

Non-starch polysaccharides of sugar-beet pulp improve the adaptation to the starter diet, growth and digestive process of the weaned pig

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SUMMARY – The influence of non-starch polysaccharides (NSP) from sugar-beet pulp (SBP) on growth performance after weaning and up to slaughter, ileal and faecal nutrient digestibility, and activity of pancreatic and intestinal enzymes of piglets was studied in a series of experiments. The inclusion of 6% of SBP in the diet improved growth performance immediately after weaning and carcass composition at slaughter. Faecal digestibility of energy and nitrogen was not affected by the presence of 6 or 12% SBP in piglet diets. However, ileal digestibility of nutrients was reduced proportionally, increasing microbial degradation in the large intestine. In piglets receiving NSP-rich diets, pancreatic enzyme activities were not affected, but intestinal N aminopeptidase and dipeptidyl peptidase IV activities were both increased in the mucous of the ileum, probably in relation with changes in physical properties of the chyme. The weaned piglet is able to partially digest NSP that contributed to the development of digestive capacity, improving health status and growth performance. Thus, the inclusion of a limited amount of sugar-beet pulp can be recommended in starter diets.

Key words: Piglet, diet, sugar-beet pulp, non-starch polysaccharides, growth, digestibility, enzymes.

RESUME – "Les polysaccharides non-amylacés de la pulpe de betterave améliorent l'adaptation aux aliments de sevrage, les performances digestive et de croissance chez le porc sevré". L'effet des polysaccharides non-amylacés (NSP) de la pulpe de betterave (SBP) sur les performances de croissance après sevrage et jusqu'à l'abattage, la digestibilité et l'activité des enzymes digestives ont été étudiés dans 3 expériences chez le porc. L'incorporation de 6% de SBP dans le régime améliore les performances de croissance immédiatement après le sevrage et la composition des carcasses à l'abattage. Chez le porcelet, l'inclusion de 6 ou 12% de SBP dans les régimes n'affecte pas la digestibilité fécale de l'énergie ou de l'azote mais augmente celle du NDF. Au niveau iléal, on observe une augmentation du transit du chyme vers le caecum, ce qui réduit la digestibilité de tous les composants mais entraîne également une augmentation des dégradations microbiennes dans le gros intestin. L'activité des enzymes pancréatiques n'a pas été affectée mais celle de l'aminopeptidase N et de la dipeptidyl peptidase IV de la muqueuse iléale a été augmentée grâce aux modifications physico-chimiques provoquées par les NSP sur le chyme. En conclusion, la capacité digestive du porcelet semble être améliorée par la présence des NSP dans l'aliment de sevrage, contribuant au bon état de santé et à l'amélioration des performances de croissance. L'inclusion d'une quantité limitée de pulpe de betterave dans les aliments de sevrage peut donc être recommandée.

Mots-clés : Porcelet, aliment, pulpe de betterave, fibres, croissance, digestibilité, enzymes.

Introduction

The distribution of solid food after early weaning commonly reduces the piglet's feed intake, nutrient digestibility, growth rate and can induce digestive disorders such as diarrhoea impairing the capacity to digest and absorb nutrients. At the origin of these problems, digestive intolerance towards dry feed components, low enzymatic activity, morphologic changes of intestinal mucous, as well as low activity of functional microflora are often indicated. Numerous attempts have been proposed to avoid these disturbances such as to formulate complex diets supplying digestible proteins or heat-treated cereals. Otherwise, the addition of antimicrobial agents, antibiotics, probiotics or acidifiers has also been recommended but results are not always consistent. Recently, there has been increasing interest on the addition of natural components of feedstuffs, like non-starch polysaccharides (NSP), in particular from sugar-beet pulp (SBP). Their digestibility seems to be relatively high in the growing pig (Chabeauti *et al.*, 1991), as well as in the piglet, improving growth performance and health status (Longland *et al.*, 1994). However, few data are available on the physiological effects of inclusion of NSP in piglet diets, in particular with respect to adaptation of digestive enzymes in the gastrointestinal

tract. In the restricted fed growing pig, the use of fibrous feedstuffs in the diet reduces the digestible energy content (Shi and Noblet, 1993) and, consequently, growth performance is reduced. Nevertheless, evidence exists that carcass fatness but not lean meat could be reduced when NSP are included in growing-finishing diets (Chauvel *et al.*, 1975).

