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Mixotrophy by rumen acetogenic bacteria in the utilization of hydrogen and sugars

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Acetogenic bacteria are present in high numbers in some digestive ecosystems such as the termite gut and the human colon. Acetogens are able to use H_2 and CO_2 to produce acetate but their range of substrates is wider than that of methanogens with which they are in competition for H_2. Their affinity for hydrogen probably not permit them to outcompete methanogens (Cord-Ruwish et al, 1986, Arch Microbiol, 149, 350-357). Therefore, we examined the possibility of two acetogenic strains to be able to grow mixotrophically by the simultaneous use of H_2/CO_2 and carbohydrates. In contrast to use of H_2/CO_2 alone, mixotrophy could theoritically provide cells with more energy per unit time (and per mol H_2 used for acetogenesis) and might ultimately contribute to a competitive advantage over methanogenesis in vivo.

The two acetogenic strains Ser5 and Ser8 were isolated from the rumen of a 20h-old lamb. Strains were precultivated on AC-11 medium (Breznak and Switzer, 1986, Appl Environ Microbiol, 52, 623-630) under H_2/CO_2 at 39°C. Fourty-eight-hour-old cultures were used to inoculated AC-11 medium supplied either with glucose, either with cellobiose or with xylose with a final concentration of 4 g/l. Tubes were pressurized with 0.3 bar of H_2/CO_2 (80:20) and incubated under shaking at 39°C. Growth was followed by absorbance (OD_{600}) and the kinetics of the use of H_2 and sugars were analyzed by gas chromatography and by total sugars method (Dishe, 1955, in: Methods of Biochemical Analysis, vol II, 313-357), respectively. Acetate produced was measured by enzymatic assay.

Ser5 was able to use H_2 simultaneously with carbohydrates whereas H_2-utilization by Ser8 was weak and often masked by a H_2-production from sugars. The rate of H_2-utilization by Ser5 during exponential growth was higher in presence of xylose (17.5 $\mu mol.h^{-1}$) than in presence of cellobiose or glucose (10.7 and 6.5 $\mu mol.h^{-1}$, respectively). These results show that some acetogenic strains are able to use simultaneously H_2/CO_2 and sugars in vitro and suggest that the composition of the diet by providing different substrates may influence competition between acetogens and methanogens for H_2-utilization.