SCIENTIFIC POSTER

Base Freezing Point Values of Untainted Goat, Sheep, and Water Buffalo Milk

J. Rosenman, E. Garry, Advanced Instruments, Inc., Norwood, MA

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ABSTRACT

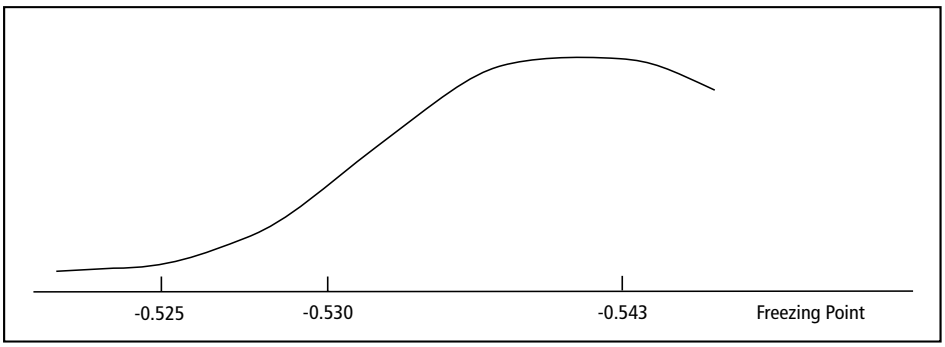
In the dairy industry, control systems are in place to ensure milk quality. A thermistor cryoscope is used to accurately determine the freezing point of milk. The average freezing point of pure cow milk is -0.543°H[1]. Milk adulterated with extraneous water, whether accidentally or intentionally, will have an elevated freezing point. The objective of this study was to determine base freezing point values for untainted goat, sheep, and water buffalo milk. Unadulterated bulk tank goat, sheep, and water buffalo raw milk samples were subjected to heat treatment at 63° ± 1C for 30 minutes prior to freezing point analysis. Freezing points of 378 goat, 46 sheep, and 87 water buffalo samples were tested on the Advanced® Cryomatic Milk Cryoscope, Model 4C2 according to the manufacturer's instructions. The mean freezing point of 378 bulk tank goat milk samples was -0.561 ± 0.009°H. The mean freezing point of 46 bulk tank sheep milk samples was -0.575 ± 0.010°H. The mean freezing point of 87 bulk tank buffalo milk samples was -0.521 ± 0.027°H. Base freezing point values were used to generate tables for estimating extraneous water in goat, sheep, and water buffalo milk. It is recommended, however, that laboratories establish their own base freezing point values for goat, sheep, and water buffalo milk in order to accurately quantify extraneous water.

INTRODUCTION

The most common adulterant in milk is extraneous water[1]. Accidental adulteration with water can occur due to poor system drainage since milk production and processing plants are wet cleaned. Purposeful adulteration to increase product yields also occurs but is believed to be rare. Adding extraneous water to milk, whether accidentally or intentionally, dilutes salt, lactose, protein, and other milk component concentrations thereby compromising milk quality.

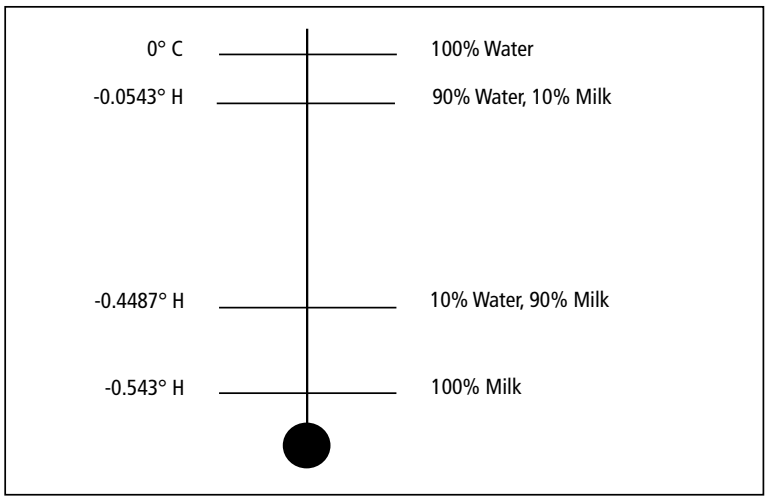
Freezing point testing is used in the dairy industry to detect the proportion of extraneous water in milk. International Standard, ISO 5764, specifies the thermistor cryoscope method as the reference method for determining the freezing point of milk by freezing point depression[2]. The freezing point test is based on the intrinsic balance of the osmotic pressure, or salt balance, of an animal's milk and that of its blood. This salt balance varies within narrow limits. Since freezing point is dictated by salt balance, it too can only vary within narrow limits, making it possible to detect extraneous water in milk. The freezing point distribution of unadulterated bulk tank cow milk (see Fig. 1.) fits a bell-shaped curve, with the highest distribution at 0.543°H[1].

Figure 1. Distribution of cow herd freezing points



Introduction (cont.)