Results of a series of experiments conducted with piglets are presented, particularly the influence of NSP from SBP on growth performance after weaning and up to slaughter, nutrient digestibility and activity of digestive enzymes.

Material and methods

The inclusion of 6% of SBP in a starter diet and its effects on the performance was studied in two experiments. In the first one, 80 PPxLW piglets (21 days) were assigned to 4 treatments containing either raw or extruded wheat combined with 0 or 6% of SBP, and their performance up to 25 kg body weight (BW) was measured (Lizardo *et al.*, 1997a). During the growing-finishing period, piglets were allotted to 2 treatments containing either 0 or 6% of SBP. Growth performance and carcass composition at slaughter was evaluated. The SBP contained 11.6% of CP, 55% NSP, 46% NDF, 23% ADF and 17.2 MJ of GE per kg of DM. Feed was offered *ad libitum* to piglets and growing pigs were fed according to a feeding scale. In experiment 2, faecal, ileal and post-ileal digestibility of major dietary and NSP components and the activity of pancreatic and intestinal enzymes was measured in piglets (Lizardo *et al.*, 1997a). Thirty-two PPxLW barrows (21 days and 7.5 kg BW) were allotted to experimental treatments similar to those used in experiment 1. Pancreatic and intestinal enzyme activities were measured after slaughter at 56 days of age. Samples of supernatant fluid recovered from jejunal and ileal digesta of 10 anastomized piglets were used for viscosity measurements. In a third experiment, 28 PPxLW barrows (25 days and 7.2 kg BW) were assigned to 4 diets based on wheat and containing either 0 or 12% SBP in combination with two different protein sources (Lizardo *et al.*, 1997b). The effect of diet was evaluated in a digestibility and N balance trial and the procedures were similar to those of experiment 2.

Results and discussion

Growth performance and carcass composition

The association of wheat with SBP improved growth rate from 156 to 193 g/day ($P < 0.02$) and decrease feed conversion ratio from 2.32 to 1.93 ($P < 0.05$) during the first 3 weeks after weaning (Fig. 1) and this effect on performance was also observed for the overall post-weaning period. Those observations agree with results of Longland *et al.* (1994) and could imply that end-products of microbial fermentation could be involved in supporting growth performance of pigs fed NSP diets (Shi and Noblet, 1993).

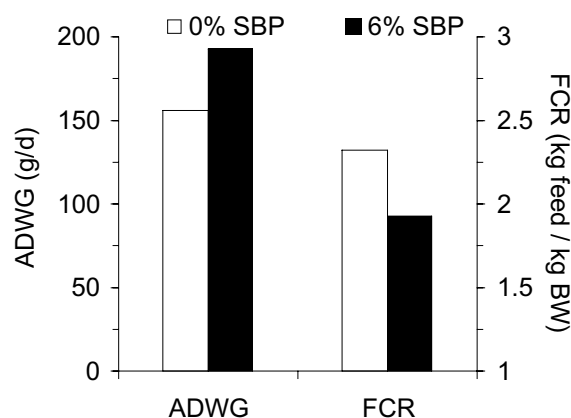


Fig. 1. Effect of NSP from SBP on daily weight gain (ADWG) and feed conversion ratio (FCR) in the weaned piglet.

During the growing-finishing period, daily weight gain was slightly but not significantly reduced and feed conversion ratio was unchanged in animals receiving SBP, in agreement with Stekar *et al.* (1991) and opposed to Chauvel *et al.* (1975). However, as growth performance was similar and energetic density was lower, the feed conversion ratio (MJ DE/ kg BW gain) was reduced in animals fed the SBP diet. At slaughter, dressing percentage was reduced with SBP and lean meat percentage was improved from 52.8 to 54.0% ($P < 0.05$; Fig. 2) associated with a decrease in backfat thickness of the carcass. No differences were observed in lean weight but the use of SBP decreased the weight of fat at slaughter ($P < 0.01$), in agreement with Chauvel *et al.* (1975) and Stekar *et al.* (1991) and opposed to Martelli *et al.* (1999). It is suggested that a reduction in DE intake reduces the deposition of fat tissue without affecting carcass lean meat.

