Abstract--- The modification of the gut microbiota with new feed additives such as probiotics, prebiotics toward host protection is to support animal health. Out of these probiotics, prebiotics are widely used. Genomic knowledge about gut microbiota as well as its deviations will advance the selection of new and specific probiotics. The suitable combination probiotics, prebiotics decrease the risk of intestinal diseases and eliminate specific disorder.

Key words--- Probiotics, Prebiotics, Animal Feeding

I. INTRODUCTION

The first aim of the livestock production is the delivery of safe foods for human consumption taking the welfare of the animal and providing value to the environment. An important field of zootechnical research is the improvement of the quality and safety of the meat. Pathogens, such as Campylobacter and Salmonella can be transmitted along the food chain and can be the source of human illness. Antibiotics included in animal feed at sub-therapeutic levels, acting as growth promoters (Antibiotic Growth Promoters, AGPs), (Dibner and Richards, 2005).

The removal of pathogens from animal diets has set a great pressure on the livestock and poultry farms. The main consequence is a substantial increase in the use of therapeutic antibiotics (Casewell et al., 2003). There is a need to look for viable alternatives that could enhance the natural defence mechanisms of animals and reduce the massive use of antibiotics (Verstegen and Williams, 2002), the specific use of feed additives or dietary raw materials affect the animal performance and welfare, particularly through the modulation of the gut microbiota which plays a critical role in maintaining host health (Tuohy et al., 2005). In this context probiotics, prebiotics and synbiotics could be possible solutions.

II. APPLICATION OF PROBIOTICS, PREBIOTICS AND SYNBiotics IN LIVESTOCK

- Pigs

Farm animals are subjected to environmental stresses (management methods, diet, etc.), which can cause imbalance in the intestinal ecosystem and could be a risk factor for pathogen infections. Each species of livestock has its critical point in the production chain. In swine production, the most stresses are related to the weaning and post-weaning (PW) periods. These periods are characterized by an immediate but transient drop in feed intake impairing growth performance of the animals. All these factors can negatively disturb the immune function and the intestinal microbiota equilibrium of the pigs (Modesto et al., 2009), leading to increased susceptibility to gut disorders, infections and diarrhoea.
Probiotic preparations including *Bifidobacterium lactis* and *Lactobacillus rhamnosus* individually reduced adherence of *Salmonella, E. coli* and *Clostridium spp.* to the intestinal mucosa in swine. Probiotic treatment using Bifidobacterium lactis HN019 reduced post-weaning diarrhoea associated with rotavirus and *E. coli* infections in a piglet model (Shu et al., 2001). *B. animalis* sub sp. *lactis* affected positively the growth performance in weaning piglets and the ratio of *bifidobacteria* to *E. coli* in the gut (Modesto et al., 2009).

Casey et al. (2007) showed that a five-strain probiotics combination, containing Lactobacillus and Pediococcus, reduces pathogen shedding and alleviates diarrhoea in pigs challenged with *Salmonella enteritidis* serovar *typhimurium* both early in the course of infection and over a longer time frame. Alexopoulos et al. (2004) reported that the administration of spores of *Bacillus licheniformis* and *B. subtilis* reduces the morbidity and the mortality in recently weaned piglets, improves the performance parameters of the fattening pigs and improves carcass quality.

Prebiotics, similar to probiotics, give contradictory results in pigs: they modulate the microbiota towards beneficial bacteria, such as *Bifidobacterium* and *lactobacilli*, enhancing the intestinal defence systems (immunomodulatory action, pathogen displacement, bacteriocin production, etc.) and only rarely influence positively growth performance.

- **Poultry**

  The application of probiotics in poultry is strictly associated with the concept of competitive exclusion (CE). The adaptation to the post hatching period and the increased stressors, deriving from practices used in modern broiler production, e.g. feed changes or imbalances, transportation, processing at the hatchery and high stocking densities (Pinchasov and Noy, 1993), may weaken immune functions and thus predispose broilers to colonization of the gastrointestinal tract by bacterial pathogens, posing a threat to birds health and food safety.

  Higgins et al. (2008) showed that Lactobacillus-based probiotic cultures significantly reduced *Salmonella enteritidis* recovery in challenged neonatal broiler chicks. Furthermore, administration by vent application, compared to traditional application by drinking water, resulted in significant reduction of *S. enteritidis* one hour following oral challenge. In a previous trial of the same author reported that the same probiotic cultures affected the concentration of *S. enteritidis*, both in cecal tonsils and in cecal content, whereas no relevant results were obtained towards *S. typhimurium* (Higgins et al., 2007).

  Kalavathy et al. (2003) found that a supplementation of twelve Lactobacillus strains in broiler diets improved the body weight gain, feed conversion rate and was effective in reducing abdominal fat deposition. Mountzouris et al. (2007) investigated the efficacy of selected probiotic bacteria, isolated from the gut of healthy chickens (*Lactobacillus reuteri, L. salivarius, Enterococcus faecium, Bifidobacterium animalis* and *Pediococcus acidilactici*) and on body weight, feed intake and feed conversion ratio of broiler chickens; overall the probiotic formula added to water and feed displayed a growth-promoting effect that was comparable to avilamycin treatment. In addition, the probiotic cultures modulated the composition and the enzymatic activities of the cecal microflora, resulting in a significant probiotic effect.

