

When incubated with PPA, the strands of spaghetti were solubilized and the starch degradation increased after 1 h of alpha-amylolysis (+ 10% at 24 h) due to the presence of contaminating proteases which partially hydrolysed the protein network (16% at 24 h). The protein network degradation reduced the pathway for the alpha-amylase to access starch. Pre-incubation with pepsin released starch into the incubation medium, only slightly increasing the initial rate of starch degradation (+ 10% at 15 min).

We concluded that the protein network does not constitute a complete physical barrier to alpha-amylase but limits its access to starch by a supposed retarded diffusion rate. The tortuosity and the steric hindrance of the protein matrix may be involved.

Effect of seaweed fibre added in a diet on the physico-chemical characteristics of pig digesta. E Worthington¹, F Guillon¹, C Hoebler¹, M Lahaye¹, B Darcy-Vrillon², P Vaugelade², JL Barry¹ (¹Centre de recherche en nutrition humaine, Inra, 44316 Nantes; ²Unité d'écologie et de physiologie du système digestif, Inra, 78352, Jouy-en-Josas, France).

Seaweed fibres have particular physico-chemical characteristics that are interesting because of their potential application to nutrition.

Two seaweed extracts (*Eucheimia Cotinii*, rich in insoluble carrageenans, EC, and *Palmaria palmata*, rich in low viscous soluble xylan, PP), were studied for their effects on the physico-chemical characteristics of digesta along the whole digestive tract. Twelve Large White pigs (80 kg), adapted for 6 days to a test-diet containing 5% algal fibre or cellulose (Cel, reference fibre), were sacrificed 5 h after meal. Fresh (FM) and dry matter (DM), chemical composition, pH and short chain fatty acid (SCFA) concen-

tration were determined in the digesta. The amount of total dietary fibre and the ratio soluble to insoluble from stomach, ileum and large intestine were determined. The amount of total fibre increased from the stomach to the colon. In the small intestine, the proportion of soluble fractions was high for EC and PP; Cel was found always in insoluble form. EC and Cel were found to be present in distal colon probably due to their poor fermentability. Supplementation of the diet with PP or EC increased the amount of wet digesta while dry matter was unchanged; this rise corresponded to an increase in the water content due to either an osmotic effect of algal fibre (PP in the small intestine), or a greater absorption of water by the fibre (EC) or by microbial mass (PP in the colon). The lowest amount of starch was found in the stomach after ingestion of the diet supplemented with PP, suggesting a more rapid gastric emptying. The SCFA concentration and pH in the large intestine are related to the fermentability of algal fibre. The high fermentation of PP in the caecum increased the concentration of SCFA (126.3 ± 55.7 mmol/g FM) and reduced the pH (6.0 ± 0.7). In contrast, EC was weakly fermented (SCFA: 72.7 ± 14.8 mmol/g FM; pH 7.0 ± 0.4) as was Cel used as the reference fibre (SCFA: 95 ± 22 mmol/g FM; pH 6.9 ± 0.1).

In conclusion, the supplementation of a diet with 5% algal fibre changes the physico-chemical characteristics of the digesta according to the algal fibre properties in the digestive compartment considered. The extent of 5% algal fibre fermentation at different sites of large intestine influences significantly the production of SCFA and consequently the pH of digestive contents.

Hydrogen production in dogs: Lactulose vs meat diet. E Pouteau, H Dumon, M Champ, M Krempf, P Nguyen (Centre de recherche en nutrition humaine, Hôpital Nord, Nantes; Laboratoire de nutrition et

alimentation, École nationale vétérinaire, 44000 Nantes, France).

Expired hydrogen level is measured in humans to assess glucidic macromolecule quantity non digested in the small bowel, and fermented in the colon. This method was used to evaluate whether the dog is capable of fermenting lactulose, and what is the origin of the hydrogen production. Six dogs (beagle, 11.3 ± 1.5 kg) were fed meat (300 g) and extruded rice (150 g) for 3 weeks; during the second week (from day 8 to day 14) 10 g of lactulose was added to the meal. Expired air from the dogs was collected at regular times for 10 h after the meal, at day 7, 8, 14 and day 21. The expired hydrogen level was assessed by gas chromatography. Five hours after the meal, the hydrogen level increased significantly. The maximum was attained 7 h after the meal, except at day 21 (9 h). The hydrogen peak fell after giving lactulose for one week (day 14: 8 ± 3 ppm), compared to day 7, 8 and 21 (23 ± 6 , 21 ± 2 , et 27 ± 14 ppm, $P < 0.05$). The dog weight did not change, and dogs did not expire any methane. We concluded that intestinal degradation of extruded rice and meat came with an hydrogen production, and that lactulose adaptation induced a behavior change within the colic bacteria flora, yielding less hydrogen.

Effect of seaweed on mineral bioavailability. A Pointillart, C Colin, H Lacroix, L Guéguen (*LNSA-Inra, 78352 Jouy-en-Josas cedex, France*).

Seaweed and seaweed by-products contain alginates and carrageenans which are potent cation chelators. In a 2-month nutritional study on pigs, the effect of seaweed ingestion on mineral bioavailability was investigated.

Three groups of 8-week Large White pigs were fed a diet containing 10% Ascophyllum powder (A1), or 10% of the same pow-

der after partial demineralisation (A2), or a control diet without seaweed. Dietary calcium content was reduced to 70% of the recommended level for the pigs to exacerbate potential seaweed effects on mineral bioavailability. Mineral (Ca, P, Na, Mg) absorption and retention were evaluated by a balance trial. At slaughter, plasma was collected to monitor various markers of bone formation: carboxyterminal propeptide of type I procollagen (PICP), osteocalcin and alkaline phosphatase activity (ALP). Collagen crosslinks (deoxypyridinoline, DPYR) and hydroxyproline (OHPr) two markers of bone resorption, have been determined in urine. At slaughter various bones were collected to measure bending moments (reflecting breaking strength) and mineral contents.

Seaweed had no effect on growth performance or on bone bending moments (BM) and mineral content (BMC). Absorption and retention of the three cations, and plasma ALP decreased in the pigs fed A2 diet only. Plasma PICP (marker of collagen synthesis) decreased and the urinary excretion of DPYR and OHPr (markers of collagen degradation) increased in the pigs fed A1 diet. Thus, direct measurements of bone mineralisation (BM, BMC) indicated no deleterious effect of seaweed, but the plasma and urine bone markers suggested altered bone collagen metabolism in one group (A1), while the balance data indicated a decreased mineral availability in another group (A2). Since both of these groups were fed diets containing seaweed, these results are not coherent. These discrepancies could be due to a time lapse between the plasma or balance changes and their occurrence at bone level. Possibly these plasma and balance changes, which usually indicate bone disturbance, were too weak or of too short a duration to register an alteration in the bone mineral content. In further investigations the mineral absorption in healthy volunteers receiving various seaweed preparations will be checked.