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Economic and environmental effects of providing increased amounts of solid feed to veal calves

H. Mollenhorst,*†[1,2] P. B. M. Berentsen,† H. Berends,‡[3] W. J. J. Gerrits,‡ and I. J. M. de Boer*
*Animal Production Systems group, Wageningen University, PO Box 338, 6700 AH Wageningen, the Netherlands
†Business Economics group, Wageningen University, PO Box 8130, 6700 EW Wageningen, the Netherlands
‡Animal Nutrition group, Wageningen University, PO Box 338, 6700 AH, Wageningen, the Netherlands

ABSTRACT

Traditionally, veal calves receive most of their nutrients from milk replacer (MR). Nowadays, however, solid feed (SF; i.e., concentrates and roughages) increasingly substitutes for MR. Studies have shown that providing SF reduces different types of nonnutritive oral behaviors. The objective of this study was to assess the economic and environmental effects of substituting SF for MR in veal calf diets. With respect to environmental effects, we considered the emission of greenhouse gases and land occupation. Substitution rates were based on an experiment in which 160 calves were provided 2 mixtures of SF at 4 levels of dry matter (DM) intake. Mixtures of SF contained either 80% concentrates, 10% corn silage, and 10% straw on DM basis (C80) or 50% concentrates, 25% corn silage, and 25% straw (C50). The 4 levels of SF during the last 17 wk of the fattening period were 20, 100, 180, and 260 kg of DM SF. Additionally, provision of MR was adjusted to achieve equal rates of carcass gain. Substitution rates, representing the SF equivalent needed to substitute for 1 kg of DM MR, were 1.43 kg of DM for C80 and 1.61 kg of DM for C50. Economic effects were assessed based on prices and substitution rates of SF for MR and the possible penalty for carcass color. Environmental effects were assessed based on effects related to the production of feed ingredients, substitution rates, and changes in enteric methane emission and energy use for feed preparation. Costs of feeding SF needed to substitute for 1 kg of DM MR were €0.68 lower for C80 and €0.71 lower for C50, compared with the costs of feeding 1 kg of DM MR. When carcass color scores became too high, however, lower feeding costs were offset by lower revenues from meat. Emissions of greenhouse gases were hardly affected when SF intake was increased. In general, increased enteric methane emission were offset by lower emissions from feed production and energy use. Land occupation increased when intake of SF was increased, mostly because of the high land occupation associated with some concentrate ingredients. In conclusion, this study only showed a negative effect on land occupation when substituting SF for part of the MR in diets of veal calves. Effects on costs and greenhouse gas emissions were neutral or positive.
Key words: life cycle assessment, greenhouse gas emission, partial budgeting, concentrate, straw

INTRODUCTION

Traditionally, veal calves receive most of their nutrients from milk replacer (**MR**). Nowadays, however, increasing amounts of solid feed (**SF**; i.e., concentrates and roughages) are provided, partly because it is enforced by EU legislation (97/182/EG) and partly because of increasing prices of MR ingredients. This increase in price is caused primarily by almost a doubling of the price for whey powder during the last decade (LEI, 2014) and by similar trends for other ingredients derived from milk. Studies have shown that good quality veal could be produced with similar rates of carcass gain, while providing amounts of SF well above EU requirements (Cozzi et al., 2002; Prevedello et al., 2012; Brscic et al., 2014). Furthermore, MR could be lowered linearly with increasing SF, whereas rate of carcass gain remained unchanged (Berends et al., 2014). Levels of SF during the final 17 wk of the fattening period increased from minimal EU legislation level (20 kg of DM) to a level close to ad libitum intake (250 kg of DM). Ad libitum intake of SF was determined in an experiment in which calves were provided free access to MR and different types of SF (Webb et al., 2014). The experiment of Berends et al. (2014) was unique for 2 reasons: their aim was to attain equal rates of carcass gain, and not to measure the effect of a pre-defined

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[1]Corresponding author: mollenhorst@qlip.nl
[2]Current address: Qlip BV, PO Box 119, 7200 AC, Zutphen, the Netherlands.
[3]Current address: Trouw Nutrition Ruminant Research Centre, PO Box 220, 5830 AE Boxmeer, the Netherlands.

ration, and they provided 2 mixtures of SF at 4 levels of intake. The mixtures of SF differed only in the ratio of roughage to concentrate. Their experimental protocol enabled calculation of the substitution value for carcass gain of SF relative to MR (in short, substitution rate) at 2 ratios of roughage to concentrate. They showed no effect of level of SF intake on substitution rate.

