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Utilization of roughages and concentrates relative to that of milk replacer increases strongly with age in veal calves

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ABSTRACT

We aimed to investigate the feeding values of milk replacer (MR), roughage, and concentrates for veal calves in a paired-gain setting, thus avoiding any prior assumptions in feeding values and major differences in nutrient intakes. One hundred sixty male Holstein-Friesian calves at 2 wk of age and 45 ± 0.2 kg of body weight (BW) were included in the experiment. Calves were allocated to pens (5 calves per pen) and pens were randomly assigned to 1 of 4 solid feed (SF) levels: SF1, SF2, SF3, or SF4, respectively, and to 1 of 2 roughage-to-concentrate (R:C) ratios: 20:80 or 50:50. An adaptation period from wk 1 to 10 preceded the experimental period (wk 11 to 27). Total dry matter (DM) intake from SF was targeted to reach 20, 100, 180, and 260 kg of DM for SF1 to SF4, respectively, during the 16-wk experimental period, and increased with preplanned, equal weekly increments. Roughage was composed of 50% corn silage and 50% chopped wheat straw based on DM. The quantity of MR provided was adjusted every 2 wk based on BW to achieve similar targeted rates of carcass gain across treatments. The reduction in MR provided (in kg of DM) to realize equal rates of carcass gain with inclusion of SF (in kg of DM) differed between the R:C ratio of 50:50 (0.41 kg of MR/kg of SF) and the R:C ratio of 20:80 (0.52 kg of MR/kg of SF). As carcass gain unintentionally increased with SF intake, the paired-gain objective was not fully achieved. When adjusted for realized rates of carcass gain, calves fed an R:C ratio of 20:80 still required 10% less MR than calves fed an R:C ratio of 50:50 for equal rates of carcass gain, indicating that the utilization of SF for gain increased with concentrate inclusion. Averaged for the 16-wk experimental period, the feeding value of MR relative to that of concentrates and roughages was close to that predicted based on their respective digestible energy contents. Nevertheless, the feeding value of SF relative to that of MR increased substantially with age. Therefore, additivity in feeding values of these ration components cannot be assumed. The results of the current study may contribute to the development of new concepts for formulation of veal calf diets with substantial amounts of SF.

Key words: veal calf, growth performance, nutrient utilization, forage

INTRODUCTION

Provision of a minimum daily amount (50 to 250 g) of fibrous feed for veal calves is compulsory according to guidelines of the European Union. Solid feed (**SF**) provision reduces nonnutritive oral behaviors (Kooijman et al., 1991; Veissier et al., 1998; Webb et al., 2012), thereby contributing to improved calf welfare. In addition, the increasing cost of milk replacer (**MR**) ingredients provides an economic incentive to replace MR with SF.

When combining SF and MR, interactions occurring at the level of digestion or postabsorption may influence nutrient utilization and growth performance in veal calves. Milk-fed calves provided with concentrate feed as the only SF source had signs of parakeratosis and so-called plaque formation (i.e., patches of focal mucosa inflammation with coalescing and adhering papillae covered by SF particles, hair, and cell debris), which may inhibit rumen development and nutrient uptake (Suárez et al., 2006, 2007). Early rumen development is thought to increase utilization of SF in veal calves, especially toward the end of the fattening period (Berends et al., 2012b). However, the provision of SF to veal calves may increase the prevalence of abomasal lesions (Welchman and Baust, 1987; Mattiello et al., 2002; Brscic et al., 2011) and concentrate provision has been associated with ruminal drinking; that is, leakage

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of MR into the rumen (Berends et al., 2012b). Recently, it has been shown that urea recycling contributes to nitrogen retention in milk-fed calves provided with a low-protein SF (Berends et al., 2012a) but this contribution decreases with increasing protein content in the SF (H. Berends, unpublished data).

Such interactions between MR and SF complicate an accurate prediction of the feeding value of a ration consisting of MR and SF in veal calves when based on well-documented separate effects of SF only (e.g., Ortigues et al., 1990) and MR only (e.g., Gerrits et al., 1996). Studying the effect of substantial exchanges of MR for SF raises methodological problems. The incremental feeding value of a particular mixture of SF is typically evaluated using a dose–response approach. When MR intake is fixed and an incremental dose of SF is provided (see e.g., Berends et al., 2012a), the assumption that differences in BW gain do not influence the feeding value of the SF provided may be violated. Furthermore, SF intake will likely affect the carcass weight:live weight ratio, which needs to be considered when comparing feeding strategies. When MR is exchanged for SF on a digestible energy (**DE**) basis (see e.g., Labussiere et al., 2009a), assumptions have to be made with regard to the DE content of all dietary ingredients before the start of the experiment. With increasing quantities of MR being replaced by SF, these design problems are exacerbated. To circumvent these methodological issues, the current study assessed the feeding values of MR, concentrates, and roughages for veal calves in a paired-gain setup. Therefore, groups of calves were subjected to preset levels of concentrate and roughage intake, whereas the level of MR was adjusted to target equal rates of carcass gain across treatments. In this way, a substantial interchange of MR, concentrates, and roughages can be addressed while avoiding undesirable changes in the rate of BW gain. Differences in feeding values between these main ration components are addressed within the bounds of a particular choice of roughage and composition of concentrates or MR.

MATERIALS AND METHODS

This study was conducted at the research facilities of VanDrie Group (Scherpenzeel, the Netherlands). Procedures complied with the Dutch Law on Experimental Animals and the ETS123 (Council of Europe 1985 and the 86/609/EEC Directive) and were approved by the Animal Care and Use Committee of Wageningen University (Wageningen, the Netherlands).

Animals, Experimental Design, and Housing

One hundred sixty male Holstein-Friesian calves were purchased from commercial dairy farms at 2 wk of age, selected based on BW, uniformity, and clinical health. Mean BW upon arrival was 45 ± 0.2 kg. Calves were randomly allocated to pens (5 calves per pen). We used a 2 × 4 factorial arrangement of treatments in a completely randomized experiment with 4 pens per treatment combination and pen as the experimental unit. We had 2 levels of roughage-to-concentrate (**R:C**) ratio, 20:80 or 50:50 on a DM basis, and 4 levels of SF: SF1, SF2, SF3, or SF4, respectively (Table 1). The experiment consisted of 2 successive periods—an adaptation period from wk 1 to 10 and an experimental period from wk 11 to 27. During the adaptation period, all pens were exposed to their assigned SF level but an R:C ratio of 50:50 was used to allow for optimal rumen development as assessed in earlier studies (Berends et al., 2012b, Suárez et al., 2007). At the onset of the experimental period (i.e., at wk 11), pens were exposed to their assigned SF level and their assigned R:C ratio. Animal health was checked daily. Hemoglobin concentration in blood was monitored throughout the trial, at wk 3, 7, 11, 15, 19, 23, and at slaughter, and corrected to comply with the minimum EU level of 4.5 mmol/L at the end of the fattening period.

Pens measured 3 × 3 m and were equipped with open fences and wooden-slatted floors, without bedding material. During the first 4 wk, calves were kept individually in 0.9-m^2 temporary pens placed inside the

Table 1. Experimental design and number of pens per treatment

		No. of pens/treatment[2]	
Solid feed (SF) level	Target DMI[1]	R:C 20:80	R:C 50:50
SF1	20	4	4
SF2	100	4	4
SF3	180	4	4
SF4	260	4	4

[1]Cumulative DMI from solid feed (kg of DM) during the 17-wk experimental period.

[2]R:C = roughage-to-concentrate ratio on a DM basis. Roughage consisted of 50% corn silage and 50% chopped wheat straw on a DM basis.