

Effect of milking time, temperature and diet nitrogen level on milk composition of dairy cows and on some milk properties (freezing point, lipolysis and heat stability)

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Take home message Cows that received a diet with high nitrogen level produced milk with less lipolysis.

Introduction The originality of this experiment was to take interest in the native properties of the milk which are decisive for future milk consumption or transformation: lipolysis, heat stability and freezing point. We tested the impact of feeding restriction (nitrogen level of diet) and climate parameters (ambient temperature) associated with milking time (morning or evening) on milk composition, structure and native properties.

Materials & methods The experiment, performed in closed and controlled experimental rooms, followed a double Latin 4 x 4 square design, using 4 Prim'Holstein dairy cows, during 4 periods of 3 weeks each and using 4 treatments. We compared 2 levels of nitrogen in the diet (a diet poor in degradable nitrogen, 13.5% crude protein, named N-, and a diet rich in degradable nitrogen, 17.5% crude protein, named N+) crossed with 2 levels of ambient temperature (18°C during the whole day, T- or a diurnal peak of 28°C for 7 hours, T+). The first week was used as an adaptation period to the diet (N+ or N-). The temperature factor (T+ or T-) was applied during the second and third weeks. Milk was sampled during 2 days of the second week at each milking (morning and evening).

Results & discussion Milking time had no effect on milk protein content, but milk fat content increased in evening milk (+1.5 g/kg, Table 1). Evening milk contained more unsaturated fatty acids (+0.9 units percent) and had an increased activity of $\Delta 9$ -desaturase (increase of c9C14:1/C14:0 and c9C16:1/C16:0 ratios). Ferlay *et al.* (2010) found the same results. This difference between morning and evening milking may be related to the intervals between the milkings or to the difference of activity of dairy cows in the day or in the night. In evening milks, freezing point was higher (+0.08 °C), heat stability was lower (-0.6) and lipolysis was higher (+0.42 mEq/100 g fat). The increased lipolysis could be explained by the longer interval between evening and morning milking (14 h) than between morning and evening milking (10 h), as suggested by Bachman *et al.* (1988) who did not find any difference in lipolysis levels between morning and evening milks taken at identical milking intervals (12/12 h).

Table 1 Effects of temperature and nitrogen level on milk physical properties.

	T-		T+		RMSE	T effect	N effect	N×T effect
	N-	N+	N-	N+				
Milk fat globule size, μm	3.89	3.92	3.87	3.97	0.154	0.795	0.079	0.335
Milk casein size, nm	141.6	146.2	139.2	133.1	10.11	<0.001	0.726	0.016
Heat stability	9.8	9.9	10.6	10.1	0.56	0.062	0.528	0.256
Freezing point, °C	-0.527	-0.527	-0.525	-0.531	0.0014	0.360	0.015	0.030
Lipolysis, mEq/100 g fat	0.85	0.75	0.89	0.69	0.162	0.891	0.012	0.345

Temperature had no effect on milk fat and protein contents. T+ decreased milk casein size. T+ significantly increased C7:0, C10:0, C11:0, C14:0, C15:0. T+ tended to increase milk heat stability (+0.4, P=0.062), and had no effect on freezing point and lipolysis. The lack of effect of temperature on lipolysis is surprising because there is often a peak of lipolysis in summer. It could be due to problems with the room temperature regulation system and therefore lower mean temperatures than expected. **Nitrogen level** had no effect on milk fat and protein contents and on milk fatty acid composition. N+ significantly decreased milk calcium content (-28.5 mg/kg). N+ tended to increase milk fat globule size (+0.06 μm , P=0.079) and had no effect on milk casein size. N+ had no effect on milk heat stability but decreased freezing point especially with T+ (0.06 °C) and lipolysis (-0.15 mEq/100 g fat). This result on lipolysis agreed with Salih and Anderson (1979) who found that diets with high levels of total nitrogen content (18% vs 9%) resulted in a decrease in lipolysis.

Conclusion Diets with high levels of nitrogen seemed to decrease lipolysis. This rather original result should be confirmed with new experiments using more animals. The effects of temperature were disappointing. We confirmed that lipolysis is higher in evening milk with no explanation at that time.

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References

- Bachman KC, Hayen MJ, Morse D and Wilcox CJ 1988. Journal of Dairy Science 71, 925-931.
 Ferlay A, Martin B, Lerch S, Gobert M, Pradel P and Chilliard Y 2010. Animal 4, 627-640.
 Salih AMA and Anderson M 1979. Journal of Dairy Research 46, 623-631.