AUSTRALIAN EGG®
CORPORATION LIMITED

# 7th World Congress on Genetics Applied to Livestock Production and 11th European Poultry Conference

**A report for the Australian Egg Corporation Pty Ltd**

By Dr R.A.E Pym

July 2003

AECL Publication No 03/17
AECL Project No TA012-23

*7th World Congress on Genetics Applied to Livestock Production and 11th European Poultry Conference*
*France and Germany August 2002*
*Publication No. 03/17*
*Project No. TA012-23*

This project was funded under the management of the Rural Industries Research and Development Corporation.



**Researcher Contact Details**

| | |
|---|---|
| Name: | Dr R.A.E Pym |
| Address: | The University of Queensland<br>School of Veterinary Science and Animal Production<br>St Lucia, Queensland, 4072 |
| Phone: | (07) 3365 2604 |
| Fax: | (07) 3365 1288 |
| Email: | r.pym@mailbox.uq.edu-au |

In submitting this report, the researcher has agreed to AECL publishing this material in its edited form.

AECL Contact Details
Australian Egg Corporation Limited
A.B.N: 6610 2859 585
Suite 502, Level 5
12-14 Ormonde Pde
HURSTVILLE NSW 2220
PO Box 569
HURSTVILLE NSW 1481

Phone: 02 9570 9222
Fax: 02 9570 9763
Email: irene@aecl.org
Website: http://www.aecl.org

**Published in July 2003**

# Reason for travel

To attend and present a paper at 7th World Congress on genetics Applied to Livestock Production at Montpellier, France from 18-23 August 2002, Visit colleagues at INRA, Station de Recherches Avicoles, Nouzilly, France for discussion on collaborative project from 28-30 August 2002, and attend and present paper at European Poultry Conference, Bremen, Germany from 6-10 September 2002. At both conferences, promote World's Poultry Congress to be held in Brisbane in August 2008.

# Summary

The travel was undertaken by Dr Pym in August/September 2002 for the purposes of presenting papers at two conferences in France and Germany, of discussing a collaborative project with colleagues at the INRA Poultry Research Centre at Nouzilly, France and of promoting the 23rd World's Poultry Congress to be held in Brisbane in August, 2008. Dr Pym departed Australia on 14 August for London and arrived at Montpellier, France on 19 August. At the 7th World Congress on Genetics Applied to Livestock Production in Montpellier, from 19-23 August 2002, Dr Pym presented a paper entitled "Selection for growth rate, feed efficiency and body fatness in Japanese quail (*Coturnix coturnix japonica).* He visited colleagues at the INRA Poultry Research Centre, Nouzilly to discuss their collaborative project on protein turnover in selected lines of chickens from 28-30 August. He subsequently attended the 11th European Poultry Conference in Bremen, Germany from 6-10 September, where he presented a paper entitled "Apparent metabolisability of dietary energy in lines of chickens selected for different aspects of body composition". Preliminary announcement brochures (copy enclosed) of the 23rd World's Poultry Congress to be held in Brisbane in August 2008, were distributed at both conferences, and a booth was organised in the exhibition area of the Bremen conference to promote the Congress in Brisbane. Dr Pym departed Paris on 12 September and returned to Brisbane on 14 September.

# Itinerary

A broad itinerary is provided below and a more detailed itinerary is provided in the attached travel diary prepared for the University of Queensland.

| | |
|---|---|
| 19-23 August 2002 – | Attend and present paper at 7th World Congress on Genetics Applied to Livestock Production in Montpellier, France |
| 28-30 August 2002 – | Visit INRA Station de Recherches Avicoles, Nouzilly, France for discussions with colleagues on collaborative research |
| 6-10 September 2002 – | Attend and present paper at 11th European Poultry Conference Bremen, Germany. |

# Travel report

## Primary purpose

The primary purpose of the travel was to promote the 23rd World's Poultry Congress to be held in Brisbane in August 2008. Following a period of limited activity by the team from WPSA Australian Branch who mounted the successful bid to stage the Congress in Brisbane at the 21st World's Poultry Congress in Montreal in August 2000, it was considered timely to commence promotion of the Brisbane Congress during 2002, and a preliminary announcement brochure was prepared for this purpose. Promotion of the Congress at the 2002 European Poultry Conference in Bremen from 6-10 September 2002, was considered important, as the next EPC, which attracts a large proportion of scientists and industry personnel from Europe and UK, will not be held until 2006. Coincidental with the desirability of promoting WPC at Bremen, following a sabbatical in France in 1998 Dr Pym had prepared two papers, one to be presented at EPC and the other main paper on protein turnover in selected lines of chickens was in draft form and in need of further input and discussion with his French collaborators. Additional to this, together with one of his postgraduate students, Dr Pym had prepared a paper on selection for body composition in quail to be presented at the 7th World Congress on Genetics Applied to Livestock Production in Montpellier, France from 19-23 August 2002. Attendance at that meeting also offered the opportunity to promote the Brisbane Congress.

