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Mechanism of action of prebiotic and probiotic

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Abstract
Ban on the use of antibiotics as growth promoters in the European Union since January 1, 2006 (*EC 2001*) urged the scientist to find a suitable alternative to antibiotics. To overcome these problems, the use of Probiotic, prebiotics and combination of probiotic and prebiotic came up as a good alternative to antibiotics. Prebiotics as selectively fermented food ingredients that improve host health by targeting indigenous components thought to be positive. The prebiotics mostly consist of dietary fibers and oligosaccharides. Probiotics are defined as "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host" The probiotics and prebiotics help in improving the host (animal) health status by reducing the pathogen load through better resistance to pathogenic bacteria colonization and enhanced host mucosa immunity.

Keywords: Prebiotic, probiotic, mechanism of action

Introduction
Antibiotics have been fed to young calves since 1950. Many researchers have reported that supplementation of antibiotics has increased BW gains (Berge *et al*., 2005; Dibner and Richards, 2005) [2, 8], feed consumption and phagocytic efficiency (Ellinger *et al*., 1978) [9] and decreased incidence of scours and calf mortality (Quigley *et al*., 1997) [23]. The development of antimicrobial resistance and transference of antibiotic resistance genes from animal to human microbiota (Mathur and Singh, 2005; Salyers *et al*.,2004) [15, 24] and a ban on the use of antibiotics as growth promoters in the European Union since January 1, 2006 (*EC 2001*) urged the scientist to find a suitable alternatives to antibiotics. Moreover, therapeutic benefits from antibiotics also possibly diminish with long term use. To overcome these problems, the use of Probiotic, prebiotics and combination of probiotic and prebiotic (synbiotics) came up as good alternative to antibiotics (Heinrich *et al*., 2003; Morill *et al*., 1995) [13, 16]. The probiotics and prebiotics help in improving the host (animal) health status by reducing the pathogen load through better resistance to pathogenic bacteria colonization and enhanced host mucosa immunity (Choct, 2009; Williams *et al*., 2001) [3, 27].

Prebiotic
Prebiotic supplementation has gained interest in recent years as a method to improve gastrointestinal health and immune function in livestock. It has been provided that prebiotic supplementation may be most effective in times of stress or increased pathogen exposure throughout the calf's lifetime (Morrison *et al*., 2010) [17]. The prebiotics help in improving the animal health status by reducing the pathogen load through better resistance to pathogenic bacteria colonization and enhanced host mucosal immunity (Choct, 2009) [3] and thus reducing the risk of food-borne pathogens in foods. Prebiotics are non-digestible food ingredients when taken sufficiently; selectively stimulate the growth and activity of one or a limited number of microbes in the gut that can improve the host health. (Walton *et al*., 2013) [26] defined prebiotics as selectively fermented food ingredients that improve host health by targeting indigenous components thought to be positive. The prebiotics mostly consist of dietary fibers and oligosaccharides. (Gibson and Roberfroid, 1995) [12] coined the term prebiotics. Recently (FAO, 2007) [11] defined the prebiotic as "a non-viable food component that confers a health benefit on the host associated with modulation of the microbes". Some commonly use prebiotic are Fructo-oligosaccharides (FOS), Mannan-oligosaccharides (MOS), Inulin, Lactulose, Xylo-oligosaccharides (XOS). Combining of both prebiotic and probiotic are known as symbiotic.
The prebiotics concept was further explained by (Gibson *et al.*, 2004) and (Roberfroid, 2007) who set certain criteria for classifying a food ingredient as a prebiotic.

1. Resistance to gastric acidity, hydrolysis by mammalian enzymes, and gastrointestinal absorption.
2. Fermentation by intestinal microflora.
3. Selective stimulation of the growth and/or activity of those intestinal bacteria that contribute to health and well-being.
4. Improve luminal or systemic aspects of the host defense system and
5. Have overall positive influence on hindgut health or wellbeing of the host

Mechanism of action

MOS is believed to act by agglutination through interaction of mannose sensitive lectins located on the cell wall surface of specific gram negative bacteria. MOS prevent colonisation of harmful bacteria by competing for the attachment site in the digestive tract (Spring *et al*., 2000; Heinrichs *et al*., 2003) [25, 13]. Instead of binding to the intestinal walls of calves, harmful bacteria with complementary fimbrie adhere to the mannans (Ofek *et al*., 1977) [20] and thus pass the intestines without colonizing (Spring *et al*., 2000) [25]. *In vitro* studies conducted by Muchmore *et al*. (1990) [18] suggested that MOS alters lymphocyte response.

On the other hand Inulin is neither digested nor absorbed in the small intestine but it is selectively and quickly fermented by bacteria in further parts of alimentary tract stimulating proliferation of *Lactobacillus* and *Bifidobacterium*. Bifidogenic mechanism of action is based on selective fermentation of fructans by *Bifidobacteria* through synthesis of beta-fructosidases enzyme decomposing beta-2,1 glycosidic bonds in inulin and oligofructosis (Gibson and Roberfroid, 1995) [12]. As a result of bifidogenic effect change of bacterial microflora in intestine, decrease in the number of harmful bacteria is observed. Their proliferation is inhibited by *Bifidobacteria* that produces short-chain fatty acids (SCFA) and lower pH of intestinal chyme, with concomitant adverse conditions for pathogens. Moreover *Bifidobacteria* competes with pathogens for adhesion in intestinal epithelium, for nutrients and produce antibiotic substances, so called bacteriocins and hydrogen peroxide. Proliferation of species such as *E. coli, Salmonella, Shigella, Campylobacter jejuni* and *Clostridium perfirgens*is depressed by various strains of *Bifidobacteria.* During bacterial fermentation of fructans SCFA are produced, especially acetic, propionic, lactic and butyric acid (Gibson and Roberfroid, 1995) [12]. These acids show beneficial effect on metabolism; nourish intestinal cells, lowers pH of intestinal chyme and increase length of intestinal villus as well as number of epithelial cells in particular villus. These acids reach colon and are highly digestible substrates for bacteria. Ingestion of fructans selectively stimulates the population of *Bifidobacteria*, usually at the expense of *Clostridia* and bacteroides species. *Bifidobacterium* species are selectively enhanced because of their β -fructosidase activity, which is selected for the β (2-1) glycosidic linkages (De Vries and Stouthamer, 1967) [7].

