

der (SMP) or a mixture (40:60, CP basis) of whey and soyabean products including a hydrolysed isolate (HSPI), a concentrate (SPC) and a heated flour (HSF). The HSF was highly antigenic *in vitro*, while the others were not. Gut permeability measurements were carried out 1 week before ( $P_0$ ) and 3 ( $P_1$ ) and 11 ( $P_2$ ) weeks after starting dietary treatments. Xylose (0.5 g/kg BW), Cr-EDTA (4 mg Cr/kg BW), and a mixture of sucrose (0.2 g/kg BW) and mannitol (0.1 g/kg BW) were fed separately as pulse doses. Calves were fasted 16 h before testing. Urine was collected quantitatively between 0 and 6 h post-dosing, and also up to 24 h for Cr-EDTA. Xylose was assayed colorimetrically, Cr by atomic absorption spectrometry, and oligosaccharides using gas-liquid chromatography [André *et al* (1990), *op cit*]. Marker excretion data (% dose) were analysed by non-parametric tests.

As expected, N digestibility was the highest with SMP, the lowest with HSF and intermediate with HSPI and SPC. Conversely, antisoya antibodies were detected in high levels with HSF only, confirming its high antigenicity. The age effect on the urinary excretion of markers was usually not significant, except for xylose excretion, which decreased between  $P_1$  and  $P_2$  in controls ( $33.8 \pm \text{SEM } 2.92$  vs  $18.8 \pm 5.72$ ,  $P < 0.05$ ). In that group, the sucrose/mannitol ratio also decreased ( $P < 0.05$ ) from  $1.27 \pm 0.21$  in  $P_0$  to  $0.65 \pm 0.09$  in  $P_1$ . Lastly, sucrose excretion also decreased ( $P < 0.05$ ) from  $2.73 \pm 0.60$  to  $0.92 \pm 0.28$  between  $P_0$  and  $P_2$  with HSF. A significant diet effect was observed only in  $P_1$  using xylose and Cr-EDTA. Their excretions were higher ( $P < 0.05$ ) with SMP than with SPC or HSF ( $33.8 \pm 2.92$  vs  $18.7 \pm 3.61$  or  $16.0 \pm 2.78$ ) for xylose, and with SMP than with HSF ( $6.0 \pm 0.99$  vs  $2.9 \pm 0.37$ ) for Cr-EDTA collected over 24 h. In conclusion, calf intestinal permeability was hardly influenced by diets, despite the low digestibility and high immunogenicity of HSF. Only xylose and Cr-EDTA absorption were transiently reduced with some of the soya diets. A similar trend reported for xylose in calves fed soya products of unknown antigenic activity was interpreted as being due to an altered gut structure [Seegraber and Morill (1979) *J Dairy Sci* 62, 972-977]. This explanation does not fit for Cr-EDTA whose excretion should have increased in that situation. Finally, urinary excretion of Cr-EDTA and oligosaccharides by calves differ substantially from those observed in humans [André *et al* (1990), *op cit*].

**Systemic humoral responses to soyabean meal in dairy cows, their calves throughout weaning, and ruminating lambs.** JP Lallès<sup>1</sup>, RG Guilhermet<sup>1</sup>, JL Troccon<sup>2</sup> (<sup>1</sup> INRA-ENSA, Laboratoire du Jeune Ruminant, 65, rue de Saint-Brieuc, 35042 Rennes Cedex; <sup>2</sup> INRA, Station de Recherche sur la Vache Laitière, 35590 Saint-Gilles, France)

Soyabean meal (SBM) introduced in milk replacers for preruminant calves causes the development of severe gut disturbances and a high production of systemic antibodies (Abs) against dietary protein [Sissons (1982) *Proc Nutr Soc* 41, 53-61]. In contrast, ruminant calves appear to tolerate high levels of SBM, and produce only moderate levels of specific Abs. The systemic immune status of adult cattle and other ruminant species to dietary antigens has not been documented so far. Thus, we determined antisoya Ab titres in dairy cows, in their calves throughout weaning, and in ruminant lambs, all consuming SBM.

Jugular blood was collected from 14 dairy cows 2 months after calving, from their 14 calves after 2, 4 and 7 weeks of life, and from 14 ruminant lambs aged 2.5 months. Besides diets based on maize silage, cows consumed SBM from 1 kg/d 1 wk before calving to  $3 \pm 1$  kg after, depending on milk production. Calves and lambs were weaned onto mixtures (80:20) of concentrates containing 17 and 12% SBM, respectively, and hay. Antisoya Abs were assayed in plasma by passive haemagglutination [Sissons (1982), *op cit*]. Ab titres ( $\log_2$  dilution from initial dilution 1:20) were compared by non-parametric tests.