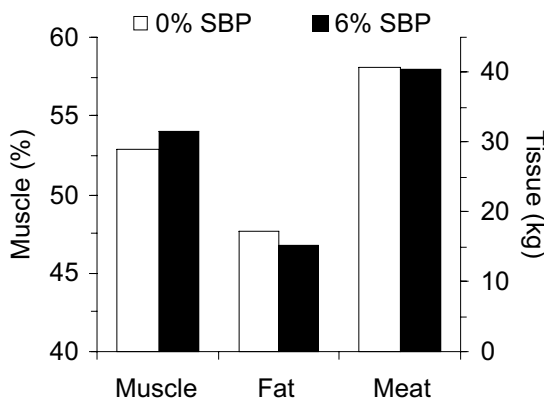


Fig. 2. Effect of NSP from SBP on carcass composition at slaughter.

Digestibility of major dietary components

Faecal digestibility of energy and N was similar between diets, where digestibility of NDF or hemicellulose was increased with increasing SBP in the diet (Fig. 3). This means that, compared to other fibrous feedstuffs (Chabeauti *et al.*, 1991), NSP of SBP are extensively digested in the piglet's GI-tract probably because of their high solubility. Results of N digestibility varied between studies (Dierick *et al.*, 1983; Longland *et al.*, 1994) but the presence of dietary NSP, in general, implied a similar N retention. The amount of ileal chyme flowing from the ileum was increased by the inclusion of NSP. Therefore, ileal digestibility of almost all dietary components, including NDF and hemicelluloses were greatly reduced ($P < 0.01$) in piglets receiving diets containing SBP, in agreement with Dierick *et al.* (1983). Digestibility of fibrous components agreed with data observed by Chabeauti *et al.* (1991) but not with those of Graham *et al.* (1986) in the growing pig and those differences could be associated with the inclusion level and the cereal source of the basal diet. In addition, ileal digestibility of nutrients was independent of the ileal or jejunal viscosity of the chyme.

Differences between faecal and ileal digestibility as a result of the addition of 6 or 12% SBP in the diet may be due to increased post-ileal digestion ($P < 0.05$) and disappearance of energetic, nitrogenous and fibrous compounds. Similar results have been observed mainly in the growing pig receiving pectins in their diet inducing an increase in the residence time of digesta in the large intestine (Drochner, 1984). Fermentation of NSP by non-pathogenic microflora and the beneficial effects of their end products on epithelial cells can contribute both to a "barrier" effect and a better health status of the piglet after weaning.

Digestive enzyme activities

The inclusion of 6 or 12% SBP in the diet had no effects on the activity of amylase and proteolytic enzymes and this could be respectively related to the starch and crude protein content and the fibre source of diets (Mosenthin *et al.*, 1994). The increase in lipase activity could be due to the ability of NSP to bind bile salts and interfere with the digestion and absorption of fat. Otherwise, N-aminopeptidase, dipeptidyl peptidase IV and alkaline phosphatase activities increased in the ileum but not in the jejunal mucous of piglets fed NSP diets (Fig. 4). This effect may be associated with

compositional and physical properties of intestinal chyme because some residues of SBP could interact with the digestive hydrolysis, impairing absorption of small peptides in the proximal intestine and, therefore, stimulate the activity of brush-border membrane enzymes in the ileal mucous.

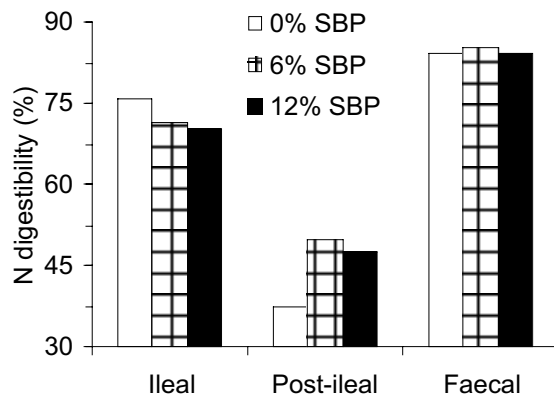


Fig. 3. Effect of NSP from SBP on apparent digestibility of nitrogen.

