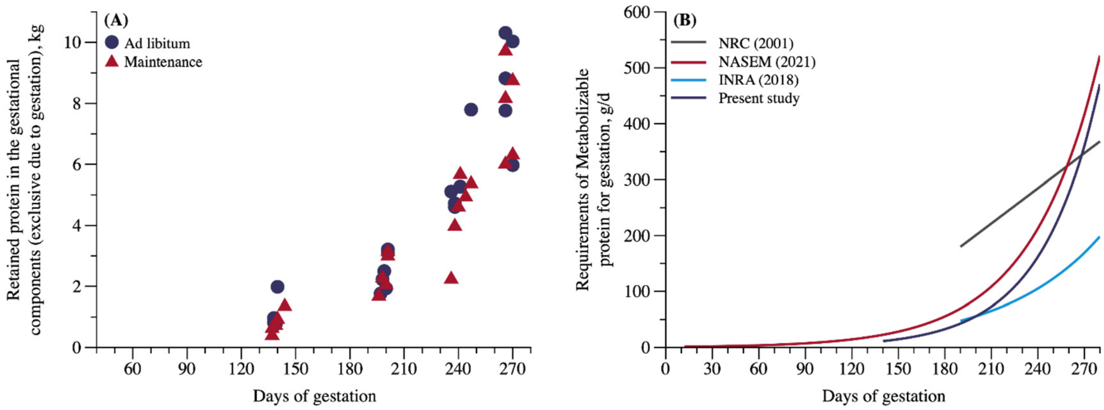

Figure 1 – Exponential relationship between days of gestation and crude protein retained in the gestational components (A); and prediction of the requirements of metabolizable protein for pregnancy proposed by NRC (2001), NASEM (2021), and INRA (2018) compared to the model proposed by the present study in days of gestation. Calculations were made considering a calf birth weight = 35 kg (B)

Figure 1. Bayesian network of volatile fatty acids concentrations (mM) parameters. Relationships among parameters are represented with edges.

the equation: $\Delta = MPI - (MPm + NPg/k_g + NPgest/k_{gest})$. The iteration was performed aiming at a zero deviation between observed MPI and MP estimated by the requirements determined herein. The linear regression parameters were estimated using PROC MIXED of SAS (version 9.4). Estimates of the parameters of non-linear regressions were adjusted using the PROC NLMIXED of SAS. Significances were declared when $P < 0.05$.

Results and Discussion

We obtained a value of 3.6 g/EBW$^{0.75}$/day for MPm. The INRA (2018) suggests 2.2 g/EBW$^{0.75}$/day for MPm, 38% lower than the present study. The estimation of NPg was calculated according to the following equation: $NPg = 0.8095 \times 0.732 \times (EBW_{open}^{-0.268}) \times EBG_{corrected}$, where EBW_{open} is the empty BW (kg) for non-pregnant animals and $EBG_{corrected}$ is the empty body gain (kg/day) corrected for the gestational component. Using the equation proposed by NRC (2001) and taking into account a cow with 450 kg BW and a 0.3 kg/day of ADG, the estimated NPg would be 43 g/day. Our equation suggests an NPg of 35 g/day (18% lower) using the same animal. The k was 0.353, which is 22% higher than NRC (2001) suggested for dairy cows with BW greater than 478 kg. The net protein requirements for gestation (NPgest) were determined as NPgest (g/day) = $0.1767 \times \exp(0.02666 \times DG)$ (Figure 1). The efficiency of using metabolizable protein for gestation (k_{gest}) was 0.653. Overall, from 140 to 275 DG, our estimates of MPgest were 30% lower than those described by NASEM (2021), while the INRA (2018) underestimated MPgest of crossbred cows by 36%.

Conclusion and Implications

The proposed equations to estimate the protein requirements for HG pregnant cows were different from those reported by INRA (2018), NRC (2001), and NASEM (2021). We recommend using our equations to estimate protein requirements for maintenance, growth, and pregnancy of HG dairy cows.

References

A.W.Bell, R.Slepetis, U.A.Ehrhardt, 1995. Growth and accretion of energy and protein in the gravid uterus during late pregnancy in Holstein cows. Journal of Dairy Science 78, 1954–1961.
INRA, 2018. INRA feeding system for ruminants. Wageningen Academic Publishers, The Netherlands.
NASEM, 2021. Nutrient requirements of dairy cattle, 8th Revised Edition. NASEM, Washington D.C..
NRC, 2001. Nutrient requirements of dairy cattle. National Academies Press, Washington, DC.

doi: 10.1016/j.anscip.2022.07.019

O10 The effect of incremental nutrient intake on energy and protein metabolism in pre-weaning dairy calves

L. Amado [a,b], L.N. Leal [a], H. van Laar [a], H. Berends [a], W.J.J. Gerrits [b], J. Martín-Tereso [a,b]

[a] Trouw Nutrition Research and Development, Amersfoort, Netherlands
[b] Animal Nutrition Group, Wageningen University, Wageningen, Netherlands

Keywords: Energy and nitrogen utilization; Young calf

Introduction

Despite growing interest in young dairy calf nutrition and health, nutrient requirements and recommendations are outdated. Also, these do not consider calves younger than 21 days of age, nor calves fed with high levels of whole milk or milk replacer (MR), since this was not a

Table 1
Effect of dietary treatments on BW, Nitrogen, energy balance, and respiratory quotient in calves younger than 21 days of age.