SBM usually contains 4-6% protein as near-native glycinin and  $\beta$ -conglycinin, which are highly immunogenic (eg, Ab titres of 8-12) in the preruminant calf [Sissons (1982), *op cit*]. Here, antisoya Ab titres were 1.29 (SEM 0.101) in cows, 0.00 (0.000), 1.36 (0.284) and 2.34 (0.291) in calves at 2, 4 and 7 weeks of age, respectively, and 1.00 (0.296) in lambs. Thus, the concentration of specific Abs in weaned calves was twice as high as in cows and lambs, and 400 times less than in preruminant calves fed antigenic soya [Sissons (1982), *op cit*]. This was probably linked with intense ruminal fermentation soon after weaning [Tukur *et al* (1993) *Can J Anim Sci* 73, 891-905]. However, titres increased significantly ( $P < 0.05$  and  $P < 0.01$ ) throughout weaning of calves, indicating the lack of systemic humoral

tolerance. This may reflect the survival of low amounts of immunoreactive proteins along the gut (Tukur *et al* (1993), *op cit*) and their passage in the blood. In addition, calf Ab titres at weeks 4 and 7 were significantly correlated ( $r = +0.64$  and  $+0.62$  respectively,  $P < 0.05$ ) with those in the dams 2 months after calving. These limited results suggest direct (genetic) and/or indirect (colostral) influences of cows on the subsequent systemic Ab response of their offsprings to dietary antigens.

In conclusion, both young and adult ruminants appear to produce dependent but rather moderate levels of plasma antisoya Abs.

**$\alpha$ -Galactosides are poorly digested by germ-free chickens.** B Carré<sup>1</sup>, A Brée<sup>2</sup>, J Gomez<sup>1</sup> (<sup>1</sup> INRA, Station de Recherches Avicoles; <sup>2</sup> INRA, Station de Pathologie Aviaire et de Parasitologie, 37380 Nouzilly, France)

$\alpha$ -Galactosides were previously found to be readily digested by chickens [Carré and Lacassagne (1992) Proc 1st Eur Conf Grain Legumes, Angers, France, Assoc Eur Protéagineux, Paris, 481-482]. However, the origin of this digestion (from endogenous enzyme activity or microbial fermentation) is not known. The current study, conducted with germ-free chickens, was carried out to investigate the origin of  $\alpha$ -galactoside digestion in chickens.

Seven white Leghorn chickens (PA 12 strain) were hatched in a germ-free isolator and reared in a cage with *ad libitum* feed and drink, in germ-free conditions [Schellenberg and Maillard (1973) In: Journées Rech Avicoles Cunicoles INRA-ITAVI-WPSA, ITAVI, Paris, 283-285]. They were fed a diet sterilized by irradiation (50 kGy), and formulated to contain 21.1% protein, 2 790 kcal/kg, 1.18% calcium and 0.66% phosphorus (Extral 1M, Extralabo, Ets Pietrement, Société Colombe, France). At 5 weeks of age, a sterilized plastic foil was put under the cage, all excreta were collected for 1 d, put in a sealed sterilized box, immediately frozen at  $-20^{\circ}\text{C}$  and then freeze-dried.

A sample of excreta was incubated and revealed no contaminating bacteria.

Polysaccharide xylose (from cereals, soyabean and sunflower meals occurring in diet), considered here an undegraded and unabsorbed marker of feed, was measured in both diet and excreta, using GLC analysis of acid hydrolysates

[Carré *et al* (1990) *Poult Sci* 69, 623-633]. Polysaccharidic xylose was measured in 6 replicates of feed and excreta.

Oligosaccharides were extracted in methanol/water 50:50 under reflux and determined by GLC analysis of trimethylsilyl derivatives [Sweeley and Walker (1964) *Anal Chem* 36, 1461-1466] using a capillary column (BP1, SGE, Australia), with melezitose as internal standard. Analyses of oligosaccharides were done on 8 replicates of feed and excreta.

Raffinose and stachyose, mainly originating from the soyabean meal in the diet, amounted to 0.39 and 0.79% dietary level, respectively. Their excreta recoveries were  $0.86 \pm 0.133$  (SD) and  $0.94 \pm 0.131$  (SD), respectively. The latter high values show a nearly complete lack of endogenous  $\alpha$ -galactosidase activity in the chicken digestive tract. Accordingly, the high digestibility values (0.80-1.0) previously found in chickens for  $\alpha$ -galactosides [Carré and Lacassagne (1992), *op cit*] were due to microbial degradation.

**Effects of resistant starch supplementation on postprandial metabolism in healthy subjects.** N Faisant<sup>1</sup>, M Champ<sup>1</sup>, S Ranganathan<sup>2</sup>, C Azoulay<sup>3</sup>, MF Kergeris<sup>3</sup>, M Krempf<sup>2</sup> (<sup>1</sup> INRA, Laboratoire de Technologie Appliquée à la Nutrition; <sup>2</sup> Centre de Recherche sur Volontaire Sain, CHU Nord; <sup>3</sup> Laboratoire de Pharmacologie, Hôtel-Dieu, 44000 Nantes, France)

Resistant starch (RS) is defined as the fraction of starch not absorbed in the small intestine of healthy individuals. These structures reach the colon and are generally fermented by the microflora. The digestive fate of RS is thus comparable to that of dietary fibers and their physiological effects should be considered in that way. When RS was substituted for digestible starch, postprandial glucose and insulin [Behall *et al* (1988) *Am J Clin Nutr* 55, 81-88] and fasting triglycerides and total cholesterol after several weeks were decreased [Behall *et al* (1989) *Am J Clin Nutr* 49, 337-344]. However, the role of RS added to a meal has not been investigated. Knowing the consequences of a supplementation with some dietary fibers on postprandial glycemia [Wolever and Jenkins (1982) *J Plant Foods* 4, 127-138] and lipemia [Cara *et al* (1992) *Am J Clin*