## Major Achievements

Attendance at the Montpellier meeting provided an opportunity to hear the latest research on livestock genetics and breeding from around the world. In terms of poultry genetics and breeding, there is a great deal of interest in the identification of Quantitative Trait Loci (QTLs) in their effect on production characters in both egg and meat-type stock. In due course, this has the potential to permit the selection of birds on the basis of DNA coding sequence at given loci, to support or replace selection on the basis of performance in the trait(s) in question. Four hundred preliminary announcement brochures for the 2008 Brisbane WPC were distributed at the meeting.

The visit to INRA, Nouzilly was most worthwhile and, as a result, a paper "Protein utilisation and turnover in lines of chickens selected for different aspects of body composition" by R.A.E. Pym, B. Leclercq, F.M. Tomas and S. Tesseraud, has recently been submitted to British Poultry Science.

With financial support from Brisbane Marketing, a booth promoting the 2008 Brisbane Congress was set up in the exhibition area of the European Poultry Conference at Bremen. The booth incorporated a very colourful display with a backdrop of posters of Brisbane and the environs on a spider display (see Attached colour photocopy). The booth was manned by Australian delegates and was exceedingly popular with all delegates; one particular attraction was the 600 clip-on koalas provided by Brisbane Marketing. Some 500 preliminary announcement brochures were handed out to delegates, many of whom expressed their intent to come to Brisbane in 2008.

## Benefits to grantee

Presentation of the papers at the two conferences and subsequent discussions with interested scientists have proven valuable in formulating follow-up research studies and the possibility of collaborative work in these areas. The opportunity to discuss the collaborative work with colleagues at INRA, Nouzilly, has resulted in the finalisation and submission for publication of the main paper on protein turnover. Whilst at the Bremen conference, Dr Pym attended by invitation the 36th meeting of the Board of WPSA in Bremen on 10 September 2002. A wide range of issues were discussed, but of particular relevance was the opportunity for Dr Pym to acquaint the Board with present and proposed developments relating to the staging of the 2008 World's Poultry Congress in Brisbane. The Board was impressed with the facilities available and has well founded expectations of an excellent Congress in Brisbane.

## Benefits to industry

The major benefit of the travel to the Australian poultry industry relates to the promotion of the 2008 World Poultry Congress in Brisbane. Properly promoted, the meeting will bring not only the top poultry scientists from around the world, many of whom would be available to industry for discussions and advice in their respective areas of expertise, but also will be by far the largest poultry trade exhibition the country has seen. This will provide excellent import and export opportunities for industry as well as having the direct effect of stimulating improvements in the economic efficiency of production.

Discussions with researchers at the two conferences and at INRA offer opportunities for further studies (e.g. through support from RIRDC or the poultry CRC), with potentially significant impact on production efficiency in broilers.

# Recommendation

The potentially profound beneficial impact on the Australian poultry industry of staging the 23rd World's Poultry Congress in Brisbane in 2008, argues for strong support from all industry bodies to make the Congress a success. This involves effective promotion both here in Australia, but particularly overseas, at poultry industry meetings and forums from now until the Congress in August of 2008.

It is suggested that there would be particular benefit from subsuming all Australian poultry meetings that year into the Congress, to maximise sponsorship as well as the participation of delegates and exhibitors. It is intended that The Australian Poultry and Feed Convention will be subsumed into the Congress that year, and the Australian Poultry Science Symposium will also not be held in February 2008. Preliminary discussions have been held with the organisers of PIX with a view to incorporate the elements of PIX as a "producers' day" into the Congress. Further discussions will be held shortly.

A steering committee has now been established and will be activated in the latter part of 2003 to determine the broad parameters of the Congress and its operation. In 2004 it is planned to establish a separate Congress corporation to financially protect WPSA Australian Branch, to set up a Congress Organising Committee with broad representation from industry and to appoint a PCO. It will be essential to mount an effective Congress promotion at the WPC in Istanbul, Turkey in June 2004.

# Apparent metabolisability of dietary energy in lines of chickens selected for different aspects of body composition.

R.A.E. Pym[1], B. Leclercq and S. Tesseraud.

