EFFECTS OF SEX AND GENOTYPE ON ENERGY AND PROTEIN METABOLISM IN THE PIG.

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SUMMARY

Protein and energy metabolism was assessed by comparative slaughter in two strains of entire male pig and in castrated male pigs given seven levels of intake of a protein-adequate diet between 45 and 90 kg live weight.

Both strain and sex affected the animals potential for protein growth, the partition of energy between protein and fat at all levels of feeding and the animals energy requirement for maintenance.

The differences in protein and energy metabolism were reflected in concommitant differences in growth performance and body composition between the two strains of entire males at between the two sexes.

INTRODUCTION

Although differences in growth performance and body composition have been reported between different strains of pigs (Siebrits and Kemm 1982, Ellis et al. 1983; Henderson et al. 1983) the metabolic changes underlying such differences remain unclear.

In a comparison of "genetically" lean and obese male pigs Siebrits and Kemm (1982) reported that both groups exhibited similar rates of protein deposition but that the obese pigs had a higher appetite than the "genetically" leaner animals.

On the other hand, in a comparison of control and selected lines of large white pigs, given feed ad libitum, Ellis et al. (1983) and Henderson et al. (1983) reported a higher rate of protein deposition in-selected line, which suggested that in terms of growth performance and carcass fatness genetic improvement may be associated with increase in the animals ceiling for protein growth.

The latter results however, provided no information on protein deposition and the partitioning of energy at energy intakes below ad libitum. Because this information is crucial in determining the animals response to change in level of feeding the present experiment was conducted to establish the relationship between energy intake and rate of protein deposition in two strains of entire male pigs and in castrated male pigs growing between 45 and 90 kg live weight.

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EXPERIMENTAL

A total of 84 crossbred (Large White X Landrace) pigs representing equal numbers of castrated males and two strains of entire males were allocated at 45 kg among an initial slaughter group comprising four pigs of each type and seven levels of intake (from 22 MJ digestible energy (DE)/d to ad libitum) of a protein-adequate diet. Three pigs of each type were allocated to each of the six restricted feeding treatments and six pigs of each type to the ad libitum feeding treatment.

One strain of entire male pigs (Strain A) was derived by caesarian section from sows obtained from a 6,000 sow commercial herd, where all breeding stock have been selected on the basis of growth performance under ad libitum feeding for some eight years. The other strain (Strain B) was from the Institute% herd of some 60 sows, and were representative of animals which have been subjected to relatively little selection pressure. The castrated males were also from the Institute's herd.

All pigs were reared on sows at the Animal Research Institute to six weeks of age and between 20 and 45 kg were given a single diet at a rate equivalent to 3.3 times energy for maintenance (22.5 MJ DE/d). During the experimental period (45 to 90 kg) the pigs on the restricted feeding treatments were fed twice daily and the feed intake of pigs given the diet ad libitum was measured daily.

On reaching 50 kg live weight each pig was killed and the eviscerated carcass, empty gut and all internal organs were ground to a fine paste and analysed for water, ash, protein and lipid.

RESULTS

Both a relationship between energy intake and rate of protein deposition (RPD) and maximal RPD were affected by strain and sex (Figure 1).

Strain A entire males deposited protein faster on all levels of feeding than Strain B entire males, which in turn deposited protein more rapidly than their castrated counterparts.

For Strain A entire males RPD increased linearly with increase in energy intake from 88 g/d on the lowest feeding level (22 MJ DE/d) to 187 g/d on the ad libitum feeding treatment (39.6 MJ DE/d). For Strain B entire males RPD increased linearly with increase in energy intake up to 32.5 MJ DE/d but remained constant at approximately 127 g/d thereafter. The form of the response for castrated males was the same as that for their entire counterparts (Strain B) except the slope of the linear portion of the relationship was lower and maximal RPD was only 85 g/d.
The relationships between energy intake and growth performance and body fat content are given in Figure 2. Strain A entire males exhibited more rapid and efficient growth than Strain B and the difference between the strains increased from 11-12% at levels of DE intake up to 32.5 MJ/d to 32-38% on the higher levels of feeding.

Strain A entire males contained less fat and more water in the empty body than Strain B, and again the differences between the strains increased when DE intake was raised beyond 32.5 MJ/d.

Castrates grew at a slower rate except on the ad libitum feeding treatment, and contained more fat and less protein and water in the empty body than Strain B entire males.
DISCUSSION

The results showed that both strain and sex had marked effects on growth performance and body composition, and that the differences were associated almost entirely with concomitant differences in the animals capacity for protein growth.

For Strain B entire males maximal rate of protein deposition was determined by intrinsic factors and occurred, at 32.5 MJ DE/d (82% of ad libitum energy intake). Similar results have been reported for pigs averaging 67.5 and 72 kg by Campbell et al. (1985) and Dunkin et al. (1984) respectively.

For Strain A entire males however, maximal rate of protein deposition was only limited by energy intake. It would appear that the intense selection of these animals under ad libitum feeding had raised their ceiling for muscle growth beyond the upper limit of appetite.
The difference in potential for protein accretion and the associated difference in lean tissue growth was directly responsible for the large and increasingly greater difference in growth performance between the strains when DE intake was raised above 32.5 NJ/d. Strain A pigs also deposited protein at a faster rate and consequently grew more rapidly and contained less fat in the empty body on the lower levels of feeding than Strain B. Similar differences have been reported between "lean" and "fat" strains of broiler chickens by Leclerq and Saadoun (1982).

In the present experiment, Strain A entire males also had a higher energy requirement for maintenance then Strain B (14.9 vs 11.2 MJ DE/d) which further increased the difference in body fat content between the strains.

The results demonstrate the difference in capacity for muscle growth between commercial strains of pigs in the Australian Industry, and show that genuine improvement in growth performance on carcass fatness is associated with increase in both the animal's ceiling for protein deposition and in the slope of the ascending linear portion of the relationship between energy intake and rate of protein deposition. Change in the latter affects the partitioning of energy at low levels of feeding, little change in the ceiling for protein growth affects the partitioning of energy at high levels of feeding.

Because of the difference in capacity of protein growth between the strains and the consequent effects of high levels of feeding on carcass fat content and feed conversion efficiency the feeding strategy required to maximise economic returns also differed between the two strains. For Strain A pigs which were considerably more profitable on all levels of feeding than Strain B returns over feed costs/pig place/day increased linearly with increase in feeding level up to ad libitum energy intake. For Strain B pigs however, maximum profitability was achieved when DE intake was restricted to 32-34 NJ/d (80 to 85% of ad libitum energy intake). The results for rate of protein deposition suggest the growing pigs requirements for dietary protein and amino acids would be affected in a similar manner by genotype or strain.

The results of field trials conducted in conjunction with the work at the Animal Research Institute have shown the majority of commercial strains of pigs have a limited capacity for muscle growth and indicate that the ceiling for protein deposition occurs at levels of DE intake ranging from 30 to 36 MJ DE/d. Thus there is considerable room for genetic improvement within the Australian Pig Industry and in the longer term the identification of superior strains and their spread throughout the industry is likely to result in major improvements in the efficiency and profitability of pig meat production. Nevertheless, if this potential is to be fully
realized the improvement in genotype will have to be matched by appropriate changes in the animals' nutritional management.

The marked effect of castration or growth performance and body composition observed in the present experiment indicates that the differences between the two strains were possibly associated with differences in the hormonal control of energy and protein metabolism, and this aspect is currently being investigated.

REFERENCES


