Concurrent Session 7: Comparative Nutrition – Production animals relevant to human nutrition

Compensatory growth in pigs and the impact of catch up growth in humans

CL Collins[1,2], BJ Leury[2], FR Dunshea[1,2]
[1.] *Department of Primary Industries, Werribee, VIC 3030*
[2.] *Institute of Land and Food Resources, University of Melbourne, Parkville, VIC 3010*

Background – Compensatory growth (or catch up growth) is the greater than normal growth of an animal following a period of nutritional restriction. In grazing animals, compensatory growth responses are commonly observed due to variations in seasonal conditions and hence pasture supply and quality. Diets of intensively housed animals can also be manipulated to include short periods of nutritional restriction to achieve changes in the body composition of the carcass. In humans catch up growth may occur during infancy/ early childhood in children born small for gestational age due to fetal undernutrition. Catch-up growth can influence ultimate body muscularity and fatness and in humans at least be associated with detrimental metabolic and health effects during later adult life.

Review – Compensatory growth responses in pigs can occur following a short period of dietary restriction, although the degree of catch up growth can vary. In some cases the animals can fully compensate such that they are the same weight at the same slaughter age as their non-restricted counterparts, while in other cases they do not reach the same final weight. There is some evidence that restricting protein intake for a short period of time during the weaner phase (similar to human infant) may result in an increase in protein deposition and decrease in fat deposition during later growth. During a period of protein restriction, both protein and lipid deposition rates are reduced, although the rate of lean tissue deposition is reduced to a greater degree (1). During realimentation the ratio of lipid to protein deposition has also been shown to decrease (1). This reduction in lipid deposition during the realimentation period may reduce the lipid content in the body. Many investigations into compensatory growth responses in pigs have also observed improvements in feed efficiency during the realimentation period, and there may be additional environmental benefits due to a reduction in the excretion of unused nutrients.

In addition to a period of dietary restriction via a reduction in the nutrient content of the diet, pigs experience periods of nutritional restriction due to other production processes such as weaning. Weaning typically occurs between 21 and 28 days of age and involves the removal of the piglet from the sow. This process imposes a number of environmental and social stresses on the piglet, including a change in diet from sows milk to solid feed, mixing with piglets from other litters and a change in environment. Weaning at younger ages, typically around 14 days of age, is practised in some systems in order to reduce the transfer of disease from sow to offspring. Such early weaning of piglets has been shown to result in larger growth depressions immediately post weaning (2). However, by approximately six weeks of age the early-weaned pigs can catch-up to be the same weight as those conventionally weaned.

In humans, compensatory growth responses may have detrimental effects in later adult life. Infants born at low birth weights for gestational age may have increased risks of disease in later life such as coronary heart disease, stroke, hypertension and type 2 diabetes (3). The basis for this hypothesis is that undernutrition during fetal development, either via poor placental function or reduced maternal nutrient intake, leads to altered homeostatic mechanisms that in turn increase the susceptibility to disease in adult life. Rapid childhood catch-up growth may exacerbate the effects of impaired fetal development. Eriksson *et al.* (1999) reported that in one study of men born in Helsinki, those that had the highest rates of coronary heart disease were thin at birth but had caught up in weight by 7 years of age and had above average BMI (4).

Conclusions – Compensatory growth responses occur in both animals and humans, although the response can be variable depending on the timing and magnitude of the restriction. Periods of restriction and subsequent realimentation can be utilised in production animals to achieve desired body compositions at slaughter. In humans, compensatory or catch-up growth during infancy following fetal undernutrition may lead to increased risks of a range of adult diseases in later life, although the mechanisms by which this occurs are not yet fully understood.

References

1. de Greef KH, Kemp B, Verstegen MWA (1992) Performance and body composition of fattening pigs of two strains during protein deficiency and subsequent realimentation. *Livestock Production Science* 30, 141-153.
2. Leibbrandt VD, Ewan RC, Speer VC, Zimmerman DR (1975) Effect of weaning and age at weaning on baby pig performance. *Journal of Animal Science* 40, 1077-1080
3. Barker Barker D.J.P., Gluckman, P.D., Godfrey, K.M., Harding, J.E., Owens, J.A., Robinson, J.S. (1993) Fetal nutrition and cardiovascular disease in adult life. *The Lancet* 341, 938-941
4. Eriksson JG, Forsen, T., Tuomilehto J., Winter, P.D., Osmond, C., Barker, D.J.P. (1999) Catch-up growth in childhood and death from coronary heart disease: longitudinal study. *British Medical Journal* 13, 427-431.