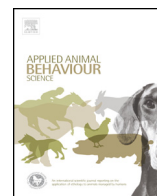




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What do calves choose to eat and how do preferences affect behaviour?



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ABSTRACT

Calves raised for milk or meat are fed diets that differ from feral-herd calf diets and are based on the nutritional requirements of the 'average calf'. These diets may not meet the dietary preferences of each individual calf. This study explored diet preferences in calves with free dietary choice, and the effect of these preferences on behaviour. Group-housed Holstein-Friesian bull calves ($N=23$) were given unlimited access to five diet components (i.e. milk replacer [MR], concentrate, maize silage, long hay and long barley straw). At 3 and 6 months of age, calves were moved for 7 days to an automated test pen in groups of four, where intake, time spent eating, and visit frequency to each diet component was recorded to assess preferences. Behaviour was recorded on 2 of the 7 days in the test pen, from 07:30 to 18:00 h using instantaneous scan sampling for periods of 30 min every 2.5 h at a 2 min interval. Solid feed intake at 6 months averaged 3205.5 ± 174.6 g DM d^{-1} . At 3 months, calves selected the following proportion (average of individual proportions) of MR, concentrate and roughage in relation to total g DM intake: $51.6 \pm 5.0\%$, $25.0 \pm 4.7\%$ and $23.4 \pm 2.8\%$. At 6 months, the calves conserved the roughage proportion ($23.3 \pm 1.6\%$), but increased concentrate intake ($47.1 \pm 2.1\%$) at the expense of MR ($29.6 \pm 1.9\%$). Order of preference for the five diet components varied according to whether intake, time spent eating each component, or visit frequency was considered. On the whole, MR was preferred followed by concentrate and hay at both ages. Offering a dietary choice led to large individual variation in intake and to 47–80% calves having the same ranking as the average ranking for diet components. This suggests diets based on the 'average calf' may meet only few calves' dietary preferences. Different variables showed different preference rankings and studies in the future should consider the relative importance of these variables in assessing animal preferences.

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1. Introduction

Calves raised for the production of milk or meat are typically fed diets that differ from those of feral cattle

herds. These artificially-created diets are usually based on the nutritional requirements of the 'average calf', and as such, will most likely not meet the needs of each individual animal (Manteca et al., 2008). Nutritional requirement is defined as the minimum nutrients required for maintenance and growth to achieve a particular production rate. One particular group of needs that may not be addressed are so-called behavioural (or ethological) needs. Here, the

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term 'behavioural needs' refers to behaviours that when suppressed would result in signs of suffering (Jensen and Toates, 1993). Prolonged prevention of behavioural needs can lead to the development of abnormal behaviours (Jensen and Toates, 1993), a warning sign for chronic stress and poor welfare (Mason and Latham, 2004; Broom and Fraser, 2007). Veal calves, for example, develop abnormal oral behaviours, which generally start around 3 months of age and include tongue playing, excessive oral manipulation of the pen structure, sham chewing, and to a lesser extent grazing the coat of other calves and sucking of other calves' body parts, or cross-sucking (Kooijman et al., 1991; Morisse et al., 1999; Mattiello et al., 2002; Webb et al., 2012). Veal calves are commonly fed large amounts of milk replacer supplement by solid feed, which tends to comprise of relatively little roughage. Abnormal oral behaviours in veal calves are thought to develop as a result of restricted access to solid feed and the subsequent limitation in eating and rumination opportunities (Kooijman et al., 1991; Veissier et al., 1998). Although cross-sucking is not often observed in veal calves (Smits and de Wilt, 1991; Webb et al., 2012), it is a problem in dairy calves, and is thought to be motivated by limited opportunities to suck for access to milk replacer (De Passillé and Rushen, 1997).

