Archivos de Zootecnia
Journal website: https://www.uco.es/ucopress/az/index.php/az/
REVIEW

# *Saccharomyces cerevisiae* as a replacement alternative to growth-promoting antibiotics in animal feed

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Additional keywords

Animal feeding.
Probiotics.
*Saccharomyces cerevisiae.*

## SUMMARY

El presente trabajo de revisión bibliográfica, exhibe el mecanismo de acción, modo de empleo, dosis utilizadas y beneficios demostrados por *Saccharomyces cerevisiae* en animales de producción comercial. Varios estudios demuestran que la levadura se utiliza en diferentes dosis y concentraciones como cultivo (probiótico) o sus paredes celulares (prebiótico), atribuyendo impacto positivo de *S. cerevisiae* sobre los parámetros productivos y reproductivos de los animales, incremento en la digestibilidad de nutrientes, mejoras sobre las variables de morfometria intestinal, regulación del pH ruminal, modulación de la población microbiana, beneficios en el sistema inmunológico, disminución en la concentración de amoniaco, entre otros; no obstante, se debe considerar que la acción benéfica de la levadura difiere por el pH, temperatura de extracción, composición nutricional, cepa utilizada, dosis, concentración, modo de empleo y por la diversidad de dietas ofrecidas a los animales. Los resultados obtenidos en investigaciones recientes conllevan a concluir que, el uso de *Saccharomyces cerevisiae* como aditivo en la alimentación animal puede sustituir a los antibióticos promotores de crecimiento, logrando similares resultados a los APC, sin dejar residuos en los productos y subproductos de los animales que resulten perjudiciales al consumidor.

**_Saccharomyces cerevisiae_ como alternativa de reemplazo a los antibióticos promotores de crecimiento en alimentación animal**

Palabras clave adicionales

Alimentación Animal.
Probióticos.
*Saccharomyces cerevisiae.*

## SUMMARY

This literature review paper presents the mechanism of action, use, doses used, and benefits showed by *Saccharomyces cerevisiae* as an additive in animal feeding; several studies show that the yeast is utilized in different doses and concentrations as a culture (probiotic) or its cell walls (prebiotic), attributing a positive impact of *S. cerevisiae* upon the productive and on the reproductive of the animals, as well as an increase in nutrient digestibility, improvements on intestinal morphometry variables, regulation of ruminal pH, modulation of the microbial population, benefits on the immune system, decrease in ammonia concentration, amongst others. Notwithstanding, it should be considered that the action of yeast differs according to pH, extraction temperature, nutritional composition, dosage, concentration and the diversity of diets offered to the animals. The results obtained in recent research, it can be inferred that the use of *Saccharomyces cerevisiae* as an additive in animal feeding can substitute antibiotic growth promoters, achieving similar results without leaving residues in both animal products and by-products that are harmful to the consumer.

Information

Cronología del artículo.
Recibido/Received: 24.06.2021
Aceptado/Accepted: 30.08.2021
On-line: 15.01.2022
Correspondencia a los autores/Contact e-mail:
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## INTRODUCTION

At present, the livestock industry is compelled to meet the protein demand of the population; thus, it has focused its efforts on increasing the productive parameters of animals, using the addition of Antibiotic Growth Promoters (AGPs) as additives in animal feeding achieving improvements in production parameters (Torres et al. 2002); however, its exaggerated use generated an important residual in meat and by-products that led to bacterial strains becoming resistant to antibiotics directly affecting the consumer's health (Gutiérrez et al. 2013).

Consequently, the use of AGPs in animal feeding was restricted by the European Commission in 2003

(Santovito et al. 2018) and for prophylactic purposes from 2006 (Espinoza et al. 2019) and (Elghandour et al. 2019), a situation that forced livestock nutritionists to search for replacement alternatives to antibiotic growth promoters, products that should have similar benefits to AGPs, without causing negative effects on either the consumer or the animal that receives them.

