing SCC, and it is remarkably more accentuated ($P < 0.05$) at >5.599 SCC range. A significant difference ($P < 0.05$) between MY at < 5.477 SCC and other values of MY and SCC range was found.

Table 2. Effects of effective vacuum reserve deficit (EVRD) on milk yield (MY) controlled at visit day and somatic cell count (Log_{10}SCC).

Cuadro 2. Efectos del déficit de reserva de vacío efectiva (EVRD) sobre la producción de leche (MY) registrada el día de visita y el recuento de células somáticas (Log_{10}SCC)

	EVRD (L min^{-1})	Means ± SEM	Confidence interval 95% Min.	Max.
MY, L	< 200	1712 ± 125 a	1457	1967
	200 - 300	1578 ± 58 a	1459	1697
	301 - 400	1550 ± 73 a	1402	1698
	< 200	5.654 ± 0.028 a	5.595	5.712
SCC,	200 - 300	5.682 ± 0.013 a	5.655	5.710
cells mL^{-1}	301- 400	5.739 ± 0.017 b	5.706	5.773

Test for multiple-comparison: Bonferroni´s t-test.
Means ± SEM in the same column without common letters differ ($P > 0.05$).
Min.: minimum; Max.: maximum.

Table 3. Effects of pulsation and pulsator type on milk yield (MY) controlled at visit day and somatic cell count (Log_{10}SCC).

Cuadro 3. Efectos de la pulsación y tipo de pulsador déficit sobre la producción de leche (MY) registrada el día de visita y el recuento de células somáticas (Log_{10}SCC)

	Pulsation-Pulsator	Means ± SEM	Confidence interval 95% Min.	Max.
MY, L	2X2-E	1383 ± 132 a	1113	1653
	2X2-V	1614 ± 200 a	1206	2023
	4X0-E	1625 ± 149 a	1321	1930
	4X0-V	1626 ± 121 a	1379	1874
	2X2-E	5.668 ± 0.042 a	5.538	5.753
SCC, cells mL^{-1}	2X2-V	5.695 ± 0.063 a	5.566	5.824
	4X0-E	5.619 ± 0.047 a	5.523	5.715
	4X0-V	5.660 ± 0.038 a	5.582	5.738

Test for multiple-comparison: Bonferroni´s t-test.
Means ± SEM in the same column without common letters differ ($P > 0.05$).
Min.: minimum; Max.: maximum.
2x2-E: Alternating pulsation - electrically operated pulsator.
2x2-V: Alternating pulsation - vacuum operated pulsator.
4x0-E: Simultaneous pulsation - electrically operated pulsator.
4x0-V: Simultaneous pulsation - vacuum operated pulsator.

Table 4. Effects of milkline height on milk yield (MY) controlled at visit day and somatic cell count (Log_{10}SCC).

Cuadro 4. Efectos de la altura de la línea de leche sobre la producción de leche (MY) registrada el día de visita y el recuento de células somáticas (Log_{10}SCC).

	Milkline height [1]	Means ± SEM	Confidence interval 95% Min.	Max.
MY, L	Low-line	1850 ± 200 a	1422	2241
	Mid-line	1630 ± 76 ab	1443	1755
	High-line	1219 ± 187 b	929	1697
SCC, cells mL^{-1}	Low-line	5.404 ± 0.046 a	5.309	5.499
	Mid-line	5.664 ± 0.018 b	5.628	5.700
	High-line	5.773 ± 0.043 b	5.684	5.862

Test for multiple-comparison: Bonferroni´s t-test.
[1] ISO (1996a).
Means ± SEM in the same column without common letters differ (P > 0.05).
Min.: minimum; Max.: maximum.

Table 5. Effects of claw capacity on milk yield controlled at visit day (MY) and somatic cell count (Log_{10}SCC).

Cuadro 5. Efectos de la capacidad del colector sobre la producción de leche (MY) registrada el día de visita y el recuento de células somáticas (Log_{10}SCC).

	Claw capacity	Means ± SEM	Confidence interval 95% Min.	Max.
MY, L	Small[1]	1415 ± 191 a	1024	1806
	Medium[2]	1481 ± 93 a	1291	1671
	Large[3]	1731 ± 115 a	1495	1966
SCC, cells mL^{-1}	Small[1]	5.740 ± 0.044 a	5.649	5.831
	Medium[2]	5.727 ± 0.022 a	5.683	5.771
	Large[3]	5.504 ± 0.027 b	5.449	5.558

Test for multiple-comparison: Bonferroni´s t-test.
Means ± SEM in the same column without common letters differ (P > 0.05).
Min.: minimum; Max.: maximum.
[1] 120 mL.
[2] 180-200 mL.
[3] 300-350 mL.