INRA Station de Recherches Avicoles, 37380, Nouzilly, France
[1] Present address: School of Veterinary Science, University of Queensland, St Lucia, Q. 4072 Australia

## Summary

Nitrogen-corrected and uncorrected measures of apparent metabolisable energy (AME) and metabolisability of dietary energy (AME%) were made in two experiments during the grower phase on 18 male chickens from each of four genetic lines given either of two isoenergetic diets varying in protein concentration (120 or 220g CP/kg). In Experiment 1, the high breast development line (QL) and its unselected control line (CL) of Ricard *et al.* (1994) were used, and in Experiment 2, Leclercq's (1988) high (FL) and low (LL) abdominal fat lines were used.
In Experiment 1, there was no difference in any of the AME measures between the QL and CL line, but in Experiment 2, the LL birds had higher ($P<0.05$) AME% (80.1%) and $AME_n$% (75.7%) than the FL birds (78.2 and 74.1% respectively). There was no line X diet interaction in either experiment for any of the AME measures. Nitrogen (N) retention coefficient [(N intake – N output)/ N intake], was higher ($P<0.05$) in the LL (0.556) than in the FL (0.484) birds in Experiment 2, but higher ($P<0.05$) in the QL (0.573) than the CL (0.524) birds only on the high-protein diet in Experiment 1. There was thus a correlated response in AME% to divergent selection for body fatness, but, in the absence of a control line, the symmetry of the response was not defined. Differences in protein retention appeared to contribute to observed differences in AME% in the LL and FL birds.

***Keywords***: *AME, Selection, Body composition, Metabolisability, Abdominal fat, Breast yield*

# Introduction

On the basis of breed and strain comparisons across species, it is generally held that there is relatively little genetic variation in digestibility or metabolisability of dietary energy (e.g. Fowler, 1962: Blaxter 1968). There are, however, a number of reports in chickens of significant differences in metabolisability of dietary energy between breeds and strains (Sibbald and Slinger, 1963) and between lines selected divergently for growth rate (Proudman *et al*. 1970), or for the components of feed utilisation efficiency (Pym and Farrell, 1977; Pym *et al.*, 1984; Jorgensen *et al*., 1990). There are, however, no reports of significant effects on metabolisability of dietary energy in birds selected for body composition *per se* (Geraert *et al*., 1987; Macleod *et al*., 1988, MacLeod and Geraert, 1988). In each case, the reported studies involved comparisons of high- and low-fat line birds and the number of birds in each study was small. The purpose of the present study was to evaluate the effect of selection for fatness and for breast meat yield on metabolisability of dietary energy in birds given diets varying in protein concentration.

# Experimental procedure

Two different selection lines were used in each of the two experiments. In Experiment 1, the high breast development line (QL) and its unselected control line (CL) (Ricard *et al*., 1994) were used, and in Experiment 2, Leclercq's (1988) high (FL) and low (LL) abdominal fat lines were used. The experiments were undertaken specifically to study protein utilisation and turnover in the lines. These results will be reported elsewhere. The present report relates only to a comparison of metabolisability of dietary energy and nitrogen retention in the lines.

## Experiment 1

Following rearing to 21 d of age on a broiler starter diet containing 12.5MJ AME and 225g CP/kg, 18 representative males from each of the QL and CL lines (Ricard *et al*., 1994) were transferred into single-bird cages in a controlled environment, air conditioned room held at 25±1$^{O}$ C where they continued to receive the starter diet for three days. At 21d of age, nine male birds from each line were given either one of the two isoenergetic diets varying in protein concentration (120 or 220g CP/kg) shown in table 1.

Following a five-day acclimatisation period, at 26d the birds in the single cages were weighed and excreta collection and food intake measurement commenced. Birds were weighed daily for the next three days and food intake and excreta production were measured daily over this period. Each bird's daily excreta production was collected quantitatively and transferred into a plastic bag and stored at –20$^{O}$C for subsequent analysis.

**Table 1.** The ingredient and calculated nutrient composition (g/kg) of the high and low protein diets from 21 d of age.

| **Ingredient** | High protein | Low protein |
|---|---|---|
| Soybean meal (47% CP) | 370 | 115 |
| Maize (7.6% CP) | 533 | 830 |
| Vegetable oil | 55 | 12.7 |
| Vitamin mineral premix | 40 | 40 |
| Lysine HCL | - | 1.60 |
| DL Methionine | 2.0 | 0.55 |
| Threonine | - | 0.20 |
| Arginine | - | 0.26 |
| **Nutrient** | | |
| AME (MJ/kg) | 12.91 | 12.89 |
| CP | 217.7 | 119.5 |
| CP (determined) | 215.8 | 121.5 |
| Digestible Lysine | 10.76 | 5.92 |
| Digestible SAA | 8.04 | 4.42 |

The three-day excreta production from each bird was pooled, weighed and freeze dried to constant weight for 48h. Following removal from the freeze drier, the excreta was allowed to equilibrate to constant weight at room conditions for 24 h before milling prior to determination of gross energy (GE) in a bomb calorimeter and Kjeldahl analysis for nitrogen (Procedure V18-100, AFNOR, 1985). Energy and nitrogen were similarly determined in ground samples of the two diets.

