**Application**

Reducing the crude protein concentration of supplementary concentrate, offered to late-lactation grazing dairy cows, did not reduce milk production performance.

**Introduction**

Irish pastures typically provide sufficient CP, especially in autumn when pasture CP is naturally high. Consumption of high CP pasture, coupled with the cow’s metabolisable protein requirements reducing during late-lactation (Bargo et al., 2003; Ipharraguerre & Clark, 2005), can lead to increased urinary nitrogen excretion. High urinary nitrogen excretion can increase the risk of nitrate leaching, especially under higher rainfall conditions (Selbie et al., 2015). To address this, low-CP concentrates offer a practical strategy to reduce nitrogen losses.

Previous research has examined the effects of lowering CP in concentrate feeds, though typically not at the reduced levels explored in this study. However, when dietary CP levels are low, specific amino acids may become limiting, potentially restricting milk production (Zhang et al., 2023). Furthermore, understanding how such reductions interact with the genetic merit of dairy cows is crucial for encouraging widespread adoption of low-CP strategies, as robustness to dietary changes may vary across different genetic lines (O’Sullivan et al., 2019). In this study, genetic merit was determined using the Economic Breeding Index (EBI), an Irish index that ranks dairy cows based on their genetic potential for profitability.

The objective of this experiment was to investigate the effect of concentrate crude protein and amino acid supplementation on the milk production of late-lactation, grazing dairy cows of divergent genetic merit.

**Materials and Methods**

An 8-wk experiment was conducted at the Dairygold Research Farm (Kilworth, Co. Cork, Ireland) from September to November, 2023. Eighty-eight Holstein Friesian cows were blocked based on pre-experimental milk production, parity and EBI and were then randomly assigned to 1 of 4 dietary treatments (n = 22). The dietary treatments consisted of supplemental concentrates with varying CP concentrations: 1) 170 g/kg of DM (H); 2) 130 g/kg of DM (M); 3) 95 g/kg of DM (L); and 4) 95 g/kg of DM with rumen-protected amino acids (LAA; 8.0 g/day absorbable Met and 7.2 g/day absorbable Lys). Cows received 1.79 kg of DM of concentrate daily in the milking parlour and grazed separately on swards consisting predominantly of perennial ryegrass. Milk yield was recorded daily (Dairymaster), with weekly analysis for constituents (MilkoScan 7). The two genetic groups (mean ± SD), high EBI (HEBI; €262.66 ± 32.92) and low EBI (LEBI; €185.02 ± 33.94), were balanced across dietary treatments. Data were analysed using the MIXED procedure in SAS (v9.4), with fixed effects of dietary treatment, week, dietary treatment by week interaction, genetic group, genetic group by dietary treatment interaction, and parity. An appropriate covariate adjustment was made per cow. Repeated measures were based on week with cow as a random effect. Significance was considered at P ≤ 0.05.

**Results**

Reducing the concentrate CP concentration had no effect on milk production and milk composition (Table 1). Amino acid supplementation also had no effect, except for milk fat concentration, where cows fed LAA had greater milk fat concentrations when compared with H, but were similar to M and L (*P* = 0.02). Genetic group had an effect on all milk production outcomes except for lactose concentration (*P* = 0.08; Table 1). Cows of LEBI had greater milk yield when compared with cows of HEBI (*P* = 0.04). Cows of HEBI had greater milk fat and protein concentration, as well as, greater milk solids yield (*P* < 0.01). There was a genetic group by dietary treatment interaction for milk fat and protein concentrations (*P* = 0.01 and 0.04, respectively).

