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Effect of milk replacer feeding rate and functional fatty acids on dairy calf performance and digestion of nutrients

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ABSTRACT

Calves fed large amounts of milk replacer (MR) gain more body weight preweaning than calves fed less MR; however, postweaning growth may be reduced because of impaired digestion of nutrients. This was explored in the current research, as was the inclusion of functional fatty acids (NT) that could ameliorate some poor growth and digestion issues in calves fed large amounts of MR. Two MR rates [moderate (MOD) or aggressive (AGG)] with and without NT were compared using 48 male Holstein calves initially 3 d old (43 ± 1.5 kg of body weight) randomly assigned to treatments. The MOD rate was fed at 0.66 kg of dry matter (DM) for 49 d. The AGG rate was fed for 4 d at 0.66 kg of DM, 4 d at 0.96 kg of DM, then 34 d at 1.31 kg of DM, followed by 0.66 kg of DM for the last 7 d. Calves were completely weaned at 49 d. The MR contained 27% crude protein and 17% fat. The textured starter was 20% crude protein. Starter and water were fed free-choice for the first 56 d when calves were housed in individual pens. From 56 to 112 d, calves were grouped (4 calves/pen), maintaining the same MR rate and NT treatments, and fed starter blended with 5% chopped grass hay free-choice with free-choice water. Digestibility was estimated from fecal collections made on d 19 to 23, 40 to 44, and 52 to 56. Data were analyzed as a completely randomized design with a factorial arrangement of MR rate and NT using repeated measures with a mixed procedure. Fiber and starch digestion increased with age and was lower for AGG versus MOD. Calf average daily gain and hip width change were greater before approximately 6 wk of age for AGG versus MOD, but this was reversed from approximately 6 to 16 wk. Calves fed AGG had lower average daily gain per unit intake of DM, crude protein, and metabolizable energy from 8 to 16 wk than calves fed MOD. Preweaning starter intake was less for calves fed AGG versus MOD. Calves fed AGG had greater body weight gain than MOD over 112 d, but hip width change did not differ. Feeding NT improved digestibility of organic matter, DM, neutral detergent fiber, and acid detergent fiber (over 50% improvement for neutral detergent fiber and acid detergent fiber), which resulted in 10.7 kg (13%) more BW gain and 1.4 cm (16%) more hip width change over 112 d. This was a greater improvement in growth than the difference in AGG and MOD programs over 112 d.
Key words: calf, milk replacer, digestion

INTRODUCTION

As milk more milk or milk replacer (**MR**) has been fed to calves, preweaning ADG has increased and preweaning starter intake has decreased (Jasper and Weary, 2002; Cowles et al., 2006; Hill et al., 2013). However, when the DM fed from liquid has exceeded approximately 0.7 kg of DM and weaning has taken place over approximately a week or less, postweaning ADG was less than when less liquid was fed (Cowles et al., 2006; Hill et al., 2007c, 2013). The lower postweaning ADG appears to largely be the result of lower digestion of OM and NDF by calves fed greater amounts of MR (Terre et al., 2007a,b; Hill et al., 2010) and less a function of postweaning DMI. The low digestibility in calves fed high levels of MR has been associated with less development of the rumen (Terre et al., 2007a,b; Suarez-Mena et al., 2011). Preweaning MR intake has not influenced DMI after 56 d when expressed as grams per day; however, intake has been less after 56 d when expressed as DM per kilograms of BW when the MR program delivered more than approximately 0.7 kg of DM daily (Hill et al., 2010, 2013; Osorio et al., 2012). Postweaning feed efficiency has been poor in calves fed high versus low amounts of MR, beyond the immediate few days postweaning (Hill et al., 2007c, 2010). This suggests that digestion is compromised for at least a few weeks postweaning.

Starter intake and the fermentation of starch in the rumen develops the rumen (Hibbs et al., 1956; Warner et al., 1956), drives ADG in the first 2 mo of a calf's life (Heinrichs and Heinrichs, 2011; Bateman et al., 2012),

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and has been associated with more milk, fat, and protein production in first lactation and throughout life (Heinrichs and Heinrichs, 2011). Thus, feeding more milk or MR can reduce starter intake and slow rumen development, often reducing growth of calves in the late preweaning and early postweaning period (Terre et al., 2007a,b; Hill et al., 2010).

