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Voluntary selection of starter feed ingredients offered separately to nursing calves

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ABSTRACT

The objective of this study was to evaluate whether calves exposed to different ingredients would consume solid feed in a similar manner than those offered the same ingredients mixed in a starter concentrate. Thirty-eight Holstein calves (initial live weight 41.0 kg and 7 days of age) were randomly assigned to a control (CTR) treatment consisting of a starter feed composed of ground corn (47.2%), soybean meal (20%), oats meal (11%), barley meal (10.1%), soybean hulls (8%), and full fat soybean (1.2%), or to a choice (CH) treatment consisting of 6 ingredients, that composed the starter of CTR calves, offered in separated buckets to each animal. Intake was recorded daily, and calves were weighed twice a week. Samples of fresh feed were taken every week and pooled for subsequent determination of nutrient composition. No differences were observed between treatments on total dry matter intake (DMI), solid feed intake, average daily gain (ADG), and gain to feed ratio. However, animals in the CH group consumed more crude protein (CP; $P<0.01$) and fat ($P<0.01$) than CTR calves. On the other hand, CH calves ingested less non-fibrous carbohydrates (NFC; $P<0.01$) than those in the CTR group. Despite these differences in nutrient intake, there were no differences in total metabolizable energy (ME) intake between CH and CTR animals. However, the CP to ME ratio was greater ($P<0.01$) in CH (81 g of CP/Mcal of ME) than in CTR calves (53 g of CP/Mcal of ME). Calves in CH group consumed less ($P<0.01$) corn and oats meal, and more ($P<0.01$) full fat soybean than CTR animals. Within the CH group of calves, soybean meal was most ($P<0.01$) preferred (32.8% of solid feed intake), whereas oats meal (3.5% of solid feed intake) was the least preferred ($P<0.01$). In terms of total amount consumed, no differences were observed among corn meal, full fat soybean, and barley meal. In conclusion, compared with calves fed a single starter feed, calves that were offered a choice of ingredients selected a diet with greater levels of CP and fat, and lower in NFC. Despite differences in nutrient consumption of the final diet consumed, no differences were observed in total DMI, solid feed intake, ADG, and gain to feed ratio. It is concluded that young calves are unable to select ingredients based on their nutrient requirements.

1. Introduction

Theoretical nutrient requirements of calves are based on the average response of a group of animals in a specific dietary treatment. However, each animal may have different individual feed preferences, nutrient tolerances

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(Provenza et al., 1996; Scott and Provenza, 1999; Villalba and Provenza, 1996) and nutrient needs (Provenza et al., 2003). Furthermore, individual characteristics may influence solid feed intake (Montoro et al., 2011). Pelleted or total mixed rations may force calves to over- or under-consume particular nutrients with respect to their individual needs. Several studies have demonstrated the ability of lambs or adult sheep to select a diet adequately balanced for macronutrients when offered the opportunity to choose among different ingredients or diets (Bach et al., 2012; Kyriazakis and Oldham, 1993; Scott and Provenza, 2000; Villalba and Provenza, 1999). Furthermore, in some instances, ruminants have been able to meet their nutritional needs more accurately when offered a choice of ingredients than when feeding a single diet (Early and Provenza, 1998; Provenza, 1996). Furthermore, it has been proposed that animals offered a diversity of feeds may be better able to select nutrients according to their specific needs and consequently achieve an adequate state of nutrition and well-being (Manteca et al., 2008). However, to our knowledge, all former studies were conducted with animals that had previous experiences with solid feed, which could condition animal behavior as a consequence of previous post-ingestive feed-back (Davis and Smith, 1988). To our knowledge, the ability of young ruminants (without previous experiences with solid feed) to modulate feeding behavior according to nutritional needs has not been tested.

Our hypothesis was that 1-week old calves offered a choice of different ingredients would be able to better meet their nutritional needs by properly selecting different proportions of the available ingredients compared with those calves offered a single solid feed, which should allow calves to grow more efficiently and at a faster rate. Thus, the objective of this study was to evaluate potential benefits of providing a choice of different ingredients compared with a single concentrate to young calves.

