

Genetic variation in broilers and predicted response

R.M. Gous^{1}, C. Fisher¹ and E.T. Berhe², ¹EFG Software (Natal), South Africa, ²University of KwaZulu-Natal, P/Bag X01, Scottsville, South Africa. E-mail: gous@ukzn.ac.za*

Abstract

Because the rate of growth of feathers varies considerably within a flock, and because one of the constraints to achieving potential growth in broilers is the inability to lose heat to the environment, fast-feathering broilers are disadvantaged at high temperatures and/or when given feeds marginally limiting in essential nutrients. Geneticists should take cognisance of this genotype x environment interaction when selecting broilers for hot climates.

Introduction

The feather cover of broilers varies considerably within a flock: in a feather-sexable strain we have measured coefficients of variation of 15% in females and 25% in males (Gous, R.M., unpublished). This variation has consequences for the response of broilers to feeds differing in nutrient content and housed in different environments. A simulation model (EFG Software, 1995) has been developed that calculates the desired intake of a given food for a broiler to grow at its potential. The consequences for food intake, growth and carcass composition if this intake is constrained by feed bulk or by a hot environment are also determined. It is this latter constraint that is invoked in birds whose feather growth is higher than normal.

Potential feather-free body protein growth is described by the three parameters of the Gompertz growth curve, namely, the starting body protein weight (BP_0), the rate of maturing (B) and the mature protein weight (BP_m) (Emmans, 1987). The lipid content of the mature body is used to define the gross chemical composition of the body. The rate of feather growth must also be defined, and a Gompertz growth curve may also be used for this purpose. The rate of maturing of feathers, which differs from that for body protein growth, and which is seen as a multiple of the latter rate, differs markedly between genotypes and sexes, especially in feather-sexable strains. Feathering rate multipliers (FR) are used in the EFG Broiler Growth Model to calculate the rates of feathering of male and female broilers, these differing for feather-sexable and non-feather-sexable strains.

The parameters described above are seen as genetic characteristics of individuals in the flock, which may be measured in commercial strains of broiler (Hancock *et al.*, 1995; Gous *et al.*, 1996). Realistic responses of individuals, whose genotypes have been described by allocating appropriate values to these parameters, may be simulated using body protein content to define the current state or condition of the animal, which is then used to quantify the remaining body constituents and their respective growth rates (Taylor, 1980). Body protein is the driving variable in the model, the goal of the broiler being to grow at its potential body protein growth rate whenever possible (Emmans, 1987). Food intake, growth, body composition and yield, and a variety of production indices are calculated in each simulation.

The parameters describing the genotype of an individual would be expected to vary normally between individuals in a population. In the model of a population of broilers, the genotype of each broiler is described by allocating a mean and standard deviation to each genetic parameter, and the response of each broiler is then simulated and averaged to determine the mean response to a given feed, feeding schedule and environment. In many cases the average

response varies considerably from the response of the average individual. The major reason for this is the non-linear effect of feathering rate on performance.

Materials and Methods

The sensitivity analysis technique proposed by Morris (1991), of varying one factor at a time, was used (Berhe, 2003) to determine how variation in each of five genetic parameters influences the performance of broilers. The parameters were hatching weight (W_0), mature protein weight (P_m), rate of maturing (B), lipid: protein ratio at maturity (LPR_m) and a feathering rate multiplier (FR). All correlations were assumed to be zero. After simulating the response of the mean individual in a population, further simulations were conducted in which each of the five genetic parameters was reduced, in turn, by 0.05, 0.10, 0.15 and 0.20, and then increased by the same proportions. The exercise was conducted separately on male and female broilers, over two periods of growth (starter, 8 – 21d, and finisher, 22 – 35d) using two feeds limiting in lysine (9 and 16g lysine/kg respectively in the starter period, and 7g and 11g/kg in the finisher period). The lysine: protein ratio was the same in both feeds within each period.

Results and Discussion

Figure 1 shows the effects of variation in the five genetic parameters on food intake in males and females of a feather-sexable strain, and in the starter and finisher periods. In both periods food intake increased almost linearly with B, W_0 and LPR_m . In the case of P_m this linear effect was seen only at the high lysine level in the starter, but at both lysine levels in the finisher period. These results indicate that, if only these four parameters were being used to describe a population of broilers, there would be little need to simulate a population, as the average response would be very similar to the response of the mean individual. However, the effect of FR was non-linear in all cases and more pronounced in females than in males, especially in the starter period. Food intake dropped more substantially with FR among males fed low lysine in the starter period than those fed the high lysine feed. The effects were greater and more uniform in the finisher than in the starter period. The theory of food intake regulation of Emmans (1987) predicts that food intake would decline with a higher rate of feather growth given that the processes of food intake and growth generate heat that must be lost to the environment if the bird is to remain in thermal neutrality and hence grow at its potential; if the bird cannot lose this heat to the environment, food intake will be constrained. This would occur either at high environmental temperatures or in a bird with an extensive feather cover. The amount of variation introduced by varying FR was as great as that resulting from the same degree of variation in B; but the important distinction is between the linear effects of B and the non-linear effects of FR.

