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Effects of active dry yeasts on the rumen microbial ecosystem: Past, present and future☆

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Abstract

Active dry yeasts (ADYs) are increasingly used in ruminant nutrition as feed additives to improve feed efficiency and performance and, at the same time, to prevent health disorders. They are particularly useful in high-producing ruminants whose digestive microbial balance can be altered by high-dietary energy input. As ADYs can survive and remain metabolically active in the gut, they can exert probiotic effects by interacting with the autochthonous microbial species responsible for feed digestion. Up to now, the most consistent positive effects of ADYs have been reported on rumen microbial activity in young ruminants, stabilisation of rumen pH and prevention of acidosis, as well as stimulation of growth and activity of fibre-degrading bacteria. Effects of ADYs vary depending on biotic factors such as the strain of yeast and its viability, but also on abiotic factors, such as the nature of the diet or animal management. It is important to better understand the way by which yeasts can act on rumen

Abbreviations: ADY, active dry yeast products; CLA, conjugated LA; DM, dry matter; HAPB, hyper-ammonia producing bacteria; LA, linoleic acid; LPS, lipopolysaccharide; VFA, volatile fatty acids

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microorganisms in order to direct selection of new generation ADYs. The objectives of this paper are to review the most important findings on effects of ADYs in the rumen, to describe identified modes of action, and to provide thoughts for further strain selection and applications in ruminant nutrition.

Keywords: Active dry yeast; Feed additive; Rumen microbiota; Fermentations

1. Introduction

Active dry yeast products (ADYs) are well accepted as having beneficial effects in livestock production. These products are generally characterised by a high concentration of viable cells (>10 billion cfu/g), with the most common species being *Saccharomyces cerevisiae*. Yeast biomass is dried to preserve cell viability and metabolic activity and, in some products, the cells are mixed together with their fermentation medium. Other products do not contain any viable cell and are used as a nutritional ingredient, so they will not be considered in this paper which will focus on effects and modes of action of live yeast products in ruminants, with emphasis on possible interactions between these allochthonous microorganisms and the resident rumen microbiota. From a regulatory view, some ADYs have been officially registered as feed additives in Europe (EU Regulation 1831/2003). In North America, *Saccharomyces cerevisiae* species is registered in the Generally Recognised As Safe (GRAS) list. In recent years, with increased consumer's concern about safety, quality of animal products and also environmental issues, the current purpose of using these "natural" additives is not only to increase productivity, but also to diminish the risk of animal digestive transfer of potential human pathogens, to decrease the antibiotic load and the risk of antibiotic resistance genes transfer, and to limit excretion of pollutants.

In dairy ruminants, ADYs have been shown to improve performance, the most consistent effects being an increase in dry matter (DM) intake and milk production (El-Ghani, 2004; Sniffen et al., 2004; Jouany, 2006; Stella et al., 2007). Also, in beef cattle or young ruminants, growth parameters (average daily gain, final weight, DM intake, feed to gain ratio) have been reported to be improved by daily ADY supplementation in several studies (Lesmeister et al., 2004; Galvao et al., 2005). However, yeast responses vary depending on the strain of yeast used, the nature of the diet, and the physiological status of the animal. It is therefore of importance to understand the underlying microbial mechanisms by which ADYs act in the rumen in order to optimise ADY utilisation in ruminant nutrition. The present paper reviews past research on these microbial interactions, and their implication in terms of rumen function. It also highlights how this knowledge can be used to select new generation microbial additives with the aim of targeting more finely tuned nutritional applications and to improve animal health and/or modulate the impact of production on its role in global environmental change.

2. Improved knowledge on ADY modes of action

Effects and modes of action of yeast additives on rumen microbiota have been extensively studied over the last 15 years. Several mechanisms have been described, mostly from *in vitro* studies but also from studies with animal models (*e.g.*, rumen-cannulated sheep or lambs