  Eggs production has been also investigated in relation to probiotic application; Davis and Anderson (2002) reported that a mixed cultures of *Lactobacillus acidophilus, L. casei, Bifidobacterium thermophilus* and *Enterococcus faecium*, improved egg size and lowered feed cost in laying hens. Moreover, probiotics increase egg production and quality (Panda et al., 2008). The prebiotic approach has not a long history of use in broiler chickens (Yang et al., 2009). However, application studies have been increasing in the last years to assess their effect on gut health, performance, and reduction of pathogen shedding.

  By feeding chicory fructans to broilers, Yusrizal and Chen (2003a) showed an improvement in weight gain, feed conversion, carcass weight and serum cholesterol decrease; additionally, the supplementation of fructans resulted in increase of lactobacilli counts in the gastrointestinal tract and Campylobacter and *Salmonella* decrease (Yusrizal and Chen, 2003b). Kleessen et al. (2003) described decreased *C. perfringens* number and a reduction in bacterial endotoxin levels by adding 0.5% of fructan-rich Jerusalem artichokes syrup in broilers drinking water.
Yeast cell wall containing MOS reduced intestinal Salmonella concentrations by 26% in broiler chicks compared with chicks fed an unsupplemented diet (Spring et al., 2000). A recent study reported no effects in body weight, feed intake and feed conversion ratio in broiler chickens fed with a standard diet and GOS at two different concentrations; however the study clearly showed a significant increase in the intestinal bifidobacteria population (Jung et al., 2008).

Mainly, prebiotics seem to selectively enhance lactobacilli and bifidobacteria populations and reduce colonization by pathogenic bacteria (Baurhoo et al., 2009). Recent development and applications of symbiotic products have focused on the assessment of beneficial effects in poultry health and production; however, information available to date is scarce. Mohnl et al. (2007) found that a symbiotic product had a comparable potential to improve broiler performance as avilamycin treatment. A Lactobacillus spp. based probiotic product, in combination with dietary lactose, was successfully assessed, improving body weight and feed conversion in Salmonella-challenged turkeys (Vicente et al., 2007). Li et al. (2008), adding FOS and B. subtilis to the diet, observed that average daily gain and feed conversion ratio were improved; diarrhoea and mortality rate were reduced compared to aureomycin treatment. A considerable increase in the bifidobacteria, lactobacilli and total anaerobes populations has been shown when feeding a diet containing a combination of a galactooligosaccharide and Bifidobacterium lactis but no effect on body weight, feed intake and feed conversion was observed (Jung et al., 2008).

Overall, all the authors agreed that a synbiotic product displayed a greater effect than individual preparations (Vandeplas et al., 2009). This coupling could represent an important and synergistic strategy to improve gut health of chickens from the first days of life and control pathogen release in the environment, decreasing the risk of food-borne infections in humans. Thus, future research and applications in the field trials are necessary to look for new combinations with the aim to produce standard safe compositions at a high functional level.

Egg production has been also investigated in relation to probiotic application; Davis and Anderson (2002) reported that a mixed cultures of Lactobacillus acidophilus, L. casei, Bifidobacterium thermophilus and Enterococcus faecium, improved egg size and lowered feed cost in laying hens. Moreover, probiotics increase egg production and quality (Panda et al., 2008). Xu et al. (2003) found a dose-dependent effect of fructooligosaccharides (FOS) on average daily gain; whereas Juskiewicz et al. (2006) reported no impact on the performance or productivity of turkeys after feeding for eight weeks with different amounts of FOS. By feeding chicory fructans to broilers, Yusrizal and Chen (2003a) showed an improvement in weight gain, feed conversion, carcass weight and serum cholesterol decrease; additionally, the supplementation of fructans resulted in increase of lactobacilli counts in the gastrointestinal tract and Campylobacter and Salmonella decrease (Yusrizal and Chen, 2003b). Kleessen et al. (2003) described decreased C. perfringens number and a reduction in bacterial endotoxin levels by adding 0.5% of fructan-rich Jerusalem artichokes syrup in broilers drinking water.

Yeast cell wall containing MOS reduced intestinal Salmonella concentrations by 26% in broiler chicks compared with chicks fed an unsupplemented diet (Spring et al., 2000). Thitaram et al. (2005), with different amounts of isomalto-oligo-saccharide (IMO), showed a significant 2-log reduction in the level of inoculated S. enterica serovar typhimurium present in the ceaca of young broiler chickens. Feed consumption, feed conversion and feed efficiency were not significantly changed compared to the control; however, the IMO containing diets significantly increased the number of the intestinal bifidobacteria. Feeding young chicks with five different oligosaccharides (inulin, oligofructose, mannanoligosaccharide, short-chain fructooligosaccharide, and transgalactooligosaccharide), no significant responses in weight gain for any of the oligosaccharides fed have been registered. Moreover the study outlined revealed that a high dosage of prebiotics can have negative effects on the gut system and retard the growth rate of birds (Biggs et al., 2007).

