The relation between nitrogen efficiency and nitrogen partitioning in dairy cows on commercial farms

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Enhancing nitrogen (N) use efficiency (NUE; milk N output/N intake) improves resource efficiency and reduces the environmental impact of dairy farming. Increasing the faecal-to-urinary N ratio (FN:UN) is desirable, as faecal N is less prone to volatilization, denitrification, and leaching than urinary N. This study aimed to improve our understanding of NUE variability in dairy cows by collecting and analysing faecal and urinary samples of 483 cows across four Dutch commercial farms, recording individual feed intake. Three farms were visited twice, and one farm was visited once, resulting in seven sampling periods. During each period, milk yield and composition were determined, and spot samples of faeces and urine were collected at six 4-hour intervals over three to four consecutive days (i.e., 0–4, 4–8, 8–12, 12–16, 16–20, 20–24 h). Nitrogen content was analysed in pooled urine, faeces, and feed. Creatinine and acid-insoluble ash concentrations were used to estimate urine and faecal output, respectively. Data were analysed using a mixed model, with NUE as dependent variable and N partitioning, sampling period, and the interaction with sampling period as explanatory variables. Days in milk (DIM), body weight and parity were included as covariates, and period was included as random effect. On average, cows had a parity of 1.5 ± 0.73, were 138 ± 53.2 DIM, producing 37.4 ± 7.33 kg/day of milk with a NUE of 305 ± 42.6 g/kg, apparent total tract N digestibility of 65.6 ± 6.67%, microbial N efficiency of 28.6 ± 5.34 g/kg digested organic matter, FN:UN of 1.06 ± 0.249, urinary N/N intake of 325 ± 53.1 g/kg, urinary N/digested N of 502 ± 105.7 g/kg, and N retention of 23 ± 67.3 g/d. Dietary crude protein averaged 181 ± 9.7 g/kg DM. Preliminary results indicate that NUE related positively with microbial N efficiency and negatively with N retention ($P < 0.01$). Furthermore, NUE related positively with N digestibility (N digestibility × period, $P < 0.05$) and negatively with FN:UN (FN:UN × period, $P < 0.05$) in three out of seven sampling periods. Additionally, NUE was positively related with the urinary N to N intake ratio (urinary N/N intake × period, $P < 0.01$) and urinary N to digested N ratio (urinary N/digested N × period, $P < 0.01$) in two out of seven sampling periods. In conclusion, preliminary findings reveal that an increase in NUE is consistently associated with greater microbial N efficiency and lower N retention. An increase in NUE was associated with a shift in N excretion, with a lower proportion of N excreted in faeces and a higher proportion excreted in urine, depending on farm or period of visiting farms.

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