**Table 1: Effect of concentrate crude protein on the milk production and composition of late-lactation, grazing dairy cows of divergent genetic merit**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Dietary treatment1 | | | |  | Genetic group2 | |  | *P*-values | | |
| Item | H | M | L | LAA | SEM | HEBI | LEBI | SEM | DT | GG | DT\*GG |
| Milk yield, kg/d | 14.1 | 13.9 | 14.3 | 14.0 | 0.20 | 13.9 | 14.3 | 0.14 | 0.33 | 0.04 | 0.72 |
| Fat concentration, g/kg | 55.1b | 57.3ab | 55.5ab | 57.6a | 0.69 | 58.7 | 54.1 | 0.50 | 0.02 | <0.01 | 0.01 |
| Protein concentration, g/kg | 44.5 | 44.2 | 44.6 | 45.2 | 0.28 | 45.9 | 43.4 | 0.20 | 0.09 | <0.01 | 0.04 |
| Lactose concentration, g/kg | 45.0 | 44.7 | 44.9 | 44.6 | 0.15 | 44.6 | 44.9 | 0.11 | 0.15 | 0.08 | 0.06 |
| Fat yield, kg/d | 0.77 | 0.78 | 0.79 | 0.79 | 0.01 | 0.80 | 0.77 | 0.01 | 0.63 | <0.01 | 0.48 |
| Protein yield, kg/d | 0.62 | 0.61 | 0.63 | 0.62 | 0.01 | 0.63 | 0.62 | 0.01 | 0.13 | 0.05 | 0.71 |
| Lactose yield, kg/d | 0.64 | 0.62 | 0.64 | 0.62 | 0.01 | 0.62 | 0.64 | 0.01 | 0.23 | 0.01 | 0.65 |
| Milk solids yield, kg/d | 1.40 | 1.39 | 1.42 | 1.42 | 0.02 | 1.44 | 1.38 | 0.01 | 0.60 | <0.01 | 0.62 |

1Dietary treatments (DT) consisted of supplemental concentrates with decreasing crude protein concentrations: H) 170 g/kg of DM; M) 130 g/kg of DM; L) 95 g/kg of DM; or LAA) 95 g/kg of DM with rumen-protected amino acids.2Genetic groups (GG) were divergent in Economic Breeding Index (EBI) with high (HEBI) and low (LEBI) sub-groups

**Conclusions**

Reducing the CP concentration of supplementary concentrates below 170 g/kg of DM did not reduce milk production in late-lactation grazing dairy cows. Low CP concentrates can potentially reduce nitrogen intake, urinary nitrogen excretion and nitrate leaching during autumn without reducing animal performance. Supplementation with rumen-protected amino acids had no major effect on milk production, likely reflecting the reduced amino acid requirements of late-lactation cows. The overall outcomes of this experiment were consistent across cows of divergent genetic merit, with cows of HEBI outperforming cows of low EBI.

**Acknowledgements**

Funded by the Department of Agriculture, Food and the Marine’s Competitive Research Funding Programme (2021R482; PASTURE-NUE).

**References**

Bargo, F., Muller, L., Kolver, E., & Delahoy, J. (2003). Invited review: Production and digestion of supplemented dairy cows on pasture. Journal of dairy science, 86(1), 1-42.

Ipharraguerre, I. R., & Clark, J. H. (2005). Impacts of the source and amount of crude protein on the intestinal supply of nitrogen fractions and performance of dairy cows. Journal of dairy science, 88, E22-E37.

O'Sullivan, M., Horan, B., Pierce, K. M., McParland, S., O'Sullivan, K., & Buckley, F. (2019). Milk production of Holstein-Friesian cows of divergent Economic Breeding Index evaluated under seasonal pasture-based management. Journal of dairy science, 102(3), 2560-2577.

Selbie, D. R., Buckthought, L. E., & Shepherd, M. A. (2015). The challenge of the urine patch for managing nitrogen in grazed pasture systems. Advances in agronomy, 129, 229-292.

Zhang, J., Deng, L., Zhang, X., Cao, Y., Li, M., & Yao, J. (2023). Multiple essential amino acids regulate mammary metabolism and milk protein synthesis in lactating dairy cows. Animal Feed Science and Technology, 296, 115557.