FACTORS THAT INFLUENCE VOLUNTARY FEED INTAKE

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Stress reduces voluntary feed intake of pigs.

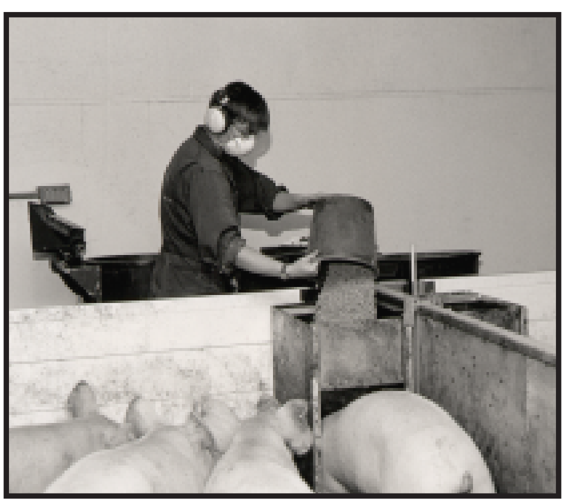
Introduction

Voluntary feed intake of pigs determines nutrient intake levels and thus has a great impact on efficiency of pork production. The intensive selection programs for pig genotypes with better feed efficiency and carcass leanness has inadvertently selected pigs with reduced voluntary feed intake (Webb, 1989).

Adequate feed intake is hard to maintain on many farms, and is an important factor limiting productivity. Surveys show that feed intake varies by at least 25 per cent among commercial farms. Stressors such as hot temperature, increased stocking density and reduced health status, together with genotype, influence feed intake and growth.

Dietary factors, including energy density, deficiencies or excesses of nutrients, antibiotics, flavours, feed processing, and availability of water all influence feed intake (NRC, 1998). In contrast to poultry, differences in intake of pigs fed different batches of ingredients have rarely been described.

The spectrum of factors that affect voluntary feed intake is very broad. The purpose of this paper is to highlight some of these factors. A clear understanding of the key factors involved in determining voluntary feed intake in pigs is an important prerequisite for designing diets to ensure adequate nutrient intake under different production systems.



Voluntary Feed Intake and Stressors

Various stress factors affect how much pigs eat. These factors can be grouped into environmental (temperature, humidity, air circulation, etc), social (space allocation, group size, re-grouping, etc.), and immunological (disease, pathogen concentration, etc.) factors.

The impact of ambient temperature on feed intake has been studied broadly. Cold temperatures increase feed intake, while hot temperatures reduce feed intake when compared to temperatures in the comfort or thermal-neutral zone (Revell and Williams, 1993). When the room temperature is too hot, grower-finisher pigs eat about 40 g per day less for each 1°C above the comfort zone. Under cold temperatures, pigs eat about 30 g more per day for each 1°C below the comfort zone.

Effects of other environmental factors on feed intake are not as well defined, and are usually explained within the context of zone of thermal comfort. It should be noted that the temperature as the pigs feel it is more important than temperature as measured by a thermometer. This will be affected by factors like bedding and ventilation rate.

As for social factors, space restriction reduces feed intake, although the response varies across studies. For example, a 37 per cent reduction in space allowance from 0.55 to 0.35 m^2/pig for grower pigs reduced feed intake by 11 per cent (Edmonds et al., 1998), whereas 55 per cent reduction from 0.56 to 0.25 m^2/pig reduced feed intake by eight per cent Hyun et al., 1998).

Mixing unfamiliar pigs reduces feed intake, suggesting that resorting pigs by weight throughout the grower-finisher phase might be counterproductive. Group size defined as number of pigs in a single pen alters the feed intake pattern of pigs, and these changes might alter overall daily feed intake. Increased group size does not reduce feed intake consistently across studies. Other factors such as space allocation might play a role if a reduction of feed intake indeed occurs.

Immunological stress or activation of the immune system results in reduced feed intake of grower-finisher pigs. The immune system responds to the presence of pathogenic agents by synthesising and releasing cytokines. These in

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turn activate cellular and humoral components of the immune system. The pigs will use physiological and behavioural strategies initiated by the activated immune system to attempt to overcome an episode of clinical or sub-clinical disease (Johnson, 1997).

The reduced feed intake of pigs exposed to space restriction or pathogens could not be overcome by increasing dietary lysine content (Brumm and Miller, 1996; Williams et al., 1997). This indicates that the lysine requirement of socially- or immunologically-stressed pigs was lower because of a reduced protein deposition rate. Diseased animals exhibit a shift in the partitioning of dietary nutrients away from lean tissue accretion towards metabolic responses that support the immune system and also accelerate the breakdown of muscle proteins.

Voluntary Feed Intake and Feed

Feed composition in terms of nutrient content and nutrient balance is an important determinant of feed intake. In general, pigs try to eat to meet the requirement of the most-limiting nutrient, which in most cases is energy. Therefore, the current assumption is that dietary energy content mainly determines voluntary feed intake of grower-finisher pigs from 15 to 110 kg (NRC, 1998).

