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Pigs have traditionally been fed diets predominantly containing substantial quantities of cereals and high value protein supplements. Because of direct competition with people, however, there is an increasing need to find substitutes and alternative feedstuffs for pigs. Considerable attention has therefore been directed in recent years towards the use of fibrous and bulky feeds for pigs. Reviews on the historical developments of this subject, the various uses of fibrous feeds, and the different fibrous materials used in pig feeding, have been published elsewhere (Zoïopoulos, 1978; 1985; 1986). A review on fibre utilisation with pigs has also recently been published by Low (1985). This paper focuses on the physiological effects of feeding fibrous diets, either for growing or breeding pigs; some other relevant aspects of the need for the exact characterisation of feedstuffs will also be touched on.

I - Growing pigs

1. Performance

With fattening pigs there have been some trials in which added fibre led to reduced daily **voluntary feed intake**, but more trials in which intake increased (ARC, 1967), particularly when the fibre increase exceeded 5%. The pattern of observed gains is that added fibre in diets given *ad libitum* causes a reduced **growth rate** despite a tendency for the pig to eat more and so compensate partially for lowered dietary Digestible Energy (DE) values. Actually, there must be an intake level with a limit imposed by bulk and/or palatability. That, coupled with reduced dietary DE concentration, would cause a marked decrease in daily gain. It should be stressed that, in all cases, **feed conversion efficiency** was worse with increased dietary fibre, and rate of weight gain varied with feed conversion efficiency and intake. It should also be mentioned that in a detailed investigation in Canada (Troelsen and Bell, 1962) it was found that daily intake varied with the source of fibre and the authors proposed figures which might be used to regulate in a predictable manner the energy intake of self-fed pigs.

2. Carcass measurements

High fibre diets given *ad libitum* usually cause reduced **carcass fat measurements** or increased carcass lean, but there have been a few exceptions (Hochstetler *et al.*, 1959). Some authors also record that high fibre diets reduce dressing or **killing out percentage**. The reduced dressing percentage may be associated with increased size of the stomach and large intestine. It was shown with wheat bran in the diet that there is an increase in water content and weight of gut contents (Cooper and Tyler, 1959). However, after one of the most detailed examinations of effects of dietary fibre (Coey and Robinson, 1954), it was made clear that decrease in dressing percentage can confuse the interpretation of performance of pigs with high fibre diets.

3. Digestibility

An excellent account of quantitative aspects of digestion and digestibility of fibrous feeds with pigs has been published by Fernandez and Jorgensen (1986). In general, fibre is not a single chemical substance and there are considerable differences between the digestibilities of some of its components (pentosans, cellulose or lignin). In this respect, the lignification of fibre is particularly important. It is thought that in addition to having low digestibility itself, lignin reduces the digestibility of cellulose with which it is associated structurally.

Regardless of the complexities of fibre digestibility, it is clear that added fibre in all cases reduces the DE value of the diet by lowering the apparent digestibility of the various components of the dietary Dry Matter (DM). It was suggested that the magnitude of the depression of digestibility depends on the source of fibre, degree of lignification, physical preparation, age and individuality of the pig.

With regard to protein, Woodman and Evans (1947) proposed that the causes of reduced digestibility might be imperfect mixing of bulky diets through the gut with digestive enzymes, increased rate of passage of bulky diets through the gut, and increased metabolic faecal nitrogen. However, there have been exceptions regarding protein digestibility and this is due to the source of fibre and its effect on the rate of passage of *digesta* through the gut (Cole *et al.*, 1967; Zoiopoulos *et al.*, 1978; 1983). The slower the rate of passage, the longer the nitrogenous compounds are exposed to the action of the proteolytic enzymes.

In this respect, one should distinguish between the effects of purified fibre sources (cellulose, methyl cellulose, pectin), fibrous sources of low nutritive value, either diluents (oat hulls, straw, corn cobs, sawdust) or energy sources (oat, dried sugar beet pulp, citrus pulp), and fibrous protein sources (dried distillers grains with solubles, brewers grains, malt culms, wheat middlings, sunflower meal, lucerne meal, cotton seed meal, tomato pomace). One should keep in mind the different groups of fibrous materials when trying to choose the right variables for producing prediction equations for DE value of pig diets based on crude dietary components and avoid generalisations when trying to extrapolate experimental results into practice.

II- Cannulated pigs

The large number of trials carried out with pigs cannulated at the *ileum* was a breakthrough in our knowledge about the role of the large intestine in fibre utilisation with pigs. Among other findings, it was shown that although Organic Matter (OM) digestibility, both overall and at the terminal *ileum*, was depressed with all groups of fibrous materials, the extent of digestion of nitrogen in the large intestine was greater with the bulkier materials. This may be due to poor mixing of digesta and enzymes in the small intestine. Conversely, it would seem that for fibrous protein sources, digestion in the large intestine has little effect on nitrogenous components encrusted in the cell wall. While causing a considerable reduction in the digestion of nitrogen to the terminal *ileum*, bulk *per se* had no effect overall (Zoiopoulos *et al.*, 1978).