DISCUSSION

It is important to remark, that NVL average measured in all dairy farms in the study should be considered as high if ISO standard guidelines are consulted (ISO, 1996b). As was demonstrated in our study, a non adequate NVL was one factor that influenced negatively SCC (Mihina *et al*., 1998). In agreement with Rasmussen and Madsen (2000), low NVL produced a decrease of SCC. The increase of SCC was more accentuated in those milking machines with high-lines than mid- and low-lines. However, the influence of NVL on udder health reported from different experiments is often contradictory (Østeras and Lund, 1988; Rasmussen and Madsen, 2000). Hamann *et al*. (1993) described that with high NVL only a transitory machine-induced edema occurs. We can not discuss this last point because a teat-end examination in order to describe damage or integrity was not performed, and an additional guideline for effectiveness of pulsation in relation to vacuum level was not considered within our objectives. Milk yield was also negatively influenced by an inadequate high NVL. Frequently, a higher NVL is used to allow more cows per hour and per day being milked (Mein, 1998). A high NVL can cause teat damage and often affects milk flow (Querengässer and Geishauser, 1999). Decreased machine milkability of single teats can impair milking the cow and/or the whole herd (Querengässer *et al*., 2002). Finally, in our opinion and in agreement with Baxter *et al*. (1992), more important than the NVL setting in the examined milking machines as a negative factor itself on SCC and MY was the presence or non-presence of vacuum fluctuation or vacuum drops during milking.

In all cases, EVRD produced a SCC higher than international recommendations (Council Directive 92/46/EEC, 1992). EVRD was remarkably manifested by the presence of vacuum fluctuations at milklines. EVR measured at/or near the regulator location, in our appreciation must not be much different than those described by Reinemann *et al*. (1992). An adequate EVR has been regarded as the essential factor to keep a stable vacuum and avoid vacuum drops in the milking installation (Mein *et al*., 1994). Vacuum stability has become recognized as a prime essential for good milking. The effect of vacuum drops on clinical mastitis has also been described recently (Rønningen, 2002). EVRD effect on MY was not remarkable. On this point is necessary to comment that in our study, a higher EVRD presence in the milking machines was always associated to smaller NVL. It can explain in great part the minimum effect of EVRD on MY, and

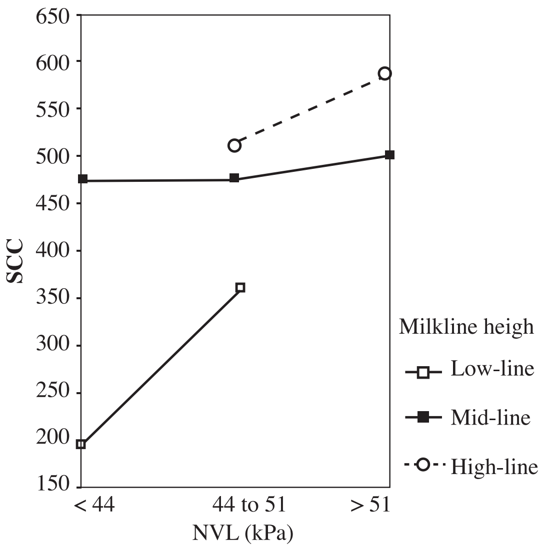

Figure 1. Effect of milkline height and nominal vacuum level (NVL) on somatic cell count [SCC (log_{10})] at thirty-four Chilean dairy farms.
Figura 1. Efecto de la altura de la línea de leche y el nivel de vacío nominal (NVL) sobre el recuento de células somáticas [SCC (log_{10})] en treinta y cuatro lecherías chilenas.

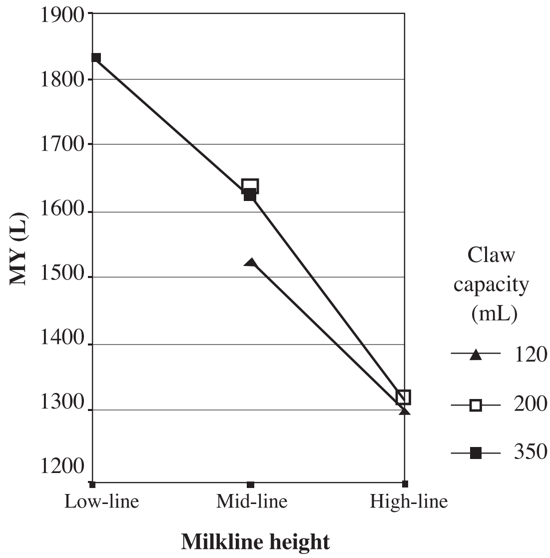

Figure 2. Effect of milkline height and claw capacity on milk yield (MY) controlled at visit day in thirty-four Chilean dairy farms.
Figura 2. Efecto de la altura de la línea de leche y la capacidad del colector sobre producción de leche (MY) registrada el día de visita en treinta y cuatro lecherías chilenas.

surely contributed to minimize this effect and maintained the NVL within acceptable ranges, in order to avoid the disastrous effects of vacuum drops or helped to provide or maintain the necessary minimum NVL when air was admitted into the system.

