Effects of diet composition on carcass fat in beef cattle: a meta-analysis

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Abstract

To improve the ability of the MecSic model to predict carcass composition of beef cattle, the objective was to identify the dietary characteristics that significantly influence the relationship between carcass composition and metabolisable energy intake and that could ultimately be introduced into MecSic. A meta-analysis was applied to 61 publications in finishing cattle. Results showed that the dietary concentrations of fibre, starch and protein had an effect on the relationship. Therefore, at iso-energy intake, the type of diets (concentrate vs forage) and the ratio protein /energy can modify carcass composition of beef cattle.

Keywords: *carcass fat, finishing cattle, energy, diet*

Introduction

Carcass quality of beef cattle is an important criteria in the remuneration of producers. With the aim of developing nutritional strategies towards improved carcass quality, models were developed to predict carcass composition. The model MecSic (Hoch and Agabriel, 2004) simulates growth and carcass composition driven by metabolisable energy (ME) intake (MEI) during the finishing period. However, the simulations do not account for the source of dietary energy (fibre vs starch) nor the level of protein intake at iso-energetic intakes, and their potential effects on tissue deposition for a given type of animal. Preliminary work identified a possible indicator of the effects of diet composition (a ratio of absorbed nutrients) on tissue deposition (Agabriel *et al.*, 2013). As a first step towards expanding these results, our objective was to identify the dietary characteristics that influence the carcass fat content besides MEI by meta-analysis from published results.

Material and methods

61 publications (76 studies, 343 treatments) on finishing cattle were extracted from the Alicar database (Vernet *et al.*, 2016). All reported results on (1) diet composition and intake; and (2) chemical carcass composition (lipid and/or protein), USDA yield grade or subcutaneous fat thickness (predictors of carcass composition). Diets were characterized using INRA Feed Tables (2007, in press), and animal breeds according to their maturing rates (early, intermediate or late). A within-study variance–covariance model was developed (Minitab 16) according to Sauvant *et al.* (2008) as: carcass fat (% of hot carcass weight) = $\alpha + \alpha_i$ (Maturing rates) + Maturing rates+ β MEI (kcal.d^{-1}.kg BW$^{-0.75}$) + e, with α = overall intercept, α_i = effect of the experimental study i on the intercept α, β = slope and e = error. Maturing rate was introduced in the model following a preliminary principal component analysis which showed its strong correlation with carcass fat. Presence of factors having a significant impact on residuals and individual slopes was tested either by analysis of variance (for qualitative factors such as animal breeds or sex) or regression (for quantitative factors such as diet composition).

Results and discussion

The dataset covered a wide range of animals in terms of breeds (68% of beef breeds) and maturing rates (46% of early maturing and 46% of intermediate maturing), with a majority of males (95% of castrated males, implanted or not). The ranges of live animal and carcass characteristics were also wide (average daily gain from 0.6 to 2.1 kg/d, hot carcass weight from 226 to 413 kg, and fat content of hot carcass from 21 to 41%). Dry matter (DM) intake ranged from 5.2 to 13 kg/d, and dietary concentrations of starch, neutral detergent fibre (NDF), protein digestible in the intestine (PDI) and ME were 0-730, 105-613, 46-147 g/kg DM and 9-14 MJ/kg DM, respectively.

At similar MEI, the proportion of fat in the carcass was 0.6 and 2.1% higher (P<0.00) in early maturing breeds than in intermediate and late maturing breeds respectively. Whatever the breed, MEI was the primary driver of carcass composition (Figure 1A) but did not totally account for changes of carcass fat concentration (Figure 1B). Residuals of the model were significantly related to the dietary concentration of PDI (P=0.04) and digestible starch /NDF ratio (P=0.01). Individual slopes were significantly affected by the dietary NDF and starch concentrations, as well as the starch/NDF ratio (P=0.02) and digestible starch /ME ratio (P=0.01). In conclusion, carcass composition in finished cattle varies with diet composition in addition to MEI. Potential indicators of these effects are the composition of ME (fibre vs starch) and the protein/energy ratio. Response equations are needed in order to improve the simulation de carcass composition from MEI (Agabriel *et al.*, 2013).

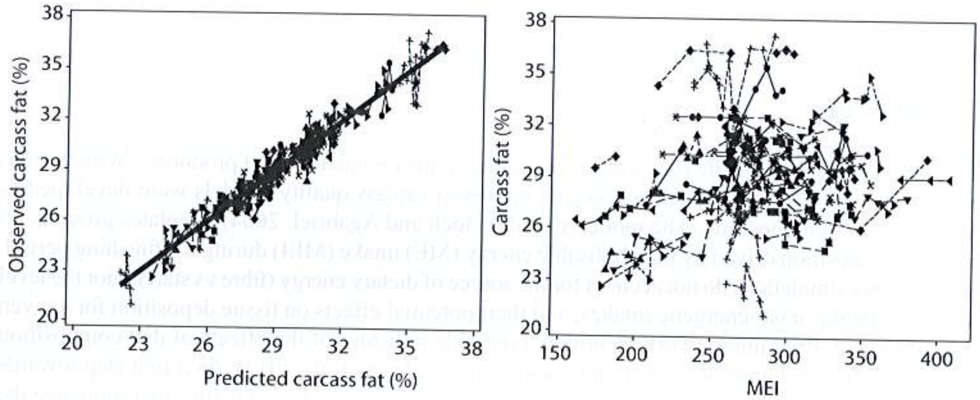

Figure 1. (A) Observed vs predicted carcass fat, % and (B) intra-study relationships between carcass fat % and metabolisable energy intake (MEI; kcal/d kg $BW^{0.75}$).

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