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Competition for hydrogen between acetogenic bacteria and methanogenic archaea

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Hydrogen is an important intermediate in the microbial anaerobic degradation of organic matter. In the rumen, hydrogen produced by hydrolytic and fermentative microorganisms could be re-utilized by three bacterial groups: the methanogenic archaea, the sulfate-reducing bacteria and the acetogenic bacteria. Methanogens are the main hydrogenotrophic population in the rumen whereas acetogens are present in low numbers contrary to other digestive ecosystems such as the gut of xylophagus termites (Breznak and Switzer, 1986, Appl Environ Microbiol, 52, 623-630) or colon of non-methanogenic human subjects (Doré et al, 1995, FEMS Microbiol. Ecol, in press). Acetogens are known to have a H_2-treshold and a $\Delta G'o$ higher than methanogens (Cord-Ruwish et al, 1986, Arch Microbiol, 149, 350-357). This work was undertaken to study the competition for H_2 between a methanogen and two acetogenic strains, in vitro.

Methanogenic strain MFC was isolated from the caecum of a horse and the two acetogens Ser5 and Ser8 were isolated from the rumen of a 20h-old lamb. Strains were precultivated on the AC-11 medium (Breznak and Switzer, 1986) under H_2/CO_2 at 39°C. Fourty-eight-hour-old cultures were used to inoculated AC-11 medium with a similar number of acetogenic and methanogenic cells. Pure cultures of each microorganism were performed as control. Tubes were pressurized with H_2/CO_2 (80:20) and incubated under shaking at 39°C. After 3 days of incubation, H_2 consumed and CH_4 produced were analyzed by gas chromatography and acetate produced was measured by enzymatic assay.

In presence of Ser5, CH_4 production by MFC decreased from 347 µmol in pure culture to 228 µmol for the same quantity of H_2 used whereas in presence of Ser8 the decrease of CH_4 production was not significatively different (347 vs 337). Acetate produced by Ser5 in the coculture with MFC was lower than in pure culture (225 µmol vs 138 µmol). Acetate production by Ser8 in coculture with MFC was severely decreased (136 vs 19 µmol, respectively). These findings show that some acetogenic strains are able to compete with methanogens for H_2, in vitro. The reduction of methanogenesis in profit of acetogenesis would be benificial for animal (decrease of energy loss) and for environment (decrease of CH_4 release). At present, we test the competition between acetogens and methanogens in vivo in the rumen of gnotobiotically-reared lambs.