IMPACT OF SOME UDDER HEALTH STATE INDICATORS ON MILK FREEZING POINT IN SMALL RUMINANTS AND CATTLE

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ABSTRACT

Milk freezing point (MFP) as physical indicator is used for milk food chain quality (MFCQ) control. Also udder health state (UHS) is important for MFCQ. This paper was aimed to show some relationships of MFP to other milk UHS indicators. There could be species differences. Cow milk was a reference to goat and sheep. Bulk milk samples came from 3 dairy herds of Czech Fleckvieh cattle (B) and 1 goat and sheep herd (White short-haired (W) and Tsigai (C)). Lactose (L), somatic cell count (SCC) and natrium (Na) content as milk indicators (MIs) were investigated as UHS indicators. Goat MFP was -0.5544 ± 0.0293 ºC and differed ($P \leq 0.001$) from B MFP -0.5221 ± 0.0043 and C MFP -0.6048 ± 0.0691 ºC. The MIs in ruminants were relatively normal with exception of higher SCC in W and C. The cow MFP was related to L (-0.36; $P < 0.01$). MFP was not correlated to L (-0.07; $P > 0.05$) in W and was related to L (0.40; $P < 0.01$) in C. In B it was in accordance with declared participation of L on MFP (54%). Different W and C results could be explainable by worse SCC. Results could be used for MFCQ control improvement.

***Key words*:** ruminant, cow, goat, sheep, milk freezing point, milk indicator, udder health state

INTRODUCTION

Raw milk quality is very essential for human nutrition. Milk freezing point (MFP) is an important polyfactorial physical and technological indicator. It is used for control of milk food chain quality (Buchberger, 1994; Kolosta, 2003) and addition water falsification. There is more measurement principles for MFP (Koops et al., 1989;

Bauch et al., 1993; Buchberger and Klostermeyer, 1995). Some authors (Demott 1969; Brouwer, 1981; Walstra and Jenness, 1984; Hanus et al., 2003b) reported lactose content as main factor of MFP depression (53.8%) in cow milk. Next factors are ions of inorganic and organic salts and urea. A practical factor could be foreign water addition by milking or next milk treatment. Rasmussen and Bjerring (2005) reported also an impact of automatic milking system. However, there is more impact factors (Freeman and Bucy 1967; Eisses and Zee, 1980; Buchberger, 1990a, b, 1991, 1994, 1997; Wiedemann et al., 1993) such as cow herd, breed of dairy cows, herd milk yield, year season, lactation stage, pasture, nutrition and feeding of dairy cows and their metabolic and udder health state (Hanus et al., 2003b). Also animal species is an essential factor (Janstova et al., 2007). Other technological impacts during pasteurization and processing are existing (Rohm et al., 1991; Roubal et al., 2004; Janstova et al., 2007) as well.

Sheep and goat farming is returning back into the Czech Republic (CR) because of confirmed positive effects of alternative milk consumption on human health. The importance of raw milk quality control is still growing not only for cows but also for goats and sheep (Antunac et al., 2001; Hejtmankova et al., 2002; Kuchtik and Sedlackova, 2003; Paape et al., 2007; Raynal-Ljutovac et al., 2007). There are also some problems with derivation of reliable MFP limits for milk quality control in various ruminant species. Aim of this paper was to compare the relations of freezing point to milk components or udder health state indicators among various ruminant species.

METERIALS AND METHODS

Breed, herd, animals and milk samples

The details of ruminant keeping were described previously (Hanus et al., 2005, 2008a, b; Gencurova et al., 2008a, b; Macek et al., 2008). Bulk milk samples (BMS) were collected from three dairy cow herds of Czech Fleckvieh (B; n = 93 BMS), one goat herd (W; White short-haired; n = 60) and one sheep herd (C; Tsigai; n = 60). BMS were obtained in spring and summer seasons for 3 years (2005-7). The herds were kept in altitudes from 360 to 475 (B) and 572 m (W and C) over the sea level. The goat and sheep herds were kept in one stable. The cow herds were fed on total mixed ration (maize silage, red clover and alfalfa silage with mineral and concentrate supplements). Feeding was performed according to actual daily milk yield. Goat and sheep herd was fed the natural grass and herb pasture and a daily grain supplement of 0.6 kg for goat and 0.3 kg for sheep (mixture of grains and mineral components). Animals were in first two thirds of their lactation (milk yield: B 20.04; W 1.75; C 0.36 kg per day). Animals were milked twice a day by machine milking.

Investigated milk indicators and statistical data processing

Milk analyses were performed regularly in accredited testing laboratory in Rapotin. The following abbreviations were used for investigated MIs: MFP = milk freezing point (°C); L = lactose (monohydrate %); SCC = somatic cell count ($10^3.ml^{-1}$); Na = natrium (in $mg.kg^{-1}$). L contents were determined by apparatus Milko-Scan 133 B. SCC was investigated by instrument Fossomatic. MFP was determined by cryoscope CryoStar automatic (Brouwer, 1981; Koops et al., 1989; Bauch et al., 1993; Buchberger and Klostermeyer, 1995). For Na was used atom absorption spectrophotometer SOLAAR S4 plus GFS97. The processing of the results included calculation of basic statistical parameters, regression analyse and correlation coefficients (Excel). Cow results were used as reference to small ruminant milk results.

