RELATIONSHIP BETWEEN MILK FREEZING POINT, SOUNDNESS OF COW'S UDDER AND MILK HYGIENIC QUALITY

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Investigation was carried out on 100 samples of milk obtained from cows of Holstein-Friesian and Ayrshire breed, being in 30–120 day after parturition. Subject of this study it was evaluation of relationship between milk freezing point level and parameters considered:
– udder health – soundness (cell number, pathogens presence, Cl, Na, K level, conductivity level, cytological tests/Mastcheck, CMT)
– milk hygienic quality (resazurine test, TBC, titration acidity, pH).
It was stated statistically correlation between milk freezing point level and parameters value characterized udder health-soundness (r = 0,297–0,456) and milk hygienic quality (r = 0,197–0,571). Evaluation of the freezing point of milk should consider also udder health and bacteriological contamination of it.

milk freezing point; soundness of cow's udder; milk hygienic quality; electrical milk-conductivity; Mastcheck test and total bacteria count

In Poland, milk evaluation is based on such factors (parameters) as: microbiological quality, antibiotics presence, health status of udder, sediments, composition, organoleptic traits as like as in Scotland. The milk freezing point is evaluated in EU countries additionally. The evaluation of milk freezing point is mainly concerned with water adulteration of it, but it can also depend on other factors.

The subject of this study is to define the relationship between the value of freezing point and two factors: udder health-soundness of cow and hygienic quality of milk.

MATERIALS AND METHODS

Investigation was carried out on 100 samples of quarter milk obtained from 25 cows (20 cows of Holstein-Friesian and 5 cows of Ayshire breeds). The cows came from the Scottish Agricultural College – Auchincruive farm. The average milk yield of a cow was 6 156 kg and 3.63% of fat. The cows used in this experiment were in one to three lactations and milk samples were collected between 30–120 days after parturition. Samples were taken by hand milking after washing. The performed analyses concerned:

- udder soundness: somatic cell count (Coulter Counter Model PA II)
- presence of pathogenic bacteria (media of Unipath Ltd.), chloride level (Chloride Meter 920), sodium and potassium level (AAS Varian AA 1275), Mastcheck test (Qualitative Mastitis Test Kit), CMT (Calgonit Milk Cell Test), electrical conductivity (Conductivity Meter Jenway 4070)
- milk hygienic quality: resazurine test, Total Bacteria count (TBC)
- titration acidity: pH, freezing point (Advanced Milk Cryoscope 4D11).

All analyses were performed in SAC laboratory (Scotish Agricultural College). The samples were not preserved and analyses were performed up to two hours after milk collection.

RESULTS AND DISCUSSION

Values of the determined parameters are presented in Tab. I. It should be mentioned that the experimental data were supplemented with the resazurine test. The results were as follows: in class I – 64 samples, in class II – 32 samples and in class III – 4 samples.

Simple tests used for the diagnostic of the udder health – soundness indicated positive reactions in 27 (CMT) and 15 (Mastcheck) of estimated samples. Based on the criteria determined by IDF / FIL, the following forms of asymptomatic mastitis were stated: latent in 36, non-specific in 9, subclinical in 6 quarters.

The main pathogens causing mastitis were: streptococci, *Escherichia coli*, *Staphylococcus aureus* in the order of incidence.

Based on the above data it can drawn that the estimated causes of the asymptomatic form of mastitis do not affect the udder immunological reaction and milk biosynthesis.

Relationships between freezing point and the experiment parameters are presented in Tab. II. It was found that the correlation between the freezing point and all estimated parameters was statistically significant.

Milk is a liquid and its chemical composition depends on biosynthesis in the mammary gland, physiological factors and its hygienic quality. Many of the physico-chemical milk traits (pH, titration acidity, time of coagulation, conductivity, viscosity) are affected by its composition. These parameters are used for evaluating milk nutritive and technological values. The freezing point is also included to them.

I. Experimental parameters values

Parameter		$\bar{x}$	SD
Cell number	(10^3/cm^3)	320.18	10.71
TBC	(10^3/cm^3)	8 469.95	109.62
Cl	(%)	0.104	0.0062
Na	(%)	0.065	0.0072
K	(%)	0.148	0.009
Titration acidity	(°SH)	6.98	0.20
pH		6.68	0.15
Freezing point	(°C)	–0.532	0.08
Conductivity	(S.m^{-1})	0.614	0.013

II. Relationship between the milk freezing point and other experimental parameters

Parameter		Freezing point (°C)	
		r	b
Cell number	(10^3/cm^3)	0.297^{++}	10.68
TBC	(10^3/cm^3)	0.197^{+}	78.51
Resazurine test	(I–III)	0.571^{++}	–
Cl	(%)	0.456^{++}	11.06
Na	(%)	0.320^{++}	15.28
K	(%)	-0.373^{++}	–15.61
Titration acidity	(°SH)	-0.329^{++}	–28.16
pH		0.357^{++}	0.18
Conductivity	(S.m^{-1})	0.561^{++}	0.78
CMT		0.375^{++}	–
Mastcheck test		0.489^{++}	–

$^{+}P = 0.05$, $^{++}P = 0.01$

According to Harding (1990) the milk freezing point is from –0.536 to 0.525 °C. Milk samples were collected from sound udders and milk hygienic quality was satisfactory.

