Communication no. 7

Influence of the nature of cereal on site and extent of starch digestion in steers.

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Current research takes an analytical approach in terms of nutrient flows to improve knowledge of how nutrients determine product quality (milk, carcass). The site of starch digestion modifies the nature and the amount of nutrients delivered to the ruminant, volatile fatty acids in the rumen and in the hindgut and glucose in the small intestine. One way to manipulate starch digestion is by selecting cultivars because the endosperm texture of corn grain affects in situ ruminal starch degradation (Philippeau C., Michalet-Doreau B., Anim. Feed Sci. Technol. 68 (1997) 25–30). The aim of our study was to determine the effect of grain source on the site and the extent of starch digestion in the digestive tract. Six Salers steers (initial BW, 320 kg) fitted with simple ruminal, duodenal and ileal cannulas were used in a double 3 × 3 Latin square design experiment. They received diets consisting of 70 % coarsely cracked cereal (wheat, dent and flint corns) supplemented with alfalfa hay and urea and balanced to be isostarchy (47.7 ± 2.3 % of DM). Steers were adapted to their diet for 3 weeks before measurements. Representative samples of duodenal and ileal digesta were composed of 12 spot samples taken over 2 d. Duodenal and ileal flows were determined using two markers (polyethylene glycol and lignin) and were analysed for starch content. Ruminal starch digestibility was greater for wheat than for corn (86.6 and 47.8 %, respectively, SEM = 2.3) which concurred with the results of McCarthy et al. (McCarthy et al., J. Dairy Sci. 72 (1989) 2002–2016) and was altered by the corn genotype (60.8 and 34.8 % for dent and flint corns, respectively) as we showed in in-situ degradation studies. Postruminal digestion varied widely and was divided between the small intestine (SEM = 3.1) and the hindgut (SEM = 4.2); (3.5 versus 5.3 %), (8.9 versus 13.5 %) and (17.6 versus 28.3 %) for wheat, dent and flint corns, respectively. When the proportion of starch digested in the rumen was low, a greater proportion of starch was digested in the lower tract, particularly in the hindgut. The compensation by digestion in the lower tract was not complete as starch digestion in the total tract was 96, 84 and 82 % for wheat, dent and flint corns, respectively, (SEM = 1.6).

In conclusion, the grain source affects the amount and the site of starch digestion. Furthermore, when a large amount of starch escapes from ruminal fermentation, much of it can be digested in the hindgut. This supports the hypothesis of a limiting capacity of the small intestine for starch digestion.

Communication no. 8

Influence of the protein source and the antigenicity of soyabean on the morphology and the enzyme activities of the proximal jejunum in preruminant calves.

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Replacing partially skim milk powder (SMP) by soyabean protein in milk replacers increases the rate of gastric emptying and decreases nitrogen digestibility. Moreover, antigenic heated soyabean flour (HSF) is less digestible than non-antigenic, alcohol-treated, soyabean protein concentrate (SPC) and it has been shown to induce immune-mediated gut hypersensitivity reactions in

the calf. The aim of this work was to assess the impact of protein source and antigenicity on morphology and some enzyme activities of the jejunum in preruminant calves.

Twenty Holstein male calves were fitted with a silicone T-piece cannula in the duodenum at the age of 3 weeks. After recovery, they were fed a liquid diet based on SMP for 2 weeks, switched to diets containing a mixture (1:1, digestible N basis) of SMP and either HSF ($n = 12$) or SPC ($n = 8$) for 8 weeks, and then return to the SMP diet for 2 weeks. The diets contained similar amounts of digestible N and energy. They were fed at a level of 55 g DM/kg$^{0.75}$/d. A Watson capsule was used to collect mucosa biopsies of the proximal jejunum before (week 0), during (week 2 and week 8) and after (week 10) feeding the soya-based diets. One biopsy was fixed in phosphate buffered formalin for microdissections and morphology measurements. Another biopsy was frozen in liquid nitrogen and kept at –80 °C until enzyme activities were determined.

Feed intake and growth were similar between the HSF and SPC groups over the experimental period. No diarrhoea was observed in the calves fed the HSF diet, in agreement with their moderate plasma antibody response to soya. Effects of antigenicity and antigenicity × time interaction were never significant ($P < 0.05$). On the contrary, villus height decreased (–22 %, $P < 0.01$) between weeks 0 and 2, and increased (+18 %, $P < 0.05$) between weeks 8 and 10. Villi enlarged by 30 % ($P < 0.001$) between weeks 2 and 8, a change that may be interpreted as an age or adaptative effect. Crypt depth also increased (+20 %, $P < 0.001$) between weeks 0 and 2. Specific activities of alkaline phosphatase (–39 %, $P < 0.01$), amino-peptidase N (–15 %, $P < 0.05$) and lactase (–21 %, $P = 0.10$) decreased between weeks 0 and 2. Conversely, the activities of alkaline phosphatase (+82 %, $P < 0.0001$), lactase (+60 %, $P < 0.01$) and dipeptidyl-peptidase IV (+103 %, $P < 0.0001$) increased between weeks 8 and 10. Specific activities of lactase and amino-peptidase N decreased (–31 and –29 %, $P < 0.01$) between weeks 2 and 8 (age or adaptative effect). Treatments had limited effects on amino-peptidase A activity.

In conclusion, feeding soyabean protein, regardless of antigenicity, negatively affected jejunal morphology and the activity of most enzymes studied. These effects, which could be partially reversed by feeding SMP, may contribute to the lower digestibility of soyabean protein usually observed. Further work is needed to clarify the mechanisms of interaction between dietary protein and the gut wall. Finally, antigenicity per se had no significant influence in this experiment. However, soyabean antigens are deleterious to the small intestinal mucosa of sensitive calves (Lallès et al., Vet. Immunol. Immunopathol. 52 (1996) 105–115).

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Biochemical approach of protein digestion in chickens. I. Crévieu-Gabriel[a], J. Gomez[a], J. Guéguen[b], L. Quillien[b], S. Bérot[b], B. Carré[a] ([a] Station de recherches avicoles, Inra, 37380 Nouzilly, France; [b] Laboratoire de biochimie et technologie des protéines, Inra, rue de la Géraudière, 44072 Nantes, France)

Protein digestion shows variability depending upon protein sources and plant varieties. For example peas, a protein-rich (18–30 %) European leguminous crop, important in animal nutrition, have a rather high variability. However, this variability is not understood. Pea proteins are composed mainly of globulins (60 %) which contain two fractions, proteins 7S (vicilin and convicilin) and 11S (legumin). In order to study the protein structure effect without interfering factors, this protein fraction was extracted with a process limiting structural modifications (Crévieu et al., Nährung 40 (1996) 237–244). It was introduced in a synthetic diet, 'globulin', as the sole protein