In this context, brewer's yeast Saccharomyces cerevisiae was born as a replacement alternative to APCs, being considered as a safe microorganism to be used in animal feed by the European Union, Japan, and the United States; therefore, the FDA (Food and Drug Administration) granted it the GRAS rank (Medina et al. 2014). *S. cerevisiae* has demonstrated several benefits, such as antibacterial effects due to the presence of organic acids and toxins (Chen et al. 2019), probiotic potential demonstrated in vitro (Ortiz et al. 2008), high protein value (40-45%), improvements in the ruminal environment (Suárez and Guevara, 2017), and the feeding efficiency (Pérez, 2007), inter alia. Benefits may differ depending on the method of production, use, animal species, and dosage.

Considering the aforementioned, the main objective of this review was to investigate studies on the yeast *S. cerevisiae*, in recent years, to provide general information upon the mechanism of action, metabolic pathway, dosage used, and variability on the benefits obtained in animal production.

## GENERAL CONCEPTS ABOUT *SACCHAROMYCES CEREVISIAE*

It was discovered as a culture and with a scientific basis in the 19th century by Louis Pasteur (Suárez et al. 2016), it is a unicellular, eukaryotic, facultative anaerobic yeast that ferments in high concentrations of glucose and aerobic media. (Estela et al. 2014), its pH is 6.6 - 6.7, which in turn is controlled by V-ATPase inactivation (Deschamps et al. 2020), it undergoes fermentation and mutation processes (Vergara and Hernández, 2016) and when mixed with other components it decomposes, as (Suarez, Porras, Laguna, Schaap, & Tamayo, 2020) cite that 160 mg/L-1 of graphene nanoplatelets mixed with *Saccharomyces cerevisiae* causes oxidative stress and changes in the physiological state within 2 to 4 hours after exposure.

Currently, yeast walls are employed as bio-adsorbents as they can remove heavy metals (Moreno and Ramos, 2018); as prebiotic sources in animal nutrition (Miranda et al. 2018), microbial function enhancer (Calabro et al. 2020); as a dietary supplement, and probiotic in bovines, swine, and poultry (Vásquez et al. 2016).

(Arici, Ozulku, Yildirim, Sagdic, & Durak, 2017) express that the technological, nutritional, and functional properties, which help to improve the organoleptic characteristics of yeast can be modified by several factors, amongst them:

pH,

Extraction temperature,

Methods of production,

Physical and environmental factors in food processing

Other authors such as (Garcia, Rodriguez, Marroquin, & Kawas, 2019) also attribute the form of use (culture or walls) asserting that the walls of *S. cerevisiae* contain lower CFU/g compared to the yeast culture, whereas (Perez, 2008) includes the physiological state of the animal; (Molina, 2019) states that heat, desiccation, and UV radiation modify yeast components. However, (Suarez, Guevara, & Amarilys, 2017) claim that the variation of the effect of yeast is due to the strain used, dosage, and concentration used; (Syauqi, Santoso, & Hasana, 2020) believe that the variation of the results is due to the method used to measure the concentration of yeast.

## CHEMICAL COMPOSITION OF *SACCHAROMYCES CEREVISIAE*

De Blas et al. (2011) detail that *S. cerevisiae* contains 46% crude protein with an energy content that differs depending on the animal species. Thus, it provides approximately 2500 Kcal/kg of ME in ruminants; in swines 2690 Kcal of ME/kg; 2010 to 2200 Kcal of ME/k in broilers and layers, and in rabbits it provides 2950 Kcal of DE/kg. Furthermore, *S. cerevisiae* contains macrominerals such as calcium, phosphorus, sodium, chlorine, magnesium, potassium, sulfur; microminerals (copper, iron, manganese, zinc) vitamin E. (Castro & Rodríguez, 2005), (Peralta, Miazzo, & Nilson, 2008), (Morales, 2007), and (Suárez & Guevara, 2017) include selenium, chromium, phytase enzymes, 45% mannose, B vitamins (biotin, choline, niacin, pantothenic acid, and thiamine), amino acids, 5'-nucleotides, and glutamic acid, and 18-20% dry matter.