Studies on calf well-being showed that providing SF, and especially roughage, reduces different types of non-nutritive oral behaviors (Veissier et al., 1998; Webb et al., 2012; Leruste et al., 2014), which are a concern in veal production (Cozzi et al., 2009). Effects of SF on rumen and abomasal health depend on the amount and composition of the SF (Mattiello et al., 2002; Suárez et al., 2007; Berends et al., 2014). Stimulating rumen development in early stages could contribute to improved performance toward the end of the fattening period, especially when high levels of SF are provided (Berends et al., 2012b; Xie et al., 2013). In addition to animal health and well-being, other sustainability issues have to be assessed before feeding strategies with higher levels of SF can be implemented successfully.

It is important for farmers to know if a new strategy is profitable. Economic potential of substituting SF for MR depends on prices and substitution rates, and if meat can be sold at the same price, because providing more SF might change meat characteristics, especially color. The recent increase of prices of MR ingredients re-enforces the idea that substituting SF for MR could be profitable. About 65% of total variable costs are feeding costs (KWIN-V, 2013), so a small difference in relative prices and substitution rate can have a substantial effect on profitability. In addition to MR, feeding 140 kg of DM SF in 201 d did not affect carcass color and was profitable (Brscic et al., 2014). For higher levels of SF, however, carcass color might change and cost reductions must be large enough to compensate for a reduced meat price, if the color score becomes too high, indicating darker colored meat.

Current livestock production contributes to some environmental concerns, because it is the largest anthropogenic user of land and produces a major share of anthropogenic greenhouse gas (**GHG**) emissions (Steinfeld et al., 2006; Gerber et al., 2013). The environmental effect of substituting SF for MR depends primarily on effects related not only to the production of the feeds and their ingredients, but also to their substitution rates. Additionally, there needs to be an accounting of emissions from animals, manure, and combustion of energy sources on the veal farm. Two environmental effects were expected to change considerably: emissions of GHG and land occupation. Expected changes in GHG emissions and land occupation have 4 causes: production of feed ingredients, enteric CH_4 emission, water heating, and manure composition. Production of feed is an important contributor to the environmental effect of animal products, and GHG emissions and land occupation differ among feed ingredients (Van Middelaar et al., 2013). Enteric CH_4 emission will increase when diets contain more SF (e.g., Beauchemin and McGinn, 2005; Van Middelaar et al., 2013). If veal calves receive only MR, they will not develop a fully functional rumen (Flatt et al., 1958; Church, 1988; Suárez et al., 2006) and enteric fermentation will be negligible (van den Borne et al., 2006; Labussiere et al., 2009). As diets of veal calves contain more SF, their rumen will develop fully, with accompanying increased CH_4 production. Providing more SF will reduce energy required to heat water for MR, and consequently reduce CO_2 emissions. Changing feed composition affects manure composition, and related N_2O and CH_4 emissions. Whether or not all these changes result in a net positive or negative effect on environmental impact is still unclear.

Because economic and environmental consequences are not yet clear, it is necessary to assess whether providing higher levels of SF is economically profitable and environmentally sound. The objective of this study, therefore, was to assess the economic and environmental effects of substituting SF for MR in veal calf diets, while maintaining equal rates of carcass gain.

MATERIALS AND METHODS

Substitution Rates

Substitution rates were based on Berends et al. (2014). In their experiment with 160 calves, 2 mixtures of SF were provided at 4 levels of DMI in a 2 × 4 factorial arrangement, with 4 pens per treatment combination and pen as the experimental unit. Mixtures of SF contained either 80% concentrates, 10% corn silage, and 10% straw on DM basis (**C80**) or 50% concentrates, 25% corn silage, and 25% straw (**C50**). The 4 levels of SF during the last 17 wk of the fattening period were 20, 100, 180, and 260 kg of DM SF, which afterward was determined to be 7 to 62% of total DMI. Additionally, MR was provided and adjusted throughout the study to achieve equal rates of carcass gain on all diets. Analysis of covariance was used to estimate the reduction of MR intake per unit of SF intake for the 2 mixtures of SF (Berends et al., 2014). The goal of equal rates of carcass gain was not fully reached, so regression coefficients were estimated while correcting for difference in rate of carcass gain by expressing MR intake per kilogram of carcass gain (Berends et al., 2014). Substitution rates were achieved for C80 and C50 by multiplying the estimated regression coefficients by the average carcass gain (81 kg) during the experimental period and then