Thus, as DE content is reduced, pigs attempt to maintain energy intake by eating more dry matter. However, even during the 1960s when pigs were less lean and this assumption was developed, grower pigs had greater difficulty dealing with a reduced dietary energy content than finisher pigs (Owen and Ridgman, 1968). This is likely because gut-size is a limiting factor for grower but not finisher pigs.

The emphasis on selecting for increased leanness or reduced backfat has reduced the amount that pigs eat. (Revell and Williams, 1993). This means present-day grower pigs may have even less leeway to deal with feed of a lower than expected energy content. Within the overall management of voluntary feed intake, a correct prediction of dietary energy content might be essential.

The energy content of complete diets can be predicted reasonably accurately from chemical characteristics (Noblet and Perez, 1993). Apart from energy, controlling balances for specific nutrient groups (carbohydrates, fat, and protein) might influence voluntary feed intake as well (Revell and Williams, 1993). Finally, a few specific dietary nutrients, e.g., content of tryptophan relative to large neutral amino acids, are known to impact brain functions directly and thereby affect voluntary feed intake.

The presentation of feed can influence voluntary feed intake. Two items of concern are presentation as a mash or pellet and wet versus dry presentation. Generally, pelleting of feed reduces feed intake but results in an improved growth performance due to improved nutrient digestibility of the feed (Hancock, 1999). Presentation of mash in a wet versus a dry form increased voluntary feed intake 5 per cent (Gonyou and Lou, 2000).

Voluntary Feed Intake and Ingredients

For pigs, information is limited about variation in voluntary feed intake among batches of ingredients. Because dietary energy content affects feed intake, attention should be paid toward the variation in DE content of ingredients. The DE content range was 16 per cent for barley, nine per cent for wheat, and 18 per cent for field peas (Fairbairn et al., 1999; Zijlstra et al., 1998 & 1999a).

Selecting for increased leanness has reduced the amount that pigs eat

The range in DE content of barley could be predicted accurately with chemical characteristics or near infrared reflectance spectroscopy (NIRS), but not with physical characteristics or available metabolisable energy (AME) content for poultry (Zijlstra et al., 1999b). Using the measured DE content of 11 field pea samples to reformulate diets to an equal DE content resulted in similar voluntary feed intake of grower pigs for 10 out of 11 samples (Zijlstra and Patience, 1998). For wheat, inclusion of selected samples into diets for weaned pigs resulted in large differences in voluntary feed intake (R.G. Campbell, personal communication). Ingredient factors other than DE content might influence voluntary feed intake, for example increased water-holding capacity was linked to reduced feed intake (Kyriazakis and Emmans, 1995).

For poultry, a wealth of information is available describing differences in voluntary feed intake among batches of cereal grains. In the standard test to measure DE content in pigs, feed allowance is maintained at 2.5 to 3 times DE intake required for maintenance.

In contrast, a broiler chick bioassay was developed to measure voluntary feed intake together with AME content of ingredient samples (Scott et al., 1998a). Subsequently, differences in voluntary feed intake of up to 20 per cent for wheat and up to 30 per cent for barley have been described in diets fed to broiler chickens (Scott et al., 1998b). The observed differences in feed intake among ingredient samples were not related strongly to measured AME values. Moreover, voluntary feed intake was a better predictor for performance than AME content of ingredient samples, indicating that factors other than AME content determine voluntary feed intake of broiler chicks.

Finally, the AME content of wheat and barley, voluntary feed intake and subsequent performance among ingredient batches could not be predicted accurately by chemical characteristics (Classen et al., 1995), but were highly predictable by NIRS (Swift et al., 1998ab). The factors that determine voluntary feed intake of broiler chicks might play an important role in swine nutrition as well, and should perhaps be considered to enable predictable performance of grower-finisher pigs.

Summary

Environmental, social, and immunological stressors affect voluntary intake of pigs. The DE content of feed appears to determine feed intake of grower-finisher pigs within limits. In poultry, factors other than dietary energy content predict feed intake and subsequent performance better.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund.

References

Brumm, M.C., P.S. Miller. 1996. **Response of pigs to space allocation and diets varying in nutrient density.** ***J. Anim. Sci. 74:2730-2737.***

Classen, H.L., T.A. Scott, G.G. Irish, P. Hucl, M.L. Swift, M.R. Bedford. 1995. **The relationship of chemical and physical measurements to the apparent metabolizable energy of wheat when fed to broiler chickens with and without a wheat enzyme source. World Poult.** ***Sci. Assoc. Proc., 10th Eur. Symp.*** Poult. Nutr. Oct. 15-19, 1995, Antalya, Turkey.