Strictly speaking any changes in milk composition may affect the value of this parameter. Reasons for those changes can be physiological (feeding, stage of lactation) and diseases (mastitis).

Mitchell (1989) observed changes in the freezing point values in milk being the result of supplementing its with such components as: lactose, chloride, citrate, lactic acid. It was shown that an addition of 5% lactose decreased the freezing point by about 0.298 °C, 0.1% of chlorides decreased it by about 0.107 °C, 0.15% citrates by about 0,035 °C, 0.15% of lactic acid by about 0.03 °C.

The effect of supplementing milk with all these components resulted in a decrease in the freezing point level by about 78.7–85.9% of its normal value.

In this experiment a statistically significant effect of udder health – soundness and milk hygienic quality on the freezing point value was shown. Those two factors influence milk composition and its reaction. In case of mastitis there are available disturbances in milk synthesis and an increased cell membrane permeability. The result of this process is an increased level of sodium and chlorides, and a simultaneous decrease of calcium and phosphate in milk. Those changes in milk composition are connected with a decreased titration acidity and an elevated value of pH (Kisza, Sejko, 1987). Fernando and Spahr (1983) described the value of the mentioned components in the milk obtained from mastitis cows' udders. The levels were as follows: sodium – 0.115%, chloride – 0.170%, potassium – 0.135%. Pijanowski (1984) estimated calcium and phosphate decrease in milk from mastitis udders at 40–50% of its level in normal milk. He also determined the normal udder milk reaction as 6.5–6.7 pH and 6.5–7.5 titration acidity.

Another factor determining an increase in milk freezing point value was its hygienic quality expressed by such parameters as total bacterial count (TBC) and the resazurine test.

In this investigation a statistically highly significant effect of the milk hygienic quality on its freezing point was stated. This fact can be explained by changes in milk character as an electrolite under the influence of the lactic acid bacteria in milk.

Pijanowski (1984) reported that milk reaction depends on the lactic level. Factors affecting the lactic acid level are TBC (particularly the lactic acid bacteria) and amount of lactose in milk.

CONCLUSIONS

1. Udder health – soundness and milk hygienic quality have a statistically highly significant effect on the freezing point level of milk.
2. Evaluation of the freezing point in milk should consider also udder health of cow and milk bacterial contamination.

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Souvislost mezi bodem mrznutí mléka a sledováním stavu mléčné žlázy a kvality hygieny mléka.

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Práce je věnována studiu bodu mrznutí mléka jako parametru pro hodnocení jakosti syrového kravského mléka za účelem jeho zařazení do tříd jakosti.

Bod mrznutí byl dříve proměřován v laboratořích pro účely výzkumu, dnes i v příjmových laboratořích mlékárenských závodů za účelem stanovení jeho kvality a tím i ceny nakupovaného mléka.

ČSN 57 0529 vyžaduje vedle obsahu tuku a bílkovin od 1. 1. 1993 bod mrznutí nižší než –0,510 °C a od 1. 1. 1995 nižší než –0,515 °C. Obdobně v Polsku se začíná mléko hodnotit vedle mikrobiologické kvality a přítomnosti antibiotik (inhibičních látek) a dalších parametrů i podle bodu mrznutí. Tento parametr mléka je dnes dodatečně zařazen do hodnocení mléka v zemích celé EU.

Hodnoty bodu mrznutí jsou dány hlavně obsahem vody v mléce, ale závisí i na jiných faktorech. Předmětem této práce je ukázat na souvislosti mezi hodnotami bodu mrznutí a dvěma faktory: stavem mléčné žlázy a kvalitou hygieny mléka.

V rámci spolupráce Zemědělské univerzity v Krakově a Vysoké školy zemědělské v Praze jsme pro ověření existujících souvislostí provedli společná měření na školních podnicích obou univerzit s možnostmi adaptace pro naše farmy.

Zatím neúplná měření v ČR a Polsku potvrdila pokles bodu mrznutí v souvislosti s obsahem Cl (a tím nepřímo i obsahem somatických buněk a počtem mikroorganismů): při obsahu chloridů o 0,1 % vyšším se snížil bod mrznutí o 0,1 °C a při obsahu chloridů o 0,2 % vyšším o 0,22 °C při klesajícím koeficientu korelace. Podle údajů zahraniční literatury byla prokázána vysoká korelace mezi bodem mrznutí a hodnotami parametrů charakterizujících zdravotní stav vemene a kvalitu hygieny mléka.

bod mrznutí mléka; zdravotní stav mléčné žlázy; kvalita hygieny mléka; konduktivita mléka; test na mastitidu a obsah somatických buněk.

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