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Studies of Milk Freezing point as a Measure of Standardization

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Abstract: Trials were carried out on ITG farms and on purchasing area of the individual sector under conditions of Pomoravlje. Milk samples were directly taken from stables and from entire milk collected in dairy from the two ITG farms as well as that purchased from the cooperatives.

Freezing point of the whole natural milk sampled directly from the Simmental and Domestic Spotted cows 'udder was tested, followed by that of the milk collected from ITG farms and that of the cooperatives. In addition, the total milk of the Simmental and Domestic Spotted cows was supplemented with 5, 10, 15 and 20% water in order to determine milk freezing points with these dilutions. The results indicated the freezing point of the Simmental cows total milk to amount to 0.5422°C and that with domestic spotted ones to - 0.5419°C. Water added to the milk of Simmental and Domestic cows brought about a higher freezing point which approximated zero point per each per cent of water added on an average by -0.0060°C in Simmental and by -0.0055°C in domestic spotted cows.

In the milk collected from the individual sector, milk freezing point averaged -0.5195°C, which was even higher, i.e. very much close to the zero point compared to the total and sum milk from the farms.

Testing the differences between the mean values of freezing points of the total milk taken from the Simmental and domestic spotted cows directly from udder in the stable, and from those of the total milk from ITG farms and cooperatives, taken on the dairy loading platform, enabled us to conclude that the milk from the farms had a standard quality, whereas 5% water was added to the total one purchased from cooperatives.

Key words: milk, water, freezing point.

Introduction

Milk is produced in milk gland of a living organism as the physiological naturally determined liquid for progeny, being irreplacable in human nutrition throughout all the stages of life.

Milk value is not only attributed to the value of its components, but also to suitable ratios among individual ones being readily accepted by human organism.

A considerable advancement in milk production and processing in the Pomoravlje district has been evidenced in recent years thanks to construction of ITG farm in Jagodina and enhanced capacaties for cheese production within the same privately owned enterprise. Therefore, establishing of cattle farms in this company has largely facilitated cooperativeness among individual milk producers in this region.

The amounts of milk produced on the farms "Koncarevo" and "Jagodina" may ensure 60% of incoming raws, and those from the organised purchase of the individual sector some 40% of the milk amounts needed. Organised purchase thus encouraged individual producers to produce milk in greater quantity, and to dedicate themselves to market oriented production substituting, with support of farms, more productive Simmental cows for less productive heads (Domestic Spotted) or artificially inseminated autochthonous heads with sperm of good quality progenously tested bulls.

However, this production trend caused many problems regarding the quality of purchased milk and did not show to be so useful.

Pomoravlje represents the area with characteristic conditions affecting the quality and composition of milk. The high temperatures existing in the summer period take place just at the time when the greatest milk amounts are delivered, hence the greatest amounts of non-condition milk.

In order to achieve high quality of milk products, milk, as a raw, must be of good quality, both by chemical composition and hygienic appropriateness.

Since it is well known that milk changes from milking up to dairy loading platform, its quality must be maintained and improved with utmost care.

This research was dedicated to the effect of water added to milk on its freezing point.

Milk freezing point is assumed to be one of the physical constants serving as a measure of the milk uniqueness. Even small amounts of the water added can be proved by the method of Cryoscopy which is considered to be one of the most accurate methods provided they are applied with high precision. The temperature at which milk is converted from liquid into solid state with normal value of 0.55°C is taken as its freezing point. Depending upon lactosis and mineral matter amounts, the freezing point of milk may vary from 0.52 to 0.56, whereas its freezing point below and above these bounds indicates that water is added.

Materials and Methods

The research was aimed at seeking milk production at the farms of ITG Jagodina and and its purhase possibilities accordingly.

For data accuracy, in conditions of the Pomoravlje region, trials were conducted with fresh milk directly taken from the stable.

The trials on checking freezing point of all the natural milk, were carried out, too. For this purpose, five cows of the Simmental race were taken from the farm "Koncarevo" and five of Domestic Spotted breed from the individual producer - cooperative. The cows of these two breeds were picked out since they dominate by number on the area concerned.

The milk produced from the individual heads was diluted with 5, 10, 15 and 20% water in order to find out to which extent water added could influence milk freezing points. Altering milk with addition of water is obviously the easiest way of unallowable economic benefit.

In order to get a complete insight in the quality of milk being processed in the dairy, the total milk of the ITG "Koncarevo" and "Jagodina" and that of purchase area of the dairy from individual sector, were analysed.

Freezing points of the milk were determined using cryoscopic method on the cryoscope - FUNKE GERBE.

