The Effects of Raw Milk Storage Conditions on Freezing Point, pH, and Impedance

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ABSTRACT

In the dairy industry, raw milk samples collected for quality testing should be tested or refrigerated immediately to control bacterial growth. A thermostor cryoscope is used to accurately determine the freezing point depression (FPD) of raw milk. Milk containing exogenous amounts of water will have a greatly elevated FPD. Milk that has been spotted or adulterated with other sources, such as sugar or salt, will similarly depress the freezing point, potentially masking the addition of added water. The pH of milk is a general measure of acidity in the sample. Lower pH values indicate an acidification process such as bacterial spoilage. Impedance methods monitor changes in the metabolic processes and will measure lactic acid as a by-product of lactose, for example.

The purpose of this study was to show the effects that storage conditions on FPD, pH, and impedance of raw milk. In two identical experiments, 20 raw milk samples were stored at 20-25°C and 2 at 2-8°C. All samples were tested at numerous intervals throughout this time period. Spoiled and unspoiled milk samples generated similar results using all three methods up to 168 hours. Three tests were completed at each testing interval, for a total of 18 tests. For the two identical experiments, raw milk was purchased and stored at 20-25°C, and 20 at 2-8°C, for 168 hours. All samples were tested at numerous intervals throughout this time period.

RESULTS

Many factors can mask the addition of water to milk. The addition of sugar, salt, and milk solids will depress the freezing point, masking any water that could have possibly been added. Another possible item that can mask the addition of water is the presence of foreign matter prior to testing. Bacterial spoilage will cause a depression in the freezing point, therefore masking the addition of water.

Spoiled and unspoiled milk samples generated similar results using all three methods up to 24 hours of storage. Above 24 and 48 hours, the FPD of the spoiled milk was erroneously depressed by an average of 102.4 m°C (Figs. 3, 4), the pH was lowered by an average of 1.19 units (Fig. 5), and the impedance measurement dropped by an average of 19.1 ohms (Fig. 6). A thermistor cryoscope is used in estimating the proportion of water in milk by the freezing point depression method. The basis of this test is related to the freezing point lowering, or freezing point depression, of a cow’s milk and its blood. Chromic pressure of a cow’s milk can vary very by narrow limits and it follows that the salt balance of her milk (throughout the day) can only vary by minor percentages. The average freezing point of normal milk is about 0.5°C. Additional solutes will depress the freezing point, whereas abnormal water intake or test feeding will elevate the freezing point up to 1°C.

Impedance measurements or electrical conductivity of milk samples stored at varying temperatures can also be used to indicate extent of spoilage. As bacteria multiply, they convert large molecules into smaller, more mobile metabolites (Fig. 2), which change the electrical properties of the medium. These metabolites increase the osmotic pressure related to the salt balance, or osmotic pressure, of a cow’s milk and its blood. Osmotic pressure is closely related to the salt balance, or osmotic pressure, of a cow’s milk and its blood.