Rate of protein growth and energy for maintenance parameter changes in the Davis Growth Model

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Abstract

The Davis Growth Model simulates protein and fat growth of the empty body of beef cattle. We have improved both model structure and parameter estimates to reflect trends in protein and fat accretion for today's more productive cattle. Initial DNA is now estimated by an equation which requires both body protein and previous rates of protein accretion and energy intake. Because the newer DNA estimates differ from the original ones, other parameters in the model were re-estimated using the same data with which the model was originally parameterized. Later data has been used to reparametrize the model for a number of different studies. Protein accretion and maintenance energy parameters have increased.

Keywords: *beef cattle, growth, body composition, energy requirements*

Introduction

The Davis Growth Model (Oltjen *et al.*, 1986) simulates protein and fat growth of the empty body of beef cattle. It is based on the net energy system but includes mechanistic representation of protein growth by simulating both DNA accretion and protein turnover. Experience with its use has revealed strengths and weaknesses, and improvements have been made both within the model structure and to parameter estimates. These changes reflect trends in protein and fat accretion due to selection pressure for more productive cattle.

Model structure

Originally initial DNA was an interpolation based on body fatness between DNA of a well-fed animal and an animal of similar protein content fed near maintenance. However, DNA estimates diverge from the model's simulated DNA at heavier weights. In subsequent implementation, initial DNA is estimated by the following equation which requires both body protein (PROT) and previous rates of protein accretion and energy intake (NUT2):

$$DNA = \left(\frac{K3 \times PROT^{0.73} + \frac{dPROT}{dt}}{NUT2 \times K2} \right)^{1/0.73}$$

Where K2 (protein synthesis rate constant), K3 (protein degradation rate constant) and NUT2 are defined as in the original model. This equation provides estimates of initial DNA that are within 1 g of simulated DNA across the entire growth path for both implanted and non-implanted steers. Because the newer DNA estimates differ from the original ones, other parameters in the model were re-estimated using the same data with which the model was originally parameterized (Oltjen *et al.*, 1986; original parameter values in parenthesis): K1=0.00493 (0.00429), K2=0.0444 (0.0461), K3=0.143 (0.143 fixed due to unidentifiability), Alpha=0.0841 (0.0858). Also, the increase in protein synthesis due to anabolic implant became 3.9% instead of the original 4.2%.

Model parameter changes over time

Data for original parameterization spanned 1960-1980. Later data was used to reparametrize the model (Table 1). Protein growth and maintenance parameters have increased, similar to increases in apparent maintenance requirements, efficiency of lactation (k_L), and efficiency of growth (k_G) in dairy cattle (Moraes *et al.*, 2013). An exception is for Nellore bulls with reduced K1, K3 and alpha in these slower growing *Bos indicus* cattle (Sainz *et al.*, 2006). Also, our recent work (unpublished data) has shown decreased K3 with use of beta-agonists.

Table 1. Estimates of growth and maintenance parameters in the Davis Growth Model.

Description	K1	K2	K3	Alpha	Reference
Original estimates	0.00429	0.0461	0.143	0.0858	Oltjen *et al.*, 1986
Revised estimates (above)	0.00493	0.0444	0.143	0.0841	Oltjen *et al.*, 2014
Angus-Hereford Steers		0.053		0.0961	Garcia *et al.*, 2008
Charolais Bulls		0.058		0.1372	
Salers Heifers		0.056		0.0901	
British Breed Steers		0.047		0.0983	McPhee *et al.*, 2009
Nellore Bulls	0.00416		0.13	0.0768	Sainz *et al.*, 2006
Angus Steers					Sainz and Oltjen, 2014
Low RFI (residual feed intake)			0.1375	0.062	
Medium RFI			0.1436	0.0737	
High RFI			0.1477	0.086	

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