As in case of other water solutions, the freezing point of milk also stems from the concentration of water-resistant components. This concentration varies within small ranges with milk and is directly proportional to the number of particles in the solution. It is primarily determined with the components of a low molecular weight, lactosis and salts which are nearly independent of coloids and fat bowls variations. Cryoscopy principle was set at the beginning of the current century on the basis of cooling and reading of the freezing point with maximal temperatures. When gradually cooled, the liquid remains in liquid state even below freezing point, which is called chilling. Chilled liquid is unstable and even slight shaking may cause its crystalisation. After shaking, the temperature rapidly rises up to the freezing point and crystals are formed. With water, temperature remains constant until the whole amount is frozen. However, milk temperature changes, but only for a short time after which it starts to decline.

The samples of summed milk were taken at the dairy loading platform. The previous routine-like analyses of the milk with standard methods used, were immediately performed.

During the experiment, 420 milk samples were taken, and 840 assays of the milk freezing point done.

All the experiments were statistically processed. The mean values (x), the error of mean value ($S_{\bar{x}}$), standard deviation (S), variation coefficients (S%) and variations (min-max), were determined.

Testing of the differences between the mean values was performed for the milk freezing point.

Results and Discussion

Testing of the freezing point with individual cows. The quality of milk of the individual heads, taken in stables served as a trial standard milk. Comparing the obtained values of the whole - standard milk of the individual heads, being diluted with 5, 10, 15 and 20% water, with the total milk of ITG complex and with that purchased from individual sector, the information on the milk quality of the purchase area of ITG dairy was provided.

Tab.1. Statistical data processing of the milk freezing points of the individual heads

Cow race	$\bar{x} \pm S\bar{x}$	S	S%	variations min-max
Simmental	-0.5422 ± 0.0050	0.0277	5.152	-0.539 do -0.546
Domestic Spotted	-0.5419 ± 0.0049	0.0274	4.9900	-0.547 do -0.552

From tab. 1. one can see milk freezing points in Simmental cows, averaging -0.5422°C, with standard deviation of 0.0277, variation coefficient 5.152% and variation from -0.539 to -0.546°C.

The mean value of the milk freezing point with Domestic cows averaged -0.5419, standard deviation 0.0274, variation coefficient 4.9900% and variation from -0.547 to -0.552°C.

The data on the milk freezing point in both Simmental and Domestic Spotted cows, were tested.

Tab.2. Absolute difference between the average values of the milk freezing point in Simmental and Domestic Spotted cows

COW BREEDS	DIFFERENCES
Simmental	-0.0011^{NS}
Domestic Spotted	-

Data indicated no significant differences between milk freezing points ($P>0.05$).

Testing freezing points milk of the individual farms with the addition of water. Dilution of milk with 5, 10, 15 and 20% water indicated so far a particular percantage of added water changed the values of milk, as presented in Tab.3 and Fig.1.

With 5% of water added to the Simmental cows' milk, the mean value of the milk freezing point was -0.5145°C, standard deviation 0.0141 and variation coefficient 3.272.

With 10% of water added to milk, the mean value of the freezing point amounted to -0.4868, standard deviation 0.0111 and variation coefficient 3.2360.

With 15% of water added, the mean value of the milk freezing point was -0.4578, standard deviation 0.0255 and variation coefficient 5.6123.

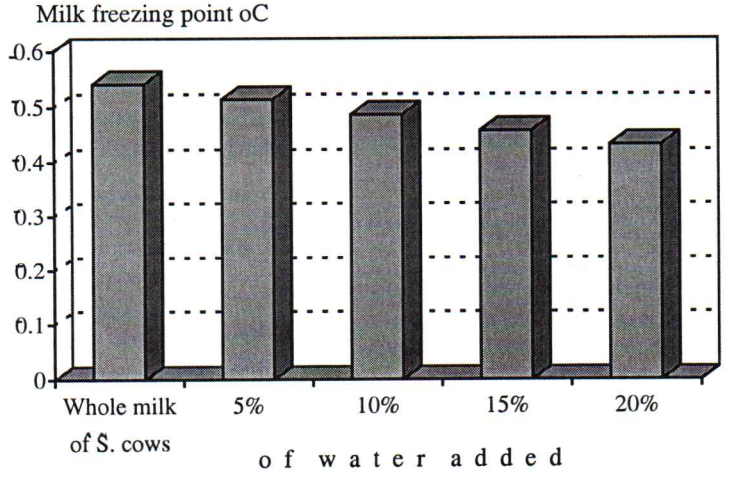
Tab.3. Milk freezing points with Simmental and Domestic Spotted cows