However, although the volatile fatty acids produced in the hind gut by fermentation of cellulose are absorbed and utilised with appreciable efficiency for productive purposes in the pig (ARC, 1981), it is important to realise that nitrogen absorbed from the large intestine is not utilised efficiently in the pig's body, and it is almost quantitatively excreted in the urine (Just *et al.*, 1981).

The more fibre in the diet, the more there is DM passing to the large intestine to be used as substrate for microbial growth. Consequently, the greater the dietary fibre, the greater the microbial transformations of nitrogen in the hind gut, and the greater the error of measuring amino acid digestibility by total faeces collection. Due to this, it was suggested that amino acid availability should be measured at the terminal *ileum* (Sauer *et al.*, 1977).

III - Breeding sow

1. Pregnancy

The use of fibrous diets in pregnancy aims at overcoming problems arising from sows kept on bare concrete or slatted floors, fed once a day on concentrate diets providing less bulk and energy than sows would consume if fed to appetite. It is also to overcome problems with gilts which are prone to foot problems when kept on dry sow stalls. In both cases, by using bulkier diets, one could apply *ad libitum* feeding systems in groups and this may save labour for weighing the feed and thus reduce the cost for individual feeders.

As for the effects of feeding fibrous diets to pregnant sows, to start with there are no detrimental effects on reproductive performance. However, there is a problem of overeating, and the excessive intake may be prohibitive, depending of course on the cost of the fibrous source used. With respect to the physiological effects, there is an increase in DM digestibility of fibrous diets with advance of pregnancy, apparently due to the adaptation of *caecum* microflora to the fermentation of dietary fibre (Etienne, 1985).

2. Lactation

Fibrous diets are used in lactation in order to reduce postnatal piglet mortality from overlying. This could be achieved by preventing the crushing of viable piglets by keeping the sow satisfied during lactation by using labour saving *ad libitum* feeding systems in which the diet contains a certain amount of fiber. The latter is required to prevent the sow from consuming excessive amounts of DE and gaining excessive weight from parity to parity.

Useful information on digestibility of fibrous diets with the breeding sow can be drawn from work published by Zivković and Bowland (1970). Another effect of using fibrous diets in sow lactation is a systematic increase in milk fat content. It is possible that the fibre fermented in the hind gut of the sow produced volatile fatty acids, predominantly acetic acid, which after absorption was used for milk synthesis. In addition there was a tendency for a greater number of piglets weaned with sows consuming fibrous diets, but the differences failed to reach significance because in experimentation with sows one needs a large number of replicates (Zoiopoulos *et al.*, 1982). It should also be mentioned that one should take into account losses due to gut fill in interpreting post-weaning weight losses when dealing with the overall energetic efficiency of the sow from parity to parity (Bowland, 1967).

IV - Characterisation of fibrous feeds

When dealing with fibrous foods one should be particularly careful when describing the exact nature of the material involved. To exemplify this, I will quote the recommendation suggested for sunflower meal by Wahlstrom (1985), i.e., sunflower meal can be the only protein supplement in maize diets for growing pigs. However, this was questioned by Zivković (1985) on the grounds that this would mean a diet of 70% maize and 30% sunflower. However, such a diet would provide 15.6% of Crude Protein (CP) and 6% of Crude Fibre (CF). Based on the Yugoslavian experience (Yugoslavia is a traditional sunflower producing country) this would result in a worse live weight gain and feed conversion efficiency. In his experience, an inclusion of sunflower higher than 3 - 4 - 5% of the diet has poor effects on diet utilisation, the reduction being proportional to the amount of sunflower in the diet. But Zivković stresses that his comments refer to a sunflower meal containing 33% of CP and 18% of CF.

V - Conclusions

Fibrous feeds can be introduced into the diet of pigs in the expectation that live weight gain will fall but that economic return will not fall because of the lower cost of the alternative fibrous feedstuffs. The economics of the use of fibrous feeds will depend on the relative cost of cereal and the digestible nutrients in the alternative food. The author's view, as regards the future role of fibrous feedstuffs in pig production, is that the economic use of non-nutritive diluents in fully *ad libitum* systems for the entire fattening period of the bacon pig should be regarded as impractical. On the other hand, fibrous energy or protein sources will be utilised in pig production, accepting the fact that this may be relatively expensive, in order to liberate conventional sources of nutrients for human consumption. In addition, fibrous foods may have a potential role to play in the overall performance of the breeding sow, particularly the bulky feeds, but in this latter case technological problems of providing the food should be resolved.

It is interesting to note that there has recently been an increasing number of papers published on the use of lucerne for breeding sows, either in the dried (meal or pellets) form (Nuzback *et al.* 1984) or ensiled (Wiesemuller, 1982). However, the question of whether one should use high or low density diets in pig production (accepting of course lower gains in the latter case) is still pending.

References

ARC, 1967. The nutrient requirements of farm livestock. Agricultural Research Council, HMSO, London.

