On-farm estimation of pig growth parameters from longitudinal data of live weight and feed consumption and the use of a mathematical model

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ABSTRACT

Experimental data of feed consumption and composition, recorded over 5 consecutive short periods of growth from 30 crossbred male pigs divided 2 two groups and fed two restricted feeding regimes from 25 to 160 kg LW, were used to run a model in which a set of theoretical values, to describe the potential chemical growth of the pig, was preliminarily assumed. Simulated values of average daily gain (ADG) and feed conversion ratio (FCR) were the outputs. Estimates of protein mass at maturity (Pm, kg) and relative growth rate (B, d⁻¹) for each feeding regimes where successively obtained through an optimization procedure which has minimized the coefficients of variation of the differences between the estimates and the measurements of ADG and FCR. The very similar values of Pm (33.7 and 33.2 kg), and B (0.0104 and 0.0105 d⁻¹), obtained for the two feed treatments suggested that these values can be used as operational data to describe the growth parameters of the experimental pigs used.

Key words: Mathematical model, Growing pigs, Inherent growth characteristics

Introduction

The major constraint in the application of mathematical model in the practice is the description of the pig (Emmans, 1989; Schiavon et al., 2004). In the Ferguson et al. (1994) model the potential growth of the pig is described in term of mature protein mass (Pm, kg), rate of maturing (B, d⁻¹) and lipid to protein ratio at maturity. Ceolin et al. (2005) run this model using a) 2 sets of theoretical values to describe a poor and a improved pig; b) longitudinal data about feed consumption and composition, measured over 5 consecutive short periods of growth, of 30 commercial crossbred pigs divided in 2 groups fed two different restricted feeding regimes. The simulated model responses in term of average daily gain (ADG) and feed conversion ratios (FCR), for each of the 5 growing periods, were compared with the measured ones with good results. The values of Pm and B of these pigs were probably intermediate to the two theoretical sets of values assumed. Thus, in this paper an optimization procedure was proposed in order to evaluate the operational values for the growth parameters of Pm and B of this group of pigs.

Material and methods

The model of Ferguson et al. (1994) was run using as input to describe the feed experimental data of a group of 30 commercial crossbred pigs, which were divided in two groups (HL and LH) and fed, from 25 to 160 kg of LW, different amounts of feeds in 5 consecutive periods. With respect to the HL group, the LH group received in the early and in the later period of growth a lower and a higher amount of feeds, respectively. In table 1 the amounts of feeds consumed in different periods are shown. The 2 groups of pigs received, but in different amounts, the same 4 feeds, which contained 13.6, 13.4, 13.3, and 12.8 MJ/kg of effective energy (EE), 16.7, 15.0, 14.3 and 13.3% of digestible crude protein, and 1.01, 0.78, 0.74 and 0.66% of digestible lysine (major detail are given by Ceolin et al., 2005). A set of theoretical values for Pm, 30 kg, B,
The two groups of pigs showed, in each period, different final live weights (FLW), ADG, FCR according to the different feeding planes adopted (Table 1).

The linear regression between actual (a) and simulated (s) values of FLW, ADG and FCR were:

a) $FLW_a = 1.001 \times FLW_s$ (10 obs., $R^2 = 0.9994$, rsd = 1.0);
b) $ADG_a = 0.996 \times ADG_s$ (10 obs., $R^2 = 0.8629$, rsd = 0.026);
c) $FCR_a = 1.002 \times FCR_s$ (10 obs., $R^2 = 0.9737$, rsd = 0.122).

For all these regressions the values of the parameters reflected a good correspondence between the model outputs and the measurements.

The simulated evolution over the time of the chemical composition of gain, for the two feeding planes, is shown in Figure 1. The continue and bold lines represent the predicted protein retentions, while the dotted lines represent the lipid retention. It can be observed that, according to the availability of net protein for growth (continue line), the model predicted some deviations as respect to the potential protein growth, particularly for the HL feeding treatment. Excess of protein supplies were estimated for the early period for the HL treatment and for the last period for both the two treatments.