Cow breeds	$x \pm Sx$	S	S%	variations min-max
Simmental				
Whole milk	-0.5422 ± 0.0050	0.0277	5.152	-0.539 do -0.546
5%	-0.5145 ± 0.0025	0.0141	3.2720	-0.510 do -0.520
10%	-0.4868 ± 0.0021	0.0111	3.2360	-0.483 do -0.490
15%	-0.4578 ± 0.0045	0.0255	5.6123	-0.453 do -0.462
20%	-0.5327 ± 0.0040	0.0226	5.2670	0.431 do -0.437
Domestic Spotted				
Whole milk	-0.5419 ± 0.0049	0.0274	4.9900	-0.547 do -0.552
5%	-0.5130 ± 0.0022	0.0118	2.3190	-0.510 do -0.518
10%	-0.4851 ± 0.0020	0.0123	2.5772	-482 do -0.490
15%	-0.4565 ± 0.0035	0.0210	4.6730	-0.455 do -0.462
20%	-0.4304 ± 0.0047	0.0274	6.3170	0.427 do -0.435

After adding 20% water to the milk, the mean value of its freezing point amounted to -0.4578, standard deviation 0.0255 and variation coefficient 5.6123.

With Domestic cows, the milk with 5%, 10%, 15% and 20 % water added had the mean value of its freezing point of -0.5130°C, -0.4851°C, -0.4565°C and -0.4304°C, respectively.

Fig.1. Freezing point of the whole milk in Simmental cows and that with 5%, 10%, 15% and 20% of the water added



Tab.4. Absolute differences between the average values of the whole milk freezing point in Simmental and Domestic Spotted cows and that with water added

Differences	Whole milk Simmental cows	Whole milk Domestic Spotted cows
with 5%	0.0277^{+++}C	0.0381^{+++}C
with 10%	0.0554^{+++}C	0.0660^{+++}C
with 15%	0.0844^{+++}C	0.0946^{+++}C
with 20%	0.1095^{+++}C	0.1207^{+++}C

P>0.05 NS, P<0.05+, P<0.01++, P<0.001+++
NS= non-significant
W= whole milk

Testing the differences between the whole milk in both breeds and that diluted with water indicated their being already significant at the level of 5% water added (P<0.001).

Testing of the sum milk freezing point at the dairy loading platform. Comparing the differences in the sum milk freezing points with study results on the whole milk of the individual cows helped to get a better insight in the quality of milk from purchase area.

From tab.5 and Fig. 2., one can see the values of the summed milk freezing points.

Tab.5. Freezing point of the summed milk

ITG Farm	$\bar{x} \pm S\bar{x}$	S	S%	variations min-max
Koncarevo	-0.5414 ± 0.0065	0.0344	6.391	-0.540 do -0.548
Jagodina	-0.5408 ± 0.0048	0.0265	4.320	-0.538 do -0.545
Cooperative	-0.5195 ± 0.0046	0.0250	4.6950	-0.517 do -0.527

From tab.5 and Fig.2., one can see the average value of the milk freezing point from the Koncarevo farm amounting to -0.5414, standard deviation 0.0344, variation coefficient 6.391 and variation from -0.540 to -0.548°C.

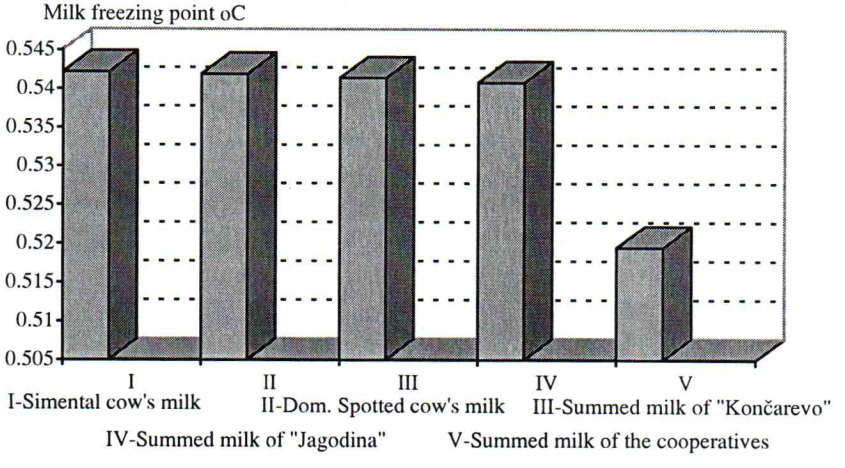
The freezing point of the Jagodina farm milk averaged -0.5400°C, standard deviation 0.0265, variation coefficient 4.320 and variation from -0.538 to -0.545°C.

The freezing point of the summed milk purchased from cooperatives averaged -0.5285°C, standard deviation 0.0250, variation coefficient 4.6950 and variation from -0.517 to -0.527°C.