Probiotic

Probiotic concept was first described by Russian scientist Elie Metchnikoff, who in the beginning of the 20th century suggested that it would be possible to modify the gut flora and to replace harmful microbes with useful microbes Metchnikoff proposed that consumption of fermented milk would "seed" the intestine with harmless LAB and decrease the intestinal pH and that this would suppress the growth of proteolytic bacteria. His work inspired Japanese scientist Minoru Shirota to begin investigating the causal relationship between bacteria and good intestinal health, which eventually led to the launching of "Yakult" (yoghurt based drink) in 1935. The term "Probiotics" was first coined by Parker (1974) who described this as "microorganism or substance which contributes to the intestinal microbial balance". A probiotic is a live microbial feed supplement that beneficially affects the host animal by improving its intestinal microbial balance. Literal meaning of probiotic is "for life" while that of antibiotic is "against life". According to FAO probiotic is "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host". Probiotics are preparations of non-pathogenic microorganisms, prepared for animal and human use, that have beneficial effects on the digestive ecosystem and confer resistance to infection (Fuller, 1992). Commonly use probiotic are genus *Lactobacillus*, *Bifidobacterium*, *Saccharomyces*, *Enterococcus*, *Streptococcus*, *Pediococcus*, *Leuconostoc*, *Bacillus*.

Characteristic of good probiotics

1. The culture should exert a positive effect on the host. it should be gram positive, and acid resistant, bile resistant and contain a minimum 30×10^9 CFU per gram.
2. The culture should posses high survival rate and multiply faster in the digestive tract. It should be strain specific.
3. The cultured organism neither be pathogenic or nor toxic to the host
4. The adhesive capacity of a microorganism must be firm and faster

Mechanism of action of probiotic

Major Probiotic mechanisms of action include enhancement of the epithelial barrier, increased adhesion to the intestinal mucosa, and concomitant inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, production of anti-microorganism substances and modulation of the immune system. The intestinal barrier is a major defense mechanism used to maintain epithelial integrity and to protect the organism from the environment. Defenses of the intestinal barrier consist of the mucous layer, antimicrobial peptides, secretory IgA and the epithelial junction adhesion complex (Ohland *et al*.,2010) [21] this barrier function is disrupted, bacterial and food antigens can reach the submucosa and can induce inflammatory responses, which may result in intestinal disorders. Consumption of non-pathogenic bacteria can contribute to intestinal barrier function, and probiotic bacteria have been extensively studied for their involvement in the maintenance of this barrier. However, the mechanisms by which probiotics enhance the intestinal barrier function are not fully understood. Several studies have indicated that enhancing the expression of genes involved in tight junction signaling is a possible mechanism to reinforce the intestinal barrier integrity (Anderson *et al*., 2010) [1]. Probiotic bacteria may be able to adhere to epithelial cells, thus blocking pathogens. That mechanism exerts an important effect on the host's health condition. Moreover, the adhesion of probiotic microorganisms to epithelial cells may trigger a signaling cascade, leading to immunological modulation. Alternatively, the release of some soluble components may cause a direct or indirect (through epithelial cells) activation of immunological cells. This effect plays an important role in the prevention and treatment of contagious diseases, as well as in chronic inflammation of the alimentary tract or of a part thereof (Oelschlaeger, 2010) [19]. Prebiotic

display various surface determinants that are involved in their interaction with intestinal epithelial cells (IECs) and mucus. IECs secrete mucin, which is a complex glycoprotein mixture that is the principal component of mucous, thereby preventing the adhesion of pathogenic bacteria (Collado *et al*., 2005) [4]. Probiotic will produce organic acid and the production of antibacterial substances termed bacitracin. Organic acids, in particular acetic acid and lactic acid, have a strong inhibitory effect against Gram-negative bacteria, and they have been considered the main antimicrobial compounds responsible for the inhibitory activity of probiotics against pathogens (Makras *et al.*, 2006) [14]. The undissociated form of the organic acid enters the bacterial cell and dissociates inside its cytoplasm. The eventual lowering of the intracellular pH or the intracellular accumulation of the ionized form of the organic acid can lead to the death of the pathogen (Russell and Diez, 1998). prebiotic will act competitive exclusion term for the scenario in which one species of bacteria more vigorously competes for receptor sites in the intestinal tract than another species. The mechanisms used by one species of bacteria to exclude or reduce the growth of another species are varied, including the following mechanisms: creation of a hostile microecology, elimination of available bacterial receptor sites, production and secretion of antimicrobial substances and selective metabolites, and competitive depletion of essential nutrients.

Conclusions

Probiotic and prebiotic both can be used as increase in body weight, average daily gain, antioxidant activity and enhance immunity and there is no harmful effect like antibiotic resistance and antibiotic residue.

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