

Complete nitrogen balance in dairy cows: does every drop of sweat count?

Nadège Edouard¹, Angèle Suzanne^{1,2}, Philippe Lamberton¹, Benoît Rouillé², Philippe Faverdin¹

¹PEGASE, INRA, Agrocampus-Ouest, Rennes, France, ²Institut de l'élevage Service Productions laitières, Paris, France

E-mail: nadège.edouard@inra.fr

Take home message Complete N balance measurements should consider N flows through cows' sweat as a potential contribution to pollutant emissions, in relation with feeding and climatic conditions.

Introduction Estimation of nitrogen use efficiency and losses towards the environment are often based on nitrogen balance measurements at the animal level. However, these N balances are most of the time positive in the literature, unaccounted N representing between 2 and 8% of the nitrogen ingested and being positively linked with the diet N level (Spanghero and Kowalski, 1997). If this unaccounted N probably has minor consequences on efficiency calculation (N intake and N in milk measurements being reliable), it could have strong impacts whether these losses contribute or not to the pollutant emissions from the system (e.g., NH₃, N₂O). Urea is the major N metabolic waste and is mostly excreted in the urine. Urea is also known to diffuse passively and should therefore be found in all aqueous body compartments. In addition, Cutullic *et al.* (2013) suggested that the unaccounted N could be positively related to the animal water balance (evapotranspiration) above thermoneutrality. We therefore tested the hypothesis that sweat contains nitrogen in the form of urea, all the more that diet N level is high, and that the consideration of this flow could contribute to reduce unaccounted N levels.

Material & methods As a preliminary step, we elaborated a device for the recovering of sweat on the animal skin surface, composed of an acidified compress placed under a plastic capsule, maintained on the cow hip (one per hip) for 24h. The experiment was performed in closed and controlled experimental rooms. It followed a double Latin 4 x 4 square design, using 8 Prim'Holstein dairy cows, during 4 periods of 3 weeks. We compared 2 diet N levels (N-: diet poor in degradable nitrogen, 13.5%CP; N+: diet rich in degradable nitrogen, 17.5%CP), 2 ambient temperatures (T-: 18°C during the whole day; T+: diurnal peak of 28°C for 7 hours, 20°C during the night) and their interaction. 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. Complete N balance measurements were performed including N losses through the cows' sweat (for half of the cows).

Results & discussion The diet N level greatly affected N intake and N excretion in urine (Table 1). N in milk was also 10 g/cow/day higher for N+ because of a higher milk production (+1 kg/cow/day). Temperature did not seem to influence N balance parameters even if a tendency (p<0.1) could be observed for N secreted in urine and sweat. Sweat urea content was on the average comprised between 150 and 300 mg/L, tending to be higher for T+ (p<0.1). These levels, believed to be minimums considering potential losses during sampling analyses, were quite close to plasma urea contents. However, inter and intra-cow variations were very elevated.

Table 1 Effects of nitrogen level and temperature and on N balance parameters (g/cow/day).

	n	N-		N+		RMSE	N effect ¹	T effect ¹	N×T effect ¹
		T-	T+	T-	T+				
N intake	31	402	393	539	534	25	***	ns	ns
N in milk	31	144	141	156	152	9	***	ns	ns
N in urine	31	121	109	220	208	18	***	t	ns
N in faeces	31	119	115	117	115	10	ns	ns	ns
N in sweat	15	3	5	4	6	2	ns	t	ns

¹ Results from the ANOVA model, ns: non-significant, t: p<0.1, ***: p<0.001

Conclusion This study showed that sweat contained urea, leading to N losses between 8 and 21% of unaccounted N at the animal level. At the skin surface, this urea could volatilize and contribute to gas emissions at the barn level. More research is now needed to refine the sweat recovering device to decrease inter and intra-cows variations and ensure that urea is not lost during sampling. Considering this flow should contribute to better evaluate complete N balance at the animal level in contrasted feeding and climatic situations.

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References

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