Edmonds, M.S. B.E. Arentson, G.A. Mente. 1998. **Effect of protein levels and space allocations on performance of growing-finishing pigs.** ***J. Anim. Sci.*** 76:814-821.

Fairbairn, S.L., J.F. Patience, H.L. Classen, R.T. Zijlstra. 1999. **The energy content of barley fed to growing pigs: characterizing the nature of its variability and developing prediction equations for its estimation.** ***J. Anim. Sci.*** 77:1502-1512.

Gonyou,H.W. and Z.Lou. 1999. **Effects of eating space and availability of water in feeders on productivity and eating behavior of grower-finisher pigs.** ***J.Anim.Sci.***(in press).

Hancock, J.D. 1999. **The benefits of pelleted feed on pig performance**. ***Feed Tech.*** 3(6):37-39.

Johnson, R.W. 1997. **Inhibitions of growth in the immunologically challenged pig.** In: ***Proc. Eastern Nutrition Conference, Guelph, Ontario.*** pp 28-33.

Kyriazakis, I., G.C. Emmans. 1995. **The voluntary feed intake of pigs given feeds based on wheat bran, dried citrus pulp and grass meal, in relation to measurements of feed bulk.** ***Br. J. Nutr.*** 73:191-207.

NRC (National Research Council). 1998. **Nutrient Requirements of Swine.** Tenth Edition. ***National Academy Press, Washington, DC.***

Noblet, J., J.M. Perez. 1993. **Prediction of digestibility of nutrients and energy values of pig diets from chemical analyses.** ***J. Anim. Sci.*** 71:3389-3398.

Owen, J.B., W.J. Ridgman. 1968. **Further studies on the effect of dietary energy content on the voluntary intake of pigs.** ***Anim. Prod.*** 10:85-91.

Revell, D.K., I.H Williams. 1993. **A review: physiological control and mani-pulation of voluntary food intake.** In: ***Manipulating Pig Production (MPP) IV, ed. E.S. Batterham.*** APSA, Attwood, Vic., Australia, pp. 55-80.

Scott, T.A., F.G. Silversides, H.L. Classen, M.L. Swift, M.R. Bedford, J.W. Hall. 1998a. **A broiler chick bioassay for measuring the feeding value of wheat and barley in complete diets.** ***Poultry Sci.*** 77:449-455.

Scott, T.A., F.G. Silversides, H.L. Classen, M.L. Swift, M.R. Bedford. 1998b. **Effect of cultivar and environment on feeding value of western Canadian wheat and barley samples with and without enzyme supplementation**. ***Can. J. Anim. Sci.*** 78:649-656.

Swift, M.L., T.A. Scott, H.L. Classen, M. Bedford. 1998a. **Prediction of AME content of whole wheat and barley by NIRS.** ***Can. J. Anim. Sci.*** 78:737.

Swift, M.L., T.A. Scott, H.L. Classen, M. Bedford. 1998b. **Prediction of body weight and feed efficiency of broiler chickens fed wheat-based diets by NIRS.** ***Can. J. Anim. Sci.*** 78:738. [Abstr.]

Webb, A.J. 1989. **Genetics of food intake in the pig**. In: ***J.M. Forbes, M.A. Varley, and T.L.J. Lawrence (Eds.).*** **The Voluntary Food Intake of Pigs**. ***Proc. Br. Soc. Anim. Prod.*** Edinburgh. pp 41-50.

Williams, K.C., P.R. Martin, R.G. Henzell, R.A. Young. 1993. **Palatability to pigs of sorghum grain differing in midge resistance.** In: ***MPP IV, ed. E.S. Batterham.*** APSA, Attwood, Vic., Australia, pp. 85. [Abstr.]

Williams, N.H., T.S. Stahly, D.R. Zimmerman. 1997. **Effect of level of chronic immune system activation on the growth and dietary lysine needs of pigs fed from 6 to 112 kg.** ***J. Anim. Sci.*** 75:2481-2496.

Zijlstra, R.T., J.F. Patience. 1998. **Performance of grower pigs fed diets adjusted for field pea DE content.** ***1998 Annual Research Report. Prairie Swine Centre Inc.***, Saskatoon, SK.

Zijlstra, R.T., J.F. Patience, S.L. Fairbairn, D.A. Gillis, D.L. Whittington. 1998. **Variation in the digestible energy content of field pea for grower pigs**. ***J. Anim. Sci.*** 76(Suppl. 2): 63. [Abstr.]

Zijlstra, R.T., C.F.M. de Lange, J.F. Patience. 1999a. **Nutritional value for wheat for growing pigs: chemical composition and digestible energy content.** ***Can. J. Anim. Sci.*** 79:187-194.

Zijlstra, R.T., T.A. Scott, M.J. Edney, M.L. Swift, J.F. Patience. 1999b. **Measurements to predict swine digestible energy content of barley.** ***J. Anim. Sci.*** 77(Suppl. 1):30. [Abstr.]