The heritability (h^2) estimates of rate of feathering of broilers measured by Singh and Trehan (2002) at 10 d varied between 0.231 and 0.580, and the h^2 of feather density scores was even higher (0.279-0.925), implying that geneticists have the potential to alter these characteristics relatively easily. As broiler genotypes continue to be selected for ever-faster growth rates, heat production by these birds will increase and food intake is more likely to be constrained by high temperatures, resulting in a loss of potential performance. Selection for decreased feather cover may prove to be a relatively successful method of overcoming the effects of heat stress, as suggested by Cahaner *et al.* (2003), given that feeding programmes are ineffective in overcoming this stress.

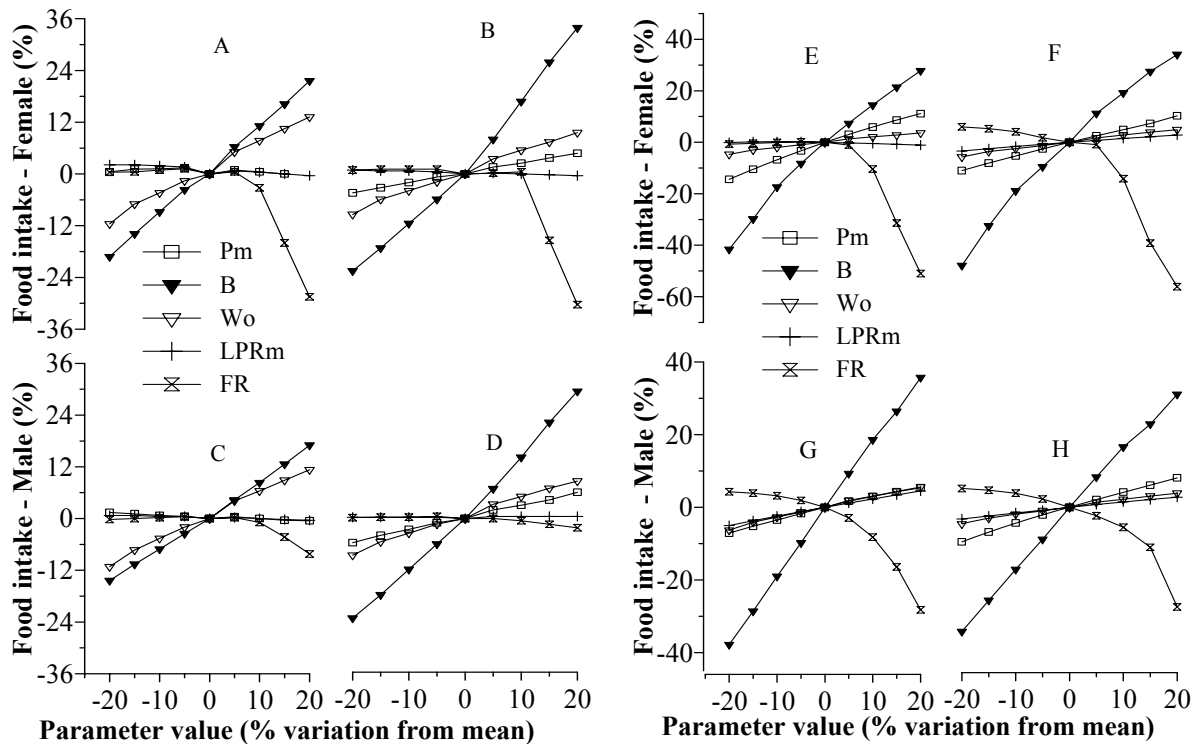


Figure 1 The relative effects on food intake of feeding male and female broilers a lysine-limiting feed containing 9g (A, C) or 16g lysine/kg (B, D) from 7 to 21d (left), or 7g (E, G) or 11g lysine/kg (F, H) from 22 to 35 d (right), when the means of each of five genetic parameters were increased or decreased by 0.05, 0.1, 0.15 or 0.20 whilst holding the four remaining genetic parameters constant.

References

- BERHE, E.T. (2003). *Introducing stochasticity into a model of food intake and growth of broilers*. M.Sc.Agric. Thesis, University of KwaZulu-Natal, South Africa.
- CAHANER, A., DRUYAN, S. and DEEB, N. (2003). Improving broiler meat production, especially in hot climates, by genes that reduce or eliminate feather coverage. *British Poultry Science*. 44: S22 – S 23.
- EMMANS, G.C. (1987). Growth, body composition, and feed intake. *World's Poultry Science Association Journal*. 43: 208-227.
- GOUS, R.M., PYM, R.A.E., MANNION, P. and WU, J.X. (1996). An evaluation of the parameters of the Gompertz growth equation that describe the growth of eight strains of broiler. *Australian Poultry Science Symposium*, Vol. 8, 174 - 177, University of Sydney, Sydney, NSW.
- HANCOCK, C.E., BRADFORD, G.D., EMMANS, G.C. and GOUS, R.M. (1995) The evaluation of the growth parameters of six strains of commercial broiler chickens. *British Poultry Science*. 36: 247-264.
- MORRIS, M.D. (1991). Factorial sampling plans for preliminary computational experiments. *Technometrics*. 33: 161 – 174.
- SINGH, P. and TREHAN, P.K. (2002). Inheritance of rate of feathering and feather density score and its relationship with body weight in broiler chicken. *SARAS Journal of Livestock and Poultry Production*. 18: 41-47.
- TAYLOR, ST. C.S. (1980). Genetic size scaling rules in animal growth. *Animal Production*. 30: 161-165.