Loviso and Libkind (2019) state that the *S. cerevisiae* has five thiamine pyrophosphate-dependent decarboxylases PDC1, PDC5, PDC6 ARO10, and THI3, which constitute a family of closely related proteins; Mejía et al. (2016), state that β-glucans, oligosaccharides, and nucleic acids, which enable it to stimulate the immune response, Cabrera et al. (2019) note that superoxide dismutase allows *Saccharomyces* to enhance antioxidant action and cause proliferation of circulating hemocytes. *Saccharomyces cerevisiae* cultures contain small amounts of live cells, enzymes, and mannan-oligosaccharides that impede the proliferation of intestinal pathogenic microorganisms and promote the growth of beneficial bacteria; therefore, it can replace growth-promoting antibiotics in the diet of commercial production animals (Reynoso, et al., 2010).

## MECHANISM OF ACTION

*Saccharomyces cerevisiae* can be used as a Probiotic (live microorganism-culture) or **Prebiotic** (cell wall) and depending on this, the mechanism of action is different. Within this context, as a **probiotic,** it has shown the capacity to cross the gastric barrier, multiply and colonize the intestine. Added to the diet of **monogastric** animals, it favors the development of the

gastrointestinal microbial flora (Castillo, 2016). Furthermore, Castro and Rodríguez (2005) acknowledge that it stimulates immunity and microvilli; it inhibits the action of microbial toxins and exerts an antagonistic effect against pathogenic micro-organisms, whereas in ruminants it exerts a beneficial activity upon ruminal fermentation, increases intestinal bacteria, promotes a natural immune system response to counteract pathogenic microorganisms, and enhance the body's defenses against infection (Fuller, 1989).

Contrarily, Pereira et al. (2016), Fernández (2017), and Saro et al. (2017) claim that the *S. cerevisiae* increases the number of fibrinolytic bacteria (Fibrobacter *Succinogenes* and Ruminococcus *Albus*) improving fiber digestion and the production of Volatile Fatty Acids (VFA). It stimulates lactate utilization by *Megasphaera Elsdenii* and *Selenomonas Ruminantium* to increase propionate production; similarly, it reduces lactic acid concentration and causes an increase in ruminal pH reducing the risk of acidosis. It utilizes hydrogen and decreases methane production by methanogenic bacteria; it regulates and stabilizes the intestinal flora and prevents the colonization of pathogenic microorganisms, Molina (2019). It also constrains and interrupts toxins and mycotoxins, and increases both the ruminal cellulolysis and microbial protein flow to the intestine (Casas, 2018).

Broadly speaking, Coppola and Turnes (2004) affirm that it affects pathogenic microorganisms through the synthesis of bacteriocins, volatile organic acids, and hydrogen peroxide; it acts on the metabolism by reducing the concentration of ammonia in the organism and releasing enzymes such as lactase.

The walls of *S. cerevisiae*, better known as mannan oligosaccharide **prebiotics**, are indigestible by the animal and have been shown to stimulate the growth and/or activity of the beneficial microflora of the digestive tract and impede the adhesion of pathogenic microorganisms, thus improving the health status of the animals. (Pereira et al. 2016) suggest that yeast binds lectins to the receptors of pathogenic bacteria blocking their implantation on the cell membranes (Castillo, 2016), alter the microbial population of the intestine by binding to mannose-binding proteins on the surface of some bacteria preventing colonization of the intestinal tract (Castro & Rodriguez, 2005).