AME, apparent metabolisability of dietary energy (AME% = AME/GE X 100), and nitrogen retention coefficient :[(N intake- N output)/N intake], was calculated for each bird. AME and AME% were calculated as N-corrected (Hill and Anderson, 1958) and uncorrected values. The significance of effects of line and diet and of the line X diet interaction, was determined from analysis of variance.

## Experiment 2

The procedures used in Experiment 1 were essentially repeated in Experiment 2, with the following exceptions: Lines QL and CL were replaced with the FL and LL lines of Leclercq, (1988), selected for seven generations for high and low abdominal fatness respectively; birds were transferred to the single cages at 30d (not 18d) of age to acclimatise; birds were given one of the two diets at 33d (not 21d) of age; excreta collection commenced at 40d (not 26d) of age and; final excreta collection was made at 43d (not 29d) of age. The change in age and intervals between the two experiments was due to the considerably slower growth rate of the two lines used in Experiment 2.

# Results

The effect of line and diet on metabolisability of dietary energy in the two experiments is shown in Table 2.

In both experiments, $AME_n$ was higher (P<0.05) on the high-protein than on the low-protein diet, but there was no significant effect of diet on AME in either experiment. Metabolisability of dietary energy, both nitrogen-corrected and uncorrected, was significantly (P<0.05) higher on the low-protein diet, in both experiments.

**Table 2** The effect of line and diet on AME, $AME_n$ (MJ/kg), AME% and $AME_n$% in the two experiments. Standard errors in parenthesis.

| Experiment 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Line | AME | | $AME_n$ | | AME% | | $AME_n$% | |
| Diet | H | L | H | L | H | L | H | L |
| QL | 13.86 | 13.71 | 13.19 | 12.77 | 77.28 | 83.21 | 73.53 | 77.52 |
| | (0.062) | (0.075) | (0.058) | (0.067) | (0.35) | (0.45) | (0.32) | (0.40) |
| CL | 13.90 | 13.80 | 13.29 | 12.86 | 77.48 | 83.74 | 74.06 | 78.05 |
| | (0.056) | (0.034) | (0.053) | (0.030) | (0.31) | (0.20) | (0.29) | (0.18) |
| Experiment 2 | | | | | | | | |
| FL | 13.42 | 13.44 | 12.92 | 12.56 | 74.83 | 81.58 | 72.02 | 76.25 |
| | (0.192) | (0.100) | (0.176) | (0.093) | (1.07) | (0.61) | (0.98) | (0.56) |
| LL | 13.78 | 13.73 | 13.19 | 12.81 | 76.83 | 83.32 | 73.50 | 77.79 |
| | (0.090) | (0.050) | (0.083) | (0.044) | (0.50) | (0.30) | (0.46) | (0.27) |

In Experiment 1, there was no difference between the two lines for any of the measures of metabolisable energy and there was no indication of an interaction between line and diet. In Experiment 2, however, AME% and $AME_n$% were both significantly (P<0.05) higher in the LL than in the FL birds (80.1 cf. 78.2% and 75.7 cf. 74.1% respectively). There was again no indication of an interaction between line and diet. The effect of line and diet on the coefficient of N retention, is shown in Table 3.

**Table 3** The effect of line and diet on the coefficient of N retention in the two experiments. Standard errors in parenthesis.

| Experiment 1 | | | | Experiment 2 | | | |
|---|---|---|---|---|---|---|---|
| Line | Diet | HP | LP | Line | Diet | HP | LP |
| QL | | 0.573 | 0.638 | FL | | 0.431 | 0.537 |
| | | (0.0086) | (0.0138) | | | (0.0185) | (0.0252) |
| CL | | 0.524 | 0.639 | LL | | 0.511 | 0.600 |
| | | (0.0143) | (0.0073) | | | (0.0120) | (0.0100) |

In both experiments the coefficient of N retention was higher (P<0.05) in birds on the low-protein diet. In Experiment 1, there was a significant (P<0.05) line X diet interaction due to a higher N retention in the QL than the CL birds on the high-protein diet, but no difference on the low-protein diet. In Experiment 2, the L line birds had higher (P<0.05) N retention than their F line counterparts (0.556 cf. 0.484 respectively); there was no indication of a line X diet interaction

# Discussion

The relatively close agreement of the AME values for the two diets in the two experiments (Table 2), indicates that formulation of two isoenergetic diets was successful. The greater reduction in AME with nitrogen correction on the low–protein than on the high- protein diet across both experiments (6.7 cf. 4.3%), however, reflects the higher N retention on the low protein diet (table 3), as found by Leeson *et al.* (1977)

The line differences in metabolisability of dietary energy indicate that divergent selection for body fatness, does impact on metabolisability of dietary energy, whilst the lack of difference between the QL and CL lines in Experiment 1, suggests that selection for increased breast yield and growth rate in the QL line, has not exerted pressure on energy metabolisability. It can not necessarily be assumed that the correlated response in AME% in the two lines in Experiment 2 is symmetrical since, in the absence of a control line, the difference may be due largely to a negative response in the high fat line. This possibility is suggested by the lower AME% in the FL line compared to the QL and CL lines in Experiment 1, although age differences may be implicated in differences in AME% between the two experiments.

