THE USAGE OF YEAST AND YEAST PRODUCT İN RUMİNANT

Hıdır GÜMÜŞ[1]; Adnan ŞEHU[1]

SUMMARY

During the last decades, various feed additives have been used in pre ruminant and young ruminant nutrition. Production benefits, together with lower incidence of digestive disorders, better body condition of the animals, and reduced feed cost are sought after. For the last 10 years, increasing consumer concern about the long-term effects of antibiotics has led to a more focused interest in probiotics (6).

Introduction

Yeasts are eukaryotic micro-organisms classified in the kingdom fungi, with 1,500 species currently described estimated to be only 1% of all fungal species. *Saccharomyces cerevisiae is the* best-known yeast in the yeast family. By fermentation, the yeast species *Saccharomyces cerevisiae* converts carbohydrates to carbon dioxide and alcohols for thousands of years the carbon dioxide has been used in baking and the alcohol in alcoholic beverages. It is also extremely important as a model organism in modern cell biology research, and is one of the most thoroughly researched eukaryotic microorganisms. Yeast is a good source of protein and amino acid. Yeast is rich in vitamin, especially B group and E group (16). Because of low metabolic activity of yeast in the rumen, this microorganism are not directly participate nutrient digestion. However yeast prepares suitable media for rumen bacteria by stimulating rumen bacteria activity (19).

Data indicate that supplementation of yeast preparations in the ruminant diet may improve feed intake, milk production, weight gain, digestion, numbers of anaerobic and cellulolytic bacteria, ruminal pH value, and alter the patterns of volatile fatty acids. It is assumed that, yeast improves the rumen environment by production of different growth factors such as peptides, amino acids, carbonic acids and vitamins and through its utilisation of oxygen. This promotes the growth of specific rumen bacteria and fungi, especially of cellulose and lactate utilising bacteria and a stabilisation of rumen pH by reduced lactate concentrations may be the consequence (17).

Yeast product

The cell wall is a sturdy structure providing physical protection and osmotic support. Electron microscopic analysis of the wall using negative staining reveals a layered structure with an electron-transparent internal layer of about 70-100 nm thick depending on growth conditions and genetic background, and an electron-dense outer layer (3,15). The mechanical strength of the wall is mainly due to the inner layer, which consists of L1,3-glucan and chitin, and represents about 50-60% of the wall dry weight. The outer layer, which consists of heavily glycosylated mannoproteins emanating from the cell surface (1), is involved among others in cell-cell recognition events. It also limits the accessibility of the inner part of the wall and the plasma membrane to foreign enzymes such as cell wall-degrading enzymes in plant tissue (10).

Yeast extract is the common name for various forms of processed yeast products made by extracting the cell contents (removing the cell walls); they are used as food additives or flavourings, or as nutrients for bacterial culture media. They are often used to create savory flavors and umami taste sensations, and can be found in a large variety of packaged food including frozen meals, crackers, junk food, gravy, stock and more. Monosodium glutamate (MSG) is used for umami. Like MSG, yeast extract often contains free glutamic acid. Yeast extracts in liquid form can be dried to a light paste or a dry powder. Glutamic acid in yeast extracts is produced from an acid-base fermentation cycle, only found in some yeasts, typically ones bred for use in baking (11).

[1] Department of Animal Nutrition and Nutritional Disease, Faculty of Veterinary Medicine, Ankara University, 06110, Ankara TÜRKİYE

Mannan oligosaccharides (MOS) are complex mannose sugars derived from cell wall fragments of yeast that are believed to block the colonization of digestive pathogens increasing the competition for attachment sites in the digestive tract. Furthermore, feeding fructo ologosaccharides in combination to spray-dried bovine serum to calves reduced the incidence and severity of enteric disease (9). In recent years, enhanced-growth feeding programs for dairy calves have been proposed to increase growth rate during the pre-weaning period (18).

Effect of Yeast Culture on Development of Rumen, Ruminal pH, Acidosis and Digestibility of Cellulose

Acidosis in a feedlot results when cattle consume fermentable carbohydrates in amounts sufficient to cause a nonphysiologic accumulation of organic acids in the rumen, with a concurrent reduction in pH. Organic acids are the products of microbial fermentation of feedstuffs. In a normal situation with normal intake, organic acids do not accumulate in the rumen because ruminal absorption keeps up with production. In such situations, ruminal fermentation is stable and ruminal pH can range from 5.6 to 6.5, with the average pH typically around 5.8 to 6.2; pH can occasionally drop below 5.6 for a brief period of time during the normal feeding cycle (13, 14, 7).