The first step in the development of novel calf diets with the aim of improving welfare, is the understanding of dietary preferences of calves raised under intensive conditions. Dietary preference is defined as the choices an animal makes in the context of a particular range of diet components, in terms of the ranking of the components based on, typically, intake. Assessing preferences for resources is often done using a so-called choice test: animals can choose from various resources (Broom and Fraser, 2007), and time spent with each resource or the frequency of choosing each resource is recorded (Petherick et al., 1993; Veillette and Reeb, 2011). Forbes and Kyriazakis propose that ruminants are able to select diets that maximise their comfort (Forbes and Kyriazakis, 1995; Forbes, 2007). Therefore, assessing dietary preferences of calves raised under intensive conditions, offered a range of diet components often used by the industry, should give us insight into (realistically achievable) diet compositions that could maximise calf welfare. Ruminants generally choose an array of different diet components to meet their nutritional requirements (Provenza, 1995; Atwood et al., 2001). This is explained by their need for various feed characteristics for nutrient uptake, a process that depends not only on the nutrient content of the feed but also on good rumen health, which is itself dependent on fermentable fibre content of the feed, feed structure and rumination. Inadequate solid feed provision, e.g. little structure or limited fermentable fibre, has been shown to cause a number of gastrointestinal health complications in veal calves, including: poor rumen development, plaque and hyperkeratosis, ruminal hairballs, and exacerbation of existing abomasal damage (Suarez et al., 2007; Brscic et al., 2011; Webb et al., 2013). Therefore, assessing dietary preferences in ruminants necessitates a choice of components varying in structure and fermentable fibre content, and enabling the fulfilment of nutrient requirements.

Ruminants also display different dietary preferences at different times of day (Atwood et al., 2001; Manteca et al., 2008). Moreover, postingestive cues are important in the establishment of dietary preferences (Favreau et al., 2010), which explains why young ruminants may need to go through a trial and error learning phase before selecting appropriate diets (Provenza and Balph, 1987). On top of this, rumen development is a long term process, which in young ruminants may result in different preferences being observed at different ages (Rushen et al., 2008). Together, these findings indicate that calf preferences should be investigated over several consecutive days, and at different ages. However, motivation or 'need' to perform a particular behaviour may change with age (Wiepkema, 1987) and carefully selecting testing periods is required. In veal calves, abnormal oral behaviours seem to appear around 3 months of age, suggesting this is when a particularly important motivation for eating solid feed and rumination develops (Kooijman et al., 1991). This may provide a starting point for the assessment of dietary preferences of calves.

The present study investigated the dietary preferences and behaviour of calves given unlimited access to five diet components (milk replacer, concentrate, maize silage, hay and barley straw) from 5 to 27 weeks of age. Preferences and behaviour were recorded at 3 and 6 months of age. This study was conducted with the aim of understanding the dietary preferences of calves at 3 and 6 months of age, reared under intensive conditions.

2. Materials and methods

The study was carried out at Wageningen University, Wageningen, the Netherlands, within the experimental facilities of the Animal Science Department. All procedures met the terms of the Dutch law for animal experiments, which complies with the ETS123 (Council of Europe 1985 and the 86/609/EEC Directive). These procedures were further approved by Wageningen University's Committee on Animal Care and Use. This experiment ran from January to August 2011. This paper focused on intake, dietary preferences and behaviour. Measurements for *in vivo* and post-mortem health and performance are described in a separate manuscript (Berends et al., submitted).

2.1. Animals and husbandry

2.1.1. General

Two-week-old Holstein-Friesian bull calves ($N=40$) were purchased from a Dutch dairy calf trader. For practical reasons (i.e. limited use of one test pen), two batches of calves 6 weeks apart in age were acquired. The calves were housed in home pens with wooden-slatted floors and 1.9 m² per calf floor area, and fed one of two feeding strategies, both comprising of milk replacer (MR) and solid feed (see following two sections). MR and concentrate composition were selected to meet beef cattle requirements in terms of minerals and vitamins (NRC, 2000). Feeding of solid feed was done at 08:00 and 16:00 h. MR (120 g DM milk powder per L) was fed using an automated milk dispenser (AMD) (TAP5-VH1-50-F2, Förster Technik®, Egen, Germany). The calves received

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