EFFECTS ON GROWTH RATE BODY COMPOSITION AND FEED EFFICIENCY IN LINES OF CHICKENS SELECTED FOR ASPECTS OF GROWTH AND BODY COMPOSITION

R.A.E. PYM *

SUMMARY

Direct and correlated responses were determined after five generations in five lines of chickens selected either for increased abdominal fatness (line F), decreased abdominal fatness (line L), increased 8-week liveweight (8WW, line W), increased 8WW combined with decreased abdominal fatness (line WL), or at random (line C). The abdominal fat calipers of Pym and Thompson (1980) were used as the measure of abdominal fatness.

After five generations of selection there was no correlated response in 8WW in the F or L lines, but line F was some 70 percent fatter than line L. Lines W and WL were about 250g heavier than the F, L and C lines and line W was some 33 percent fatter than line WL. Despite these differences in fatness, there was no difference in feed efficiency from 4 to 8 weeks of age in the W and WL lines. There were significant positive responses in feed efficiency in the L, W and WL lines and a significant negative response in the F line. The results demonstrate that the abdominal fat calipers can be used as an effective tool in selecting for increased lean tissue growth rate in chickens.

INTRODUCTION

Although broiler chickens have until relatively recently enjoyed a reputation as lean meat, it is now generally recognised that chickens are fatter than desirable. Consumers now prefer meat with only a minimal amount of fat, and from a cost of production point of view, it is energetically expensive to deposit fat in excess of requirements.

Commercial breeders have only recently begun to select for reduced fatness in their meat stocks. Prior to the 1980's, even when some breeders became aware of a fatness problem in their broilers, there were no techniques available for measuring fat in the live bird. The only method then available to the breeder was to slaughter birds to determine body composition and use sib selection. This is tedious, expensive and inefficient.

Two techniques are now available which offer quite good prediction of fatness in the live bird. The first (Pym and Thompson 1980), employs a specially designed set of calipers which measures the thickness of the abdominal fat pad, and the second (Griffin et al 1982), involves measurement of plasma very-low-density lipoprotein (VLDL) concentration. Research workers and commercial breeders have met with varied success with the two techniques, but in the hands of experienced operators in the case of the calipers, and careful attention to the blood sampling and analysis protocol in the case of the VLDL technique, both methods give quite good prediction of abdominal and/or total body fatness.

*Dept. of Animal Sciences and Production, University of Queensland, St. Lucia, 4067, Qld.
This paper describes direct and correlated responses to selection for five generations for increased or decreased fatness, increased growth rate or increased lean tissue growth rate in meat-type chickens. The abdominal fat calipers of Pym and Thompson (1980) were used as the measure of fatness. Results to three generations of selection have been reported by Pym (1985b).

THE SELECTION EXPERIMENT

The zero generation of the selection experiment was generated from a mating between 80 cockerels and 240 pullets in a line which was derived three generations earlier from a crossbred commercial broiler population. In the intervening period, the line was regenerated each year by mating sixteen cockerels each with four pullets. Breeders were selected at random within sire families and there was equal representation from families in the previous generation. Close relative matings were avoided.

Five lines were produced for the zero generation. Each line was generated from mating sixteen cockerels each with three pullets. There were four fortnightly hatches. Parents of the zero generation were selected such that there was minimal body weight bias in the five lines and there were equal representation from families in the previous generation. Close relative matings were again avoided.

The five lines were: line F - selected for high caliper measure at 8 weeks (high fat); line L - selected for low caliper measure at 8 weeks (low fat); line W - selected for high 8-week liveweight (high weight); line WL - selected for high 8-week liveweight combined with low caliper measure (high lean weight); and line C - randomly selected control line.

Individual selection was used in all lines and independent culling level selection was used in the WL line. In this line, birds were pre-selected on 8-week weight and then culled on caliper measure. In each hatch approximately 50% more of the heaviest males and 30% more of the heaviest females than were-selected in the W line, were considered for selection. These were reduced to comparable numbers selected in the other lines by elimination of those birds with the highest caliper measures. In each generation, each line was generated by mating 16 cockerels each with 3 pullets.

Management of Birds

In each generation four fortnightly hatches were reared to 8 weeks of age in deep litter broiler sheds under conditions typical for broiler production. Within each hatch, the five lines were reared intermingled in one large group. At hatching, chicks were wingbanded for pedigree identification and vaccinated against Mareks disease. All birds received a typical broiler starter diet (220g CP and 13.0 MJ or ME per kg) from day-old to 4 weeks of age, and a typical broiler finisher diet (200g CP and 13.0 MJ of ME per kg) from 4 to 8 weeks of age. At 8 weeks of age all birds were weighed and measured with the abdominal fat calipers. There were approximately 800 birds tested per line per generation.

A fifth hatch was produced each generation for measurement of responses in body composition and food utilisation efficiency. In generations 1, 2, 3 and 5, these birds were reared to four weeks of age in brooder cages and then transferred to single-bird cages where individual
food consumption and growth rate were measured to 8 weeks of age. In generation 4, between four and eight weeks of age the birds were housed in follow-on rearing cages with three cages per sex/line subgroup and about nine birds per cage. Following the 8-week weight the birds were slaughtered for measurement of abdominal and total body fatness. The diets used were the same as used for hatches one to four.

