

Although ruminants evolved to efficiently use forages and plant fibre (i.e., cellulose and hemicellulose) as a main source of energy, livestock ruminants are commonly fed diets high in cereal grains that contain mostly starch. Such a feeding strategy increases energy content of the diet, and thus efficiency of meat or milk production. However, high intake of starch also challenges gastrointestinal tract of ruminants, particularly the rumen, which has evolved to process mainly fibre, not starch.

The rumen bacteria digest slowly-fermenting carbohydrates – plant fibre – as well as fast-fermenting carbohydrates – like starch, and produce the so-called short-chain fatty acids. After absorption into the blood the ruminant uses these short-chain fatty acids for energy. If this production occurs too fast, when more starch than fibre is present in the diet, then this fast ruminal short-chain fatty acids production may lead to their accumulation in the rumen and a drop in ruminal pH. When ruminal pH drops below 5.6-5.8 (a condition called ‘acidosis’) for several hours per day, this results in a dysbiotic ruminal microbial community, less efficient fibre digestion, less efficient short-chain fatty acids absorption from the rumen, and reduced rumen epithelium barrier function, all resulting in compromised function and health of the gastrointestinal tract. The negative consequences of high-starch diets may affect over 20% of high-yielding livestock ruminants. The dilemma between the necessity to feed high-energy diets on the one hand (to achieve economically rewarding production) and the problem of inducing disease is well known. However, the high variability in susceptibility to high-starch diets between animals, where some animals appear more resistant than others, is not well explained.

High-starch diets are also commonly fed to livestock ruminants in their first weeks of life, i.e. to calves and lambs. An important aim of such a feeding strategy is to accelerate the development of the rumen, which is not yet fully developed at birth. However, the intake of starchy feeds in amounts that would be never consumed in a natural diet may substantially alter the development of the rumen and also challenge its main functions in a way similar to that observed in adult ruminants. It is suspected that such early life challenges affect the response of organisms to challenges later in life – making the adult animal ‘more susceptible’, e.g. to gastrointestinal tract disease.

In this project we hypothesize that the intake of high-starch diet in first weeks of life has a long-term impact on various aspects of rumen development and functions, including ruminal microbial community, ruminal epithelium structure and functions, rumen anatomy, rumination, digesta passage and nutrient digestibility, and thus affect the response of the rumen to high-starch diet later in life. Specific aims of this project are: 1) to determine the impact of high-starch diet early in life on rumen anatomy, ruminal microbial community, ruminal epithelium, rumination, digesta passage and nutrient digestibility later in life; 2) to determine the impact of a high-starch diet early in life on the response of the rumen to challenge with high-starch diet later in life; and 3) to determine the impact of high-starch diet early in life on epigenetic markers within ruminal epithelium potentially controlling its long-term impact on rumen functions.

In order to verify research hypothesis, two experiments will be conducted, each using different species, i.e., sheep and cattle (Study 1, and 2, respectively), in order not to limit conclusions of this project to a single ruminant species. Each study will be divided into three stages. In each study, the same experimental design and research methods will be used. Newborn lambs and calves will be allocated to two treatments and fed milk replacer with *ad libitum* access to forage (Control) or concentrate mixture containing mostly cereal grains (Starch). *Ad libitum* access to the forage or the concentrate mixture will be continued for two weeks after weaning from milk replacer (Stage 1), when animals will be shifted to an all forage diet (Stage 2). Upon reaching rumen maturity, animals will be challenged with a high-starch diet (Stage 3). In each stage of the project feed intake, rumination, digesta passage, nutrient digestibility and fecal scores will be monitored as markers of gastrointestinal tract functioning, as well as rumen anatomy, ruminal microbial community structure, ruminal epithelium development and functions and its genetic and epigenetic status will be investigated.

This project will be the first aiming to determine whether early life exposure to high-starch diet affect response of the rumen to high-starch diet in later life, and particularly whether it increases the probability of low ruminal pH, dysbiosis and ruminal epithelium damage once the animal is exposed to a high-starch diet in adulthood, which is oftentimes reported in livestock ruminants.