Figure 2. Linear relationship between extraneous water in cow milk and freezing point



Dilution of milk with water progressively gives a freezing point approaching that of pure water (see Fig. 2.). Therefore, assuming a linear relationship, each 1% extraneous water will move the freezing point of cow milk 0.00543°H closer to 0°C.

In 2009, cows produced 580 million tonnes of milk, leading the world in milk production. Second to cows worldwide, buffalos produced 89 million tonnes of milk. Goats and sheep also provided significant, but lesser, amounts of commercial milk[3]. This study was conducted to establish base freezing point values for unadulterated goat, sheep, and water buffalo milk for the accurate quantification of extraneous water. While informative, base freezing point values must be applied with caution as a variety of factors may affect the freezing point of milk. These include but are not limited to season, geographical region, weather, animal health and breed, milk treatment and storage prior to testing, water intake, feed type, and time of milking.

MATERIALS AND METHODS

Sample Preparation

Bulk tank goat, sheep, and water buffalo raw milk samples were stored in the range 0°C to 4.4°C prior to sample preparation and analysis. Samples were subjected to heat treatment at 63° ± 1C for 30 minutes.

Testing Procedures

Freezing points of pasteurized samples were determined on the Advanced® Cryomatic Milk Cryoscope, Model 4C2 (Advanced Instruments, Inc.) according to the manufacturer's instructions. Samples were inverted 25 times in seven seconds through a one-foot arc before testing. Data was collected over seven years. In total, 378 goat, 46 sheep, and 87 buffalo milk bulk tank samples were tested.

"Adding extraneous water to milk, whether accidentally or intentionally, dilutes salt, lactose, protein, and other milk component concentrations thereby compromising milk quality."

RESULTS

The mean freezing point based on 378 bulk tank samples of goat milk taken over seven years was -0.561 ± 0.009°H (Fig. 3). The mean freezing point based on 46 bulk tank samples of sheep milk taken over seven years was -0.575 ± 0.010°H (Fig. 4).

The mean freezing point based on 87 bulk tank samples of buffalo milk taken over seven years was -0.521 ± 0.027°H (Fig. 5).

Extraneous water percentages based on mean freezing points are displayed for goat, sheep, and water buffalo in Tables 1, 2, and 3, respectively.

Figure 3. Vermont Agency of Agriculture, freezing point data for goat bulk tank milk

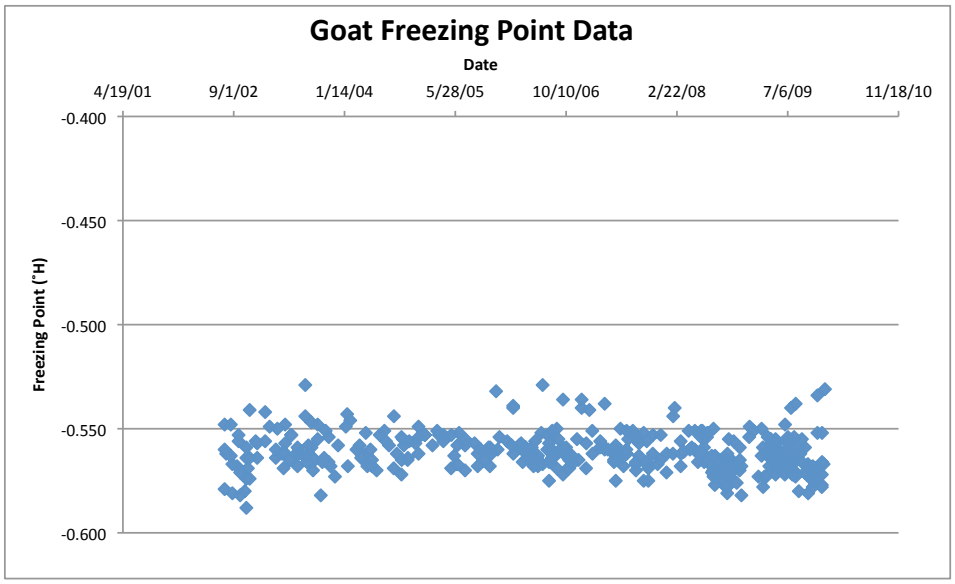


Table 1. Estimation of extraneous water in goat milk

Observed Freezing Point (°H)	Observed Freezing Point (°C)	Extraneous Water (%)
-0.561	-0.540	0
-0.555	-0.535	1
-0.550	-0.529	2
-0.544	-0.524	3
-0.539	-0.518	4
-0.533	-0.513	5
-0.527	-0.508	6
-0.522	-0.502	7
-0.516	-0.497	8
-0.511	-0.491	9
-0.505	-0.486	10

Figure 4. Vermont Agency of Agriculture, freezing point data for sheep bulk tank milk

