The influence of feeding level and milk replacer protein content on growth and blood protein levels of Holstein-Friesian calves

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Introduction

Data from the USA (Van Amburgh and Drackley 2005) suggests that the current UK industry recommendations for feeding the neonatal calf (~500g milk replacer/d, at ~230 g crude protein per kg fresh milk powder) are inadequate to sustain high growth rates in early life. They suggest that feeding levels need to be increased to 1000 g milk replacer powder/d, and that the crude protein content of the milk replacer should be increased to 300 g crude protein per kg milk powder. At the Agricultural Research Institute of Northern Ireland a study to evaluate the effects level of milk replacer intake and milk replacer crude protein (CP) content on live weight gain, skeletal size, body condition and blood protein profiles, has been initiated.

Materials and Methods

One hundred and one autumn born, Holstein-Friesian calves (57 heifers and 44 bulls; PIN2000 47.8 (s.d. 10.34)) were allocated to one of the four treatments at 5 days old. Calves were weighed on entry to the calf house at <12 hours old and this weight was recorded as birth weight. Calves received colostrum for the first 5 days of life. From day 5 until weaning at 56 days, milk replacer (MR) was fed via automatic teat feeders, and calves were housed in groups of 25. A 2x2 factorial design was used which involved two levels of feeding: 5 or 10 l/d at 120 g of milk replacer powder per litre; and two MR with crude protein (CP) contents of 230 and 300 g CP / kg fresh powder. Animals were allocated so that treatments were balanced for birth weight, genetic merit of dam, sire, and sex. Live weight was recorded at weekly intervals and skeletal size (height at withers, body length, heart girth) was recorded fortnightly throughout the pre-weaning phase of the study. Live weight and skeletal size were recorded monthly post weaning.

Milk Replacer intakes were recorded daily on 5 days per week and calves had access *ad libitum* to concentrate from day 5. Single point blood samples were taken at fortnightly intervals throughout the pre-weaning period. Samples were taken using lithium heparin coated vacutainer sample tubes (BD Vacutainer Systems, Plymouth, UK). Following centrifugation plasma aliquots were frozen at -20 ^{o}C until assayed. Plasma total protein, albumin and urea estimations were carried out using Roche Diagnostics (East Sussex) kits on a Hitachi 917 (Roche Diagnostics) clinical chemistry analyser. The globulin concentration was calculated by subtracting the albumin from the total protein concentration. The data were analysed using repeated measures analysis of variance, fitting fixed effects for treatment, sex, age and their interactions, with birth weight as a covariate.

Results

Calves offered the high milk replacer intakes (10 l/d; 120 g milk powder/l water) gained significantly more live weight per day compared with the calves on the standard intake treatments. This resulted in calves on these treatments being 6 kg heavier ($P<0.001$) by day 28 (Table 1). No difference in live weight gain was recorded for the period from 28 to 56 days. Calves offered 10 l/d also had greater skeletal size at weaning, (+ 2 cm height ($P<0.01$), + 3 cm body length ($P<0.001$), and + 3 cm greater heart girth diameters ($P<0.001$)) and higher body condition scores ($P<0.05$) compared with calves offered 5 l/d. No significant difference was recorded for live weight of calves fed either the standard (230 g CP/kg DM) or the high (300g CP/kg) protein milk replacer at day 28. By day 56, calves fed the standard protein milk replacer were 3.65 kg ($P<0.01$) heavier compared with the calves fed the high protein milk replacer. There was no significant difference in the live weight gains of calves fed the standard versus high protein milk replacer between 0-28 and 28-56 days, however live weight gains over the whole period from birth to weaning (0-56 days) were significantly lower ($P<0.01$) for calves offered the high protein milk replacer compared with those offered the standard protein milk replacer. There was a trend for calves offered the high protein milk replacer to have smaller skeletal size compared with calves offered the standard protein milk replacer. Although there was no significant difference between height at withers for calves offered either milk replacer, both body length and heart girth were significantly smaller for calves offered the high protein milk replacer compared with calves offered the standard protein milk replacer (- 2.6 cm body length (P<0.05); - 2.5 cm heart girth (P<0.01)). There was no difference in body condition scores recorded for calves offered the standard or high protein milk replacers. There was no significant difference in the plasma concentrations of total protein, urea, albumin or globulin for calves offered either 5 or 10 l milk replacer per day (Table 2). Over the period from birth to weaning (0-56 days) calves offered the high protein milk replacer had significantly higher total blood protein (P<0.05) and blood urea (P<0.001) compared with calves offered the standard protein milk replacer. Calves offered the high protein milk replacer also had significantly (P<0.05) higher plasma globulin concentrations.