Effects of live yeasts have been extensively studied on lactate-metabolizing bacteria. In vitro, one strain of S. cerevisiae was able to outcompete S. bovis for the utilization of sugars; the reduction in quantity of fermentable sugars available for the bacteria consequently limited the amount of lactate produced. This effect was only observed when the yeast cells were alive. Dead cells had no effect on lactate production. Moreover, stimulation of growth and metabolism of lactate-utilizing bacteria, such as Megasphaera elsdenii or Selenomonas ruminantium was observed in vitro in the presence of different live yeasts through a supply of different growth factors, such as amino acids, peptides, vitamins, and organic acids, essential for the lactate-fermenting bacteria (4).

Cellulose and hemicelluloses constitute 15–70% of most ruminant diets. These plant cell wall polymers are insoluble, structurally complex and not physically totally accessible, and their degradation is sometimes less than desirable (12). Moreover, they cannot be digested by the host enzymes. The objective of the ruminant nutritionist is to maximize nutrient intake and availability. In certain conditions, probiotic yeasts have demonstrated their effectiveness to influence growth and activities of fibre-degrading microorganisms in the rumen; their effects have mostly been shown in vitro. Germination of zoospores from a rumen fungal strain of Neocallimastix frontalis was stimulated in vitro by two different strains of S. Cerevisiae which indicated that probiotic yeasts could enhance fungal colonisation of plant cell walls. In the same studies, cellulose filter paper degradation by N. frontalis was also stimulated in the presence of live yeast cells. Several modes of action were identified in this effect, one being the supply of thiamin, a vitamin required by rumen fungi for zoosporogenesis (2,5). In vitro, a yeast culture stimulated growth of Fibrobacter succinogenes S 85 and reduced the lag time for growth of Ruminococcus albus 7, Ruminococcus flavefaciens FD1 and Butyrivibrio fibrisolvens D1 showed that the same YC could accelerate the rate, but not the extent, of cellulose filter paper degradation by F. succinogenes S85 and R. flavefaciens FD1

Effect of Yeast Culture on Nitrogen and Hydrogen Metabolism

In the rumen, most of the dietary proteins are rapidly degraded by bacteria and protozoa into peptides, amino acids and ammonia. A part of ammonia is converted into microbial proteins, which represent an essential source of nitrogen for the ruminant, and a part is recycled in the form of urea by the animal; in the meantime, an important proportion of ammonia produced in the rumen is excreted and represents a nitrogen loss of 20 to 25% of the dietary N intake and a potential environmental pollution. Recent in vitro findings suggested that one yeast strain could influence growth and activities of proteolytic rumen bacteria, by limiting their action on protein and peptides. The mechanisms of yeast action may be explained by a competition between live S. cerevisiae cells and bacteria for energy supply but also by a direct inhibitory effect of yeasts' small peptides on targeted peptidases (8).

In ruminants, hydrogen is produced by several hydrolytic and fermentative microbial species, and is mainly used to reduce carbon dioxide into methane by methanogenic Archaea, which represents the main ruminal hydrogenotrophic microbial community. Acetogenic bacteria, which produce acetate from CO2 and H2, appear to play an important role in the re-utilisation of fermentative hydrogen in some non-ruminant digestive ecosystems. In these in vitro studies, interesting beneficial effects of the yeast strain on growth and H2-utilisation of acetogenic bacteria were observed even in the presence of methanogens (8).