There is more to providing nutrients to calves than simply amount of MR, energy, or CP. A balance of AA (Hill et al., 2007b, 2008) and fatty acids (Hill et al., 2011; Kato et al., 2011; Esselburn et al., 2013) have been reported to optimize growth and health of calves, and many MR in the United States lack specific fatty acids (i.e., butyric and linolenic acids) for optimum growth and health of calves. Butyric and linolenic acid are functional in the immune and digestive systems (Hill et al., 2011; Esselburn et al., 2013). Butyric acid stimulates the maturation of pancreatic enzymes (Guilloteau et al., 2009; Górka et al., 2011; Kato et al., 2011) and rumen papillae, both digestive components that may be delayed in calves fed large amounts of milk or MR.

More information is needed to understand how MR rate alters digestion with age in calves. For that reason, we evaluated 2 MR feeding rates on calf performance, as well as pre- and postweaning digestion of several nutrients. Additionally, functional fatty acids that are missing in typical MR and that influence the digestive development of the calf were evaluated. Our hypothesis was that pre- and early postweaning digestion of nutrients would be less in calves fed more MR and that specific functional nutrients could increase digestive maturation.

MATERIALS AND METHODS

All animals were cared for as described in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 2010). This trial began with a 56-d nursery phase where calves were housed in individually pens. Two MR rates [moderate (**MOD**) or aggressive (**AGG**)] with and without functional nutrients of NeoTec5g (**NT**; Provimi, Brookville, OH) were compared using 48 calves (12/treatment; 43 ± 1.5 kg of BW) randomly assigned to treatments. NeoTec5g contains a specific blend of functional fatty acids that are primarily butyric, lauric, myristic, and linolenic acid. These fatty acids have been shown to have function in the immune and digestive systems and for growth in calves, and are typically in low concentrations of the diets fed to calves (Hill et al., 2009a, 2011; Kato et al., 2011). The MOD rate of MR was fed at 0.66 kg of DM for 49 d. The AGG rate of MR was fed for 4 d at 0.66 kg of DM, 4 d at 0.96 kg of DM, then 34 d at 1.31 kg of DM, followed by 0.66 kg of DM for the last 7 d. The MR feedings were divided into 2 equal morning and evening meals. The MOD rate was reconstituted to 13% solids. The AGG rate was reconstituted to 15% solids for the first 42 d, then 13% solids for the last 7 d. All calves were fed the same the last 7 d (0.66 kg of DM from MR in a 13% solution, divided into 2 equal meals daily d 41 to 49 and no MR was fed on d 50 and after) to minimize any effect that liquid feeding method would have on calves postweaning to better evaluate the amount of MR fed. The MR powder had 27% CP and 17% fat from whey, whey protein concentrate, lard, minerals, and vitamins. Calves were fed a 20% CP textured starter, composed of 37% whole corn, 35% supplement pellet (soybean meal, wheat middlings, minerals, and vitamins), 25% whole oats, and 3% liquid molasses. A premix with the fatty acids for NT was included in the designed MR and starters. Calves were fed the starter and water ad libitum for the 56-d trial. During the first 49 d, the starter fed to all calves did not contain NT. For last 7 d of the nursery phase, a second similar starter with NT was fed to calves previously receiving NT via the MR whereas other calves continued on the starter without NT. The MR were formulated to contain 0.25% chromic oxide (as-fed basis). The basis was to achieve an intake of approximately 2 g or more of chromic oxide per calf daily, exceeding the minimum suggested 1 g/calf daily for digestibility estimates (Bouchard et al., 1973).

From 56 to 112 d, a grower phase was conducted with the same calves grouped (4 per pen) based on the 4 nursery phase treatments. The same starters with and without NT were fed blended with 5% chopped grass hay. This allowed the continuation of the factorial arrangement of 2 MR rate (previously fed) and 2 starters (with and without NT). The analyses of MR, starters, and hay are reported in Table 1.

Calves were 2 to 4 d of age at the beginning of the trial and came from a single dairy farm. According to the farm's protocol, these calves were fed 3 L of maternal colostrum at birth and again approximately 12 h after birth. Calves were received at midday after a 3.5-h transit and at the evening feeding calves were randomly assigned to experimental programs. The day after arrival, at approximately noon, the calves were weighed (d 0, initial BW), and blood was collected from the jugular vein. Serum was separated by centrifugation at 3,000 × *g* at 20°C for 15 min (VWR, Batavia, IL) and serum protein concentration was estimated using an optical refractometer (ATAGO U.S.A. Inc., Bellevue, WA). Fecal grab samples were taken from the same 5 calves randomly selected per treatment on d 19 to 23,