2. Materials and methods

2.1. Animals, housing and milk feeding

Thirty eight Holstein male calves (initial live weight 41.0 kg and 7 days of age) were purchased from commercial farms and raised in the facilities of Mas Jonquer (Parets d'Empordà, Spain). After arrival, all calves received 3 ml of a broad-spectrum antibiotic (tulathromycin; Draxxin, Pfizer Animal Health, Spain). Furthermore, calves were vaccinated against respiratory syncytial virus (2 ml of Rispoval RS, Pfizer Animal Health, Spain) 3 days after arrival. Calves were housed in individual hutches ($1.10 \times 1.40\ m^2$) with an open area ($1 \times 1.25\ m^2$) during the 35 days of study. Hutches were bedded with sawdust every 3 days. Calves were managed under the guidelines and approval of the Animal Care Committee of IRTA (Barcelona, Spain). Each hutch had seven places to hold buckets that contained different feeds and water separately. A commercial milk replacer [24% crude protein (CP) and 19.5% fat, Sereno, Celtilait, France] was offered in a bucket twice daily at 0700 and 1600 h. Calves received 4 l/d of milk replacer (MR) at 10% dry matter (DM) dilution rate until 28 days of age (21 days of study). From 28 to 35 days of age, calves received only a morning feeding of 2 l at 10% DM. Animals were weaned at 35 days of age, and the study ended when calves were 42 days old (day 35 of study).

2.2. Treatments, feed sampling and chemical analysis

The day after arrival, animals were weighed and randomly distributed according to BW and age in two treatments: control (CTR) or free-choice (CH). Calves in CTR treatment [40 ± 1.2 kg of body weight (BW) and 7 ± 0.7 day of age] were fed mash starter feed (with all ingredients ground to 3 mm prior mixing), whereas each calf in CH treatment (42 ± 1.2 kg of BW and 7 ± 0.8 days of age) received the same ingredients (barley, corn, oats, full fat soybean, soybean hulls, and soybean meal) that composed CTR starter feed offered in separate buckets. The location for each feed within each hutch was randomized (i.e., it was different from hutch to hutch), and then it was kept constant for each calf on CH treatment throughout the study. To avoid potential interference of particle size on preference or nutrient selection, all ingredients for the CH treatment were ground to 3 mm. Throughout the study, individual daily intake of starter and ingredients was recorded. Buckets were checked on a daily basis to ensure ad libitum provision of feed. Calves were weighed at the same time each day on two consecutive days each week during the 5 weeks of study.

To determine DM and nutrient content of the experimental feeds (starter feed or individual ingredients), fresh samples of each feed were taken on a weekly basis and frozen at $-20\ ^\circ C$. After completion of the experiment, these samples were thawed and pooled within feed and sent to Laboratorio de Mouriscade (Pontevedra, Spain) for analysis of DM (24 h at 103 °C), ash (4 h at 550 °C), neutral detergent fiber (NDF) with heat-stable-amylase and sodium sulfite (Van Soest et al., 1991), nitrogen content using the AOAC (1990) method (988.05), and ether extract using the AOAC method (920.39) using petroleum ether for distillation instead of diethyl ether (AOAC, 1990). Furthermore, to determine the particle size distribution, each ingredient (100 g) was sieved through a 2- and 1-mm mesh.

2.3. Calculations and statistical analyses

Ingredient consumption (g/d) of the CTR calves was estimated using the proportion of each ingredient in the starter feed multiplied by the consumption of starter feed. The CP to energy ratio was calculated as the total CP consumption from all ingredients divided by the total metabolizable energy (ME) consumed from all ingredients. For the CTR calves, the CP to energy ratio was fixed at 53 g of CP/Mcal of ME. The ME content of each ingredient was calculated based on NRC (2001). The efficiency of CP utilization was calculated as the average daily gain (ADG) divided by the total CP consumption (from MR and starter feed). Particle size distribution of feeds was assessed as the weight of the different fractions (< 1 mm, 1–2 mm, and > 2 mm) was expressed as a