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# Dietary additives to control methanogenesis in the rumen

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**Abstract.** Three approaches to decrease ruminal methanogenesis which vary from commercial accepted (yeast) to well verified but yet to enter widespread practical usage (organic acids) to an approach which although theoretically sound has yet to be substantively verified (plant extracts) are considered. Likely costs, benefits, both in terms of decreased methane and enhanced farmer profitability, and regulatory barriers to use these additives are considered. No clear favoured technology is identified; however, it is clear that the ultimate success of any of these approaches on reducing methanogenesis will rest not only on their biological efficacy but also with their economic impact. © 2006 Published by Elsevier B.V.

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## 1. Introduction

Methane produced during anaerobic fermentation in the rumen represents an energy loss to the host animal as well as contributing to emissions of greenhouse gases into the environment [1]. Numerous studies have reviewed the effect of diet on methane production and attempts have been made to provide models to predict methane production based on dietary intake [2,3]. Similarly the use of additives to decrease ruminal methanogenesis has been and remains a highly active area of research [4,5]. However, only limited consideration appears to have been given to the practical application of these technologies. While both taxation and carbon trading schemes are operational for greenhouse gases [6–8] there have been only limited and currently unsuccessful attempts to introduce these schemes to animal agriculture (i.e. the animal emissions "fart" tax in

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New Zealand). Thus in the current political and economic framework it is difficult to envision farmers accepting the financial burden of including, in the diet, additives which decrease methane production if these additives do not also bring direct or indirect financial benefits to their operations.

Here we would like to develop this idea through examination of three approaches to decrease ruminal methanogenesis; an additive in common usage that might have an effect of ruminal methane production (yeast culture), an approach that has been well verified experimentally to decrease methanogenesis but has yet to enter widespread practical usage (organic acids) and an approach which although theoretically sound has yet to be substantively verified (plant extracts).

## 2. Yeast culture

Yeast cultures based on *Saccharomyces cerevisiae* are widely used in ruminant diets. Available products vary widely in both the strain of *S. cerevisiae* used and the number and viability of cells present. Some products guarantee high numbers of live yeast cells and are sold as live yeast while other products are sold as yeast cultures containing both yeast cells and the media on which they are grown. It has been noted that not all strains of yeast are capable of stimulating digestion in the rumen [9–11]. These differences were not related to the number of viable yeast cells in the preparations [10], although their ability to stimulate rumen fermentation may be related to differences in metabolic activity.

The effects of *S. cerevisiae* on methane production in short term incubations with rumen fluid have been variable. Mutsvangwa et al. [12] reported that the commercial product Yea-sacc (Alltech) decreased methane production from a barley based ration after 12 but not 24 h incubation. Sullivan and Martin [13] failed to find any effect of a commercial yeast culture (XP Yeast, Diamond V) on methane production over 24 h with ground corn as a substrate or over 48 h with alfalfa or Bermuda grass as substrates, but in a latter study comparing a live yeast (PMX70SBK, Saf Agri) with the same yeast culture [14] live yeast significantly decreased methane production from alfalfa after 48 h (by 20%) but had no effect when Bermuda grass was the substrate. Lila et al. [15] failed to find any effect of live yeast preparation containing *S. cerevisiae* strains 8417 and 1026 (Bussan Biotech Co, Ltd.) on methane production after 6 or 24 h incubation with either cornstarch, potato starch or Sudan grass hay as substrates. It might however be argued that short term incubations such as those above are inappropriate to study the effects of yeast on rumen fermentation, if as noted elsewhere [16] the effects of *S. cerevisiae* are mediated through an effect on the numbers and activity of microbes in the rumen, then periods longer that 24 to 48 h may be required to fully realise the effects of the yeast.

Rumen simulating fermentors provide a suitable tool to study the longer term effects of additives on ruminal fermentation and they have been used extensively by ourselves and others, to study the effect and mode of action of *S. cerevisiae* in the rumen [9,11,17,18]. Unfortunately, none of these studies have reported methane production, we however, have access to a database of trials carried out in the Rusitec rumen simulating fermentor to screen strains of *S. cerevisiae* for their effects in the rumen. In these trials we found that responses varied dependent on the yeast used. When tested in four independent trials, each 21 days in length with 3 controls versus 3 yeast supplemental vessels, one yeast