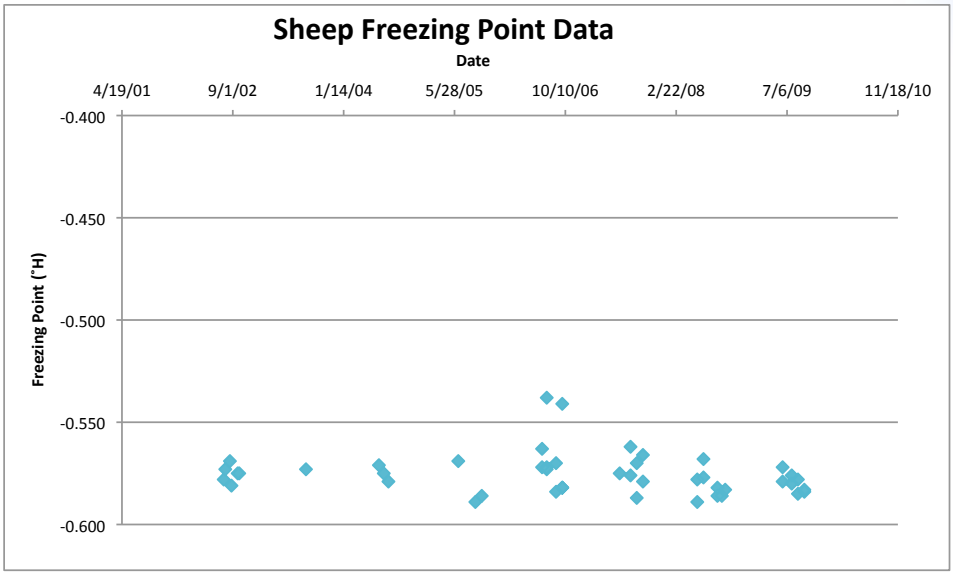


Table 2. Estimation of extraneous water in sheep milk

Observed Freezing Point (°H)	Observed Freezing Point (°C)	Extraneous Water (%)
-0.575	-0.554	0
-0.569	-0.548	1
-0.564	-0.542	2
-0.558	-0.537	3
-0.552	-0.531	4
-0.546	-0.526	5
-0.541	-0.520	6
-0.535	-0.515	7
-0.529	-0.509	8
-0.523	-0.504	9
-0.518	-0.498	10

Results (cont.)

Figure 5. Vermont Agency of Agriculture, freezing point data for water buffalo bulk tank milk

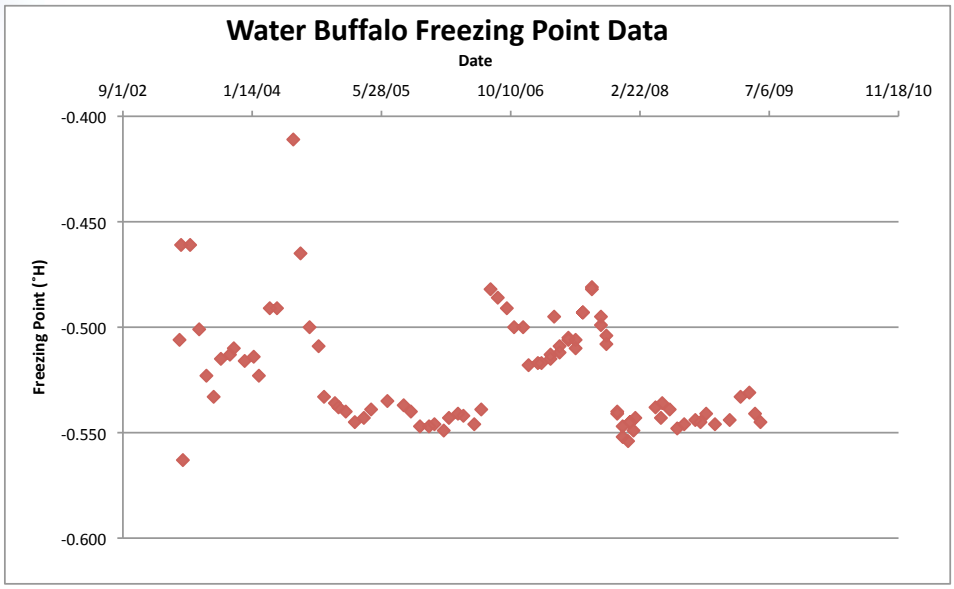


Table 3. Estimation of extraneous water in water buffalo

Observed Freezing Point (°H)	Observed Freezing Point (°C)	Extraneous Water (%)
-0.521	-0.501	0
-0.516	-0.496	1
-0.511	-0.491	2
-0.505	-0.486	3
-0.500	-0.481	4
-0.495	-0.476	5
-0.490	-0.471	6
-0.485	-0.466	7
-0.479	-0.461	8
-0.474	-0.456	9
-0.469	-0.451	10

CONCLUSION

The base freezing point values reported herein for goat, sheep, and water buffalo milk should be applied with caution since values may vary both seasonally and regionally. It is recommended that laboratories establish their own base freezing point values. Once established, base freezing point values can be used to generate tables for estimating extraneous water in milk.

REFERENCES

1. Harding, F, 2005. Milk Quality. New York, Chapman & Hall.
2. ISO 5764. Milk - Determination of freezing point - Thermistor cryoscope method (Reference method).
3. World Dairy Situation, International Dairy Federation (IDF) World Dairy Summit, 2009.

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ADVANCED INSTRUMENTS, INC.
Two Technology Way / 781-320-9000
Norwood, Massachusetts 02062, USA
800-225-4034 Fax: 781-320-8181
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