**Results and conclusions**

The values of Pm and B, obtained after the optimization procedure, were quite similar: 33.7 and 33.2 kg and 0.0104 and 0.0105 d$^{-1}$ for the LH and the HL groups, respectively. The values of Pm and B were in the range observed by others (Emmans and Kyriazakis, 1999; Whittemore et al., 2003). The two groups of pigs showed, in each period, different final live weights (FLW), ADG, FCR according to the different feeding planes adopted (Table 1).

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**Table 1.** Growth periods (days), amounts of feed consumed (kg/period) and actual and simulated values of final live weight (FLW, kg), average daily gain (ADG, kg/d) and feed conversion ratios (FCR) for the 2 feeding treatment using the optimized values of Pm and B.

| Days   | Actual feed consumed | FLW | ADG | FCR |
|--------|----------------------|-----|-----|-----|
|        |                      | Actual | Simulated | Actual | Simulated | Actual | Simulated |
| LH     |                      |       |     |     |     |     |     |     |
| 0-41   | 56.7                 | 51.0 | 50.7 | 0.617 | 0.610 | 2.240 | 2.267 |
| 41-62  | 96.6                 | 67.0 | 66.2 | 0.762 | 0.736 | 2.498 | 2.573 |
| 62-97  | 176.8                | 94.5 | 93.5 | 0.786 | 0.781 | 2.915 | 2.934 |
| 97-125 | 248.4                | 115.7| 115.0| 0.757 | 0.766 | 3.377 | 3.329 |
| 125-194| 445.5                | 160.3| 160.0| 0.646 | 0.653 | 4.420 | 4.358 |
| HL     |                      | 64.4 | 53.0 | 52.1 | 0.688 | 0.665 | 2.286 | 2.37 |
| 41-62  | 111.7                | 69.6 | 69.4 | 0.790 | 0.826 | 2.847 | 2.71 |
| 62-97  | 188.7                | 94.2 | 95.6 | 0.703 | 0.749 | 3.131 | 2.94 |
| 97-125 | 255.3                | 113.2| 115.1| 0.678 | 0.695 | 3.507 | 3.41 |
| 125-194| 447.9                | 159.5| 159.0| 0.672 | 0.636 | 4.156 | 4.38 |
| Final CV% |               | 0.8 | 2.2 | 1.8 |
| LH     |                      |     |     |     |     |     |     |     |
| 0-41   | 64.4                 | 53.0 | 52.1 | 0.688 | 0.665 | 2.286 | 2.37 |
| 41-62  | 111.7                | 69.6 | 69.4 | 0.790 | 0.826 | 2.847 | 2.71 |
| 62-97  | 188.7                | 94.2 | 95.6 | 0.703 | 0.749 | 3.131 | 2.94 |
| 97-125 | 255.3                | 113.2| 115.1| 0.678 | 0.695 | 3.507 | 3.41 |
| 125-194| 447.9                | 159.5| 159.0| 0.672 | 0.636 | 4.156 | 4.38 |
| Final CV% |               | 1.3 | 5.2 | 5.5 |

Initial live weight of groups LH and HL were 25.7 and 24.8 kg, respectively; CV% = coefficient of variation of the differences between the actual and simulated values after optimization.
In conclusion, the approach followed in this work allowed to obtain some estimates of the parameters required to describe "the pig growth characteristics" under on-farm conditions which can be considered as operational values for this kind of pigs. Even though more tests are required, the results obtained in this work suggest that the approach based on simple measurements of feed consumption and live weight, can be applied to a mathematical model to approximate the inherent growth characteristics of a group of pig. Many benefits can be achieved from the possibility of using a model in the farm: a better definition of the feeding standards for a given kind of production, the possibility of predicting changes of body composition when different feeding regimes are applied, the possibility of studying the effects of different genotype on the evolution of body composition under different feeding regimes. It is desirable that the mathematical model will be developed in the future in order to establish a link between the farmer and the industry for optimizing the feeding practices, to improve the quality of the products and to reduce the excretion of nutrients in the environment.

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