In the present study, there was no influence of the pulsation type - simultaneous and alternating - on SCC and MY, but in all cases the association pulsation-pulsator produced a SCC higher than international recommendations (Council Directive 92/46/EEC, 1992). Recommendations appear to be slightly in favor of alternating pulsation (Kovac, 1995). On the contrary, O´Callaghan (2001) reported that a simultaneous pulsation produced lower vacuum losses than alternated pulsation in mid-level and low-level milking units. In practice, pulsator type could be more important that pulsation type, due to electromagnetic pulsators, as opposed to pneumatic (vacuum) pulsators, tend to produce more consistent pulsation from unit-to-unit and day-to-day. Thus, teat injuries and an increase of SCC and a decrease of MY is avoided, but we observed also that checking pulsators – uniformity and completeness of inflation collapse - was not a frequent management task at farms. It is necessary to keep in mind that pulsator uniformity, both in length of time and force of inflation collapse, increases MY.

As was observed, the most frequent milkline height was mid-line. Probably, this number will continue increasing because more and more farmers were interested in replacing the high-lines for mid-lines rather than low-lines. Farmers know that low-level milkline can improve vacuum stability during milking but also know that a great disadvantage of a low-line includes blocked aisles and the additional expense of a low line receiver group (twice or more expensive than others). In the same sense, advantages and disadvantages have been early commented by other authors (O´Brien *et al*., 1998). In the present study, the highly significant positive correlation between milkline height and SCC was demonstrated and was coincident with Clarke *et al*. (1997). Only the low-lines presented SCC within the recommended international level (Council Directive 92/46/EEC, 1992). Higher milklines could have a direct or indirect effect on SCC. The direct effect could be due to milk

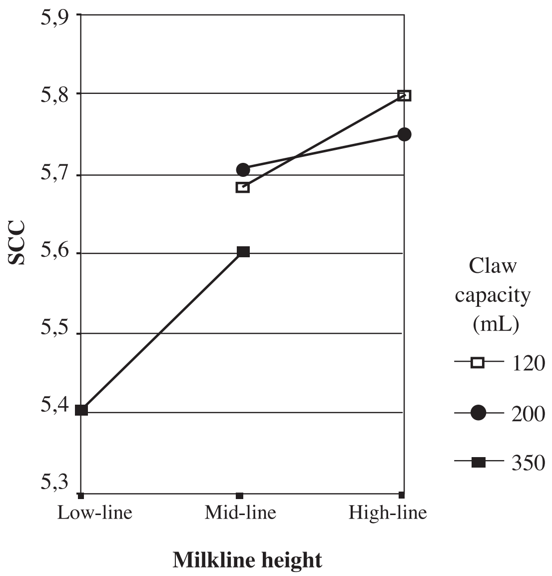

Figure 3. Effect of milkline height and claw capacity on somatic cell count [SCC (log_{10})] in thirty-four Chilean dairy farms.

Figura 3. Efecto de la altura de la línea de leche y la capacidad del colector sobre el recuento de células somáticas [SCC (log_{10})] en treinta y cuatro lecherías chilenas.

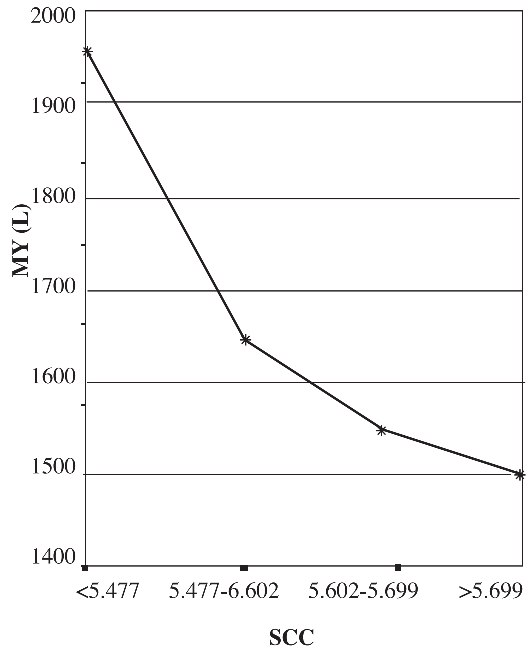

Figure 4. Effect of somatic cell count [SCC (log_{10})] on milk yield (MY) controlled at visit day in thirty-four Chilean dairy farms.