References

1. BABA, M., OSUMI, M. (1987). Transmission and scanning electron microscopic examination of intracellular organelles in freeze-substituted *Kloeckera* and *Saccharomyces cerevisiae* yeast cells. *J. Electron Microsc*. Tech., **5**: 249-261.
2. CALLAWAY, T.S., MARTIN, S.A. (1997). *J. Dairy Sci*., **80**: 2035– 2044.
3. CAPPELARO, C., BALDERMANN, C., RACHEL, R., TANNER, W. (1994). Mating type-specific cell-cell recognition of *Saccharomyces cerevisiae*: cell wall attachment and active sites of a- and alpha-agglutinin. *Embo J*., **13:** 4737-4744.
4. CHAUCHEYRAS, F., FONTY, G., SALMON, J.M., GOUET, P. (1996). Effects of a strain of *Saccharomyces cerevisiae* (Levucell SC1), a microbial additive for ruminants, on lactate metabolism in vitro. *Can. J. Microbiol*., **42**: 927-933. In: FONTY, G., CHAUCHEYRAS, D.F. (2006). Effects and modes of action of live yeasts in the rumen. *Section Cellular and Molecular Bıology a review*. p.: 741-750.
5. CHAUCHEYRAS-DURAND, F., FONTY, G. (2001). Establishment of cellulolytic bacteria and development of fermentative activities in the rumen of genotobiotically-reared lambs receiving the microbial additive *Saccharomyces cerevisiae* CNCM I-1077. *Reprod. Nutr. Dev.* **41**: 57-65
6. CHAUCHEYRAS-DURAND, F., FONTY, G. (2002). Influence of a probiotic yeast on microbial colonization and fermentations in the rumen of new born lambs. *Microb. Ecol. Health. D.,* **14**: 30-36
7. CHAUCHEYRAS-DURAND, F., DURAND, H. (2010). Probiotics in animal nutrition and health. *Beneficial microbes*, **1**: 3-9
8. FONTY, G., CHAUCHEYRAS, D.F. (2006). Effects and modes of action of live yeasts in the rumen. *Section Cellular and Molecular Bıology a review*. p.: 741-750.
9. HEINRICHS, A.J., JONES, C.M., HEINRICHS, B.S. (2003). Effects of mannan oligosaccharide or antibiotics in neonatal diets on health and growth of dairy calves. *J. Dairy Sci*. **86:** 4064–4069.
10. KLIS, F.M., MOL, P., HELLINGWERF, K., BRUL, S. (2002). Dynamics of cell wall structure in *Saccharomyces cerevisiae. Micro. Reviews.* **26**: 239-256.
11. LUKONDEH, T., ASHBOLT, N.J., ROGERS, P.L., 2003. Evaluation of kluyveromyces marxianus as a source of yeast autolysates. *J. Ind. Microbial. Biot*. **30**: 52-56
12. NAGARAJA, T.G., NEWBOLD, C.J., VAN NEVEL, D., DEMEYER, D.I. (1997). pp. 523–632. In: HOBSON, P.N., TEWART, C.S. The Rumen Microbial Ecosystem, Chapman, Hall, London, CALLAWAY, T.S., MARTIN, S.A. (1997). *J. Dairy Sci*. **80**: 2035–2044.
13. NAGARAJA, T.G., TITGEMEYERT, E.C. (2007). Ruminal acidosis in beef cattle: The Current microbiological and nutritional outlook [1, 2]. *J Dairy Sci*. **90**: E17-E38.
14. NOCEK, J.E. (1997). Bovine acidosis: Implications on laminitis. *J Dairy Sci*., **80**: 1005-1028

15. OSUMI, M. (1998) The ultrastructure of yeast: cell wall structure and formation. Micron. **29**: 207-233.

16. ÖZSOY, B., YALÇIN, S., CANTEKIN, Z., AKSU, T., ERDOGAN Z. (2011). Oğlak kesif yemlerinde canlı maya kültürü kullanımının rumen ve dışkı mikrobiyal florası üzerine etkisi; VI. Ulusal Hayvan Besleme Kongresi, 29 Haziran- 2 Temmuz 2011 Ondokuz Mayıs Üniversitesi SAMSUN, p.: 370-373

17. ÖZTÜRK, H. (2008). Ruminant beslemesinde Probiyotik mayalar; *Vet Hekim Der Derg*., **79**: 37-42.

18. TERRE, M., CALVO, M.A., ADELANTADO, C., KOCHR, A., BACH, A. (2007). Effects of mannan oligosaccharides on performance and microorganism fecal counts of calves following an enhanced-growth feeding program. *Anim. Feed. Sci. Tech.* **137**: 115-125

19. SARIPINAR, D., SULU, N. (2005). Ruminantlarda probiyotiklerin kullanımı ve rumene etkileri. *Kafkas Üniv Vet Fak Derg*., **11**: 93-98.