## Benefits found in production animals

### In broilers

The cell wall of *Saccharomyces cerevisiae* brewer's yeast has been shown to stimulate productive performance, exert an effect on the innate immune response, and possess antimicrobial action (Santovito et al. 2018). However, Pascual et al. (2020) declare that the yeast added at 250 and 500 g/t of feed has no beneficial activity on weight gain, decreases food intake, and thus improves feed conversion. On the other hand, they recorded an increase in the height of villi, secretion of a glycoconjugate, number of calciform cells, and a reduction in the number of CD45 cells, which led to a decrease in pathogens.

Poloni et al. (2020) incorporated *Saccharomyces cerevisiae* RC016 at a rate of 1 g/kg, combined with Aflatoxin B1 (AFB1) in the diet of Ross line broilers breeders to reduce liver toxicity, residual AFB1 levels, and influence upon their intestinal structure. The research showed that poultries that consumed the yeast alone or in combination with AFB1, showed an absence of inflammatory infiltrate in the intestinal villi and improvements on intestinal histomorphometry parameters.

Therefore, they concluded that *S. cerevisiae* counteracts the toxic effects of aflatoxins in the liver, modulates the toxic effect in the intestine, and improves intestinal villi; data that are endorsed by Slizewska et al. (2019) who confirmed that 5 mg of AFB1/kg of food reduces intake, animal weight, and causes both liver and kidney damage. Notwithstanding, when a probiotic combination of *Lactobacillus* and *S. cerevisiae* is added to the food, the concentration of AFB1 is reduced and prevents or reduces degenerative changes in the liver and kidney.

Bortoluzzi et al. (2018) made use of 1,260 1-day-old male Ross broilers to investigate the benefits of *S. cerevisiae* at 0.2 and 0. 4% inclusion in the diet of the poultries, and revealed that the yeast improves feed efficiency, increases the number of *Enterococcus*, reduces the concentration of *Lactobacillus* in the *ileal digesta* and *Escherichia coli* in the *cecal digesta*, and positively regulates the expression of IL-1β, concluding that *S. cerevisiae* improves the productive parameters of the broilers, and modulates the intestinal microbiota and the immune system.

Froebel et al. (2019) studied the effect of yeast as a prebiotic in broilers and showed that when added at a rate of 100 g/t food, it improves live weight gain, carcass weight yield, and feed efficiency. Similar results were obtained by Granstad et al. (2020) when adding *Saccharomyces cerevisiae* combined with a probiotic strain of *Bacillus subtilis* to the portion of broilers as a replacement additive to AGPs and proved a positive impact upon the intestinal health with a decrease in the population of *Clostridium perfringens* at the cecal level and improvements in the productive performance of poultry; data endorsed by Al-Khalaifa et al. (2019) who determined that the inclusion of 5 g/kg feed of Bio-MOS, a commercial prebiotic derived from the cell wall of the yeast *S. cerevisiae*, enhances the immune status and production parameters of broilers.

Kiros et al. (2019), added different inclusion levels of *S. cerevisiae* as a probiotic and prebiotic and corroborated a decrease in the prevalence of *Salmonella Heidelberg* at the cecal level in poultries infected by direct contact with the bacteria; therefore, leading to less contamination of chicken meat in processing plants, reducing the incidence of zoonotic transmission of *S. Heidelberg*.

Seminario and Cuenca (2018) investigated the use of *S. cerevisiae* as a prebiotic at 400, 500, and 600 g/t of food in the diet of broilers and corroborated that by adding 600 g/t, the productive parameters improve (weight gain, feed conversion, and cost-benefit ratio).

### In swine

Xiaoqing et al. (2020) analyzed the advantages of using fermented tea residues with *Bacillus subtilis*, *Aspergillus niger*, and *Saccharomyces cerevisiae*, in proportions of 1:1: 2, adding (5 × 107 cfu/g), in the feeding of swine (Duroc × Landrace × Yorkshire) at the finishing stage, and verified that dietary supplementation with tea fermented by these microorganisms, improved fattening performance, nutrient digestion, digestive enzyme activity, and intestinal morphology parameters.