Figura 4. Efecto del recuento de células somáticas [SCC (log_{10})] sobre producción de leche (MY) registrada el día de visita en treinta y cuatro lecherías chilenas.

Regression method: inverse: MY(L)= b0 +(b1/ log_{10}SCC)
bo = -8691 SE 3621; b1 =57887 SE 18225; R^2 0.834 SE 102
SE: standard error

backflow from the long milk tube to the cluster bowl. The indirect effect could be on milking machine functioning (e.g. vacuum drops, droplet impacts, etc.), and these cause disturbances in udder health. Milkline height also had an effect on MY. In all those farms which had low-lines, MY was higher than those with high-line. It is known that low-line contributes better to avoid air flow blockage or unstable vacuum at teat-end during milking.

In the literature, there is little specific information concerning minimum recommended volume for claws due to claws and their capacity is closely related with other milking machine characteristics. In general terms, it is accepted that claws must have enough capacity for avoiding plethora during milking time when the milk flow peak occurs (Griffing *et al*., 1988). A smaller claw bowl volume was earlier described by Ohnstand (1998). As the milk production and milk flow rate increase, it becomes increasingly difficult to maintain the ideal vacuum conditions. A spacious claw and large diameter short milk tube make it possible to maintain a more even liner vacuum without having the teats floating in milk. In our study, daily milk yield per cow was not extremely high and probably the relationship milk yield/cow/day played an important role for avoiding a strong influence on SCC and clusters preventing backflow of milk. On the contrary, as was clearly observed, all those sampled dairy farms in which clusters had a small capacity SCC was higher. It is known that large capacity collectors proved that apparatus types and vacuum level have a significant influence on the majority of milking parameters (Krzys and Szlachta, 1999). More than corrective actions on cluster components (Lind *et al*., 1994), in sampled farms it shall be necessary to replace small clusters by medium or large ones depending on milk yield/cow and considering also the kind of milkline height available.

In our study, cows with high SCC also produced below the optimal level (Bartlett *et al.*, 1990). In the European Union, stricter regulations have been applied to SCC limits (Council Directive 92/46/ EEC, 1992). Poor milk quality at some Chilean farms, as was found in this study, have already been described (Garces-Avilez, 2000). These are in agreement with Majchrzak and Pelczynska (1997), but are very distant from others (Kalit and Havranek, 1998; Koldeweij *et al.*, 1999).

With respect to the results of our study, we agree completely with LeMire *et al*. (1999), that recommendations on milking equipment and settings are often based on general rules without taking into account the conditions on an individual farm. As we observed in our inspection visit, the construction of milk barns without an expert opinion will also influence milk yield (not reaching high levels) and udder health.

Although mastitis, expressed in SCC increasing with the consequent low milk yield due an udder health disruption, is not considered as a new disease. As in material and methods was commented, the results are based on a field study with a high diversity of farm structures. The farms mainly had in common (according SCC) a high prevalence of mastitis, and probably this will be maintained if the milking machine functioning and maintenance continues to be ignored by farmers, veterinarians and technicians. Good milking machine functioning and maintenance might be the only solution in order to obtain maximum benefits at studied farms.

Finally, in our opinion the best way to improve milk yield and SCC in all sampled Chilean dairy farms, must be better education on milk quality topics and an effective rural extension.

CONCLUSIONS

1. A non adequate NVL was one factor that influenced negatively SCC and MY.
2. The increase of SCC was more accentuated in those milking machines with high-lines than mid- and low-lines. A highly significant positive correlation between milkline height and SCC was found ($r = 0.41$; $P < 0.01$). Only low-lines presented SCC within recommended international levels.
3. Higher MY value was found in those farms which had < 44 kPa NVL.
4. In all cases, EVRD produced SCC above international recommendations. EVRD effect was not significant ($P > 0.05$) on MY.
5. There was no influence of the pulsation type on SCC and MY, but in all cases the association pulsation-pulsator produced a SCC above international recommendations.
6. Milking machines with a small capacity cluster volume showed a higher SCC. Low-lines with large claws (300-350 mL) had lower SCC ($P < 0.05$) when compared with mid-lines.
7. No significant influence of claw capacity on MY was found.
8. Cows with high SCC level produced below the optimal level.
9. Good milking machine functioning and maintenance might be the only solution in order to obtain maximum benefits at the studied farms.

ACKNOWLEDGEMENTS

We are grateful to Mr. L. Aránguiz P., serviceman of TPI-Chile S.A., Dairy Production/ Division Agri., for advising on milking machine testing at dairy farms.

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