Item	CON	Differences between C+FAT, C+LAC, C+PRO vs. CON[1]			Pooled SE	*P*-value
		C+FAT	C+LAC	C+PRO		
Metabolic BW, $kg^{0.85}$/animal	27.83	0.44	0.82	1.19	0.23	0.17
BW, kg	50.9	1.53[a]	2.08[a]	4.33[b]	0.41	<0.001
ADG, g/day	339	81[a]	110[a]	228[b]	85.5	<0.001
N balance, g of N/kg of $BW^{0.85}$ per day						
Total N intake	0.9	0.01[a]	0.02[a]	0.64[b]	0.02	<0.01
N retention	0.54	0.04[a]	0.02[a]	0.34[b]	0.03	<0.001
Energy balance, kJ/kg of $BW^{0.85}$ per day						
GE intake from milk replacer	556	134	118	103	8.03	0.08
Fecal energy excretion	36	8	16	6	3.40	0.12
ME intake	520	126[a]	101[ab]	97[b]	8.00	0.06
Heat production	382	29[a]	35[ab]	43[b]	3.40	0.03
Energy retention	138	97[a]	66[ab]	54[b]	9.25	0.02
Energy retention as protein	81	6[a]	3[a]	50[b]	4.75	<0.001
Energy retention as fat	57	90[a]	63[b]	4[c]	6.43	<0.001
Respiration quotient	0.89	−0.02[a]	0.06[b]	−0.01[c]	0.001	<0.001

[1] CON: basal milk replacer; C+FAT: basal milk replacer supplemented with milk fat; C+LAC basal milk replacer supplemented with lactose; C+PRO basal milk replacer supplemented with milk protein.
[a,b,c] Least squares means within a row with different superscripts differ ($P < 0.05$). P-Value for comparison among C+FAT, C+PRO and C+LAC.

common practice in the past. The efficiency in which certain macronutrients are utilized, particularly protein, substantially drops with age (Labussière et al., 2008), but there is a lack of information for the first weeks of life. In addition, in older ruminants, protein and energy can be simultaneously limiting protein gain. Whether this also applies to young calves is unknown. Therefore, the objective of this study was to quantify the responses of protein and fat gain to increased intakes of protein, fat, and lactose in a MR in very young calves.

Material and Methods

Ninety-six mixed-sex Holstein-Frisian calves (3.4 ± 1.6 days of age), were randomly assigned to one of four treatments for 19 days: a basal MR (23.3% CP, 21.2% CF and 48.8% lactose of DM) at 550 kJ/kg $BW^{0.85}$ per day (CON; n = 24) or the basal MR supplemented with milk fat (C+FAT; n = 23), lactose (C+LAC; n = 24) or milk protein (C+PRO; n = 23) at 675 kJ/kg $BW^{0.85}$ per day. Supplemented treatments were isoenergetic, provided at the same concentration (150 g/L) two times daily and adjusted for progressing ADG on a weekly basis. Calves had ad libitum access to water but did not have access to calf starter. After 2 weeks of adaptation to their respective diets, the calves were placed for 1 week in an open-circuit respiration chamber for nitrogen and energy balance measurements (5 days). Data were analyzed using PROC MIXED with SAS software. Fixed effects included treatment, sex, and arrival batch.

Results and Discussion

ADG was lower ($P < 0.01$) for C+FAT and C+LAC calves (424 and 447 g, respectively) than for C+PRO calves (563 g). Nitrogen retention increased from 0.54 to 0.88 g of N/kg of $BW^{0.85}$ per day when CP concentration was higher in the diet ($P < 0.01$; Table 1). Calves in the C+PRO group retained 131 kJ/ kg of $BW^{0.85}$ per day as protein at GE intake of 617 kJ/ kg of $BW^{0.85}$ per day, whereas energy retained as fat was the highest for C+FAT (148 kJ/kg of $BW^{0.85}$ per day) and the lowest for the C+PRO group (61 kJ/kg of $BW^{0.85}$ per day; $P < 0.01$). The respiratory quotient was higher in the C+LAC treatment when compared to C+FAT and C+PRO ($P < 0.01$). This study provides quantitative estimates of the efficiency with which changes in nutrient source are deposited by very young calves. The efficiency with which increased nitrogen intake was retained by the calves in this study (53%) was not higher than values observed for calves between 60 and 80 kg of BW by Labussière et al. (2008). Unlike in heavier (pre)ruminants, increased intake of non-protein energy did not increase protein efficiency (Gerrits, 2019).

Conclusion and Implications

In this study, young calves were more efficient at utilizing protein as energy to grow, without it being influenced by the energy intake from lactose or fat. Moreover, it was found that as fat or lactose intake increases so does body fat deposition, with the largest effect of fat intake on body composition.

Acknowledgments

The authors thank the personnel of Carus research facilities (Wageningen University, the Netherlands) and Calf and Beef research facilities (Trouw Nutrition, the Netherlands).

Funding

This work was funded by Trouw Nutrition (the Netherlands), a company with commercial interests in milk replacers for calves.

References

W.J.J.Gerrits, 2019. Symposium review: Macronutrient metabolism in the growing calf. Journal of Dairy Science 102 (4), 3684–3691.
E.Labussière, S.Dubois, J.Van Milgen, G.Bertrand, J.Noblet, 2008. Effects of dietary crude protein on protein and fat deposition in milk-fed veal calves. Journal of Dairy Science 91 (12), 4741–4754.

doi: 10.1016/j.anscip.2022.07.020