García et al. (2014) added *Saccharomyces cerevisiae* at 2 and 4% to the diet of post-weaning piglets and observed that the 4% inclusion increases the weight, carcass yield, the magnesium content in blood serum, weight, and length of the large intestine, while Reynoso et al. (2010) demonstrated that the inclusion of 0.75 and 1.5% of *S. cerevisiae* yeast culture in the diet of wheat-based pigs during the growing and finishing stages does not have a beneficial influence on the productive response or the carcass characteristics. *Galaz* et al. (2018) suggest that supplementation with *Saccharomyces cerevisiae* live yeast at a rate of 0.7 kg/ton of food during high heat stress improves growth, health, and feed efficiency of growing and fattening swine.

### In goats

Gomes et al. (2012) allude that the use of *S. cerevisiae* dry yeast at 234.1 g/kg of food can replace soybean meal in the diets of suckling Saanen goats as a protein source since it does not alter dry matter intake, feed efficiency, milk yield, and the total milk solids composition during the various stages of lactation.

Ma et al. (2020) used *Saccharomyces cerevisiae* as an additive in the diet of Saanen goats in milk production, 5 g/day and per goat, registering an increase in the fat, protein, and lactose content of the milk, as well as an improvement in milk yield and intestinal microecology. Khan et al. (2020) obtained similar results by adding 3g of the yeast in lactating goats of Beetal breed and observed gains in milk yield and composition.

Similarly, Stella et al. (2007) state that the use of 0.2 g of *S. cerevisiae*/goat/day significantly increases milk production, reduces dry matter intake without affecting body condition, decreases the content of fecal *E. coli*, and increases the number of *lactobacilli*, thus regulating the intestinal ecosystem.

Cuenca and Sojos (2018) describe positive effects with the incorporation of 20 g/day of *Saccharomyces cerevisiae* in Saanen goats during the milk production stage, by prolonging the lactation curve and significantly ($P<0.05$) increasing the fat content in milk; nevertheless, these data differ from those reported by Zicarelli et al. (2016), who suggest that by adding 20 g of *S. cerevisiae*/goat/day decreases milk fat content and does not exert positive action on production in goats fed forage-based diets.

Lu et al. (2016) added 6 and 12 g of *S. cerevisiae*/kg dry matter intended for consumption by growing goats to evaluate variables, such as ruminal fermentation characteristics, enteric methane (CH 4) emissions, and methanogenic diversity, as well as determined that yeast significantly decreases ruminal ammonia concentration and enteric methane emissions.

On the other hand, Jarczark et al. (2014) dosed dairy goats with 10g of *Saccharomyces cerevisiae* as a probiotic after parturition and for a period of 100 days; and thereafter, dosed the animals with 20g evaluating the effect of the yeast upon the expression of the immune system genes in both somatic cells and physicochemical composition of milk. The authors concluded that yeast does not affect the yield and composition of milk. However, genes encoding β2-defensin, bactenecin 7. 5, and hepcidin were influenced by *S. cerevisiae* supplementation, resulting in a higher expression in the number of somatic cells, and thus contributing to the maintenance of mammary gland health in goats.

### In sheep

Zaleska et al. (2015) added to the feed portion of sheep and lambs 50 g of *S. cerevisiae* and 3g of yeast extract/kg of food and determined that the yeast wall induced stimulation of the reproductive tract of sheep, increasing the number of ovulated eggs, and consequently higher prolificacy. They also evidenced an increase in milk production and milk fat content, while lambs that received Biolex showed higher body weight and growth rate.

Hernández et al. (2015) supplemented the diet of growing lambs with a *Saccharomyces cerevisiae* culture at the rate of 1.50 g/kg dry matter intake and a mixture of the yeast with the same inclusion, plus 1.5 g of selenium and 1. 5 g chromium, and recorded that animals supplemented with the yeast alone or mixed, increased dry matter intake with no positive effect on daily and final body weight gain, fat content, and carcass yield during lamb growth.