The contribution to the line differences in AME% and $AME_n$% of protein retention, is indicated by line differences in N retention coefficient (Table 3). In Experiment 2, line differences in AME% were reduced with N correction, suggesting that differences in N retention (possibly including a component of protein digestibility) contributed to the line differences in metabolisability of dietary energy. The significant residual difference between the lines in $AME_n$% suggests that other factors are also involved. The significant interaction between line and diet for N retention coefficient in Experiment 1 (Table 3), however, was not reflected in line X diet effects upon AME% and $AME_n$%. These differences suggest that where dietary protein was sufficiently high, protein utilisation was improved by selection for increased breast yield and growth in the QL line, but was not expressed where dietary protein was limiting. Line comparisons of N retention based on N intake and N accretion in the body, not presented here, were very similar to the comparisons shown in Table 3 of N retention based on N intake and N output in excreta.

Of the studies conducted with lines selected for high or low body fatness (Geraert *et al.* 1987, using the same FL and LL lines used in the present study, and MacLeod *et al.* 1988, using lines selected for fatness on the basis of plasma VLDL concentration ), there was no significant difference between the two lines in metabolisability of dietary energy. In nearly all studies with fat- and lean-line birds, although not significant, the arithmetic mean metabolisability of dietary energy of the lean line birds was greater than the fat- line birds (MacLeod and Geraert, 1988), and in some cases (e.g. MacLeod *et al.*,1988) the difference was relatively large (75.0 cf. 73.0%). This suggests that the difference may be real but not great, and with the relatively small numbers of birds typically used in AME determinations, it has not registered as significant. In the present study with nine birds per line X diet group, the absolute difference in AME% between the LL and FL birds was two percentage points compared to a non-significant 0.8 percentage points in the earlier study (Geraert et al 1987).

It might reasonably be expected that if genetic variation in metabolisability of dietary energy exists, selection for improved food utilisation efficiency would effectively manipulate this variation. This is confirmed by the results of a number of studies involving selection for improved food utilisation efficiency where a significant improvement in AME% has been recorded (Pym and Farrell, 1977; Pym *et al.*, 1984; Jorgensen *et al.*, 1990). The effect of generation of selection for feed efficiency on correlated response in AME% is demonstrated by the results of Pym and Farrell (1977) and Pym *et al.* (1984). After three generations, the AME% response in the efficiency line was 0.9%, increasing to 3.3% after 12 generations of selection. It is noteworthy that response in AME% to selection for increase appetite went in the opposite direction, there being no response after 3 generations, dropping to 10 percentage points lower than the controls (62.7 cf. 72.7%) after 12 generations of selection. It would appear to be much easier to select for reduced than for improved nutrient utilisation. The physiological mechanisms underlying the correlated response in AME% to divergent selection for body fatness in the present study, are not immediately apparent.

The results of the present study pose questions, firstly as to the symmetry or otherwise of the correlated response in AME% to divergent selection for fatness, and secondly, as to the relative contribution of protein, fat and carbohydrate digestion and metabolism to the observed line differences in AME. With regard to impact on selection in broilers, it would seem that any combination of selection for feed efficiency and for leanness would be complementary in their effect on metabolisability of dietary energy.

# Acknowledgments

We would like to express our gratitude to K. Gerard for assistance with animal care, to E. Lebihan-Duval and N Millet for provision of the experimental lines, and to J. Michel and R. Peresson for technical assistance.

# References


Afnor. 1985. Norme V18-100. In: Recueil de normes françaises. méthodes d'analyses françaises et communautaires. 2nd ed. pp 89-93. Association Française de Normalisation, ed. Paris, France.

Blaxter, K.L. 1968. The effect of the dietary energy supply on growth. In: G.A. Lodge and G.E. Lamming. Eds. Growth and development of Mammals. Butterworths, London.

Fowler, R.E. 1962. The efficiency of food utilisation, digestibility of foodstuffs and energy expenditure of mice selected for large and small body size. Genet. Res. (Camb) 3: 51-68.

Geraert, P.A., M.G. McLeod, T.R. Jewitt, and J. Anderson, 1987. Energy and nitrogen metabolism in genetically fat and lean chickens. Proc. Nutr. Soc. 46: 34A.

