Significance of Nutritional Effects on the Freezing Point of Milk

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Milk freezing point estimates are used by Dairy Farmers of Ontario (DFO) to indicate milk with water added. Average milk freezing point is –0.540 °Hortvet (H). If the freezing point estimate is >-0.530 °H in a milk sample a warning is provided to the producer. At a freezing point test >-0.525 °H a financial penalty is imposed on the producer.

High milk freezing point (penalty level) is widely recognized to be caused in almost all cases by freezing of the milk during cooling, or water added to the milk due to rinse water going into the tank or water added to the tank. An unbalanced ration, including factors such as low energy or lack of grain, and lack of salt or minerals are frequently cited as other possible causes of high milk freezing point when problem cases are investigated.

Little research has been published in the past 20 – 30 years on the effect of feeding on milk freezing point. Reviews of older published research (3 and 6) indicate that nutrition can have a statistically significant effect on milk freezing point. Whether the effects of feeding on milk freezing point can be large enough to cause a milk freezing point violation is uncertain.

Milk is in osmotic equilibrium with the blood so that the physiological mechanism that keeps the osmotic equilibrium of blood within narrow limits is the direct cause of the relatively constant freezing point of milk (3). Lactose, chloride, citrate and lactic acid account for 79 – 86 percent of milk freezing point depression relative to water (4 cited in 6). However, (4 cited in 6) also reported that these components are not independent of each other. In most cases variation in one component is compensated for by variations in the other components to keep the freezing point constant. Given these tight physiological constraints on milk freezing point it is unlikely that nutritional factors could have a large impact except in very extreme cases that severely compromise the health or even the survival of the cow.

Low energy diets due to low grain feeding and/or poor quality forages are often indicated as a possible cause of elevated milk freezing point. In Australia (5) fed 4 Jersey heifers in a series of cross-over experiments. Restricted energy & restricted roughage rations compared with a high energy ration (pasture plus 8 lbs/day corn) and a normal pasture ration (no supplement) were investigated. The animals on the low roughage, low energy rations lost weight rapidly, milk yield was depressed and the solids-not-fat content of the milk declined by approximately 20%. These rations were essentially starvation level. Milk freezing point was –0.538 °H versus –0.547 °H for the animals fed the control
(normal pasture) ration, an increase of 0.009 °H. Although the milk freezing point remained well below the warning level in this case, an increase of this magnitude could possibly elevate milk freezing point to the warning level in Ontario.

In a trial involving 18 cows for weeks 8 to 40 of lactation the effect of fibre levels on milk freezing point was measured by feeding TMR’s ranging from 51% chopped hay & 49% concentrate to 9% chopped hay & 91% concentrate (2). These diets ranged from normal lactating dairy diets to feedlot finishing type diets in regards to fibre and grain levels. Milk freezing point was 0.005 °H higher, -0.548 °H, for the 9% chopped hay diet compared to –0.553 °H for the 51% chopped hay diet. Very high grain feedlot type diets in dairy cattle would cause acidosis and depressed butterfat and milk production, although production data was not reported in this trial. These results indicate that extremely high grain – low fibre diets can increase milk freezing point, but not enough to reach the warning or penalty level.

Salt is often cited as a possible nutritional factor affecting milk freezing point. (1) compared 0, 1, 2 and 4 percent salt levels added to the grain mix fed to Holstein cows milking approximately 20 kg/day in a 4 x 4 Latin Square design with 2 week feeding periods. Feeding no salt resulted in milk freezing point of –0.548 °H, an increase of 0.003 °H, compared to –0.551 °H for the normal salt (1% added to grain mix) diet. Increasing salt up to 4% of grain mix only reduced milk freezing point by an additional 0.002 °H to –0.553 °H. These results indicate that lack of salt will not increase milk freezing point nearly enough to reach the warning level. If no source of sodium were included in the diet for longer periods of time it would result in depressed feed intake and milk production and severe health problems long before it would cause a milk freezing point problem.

Case histories from Wisconsin are discussed in (6) in which bulk tank samples had freezing points as high as –0.523 °H. Individual cow samples from these herds had milk freezing points in the range of –0.534 °H to –0.523 °H. Poor quality hay, high in fibre, is mentioned for 2 of the farms and lack of available salt mentioned for another farm. However no details are provided regarding the diets fed or the condition of the cows, making it impossible to draw conclusions from these reports regarding nutritional effects on milk freezing point.

In Ontario, George MacNaughton of DFO and Jack Rodenburg of OMAF (personal communication) can recall approximately 4 cases of nutritionally related milk freezing point problems during the past 25 years. These involved herds feeding poor quality pasture or hay with little or no grain. Body condition scores of cows were often in the range of 1 to 2. The diets were described as starvation type by both sources.

In conclusion, based on the physiological controls on milk freezing point, published research and case history in Ontario, the probability of an unbalanced feeding program causing a milk freezing point warning or penalty is extremely remote, although perhaps not impossible. A nutritionally related milk freezing point problem could only be considered a possibility where a starvation type of diet including very poor quality and/or
restricted amount of forages and little or no grain is fed. Evidence of this would include extremely low milk production and body condition scores of 2 or below for many cows in the herd. Animal welfare and humane treatment of animals would be a probable concern. There is no evidence that lack of salt or mineral imbalance could cause a milk freezing point problem. With the exception of very rare cases where starvation type feeding is evident, unbalanced feeding programs or nutrition should not be noted or discussed by industry professionals as a possible cause of elevated milk freezing point when problem cases are investigated. Within the bounds of normal feeding practices – including poorly balanced rations sometimes fed – nutritional effects on milk freezing point are not large enough to cause a milk freezing point warning or penalty.

References