Cömert et al. (2015) added 4 g/day of *S. cerevisia*e and anhydrous ammonia (3%) in one-year-old male Menemen breed lambs, with an intake of 1% dry matter over their live weight and showing an increase in the effective degradability of dry matter, voluntary intake of metabolizable energy and crude protein, improving rumen fermentation efficiency and animal productivity.

Libién et al. (2015) added 0.35 ppm of *S. cerevisiae* combined with 0.60 ppm of selenium to the diet of Pelibuey sheep at the finishing stage, to evaluate its effect and color, and pH on long back muscle concluding that yeast does not affect meat color and pH characteristics; data that are corroborated by Sowińska *et al*. (2016) who dosed weaning lambs with 50 g of *S. cerevisiae*/kg of food until the time of slaughter to evaluate the impact of yeast on the cortisol levels of lambs during weaning, transport, and pre-slaughter. Likewise, the authors depict that the meat from supplemented lambs showed lower cortisol levels in supplemented lambs, decreased pH, water retention, and color of tenderness, ultimately concluding that yeast strengthens immunity and alleviates the effects of pre-slaughter stress in the animals.

Ahmadzadeh et al. (2018) added monensin sodium (30 mg/sheep/day) and *Saccharomyces cerevisiae* yeast (4x109 CFU/sheep/day) to the diet of Ghezel breed

sheep during the reproductive stage and achieved a greater number of lambs born with higher weights, while in the mothers they evidenced a higher concentration of 17β-estradiol, progesterone, blood urea nitrogen, insulin, glucose, cholesterol, and total protein, determining that the inclusion of monensin sodium and S. cerevisiae in the diet of sheep improve their reproductive performance.

Pazla et al. (2018) added 1 and 2% *Saccharomyces cerevisiae*, plus 0.4% phosphorus (P), and 0.3% sulfur (S) on sheep food and determined that 1% inclusion of yeast mixed with P and S significantly improved dry matter, organic matter, crude protein, and crude fiber intake as well as increased digestibility, weight gain and feed efficiency of supplemented animals.

Jia et al. (2018) supplemented growing lambs with (4×109 CFU) and (6×109 CFU) of *Bacillus Licheniformis*, and with (3. 2×109 CFU) and (4×109 CFU) of *Saccharomyces cerevisiae*, evaluating growth performance, antioxidant capacity, immunity, ruminal fermentation, and microbial diversity of fattening lambs recording higher weight gain, increased growth hormone (GH), growth factor (IGF-I) and insulin (INS); a decrease in ammonia nitrogen, as well as an increase in microbial protein. They concluded that *B. Licheniformis* and *S. cerevisiae* -regardless of the level of inclusion- improve growth performance, antioxidant capacity, immune function, ruminal fermentation, and microbial diversity of the animals.

Similar results detail, Sheikh et.al (2019) who with the addition of *Saccharomyces cerevisiae* (2 × 10 10 CFU /g) and *Lactobacillus acidophilus* (6 × 10 9 CFU /g) on ruminal microflora, fermentation pattern, and enzyme activity of Corriedale sheep observed a positive impact of probiotics on these parameters.

On their part, Khattab et al. (2020) added 2 g Saccharomyces cerevisiae + 2 g *Bacillus subtilis* + 1 g *Lactobacillus Casei*/Kg food/day to the diet of Barki sheep at the gestation stage, recording an increase in dry matter intake, organic matter, crude protein, and neutral detergent fiber. Additionally, an increase in the concentration of ruminal Ammonia-N and blood urea nitrogen; an increase in both the weaning weight and the average daily weight; a decrease in lipids and total triglycerides, and finally an improvement in health status in the lambs.