Hill, F.W. and D.L. Anderson, 1958. Comparison of metabolizable and productive energy determinations with growing chicks. J.Nutr. 64: 587-604.

Jorgensen, H., P. Sorensen and B.O. Eggum, 1990. Protein and energy metabolism in broiler chickens selected for either weight gain or feed efficiency. Br. Poult. Sci. 31: 517-524.

Leclercq, B., 1988. Genetic selection of meat-type chickens for high or low abdominal fat content. *In*: Leanness in Domestic Birds: Genetic, Metabolic and Hormonal Aspects. B Leclercq and C.C. Whitehead, Eds. Pp 25-40. Butterworths, London.

Leeson, S., K.N. Boorman, D Lewis and D.H. Shrimpton, 1977. Metabolisable energy studies with turkeys: Nitrogen correction factor in metabolisable energy determinations. Br. Poult. Sci. 18: 373-379.

MacLeod, M.G. and P.A. Geraert, 1988. Energy metabolism in genetically fat and lean birds and mammals. *In*: Leanness in Domestic Birds: Genetic, Metabolic and Hormonal Aspects. B Leclercq and C.C. Whitehead, Eds. Pp 25-40. Butterworths, London.

MacLeod, M.G., C.C. Whitehead, H.D. Griffin, and T.R. Jewitt, 1988. Energy and nitrogen retention and loss in broiler chickens genetically selected for leanness and fatness. Br. Poult. Sci. 29: 285-292.

Proudman, J.A. W.J. Mellen, and D.L. Anderson, 1970. Utilisation of feed in fast and slow growing lines of chickens. Poult. Sci. 49: 961-972.

Pym, R.A.E., and D.J. Farrell, 1977. A comparison of the energy and nitrogen metabolism of broilers selected for increased growth rate, food consumption and conversion of food to gain. Br. Poult. Sci. 20: 73-86.

Pym, R.A.E., P.J. Nicholls, E Thomson, A Choice, and D.J. Farrell, 1984. Energy and nitrogen metabolism of broilers selected over ten generations for increased growth rate, food consumption and conversion of food to gain. Br. Poult. Sci. 25: 529-539.

Ricard, F.H., G. Marche, and E. Le Bihan-Duval, 1994. Essai d'amelioration par selection de la qualite de carcasse du poulet de chair. INRA, Productions Animales, 7: 253-261.

Sibbald, I.R. and S.J. Slinger, 1963. The effects of breed, sex, and arsenical and nutrient density on the utilisation of dietary energy. Poult. Sci. 42: 1325-1332.

# Selection For Growth Rate, Feed Efficiency And Body Fatness In Japanese Quail (*Coturnix Coturnix Japonica*)

H. Sutedjo and R.A.E. Pym
School of Veterinary Science, University of Queensland, St Lucia Q. 4072, Australia

# Introduction

Food utilisation efficiency and body composition are very important determinants of profitability in poultry meat production. In commercial meat chicken breeding programs, improvement in lean tissue deposition efficiency is typically addressed through within and between line selection for growth rate, food utilisation efficiency for growth, and body composition. Most of the selection studies in this area have been undertaken with chickens, and notwithstanding the recognised role of Japanese quail as a commercial poultry species and as a genetic model for chickens, little work has been undertaken with this species in this area. The purpose of the study described here was to determine in the one selection experiment, the direct and correlated responses to selection for growth rate, food utilisation efficiency and carcass fatness in Japanese quail, to facilitate the assessment of appropriate selection strategies for improvement in the efficiency of lean tissue growth rate in this species.

# Materials And Methods

**The selection experiment.** Birds used in the base population from which the lines were selected, were derived from the unselected control line of an earlier selection experiment (Pym *et al.,* 1998). The base population was constituted from matings between 50 males each mated to three females. From each of the four hatches, birds were selected as parents of the selection lines shown in Table 1. Lines were constituted each generation from matings between 10 males each with three females. There were four weekly hatches each generation, three to produce birds from which parents of the subsequent generation could be selected and the fourth to measure direct and correlated responses. For the individual selection lines (HW and FE), approximately 120 birds of each sex were available in each line for selection each generation. (the *i* values in males and females were approximately 1.8 and 1.3 respectively).