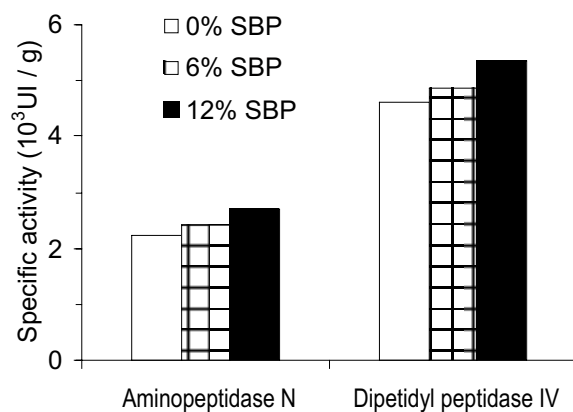


Fig. 4. Effect of the NSP of SBP on the ileal peptidase activities in the piglet.

Conclusions

The use of sugar-beet pulp in diet helps digestive adaptation of piglets to solid food at weaning, and improves growth performance and health status. Therefore, the inclusion of a low level (<10%) of NSP in piglet starter diets can be recommended.

References

- Chabeauti, E., Noblet, J. and Carré, B. (1991). Digestion of plant cell walls from four different sources in growing pigs. *Anim. Feed Sci. Technol.*, 32: 207-213.
- Chauvel, J., Villain-Guillet, J., Bourdon, D. (1975). Valeur énergétique de pulpes de betteraves déshydratées et utilisation par le porc en croissance-finition. *Journées Rech. Porcine*, 7: 53-60.
- Dierick, N., Vervaeke, I., Decuyper, J. and Henderickx, H. (1983). Influence de la nature et du niveau des fibres brutes sur la digestibilité iléale et fécale apparente de la matière sèche, des protéines et des acides aminés et sur la rétention azotée chez les porcs. *Rev. Agriculture*, 6: 1691-1712.
- Drochner, W. (1984). The influence of changing amounts of crude fibre and pectic components on prececal and postileal digestic processes in the growing pig. *Advances Anim. Physiol. Anim. Nutr., suppl. No. 14*, Verlag Paul Parey, Berlin, 125 pp.
- Graham, H., Hesselman, K. and Aman, P. (1986). The influence of wheat bran and sugar-beet pulp

- on the digestibility of dietary components in a cereal-based pig diet. *J. Nutr.*, 116: 242-251.
- Lizardo, R., Peiniau, J., Lebreton, Y. and Aumaitre, A. (1997a). Effets de l'incorporation de pulpe de betterave dans les aliments du porcelet et du porc en croissance: Performances de croissance, digestibilité et composition corporelle. *Ann. Zootech.*, 46: 281-294.
- Lizardo, R., Peiniau, J. and Aumaitre, A. (1997b). Inclusion of sugar-beet pulp and change of protein source in the diet of the weaned piglet and their effects on digestive performance and enzymatic activities. *Anim. Feed Sci. Technol.*, 66: 1-14.
- Longland, A.C., Carruthers, J. and Low, A.G. (1994). The ability of piglets 4 to 8 weeks old to digest and perform on diets containing two contrasting sources of non-starch polysaccharide. *Anim. Prod.*, 58: 405-410.
- Martelli, G., Parisini, P., Sardi, L., Scipioni, R., Vignola, G., Panciroli, A. and Mordenti, A. (1999). Intérêt zootechnique de l'utilisation de la pulpe de betterave ensilée dans l'alimentation du porc lourd. *Ann. Zootech.*, 48: 173-188.
- Mosenthin, R., Sauer, W.C. and Ahrens, F. (1994). Dietary pectin's effect on ileal and fecal amino acid digestibility and exocrine pancreatic secretions in growing pigs. *J. Nutr.*, 124: 1222-1229.
- Shi, X.S. and Noblet, J. (1993). Contribution of hindgut to digestion of diets in growing pigs and adult sows: Effect of diet composition. *Livest. Prod. Sci.*, 34: 237-252.
- Stekar, J.M.A., Cahuk, A., Zagozen, F. and Stibilj, V. (1991). The effect of different portions of dry sugar beet pulp in the fattening rations: Growth, consumption and food conversion and slaughtering properties. *Zb. Biotehniške fak., Univ. v Ljubljani, Kmetijstvo (zivinoreja)*, 58: 51-77.