### In bovines

Li et al. (2016) used ruminal and cecal cannulae to provide 14 g/day of *Saccharomyces cerevisiae* to lactating dairy Holstein cows under conditions of grain-induced Sub-Acute Ruminal Acidosis (SARA), to determine the effect of yeast on microbial fermentation in the digestive tract, milk production, and inflammatory response verifying that *S. cerevisiae* does not affect measures of intestinal fermentation. However, it stabilizes rumen pH in the absence of SARA, reduces ruminal endotoxic lipopolysaccharide after feeding, enhances milk fat reduction during subacute ruminal acidosis, and reduces the inflammatory response associated with SARA.

Zhu et al. (2016) supplemented 81 Holstein dairy cows under heat stress with 120 and 240 g cow/day of *Saccharomyces Cerevisiae* and demonstrated that the higher dose of supplementation alleviated the negative impact of heat stress increasing milk production, body weight gain, energy balance; and on the other hand, it decreased milk urea nitrogen and improved feed efficiency.

Jiang et al. (2017) studied the addition of *Saccharomyces cerevisiae* at the rate of (5.7 × 107 CFU/day) and (6. 0 × 108 CFU/day) to lactating dairy cows as well as its impact upon ruminal fermentation variables, milk yield, and the correlation between rumen microbial population, and productive performance. The authors demonstrated that yeast increased the digestibility of dry matter, neutral detergent fiber, and acid detergent fiber, and with the lowest concentration dose of *Saccharomyces* it increased milk yield, fat, and milk protein.

Similar data were found by Faccio et al. (2019) with the dosage of 28 g of yeast culture/animal/day, during the transition and lactation period of Holstein cows finding that yeast increased milk production without altering the metabolic profile of the animals.

Contrarily, Ferreira et al. (2019 assessed the use of 5.4 x 1011 CFU/day of *S. cerevisiae* in Holstein cows during the lactation period, same which were fed with low-forage and high easily-fermented carbohydrates diets. The authors note that neither did yeast affect production yield nor nutrient digestibility, possibly due to an interaction between live yeast and the amount of neutral detergent fiber, which may have hindered the beneficial effects of *Saccharomyces* culture on production performance and nutrient utilization.

Faccenda et al. (2020) interpreted the impact the addition of 15 g/day of *Saccharomyces cerevisiae* (1.0 x 10 9UFC/g) enriched with 170 mg selenium/kg exerts on milk yield, composition, and quality, thus recording that *Saccharomyces cerevisiae* combined with selenium does not improve fiber digestibility nor does it affect milk oxidative stability; however, it increases the concentration of selenium in milk.

Gao et al. (2020); added 4 and 8 g of *S. cerevisiae* yeast, and in similar quantities, lactic acid bacteria to 30 lactating Holstein cows to assess the activity it exerts on mastitis as well as the composition of the dairy microbiota of dairy cows, observing a decrease in the amount of *Enterococcus* and *Streptococcus* concluding that supplementations with these probiotics prevent mastitis, alleviating inflammation of the mammary gland and regulating milk microorganisms.

## CONCLUSIONS

Depending on their use, Probiotic (culture) or Prebiotic (cell walls) and the yeast *Saccharomyces cerevisiae*, differ in their mode of action, metabolic pathway, and benefits. As a Probiotic, it can cross the gastric barrier, multiply and colonize the intestine, and as a Prebiotic is indigestible by the animal, is located at the level of cecum and colon, and there it stimulates the growth and/or activity of beneficial microflora improving animal health. Generally speaking, in ruminants, it has a stimulating and modifying effect on fermentation and ruminal microbial growth, increasing ruminal cellulose

and microbial protein flow to the intestine. Similarly, it increases milk production and reproductive parameters, body weight gain, energy balance, nutrient digestibility, and feed efficiency. In monogastric, it improves productive parameters and intestinal morphometry; however, its beneficial action differs by pH, extraction temperature, nutritional composition, the strain used, dosage, yeast concentration, when mixed with other components, and by the diversity of diets offered to the animals.

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