Table 1. Selection lines used in the study

| Line | Selected for |
|---|---|
| HW | Increased liveweight at 35d of age |
| HF | Increased 35d abdominal fatness – by sib selection |
| LF | Decreased 35d abdominal fatness – by sib selection |
| FE | Decreased 15-30d FCR – in individual cages |
| C | Unselected control |

All birds were given a crumbled broiler starter diet containing 220 g CP and 12.5 MJ ME/kg from hatch to 35d of age. Selection in the HW line was based on liveweight at 35d of age. The birds were reared to 14d in brooder cages and then transferred to deep litter pens where they were reared to 35 d when they were weighed. In the FE line, following group cage rearing to 14d of age, feed efficiency was determined in individual cages from 15 to 30d. Birds in hatch 1 of the high and low fat lines were reared to 35d as for the HW line birds and, after weighing, two birds per sex per dam family were killed and the abdominal fat pad excised and weighed. For each bird this was expressed as a proportion of liveweight and the dam family averages within each line were ranked on this criterion. Birds in the subsequent two hatches from the selected dam families were retained for breeding.

To reduce the deleterious effects of inbreeding, for the high and low-fat lines, a restriction was placed on the number of males (2) and females (3) from the same full sib family that could be selected as parents within each line and birds were selected from the highest (line HF) or lowest (line LF) full sib families. For the HW and FE lines, no more than two males were selected from any one sire family. There were no restrictions on females, but in all lines there were no full- or half-sib matings. All birds were pedigree wingbanded at hatch.

**Selection responses.** Direct and correlated responses in performance and body composition traits to selection in the four lines were measured in the second, third and fourth generation. In each generation, responses were determined in a fourth hatch of about 250 birds (50 per line) reared in group cages to 14d of age and then transferred to the single–bird cages and reared there to 30d of age. Birds were weighed at 14 and at 30d of age and individual food intake over the 14 to 30d interval was measured. Following a 10 h fast, the birds were killed on d 31 by neck dislocation and abdominal fat and breast meat were excised and weighed. Responses were calculated from the difference between the control and selected line means for the traits.

# Results and Discussion

The direct and correlated responses in the four lines are shown in Figs 1 a-f. Whilst selection for high 35 d bodyweight in the HW line resulted in a marked correlated increase in both 14 d bodyweight and 14-30 d weight gain, selection for improved feed efficiency in the FE line actually resulted in a significant depression in 14 d body weight, but an overall positive response by generation 4, in 14-30 d weight gain. In the FE line, the reduced maintenance requirement at commencement of the food intake test interval as a result of the low initial body weight (Fig 1a), combined with the relatively high growth rate (Fig 1b), contributed to the improved feed efficiency in this line (Fig 1d). Both 14 d weight and weight gain were initially lower in the low-fat LF line birds than in their high-fat HF counterparts, but by generation 4 they were similar and showed little deviation from the control birds. The latter finding is in keeping with the published results from a number of studies (Leclercq, 1988; Whitehead and Griffin, 1984; Cahaner *et al*., 1986; Pym 1987), where little difference in growth rate was observed between high and low fat lines of chickens. The corollary to the overall lack of growth response in the HF and LF lines, is the essential lack of response in abdominal fat proportion in the HW line (Fig 1e), which supports the contention of Pym (1987) that selection for increased growth rate in chickens does not result in an increase in fatness, particularly when birds are measured at a given body weight.