Vasic J. (1973) obtained similar results, with the milk freezing point over the lactation averaging -0.5405, whereas Gutic, M. (1984) found this value to be -0.541°C in his research performed on the farm Buna.

From the following table (6), one can see the absolute differences between the mean values of the whole milk from stables and those of the sum milk from the farms and cooperative.

Fig.2. Freezing point of the whole and summed milk from the area under study



Tab. 6. Absolute differences between the mean values of the freezing points of the whole milk from stables and those of the summed milk from the farms and cooperative

Milk origin	Whole milk	
	Simmental breed	Domestic Spotted breed
Farm Koncarevo	0.0008^{NS}_{CM}	0.0005^{NS}_{CM}
Farm Jagodina	0.0014^{NS}_{CM}	0.0011^{NS}_{CM}
Cooperative	0.0303^{+++}_{CM}	0.0224^{+++}_{CM}

By testing the difference existing between the mean values of the whole milk directly taken from the stables with Simmental cows and those of Domestic Spotted cows' milk with the summed milk from the farm Koncarevo, "Jagodina" and that from cooperative, the following results were obtained: first, the differences in the mean values of the freezing points between the whole milk of both cow breeds and those of the summed one from the farms were non-significant ($P>0.05$), whereas those between the freezing points of the whole milk taken from the stable of both breeds, and that of the summed milk from cooperative were in favour of the whole milk of both breeds ($P<0.001^{++}+$) which means that the summed milk puchased from the dairy loading platform was diluted with 5% water.

Conclusion

Milk freezing point as a standardization measre was sought on ITG Jagodina farm with the whole milk of Simmental and Domestic Spotted cows being subjected to study. The milk was diluted with 5, 10, 15 and 20% water, as well as the summed milk from the ITG Koncarevo and Jagodina farms and that from the indivudual sector purchased from cooperatives.

On the basis of everything done, the following may be concluded:

- the average milk freezing point in Simmental and Domestic Spotted cows amounted to -0.5422°C and -0.5419°C, respectively;
- the addition of water in both Simmental and Domestic Spotted cows, brought about a higher freezing point of milk during the investigations, i.e. to a shift to zero for each per cent of water added, averaging by -0.0060°C in Simmental and by -0.0055°C in Domestic Spotted cows. The freezing point of the summed milk from individual sector was found to amount to -0.5195, which was visibly higher, i.e. closer to zero;
- by testing the differences in the mean values of freezing points of the milk directly taken from udder in stable with those of summed milk from the farms "Koncarevo" and "Jagodina" and with sum milk of the cooperative, the milk from farms was found to have standard quality, whereas that purchased from cooperatives had 5% water added.

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PRILOG PROUČAVANJU TAČKE SMRZAVANJA MLEKA KAO MERILA STANDARDIZACIJE

-originalni naučni rad-

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Rezime

U uslovima Pomoravlja rađeni su ogledi na ITG farmama i na otkupnom području individualnog sektora. Uzorci mleka uzimani su direktno iz štale i zbirnog mleka na rampi mlekare od dve farme ITG i od otkupa od kooperanata.

Ispitivana je tačka smrzavanja celog nepatvorenog mleka na osnovu uzoraka uzetih direktno iz vimena od krava simentalske i domaće šarene rase, zatim zbirnog mleka sa farmi ITG i zbirnog mleka iz otkupa od kooperanata. Osim toga, celom mleku krava simentalske i domaće šarene rase dodavano je 5, 10, 15 i 20% vode da bi se utvrdile tačke smrzavanja mleka sa tim razređenjima. Na osnovu dobijenih rezultata konstatovano je da je tačka smrzavanja celog mleka kod simentalske rase -0,5422^{o}C, a kod krava domaće šarene rase -0,5419^{o}C. Dodavanjem vode mleku simentalskih i kravama domaće šarene rase došlo je do povećanja tačke smrzavanja koja se pomerala prema nuli i to za svaki 1% dodane vode u proseku kod simentalske rase za -0,0060^{o}C, a kod domaće šarene rase za -0,0055^{o}C.

Kod zbirnog mleka individualnog sektora prosečna vrednost tačke smrzavanja iznosila je -0,5195^{o}C, što je znatno više, tj. bliže nuli u odnosu na celo mleko kao i zbirno mleko sa farmi.

Testiranjem razlika srednjih vrednosti tačaka smrzavanja celog mleka uzetog od simentalskih i domaćih šarenih krava direktno iz vimena u štali sa tačkom smrzavanja zbirnog mleka sa farmi ITG i zbirnim mlekom kooperanata, uzetog na rampi mlekare, može se konstatovati da je mleko sa farmi imalo standardan kvalitet, dok je zbirnom mleku otkupljenom od kooperanata dodato oko 5% vode.