Discussion

Previously reported results indicated that there was no response (in terms of live weight and live weight gain) to increasing the crude protein content of milk replacer offered to neonatal calves from 230 g CP/kg DM to 300 g CP/kg DM (Wicks *et al* 2005). These findings were supported by Fallon *et al* (2005), but were in contrast to results reported by Davis and Drackley (1998), Diaz et al (2001) and Van Amburgh and Drackley (2005). In the current study differences in concentrations of plasma total protein and urea were recorded between calves offered the standard (230 g CP/kg DM) CP milk replacer and those offered the high (300 g CP/kg DM) CP milk replacer. This has led to the proposed, but untested, hypothesis that calves fed the high protein milk replacer utilized the protein less efficiently compared with calves offered the standard (230 g CP/kg DM) milk replacer. Blome *et al* (2003) suggested that calves fed a standard/lower protein milk replacer had insufficient crude protein in the diet, and showed that calves fed a 229 g CP/kg DM milk replacer had lower plasma urea nitrogen compared with calves fed a higher (258 g CP/kg DM) CP milk replacer. This supports the suggestion by Diaz *et al* (2001) that in order to optimise protein deposition, calves should be offered a milk replacer with a crude protein content of approximately 280 g/kg DM.

At present it is unclear why calves offered the high protein milk replacer showed an increased plasma globulin concentration compared with calves offered the standard protein milk replacer. Higher plasma globulin concentration may indicate either better immunity and therefore disease resistance or alternatively an increased disease incidence.

Conclusion

Feeding calves higher levels of milk replacer from birth to weaning increased live weight gain to weaning, however there was no benefit to feeding the high protein (300 g CP/kg DM) milk replacer compared with a standard (230 g CP/kg DM) milk replacer. Calves offered the high protein milk replacer showed elevated plasma total protein and urea concentrations.

Table 1: Treatment effects on live weight (kg) and live weight gains (kg/d) for autumn-born Holstein-Friesian heifer calves from birth to 6 months¶

	Milk Replacer Offered (l/d)				Milk Replacer CP Content¶¶			
	5	10	s.e.d	sig	Standard	High	s.e.d	sig
Live Weight (kg)								
Day 1 (Birth Weight)	44.4	43.7	0.89	NS	44.0	44.0	0.89	NS
Day 28	50.7	56.8	1.10	***	54.3	53.2	1.10	NS
Day 56	66.3	73.2	1.50	***	71.6	67.9	1.49	**
Day 180	168.3	174.1	5.77	NS	172.5	169.9	5.75	NS
Live weight Gain (kg/d)								
0-28	0.23	0.44	0.043	***	0.35	0.32	0.043	NS
28-56	0.67	0.59	0.041	NS	0.65	0.62	0.041	NS
0-56	0.45	0.54	0.027	***	0.53	0.46	0.027	**
56-180	0.79	0.82	0.046	NS	0.80	0.82	0.046	NS
Height at Withers (cm)								
Day 56	82.3	84.3	0.73	**	83.7	82.9	0.72	NS
Body Length (cm)								
Day 56	87.9	91.3	1.03	***	90.7	88.1	1.03	*
Heart Girth (cm)								
Day 56	92.1	95.2	0.87	***	94.9	92.4	0.85	**
Body Condition Score								
Day 56	1.72	1.92	0.08	*	1.81	1.83	0.079	NS

¶There were no significant feeding level by crude protein content of the MR interactions (P>0.05).

¶¶ Standard was 230 g CP/kg DM, and High was 300 g CP/kg DM; * P<0.05; ** P<0.01; *** P<0.001.

Table 2: Treatment effects on blood protein parameters, including total protein, albumin, globulin and blood urea[¶]

	Milk Replacer Offered (l/d)				Milk Replacer CP Content [¶]			
	5	10	s.e.d	Sig.	Standard Protein	High Protein	s.e.d	Sig.
Pre-weaning (0-8 weeks)								
Total Protein (g/l)	67.32	65.38	1.186	NS	64.79	67.90	1.185	*
Urea (mMol/l)	3.52	3.20	0.164	0.053	2.99	3.73	0.164	***
Albumin (g/l)	29.09	29.07	0.254	NS	29.48	28.68	0.254	**
Globulin (g/l)	38.25	36.34	1.216	NS	35.33	39.26	1.214	*

[¶]There were no significant feeding level by crude protein content of the MR interactions (P>0.05).

[¶¶] Standard was 230 g CP/kg DM, and High was 300 g CP/kg DM; * P<0.05; ** P<0.01; *** P<0.001.

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