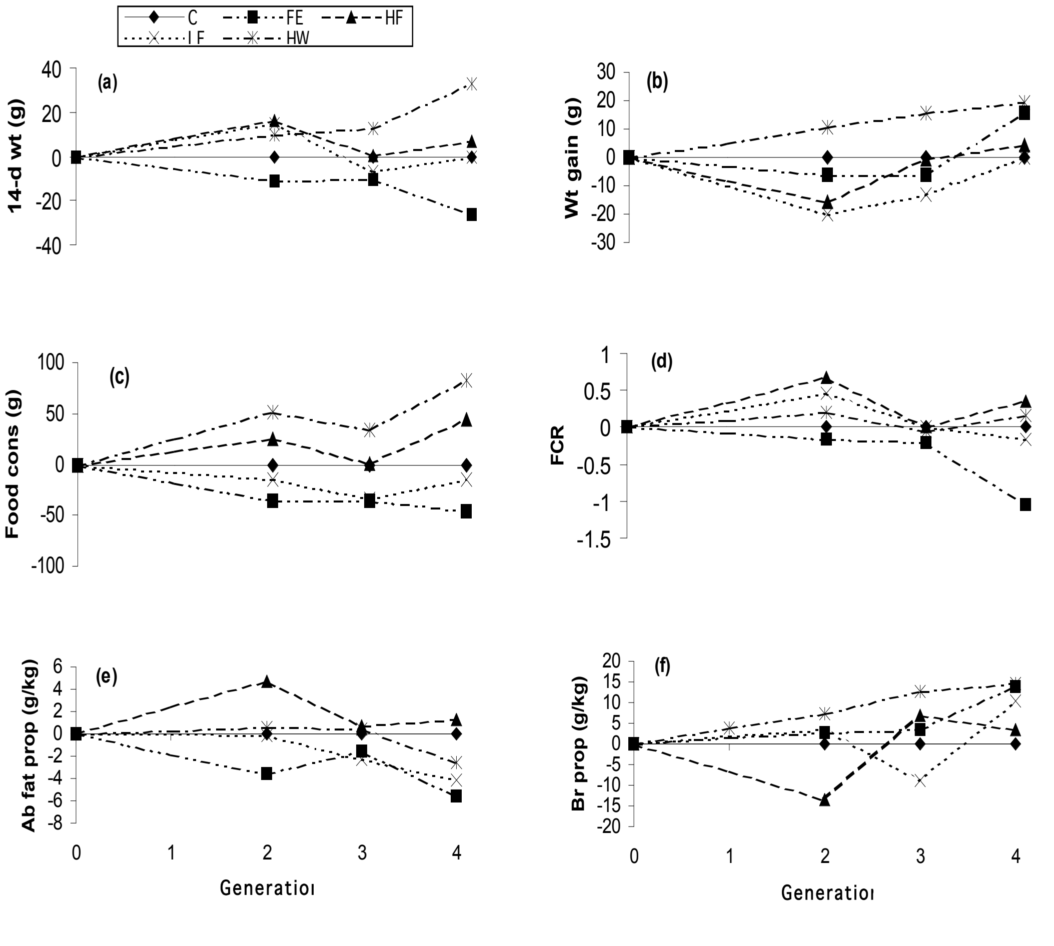


**Figure 1.** Direct and correlated responses in 14 d body weight (g), 14-30 d weight gain (g), food consumption (g) and FCR, and the proportion (g/kg) of abdominal fat and breast muscle in the carcass at 31 d in the four selected lines

There was marked divergent correlated response in food consumption in the HW and FE lines (Fig 1c), which combined with the response in weight gain (Fig 1b), resulted in a substantial negative direct response in FCR in the FE line (Fig 1d), but a small positive response in the HW line. The absence of the typically observed positive response in feed efficiency in high growth rate chicken lines (see review by Chambers, 1990), is possibly associated with the greater proportional contribution of maintenance cf. growth towards energy intake in Japanese quail than in chickens, and is supported by the findings of the earlier study with Japanese quail (Pym *et al.,* 1998). The divergent correlated response in FCR to divergent selection for fatness in the HF and LF lines is in agreement with findings of similarly selected lines of chickens (Leclercq, 1988; Whitehead and Griffin, 1984; Cahaner *et al*., 1986; Pym 1987) and confirms the high energetic cost of fat deposition.

The divergent direct response in abdominal fatness in the HF and LF lines (Fig 1e) was essentially as anticipated. However, the similar response in the LF and FE lines suggests that individual selection for feed efficiency is as effective in reducing fatness as direct sib-selection for reduced fatness. Results from the chicken selection experiment of Leenstra and Pit (1987) showed the same directional responses, but sib selection for reduced fatness was shown to be more effective in reducing body fat than selection for low FCR. Many factors may be implicated in the differential response, but the results tend to discount any suggestion of body fat playing an important role in insulation to heat loss and energy retention, with its effect on food utilisation, in the smaller species. Whilst the responses in breast yield in the HF and LF lines were not consistent across generations (Fig 1f), both the HW and FE lines showed positive response in this trait.

# Conclusion

The results of this albeit relatively short term selection experiment, suggest that an improvement in overall efficiency of lean tissue deposition in Japanese quail is not achievable by selection for growth rate or reduced fatness alone and is likely to require some direct selection pressure on dietary nutrient utilisation. Comparison with reported results from chicken selection studies show some notable differences in responses between the two species.

# References

Cahaner, A., Nitsan, Z. and Nir, I. (1986) *Poult. Sci*. 65 : 215-222.

Chambers, J.R. (1990) In: *Poultry Breeding and Genetics.* Ed. R.D. Crawford, Pp. 599-643. Elsevier, Amsterdam.

Leclercq, B. (1988) In: *Leanness in Domestic Birds,* Eds. B. Leclercq and C.C. Whitehead, Pp 25-40. Butterworths, London.

Leenstra, F.R. and Pit, R. (1987) *Poult. Sci.* 66 : 193-202.

Pym, R.A.E. (1987) In: *Recent Advances in Animal Nutrition in Australia*, 1987. Ed. D.J. Farrell, Pp 222-227. The University of New England, Armidale, Australia.

Pym, R.A.E., Popovic, B. and Bodero, D.A.V. (1998) *Proc. 6th World's Congr. Genet. Appl. Livestock Prod.* 24 : 290-293.

Whitehead, C.C. and Griffin, H.D. (1984) *Br. Poult. Sci*. 25 : 573-582.