ARC, 1981. The nutrient requirements of pigs. Commonwealth Agricultural Bureaux, Farnham Royal.

Bowland, J.P., 1967. The energetic efficiency of the sow. J. Anim. Sci. 26:533-537.

Coey, W.F. and K.L. Robinson, 1954. Some effects of dietary fibre on live weight gains and carcass conformation of pigs. J. Agr. Sci. 45:41-47.

Cole, D.J.A., J.E. Duckworth and W. Holmes, 1967. Factors affecting voluntary feed intake in pigs. II. The effect of two levels of crude fibre in the diet on the intake and performance of fattening pigs. Anim. Prod. 9:149-154.

Cooper, P.H. and C. Tyler 1959. Some effects of bran and cellulose on the water relationships in the digesta and faeces of pigs. I. The effects of including bran and two forms of cellulose in otherwise normal rations. J. Agr. Sci. 52:332-339

Etienne, M., 1985. Utilisation of high-fibre feeds and cereals by sows. Paper N1.4. presented at the 36th Annual Meeting of the EAAP, Thessaloniki, Greece.

Fernandez, J.A. and J.N. Jorgensen, 1986. Digestibility and absorption of nutrients as affected by fibre content in the diet of the pig. Quantitative aspects. Livest. Prod. Sci. 15:53-71.

Hochstetler, L.N., J.A. Hoefer, A.M. Pearson, and P.W. Luecke, 1959. Effects of level and source of fibre on performance of pigs. J. Anim. Sci. 18:1397-1404.

Just, A., H. Jorgensen, and J.A. Fernandez, 1981. The digestive capacity of the caecum-colon and the value of the nitrogen absorbed from the hind gut for protein synthesis in pigs. Brit. J. Nutr. 46:209-219.

Low, A.G., 1985. The role of dietary fibre in digestion, absorption and metabolism. IN: Digestive physiology in the pig. Proceedings of the 3rd International Seminar, Copenhagen 16-18 May 1985, Report 580 from the National Institute of Animal Science, Denmark.

Nuzback, L.J., D.S. Pollmann, and K.G. Behuke, 1984. Effect of particle size and physical form of sun-cured alfalfa on digestibility for gravid swine. J. Anim. Sci. 58:378-385.

Sauer, W.C., S.C. Stothers, and R.J. Parker, 1977. Apparent and true availabilities of amino acids in wheat and milling by-products for growing pigs. Can. J. Anim. Sci. 57:775-784.

Troelsen, J.E. and J.M. Bell, 1962. Ingredient and processing interrelationships in swine feeds. IV. Effects of various levels and kinds of fibrous diluents in finisher rations, fed as meal or pellets on performance and carcass quality of swine. Can. J. Anim. Sci. 42:63-74.

Wahlstrom, R.C., 1985. Sunflower in pig nutrition. Pig News and Information, 6:151-154.

Wiesemuller, W., 1982. Lucerne silage as a source of amino acids in sow nutrition. Pig News Information, 3:149-156.

Woodman, H.E., R.E. Evans, 1947. The nutritive value of fodder cellulose from wheat straw. J. Agr. Sci. 37:202-210.

Zivković, S., 1985. Letter and comments on sunflower in pig nutrition. Pig News Information. 6:405-406.

Zivković, S. and J.P. Bowland, 1970. Influence of substituting high-fibre ingredients for corn on the digestibility of diets and performance of sows and litters. Can. J. Anim. Sci. 50:177-184.

Zoiopoulos, P.E., 1978. Evaluation of Fibrous Ingredients in Diets for Growing and Breeding Pigs. PhD. Thesis. University of Aberdeen.

Zoiopoulos, P.E., 1985. Fibrous feeds in pig nutrition: Introduction and objectives. Opening paper presented at the 36th Annual Meeting of the EAAP, Thessaloniki, Greece.

Zoiopoulos, P.E., 1986. Evaluation of plant protein sources in diets for non-ruminants in Greece. Paper presented at the EEC Workshop on "Protein Evaluation in Cereals and Legumes", 23 - 24 Oct. 1985, Thessaloniki, Greece, EEC Publication (in press).

Zoiopoulos, P.E., P.R. English, and J.H. Topps 1982. High-fibre for *ad libitum* feeding of sows during lactation. Anim. Prod. 35:25-33.

Zoiopoulos, P.E., J.H. Topps and P.R. English, 1978. Digestion by growing pigs of fibrous diets measured overall and at the terminal ileum. Proc. Nutr. Soc. 37:78A.

Zoiopoulos, P.E., J.H. Topps and P.R. English, 1983. Fibrous agro-industrial by-products as protein sources for bacon pigs. 2. Study of digestion with pigs cannulated at the ileum. Z. Tierphysiol. Tierernahrg.u.Futtermittelkde 49:219-228.

Zoiopoulos, P.E., J.H. Topps and P.R. English, 1983. Losses in weight and body water in sows after weaning. Br. J. Nutr. 50:163-172.