RESULTS AND DISCUSSION

Combined sire and dam component sib analysis estimates of the heritabilities of El-week liveweight and caliper measure in the zero generation were 0.34 ± 0.08 and 0.31 ± 0.10 respectively. The genetic and phenotypic correlation estimates between these two traits were 0.34 ± 0.17 and 0.33 ± 0.04 respectively. Based on these estimates, selection for increased-body weight is likely to result in an increase in abdominal fatness. Responses in 8-week liveweight (8WW) and caliper measure to selection for five generations in the four lines are shown in Figure 1.

Fig. 1. Direct and correlated responses in 8-week liveweight and caliper measure to five generations of selection in the FO, L ▼, W □ and WL △ lines.
The figure shows substantial response in 8WW in both the W and WL lines, but no response in this trait in the F or L lines. From the base population parameter estimates, liveweight should increase in the F line and decrease in the L line. Whilst this was the initial trend during the first two generations, there appears to have been a change in the genetic correlation as selection proceeded. There would thus appear to be little effect on body weight with divergent selection for fatness. This agrees with the results of Leclercq (1980) and Whitehead and Griffin (1984).

The similarity in response in 8WW in the W and WL lines indicates the relatively high selection pressure that could be maintained on growth rate in the WL line whilst culling excessively fat individuals from selection. The initial greater response in the WL line probably simply reflects sampling variation.

Response in caliper measure in the F and L lines has been reasonably linear and in the expected direction. There appears to have been a slightly negative response, as expected, in the WL line. A factor which has undoubtedly reduced the downward response in this line is that there is a positive correlation between body weight and caliper measure and the WL line birds were some 249g heavier than the control line birds at 8 weeks by generation 5. The initial positive response in caliper measure in the W line to generation 4 is in keeping with the direction of the genetic correlation determined in the zero generation population. The significance of the change in response between generations 4 and 5 is not immediately apparent but reflects similar changes in abdominal fatness.

Correlated responses in abdominal fatness and food conversion efficiency to selection for 5 generations in the four lines are illustrated in Figure 2.

Responses in abdominal fatness of the F and L lines have been reasonably linear and in the expected direction indicating that the calipers can be used to select for high or low abdominal fatness in chickens. The F line has some 70 percent more abdominal fat than the L line. The WL line has also responded in a linear manner and by generation 5 has the same proportion of abdominal fat as the L line and some 25 percent less fat than the W line. This result is particularly encouraging and indicates that the calipers can be effectively used as a tool in selecting for lean tissue growth rate in chickens. Improvement in lean tissue growth rate was similarly achieved by Cahaner et al (1985) using sib selection for abdominal fatness and within family selection for body weight in lines of meat chickens, although comparison was not made with a line selected for growth alone.

The response in abdominal fatness in the W line was not linear. There was an initial positive response to generation 3 followed by a negative response to generation 5 by which time overall response was zero. It appears that different physiological pathways may be brought into play at different stages of selection. This was observed by Pym et al (1984) in selection for twelve generations for food conversion efficiency and its components. In the latter two generations of selection in the W line in the present experiment, there appears to have been an emphasis upon lean gain, possibly as genes controlling other pathways became fixed. The zero response at generation 5 agrees with the results of the earlier feed efficiency selection experiment (Pym 1985a) where there was no response in fatness to selection for increased weight gain when body fat was measured.
at the same age. There was, however, a mild reduction in fatness in this line when body composition was measured at about typical slaughter weight.

Housing of the birds in cage groups rather than in single cages in generation 4 may have had an effect upon measured FCR in this generation. It would appear that both the W and WL lines, which were the heaviest birds, may have suffered in this regard. By generation 5, the L line birds were significantly more efficient than the F line. This agrees with the results of both Leclercq et al (1980) and Whitehead and Griffin (1984).

The lack of difference in FCR between the W and WL line birds by generation 5 is unexpected. Since the W line was some 33 percent fatter at that stage than the WL line, it would be expected, all other things being equal, that the latter line would be considerably more efficient.
given the high energy cost of depositing fat. That they were not is of concern, and tends to remove one of the important arguments for selecting for lean tissue growth rate rather than selecting simply for growth rate itself. Since the birds were tested over a part (4 to 8 weeks) and not the whole of the growth period, there may be an effect of the initial unmeasured period on overall feed efficiency. An attempt will be made next generation to extend the measurement period and commence measurement of intake as early as possible.

FURTHER STUDIES

The selection experiment has demonstrated that the calipers can be effectively used as a tool in selecting for lean tissue growth rate in chickens and has produced unique lines of birds to study the effects of such selection upon reproductive and nutritional physiology and to study non-genetic effects upon body composition.

Studies using these birds are presently proposed, both at the University of Queensland and in collaboration with other research institutes throughout Australia, on aspects of reproductive physiology and performance in breeders and on nutrient requirements and nutritional physiology in young growing stock.

Such information should be of considerable value to the commercial breeding companies in determining the likely consequences of selection for aspects of body composition in meat chickens upon reproductive performance and nutritional management of broiler breeders and upon nutritional requirements in young growing stock.

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