RESULTS AND DISCUSSION

The average MFPs for goats, cows (B) and sheep (Table 1) were -0.5544 ± 0.0293, -0.5221 ± 0.0043 and -0.6048 ± 0.0691 ºC (Macek et al., 2008). Average MFP for Holstein cows was -0.532 ± 0.005 ºC (Hanus et al., 2008a, b). Rohm et al. (1991), Roubal et al. (2004) and Janstova et al. (2007) reported similar values. Values of other MIs in ruminants were within normal ranges (Hanus and Foltys, 1991; Antunac et al., 2001; Hejtmankova et al., 2002; Kuchtik and Sedlackova, 2003; Hanus et al., 2003a, 2004) with exception of SCC in W and C (Kuchtik and Sedlackova, 2003; Paape et al., 2007; Raynal-Ljutovac et al., 2007). Our values were higher. SCC results are usually higher in small ruminants.

Table 1. Averages and differences in MFP and other selected MIs according to ruminant species, goats (W), cows (B) and sheep (C)

MI	Unit	B x ± sd	W x ± sd	C x ± sd	B–W	B – C	W – C
MFP	°C	-0.5221 ±0.0043	-0.5544 ±0.0293	-0.6048 ±0.0691	***	***	***
L	%	5.06 ±0.117	4.43 ±0.287	4.44 ±0.380	***	***	ns
SCC	10^3 ml^{-1}	230.1 ±222.7	4,267.4 ±2297.9	948.5 ±1404.7	***	***	***
log SCC		2.2012 ±0.3694	3.5618 ±0.2589	2.7479 ±0.4012	***	***	***
Na	mg kg^{-1}	395.6 ±80.0	438.6 ±98.1	740.1 ±157.8	**	***	***

(MFP milk freezing point; L lactose; SCC somatic cell count; Na natrium; x arithmetical mean; sd standard deviation; *, ** and *** statistical significance $P \leq 0.05$, ≤ 0.01 and ≤ 0.001; ns $P > 0.05$.)

As shown in Table 2, regarding logical relationship between cow's MFP and L (-0.36; $P < 0.01$), surprisingly the goat MFP was poorly correlated to L (-0.07; $P > 0.05$) while sheep MFP was related positively to L (0.40; $P < 0.01$). This is in accordance with declared participation of L on MFP depression effect in cow milk (54%; Demott, 1969; Brouwer, 1981; Walstra and Jenness, 1984; Koops et al., 1989; Wiedemann et al., 1993; Buchberger, 1990, 1991, 1994; Hanus et al., 2003b). There are 12.6% of variation in cow MFP explainable by L variations. Opposite results could be explained by the worse geometric averages of SCC (poorer udder health state) for goat (3,646 $10^3.ml^{-1}$) and sheep (560 $10^3.ml^{-1}$) in comparison to cow (159 $10^3.ml^{-1}$). The current cow SCC with relatively good udder health state did not reduce L. It had not being compensated by Na ion secretion into milk or only restrictedly in terms of preservation of osmotic pressure. L could participate on Table 2.

Table 2. Comparison of relations of MFP to selected MIs (with linke to udder health state) among goats (W), cows (B) and sheep (C)

Species	MI	Regression equation	R^2	r	Significance
B	L	y = -9.64x + 0.0239	0.1262	-0.36	**
	log SCC	y = 6.6604x + 5.6784	0.0060	0.08	ns
	Na	y = 4,287.8x + 2,634.1	0.0534	0.23	*
W	L	y = -0.6457x + 4.0745	0.0043	-0.07	ns
	log SCC	y = -1.6751x + 2.633	0.0360	-0.19	ns
	Na	y = 322.76x + 617,5	0.0093	0,10	ns
C	L	y = 2.1723x + 5.7579	0.1561	0.40	**
	log SCC	y = -3.5673x + 0.5904	0.3778	-0.61	***
	Na	y = -368.87x + 517.04	0.0261	-0.16	ns

(R^2 determination coefficient; r correlation coefficient.)

MFP without disturbance. Under such circumstances, the MFP can be a little better along light SCC decrease (Table 2; $P > 0.05$). Also, Na concentration had not to have a negative effect on MFP (Table 2; 0.23; $P < 0.05$). In the case of higher or high SCC and worse udder health state (sheep and especially goats in this case) the L was probably a little reduced and osmotic pressure was balanced by higher simultaneous Na ion secretion with improvement of MFP (especially in sheep; Table 2). The participation of L on MFP was limited under such circumstances. The mentioned relationships could explain the obtained apparently antagonistic results.

CONCLUSION

MFP depression was created by various factors and rules as compared among more ruminant species. On this base, it could be possible to derive more reliable MFP quality discrimination limits for various ruminant species towards more efficient rules in monitoring possible milk quality problems in cows and small ruminants.

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