Likewise, a recent study reported no effects in body weight, feed intake and feed conversion ratio in broiler chickens fed with a standard diet and GOS at two different concentrations; however the study clearly showed a significant increase in the intestinal bifidobacteria population (Jung et al., 2008). Mainly, prebiotics seem to selectively enhance lactobacilli and bifidobacteria populations and reduce colonization by pathogenic bacteria (Baurhoo et al., 2009).
Results on animal performance, either with a probiotic or a prebiotic treatment, are often contradictory and mostly affected by the microorganisms or compound chosen, the dietary supplementation level, and duration of use. In many cases, the environmental and the stress status of the animals are not reported or considered, as the experimental settings are often too far from farm conditions.

Recent development and applications of synbiotic products have focused on the assessment of beneficial effects in poultry health and production; however, information available to date is scarce. Mohnl et al. (2007) found that a synbiotic product had a comparable potential to improve broiler performance as avilamycin treatment. A Lactobacillus spp. based probiotic product, in combination with dietary lactose, was successfully assessed, improving body weight and feed conversion in Salmonella-challenged turkeys (Vicente et al., 2007). Li et al. (2008), adding FOS and B. subtilis to the diet, observed that average daily gain and feed conversion ratio were improved; diarrhoea and mortality rate were reduced compared to aureomycin treatment.

Overall, all the authors agreed that a synbiotic product displayed a greater effect than individual preparations (Revolledo et al., 2009; Vandeplas et al., 2009). This coupling could represent an important and synergistic strategy to improve gut health of chickens from the first days of life and control pathogen release in the environment, decreasing the risk of food-borne infections in humans. Thus, future research and applications in field trials are necessary to look for new combinations with the aim to produce standard safe compositions at a high functional level.

- **Ruminants**

The application of probiotics in ruminants has been performed in the pre-ruminant’s life and in adult ruminants, considering both the health status of the animals (reduction of incidence/severity of diarrhoea, carriage of pathogenic microorganisms) and the economic parameters. The administration of viable E. coli bacteria, strain Nissle 1917, had a clear beneficial effect on the prophylaxis and treatment of neonatal-calf diarrhoea. (Von Buenau et al., 2005). Neonatal-calf diarrhoea, most often caused by enterotoxigenic E. coli, is an important cause of morbidity and mortality in young ruminants.

In young calves, incorporating live yeasts into the grain, reduced the number of days with diarrhoea (Galvao et al., 2005). Two different probiotic preparations, containing six Lactobacillus spp. of bovine and human origin, were successful in reducing the overall mortality, incidence of diarrhoea and fecal coliforms counts in veal calves (Timmerman et al., 2005).

The use of prebiotics in cattle has been inadequate due to the ability of ruminants to degrade most prebiotics; however enhancements in rumen-protective technologies may allow these compounds to be used in feedlot and dairy cattle (Callaway et al., 2008), considering also that several classes of nondigestible oligosaccharides are found in plant cell wall in nature including feeds normally used for livestock feeding (Lema et al., 2002). Fleige et al. (2007) investigated the effect of lactulose in pre-ruminant calves in combination with E. faecium to determine influence and effect on the growth performance and on the intestinal morphology; while Yasuda et al. (2007) evaluated the effect of a new synbiotic product consisting of a Lactobacillus casei subsp. casei and dextran on milk production in Holstein dairy cows.

Both combinations were beneficial for the animals; the second study evidenced the improvement in milk production as a result of a positive change in the intestinal bovine microbiota, a reduction in the incidence of infectious diseases and a decrease in some forms of stress.

### III. CONCLUDING REMARKS

The idea of using antibiotics resulting in the improvement of nutrient absorption enhancing feed intake and weight gain, in the inhibition of pathogens at the primary production level. Therefore new alternative strategies for good animal performance collectively with low or absence of pathogens in the livestock food chain has to be promoted. The fine manipulation of gastrointestinal microbiota in maintaining animal gut health, through diversity, stability, metabolites and crosstalk with the epithelium and the basic immune system by probiotics and prebiotics could be a hopeful route. Probiotics can find their main application in the prevention of gastrointestinal infection and disease more than a therapeutic approach. Because, the action of probiotics is not generally aimed as antibiotics to kill pathogen bacteria but they modulate the
gastrointestinal environment thereby reducing the risk of gastrointestinal disease synergistically with the immune system of the host.

Several studies in farm health or stressed animals confirmed the effects of these feed additives in pigs, poultry and ruminants, by improving the number of beneficial bacteria and the reduction of the potential pathogen load. Probiotic treatments are sometimes positively influenced the growth performance, promoting the feed efficiency of the animal.

The study of the mechanisms of action of pro and prebiotics is a network where from human studies it is possible to increase knowledge of animal application and vice versa. Oligofructose treatment increases satiety following breakfast and dinner, reduces hunger and prospective food consumption following dinner also in healthy humans stabilizing the weight of an individual, and it can be helpful in overweight individuals (DiBaise et al., 2008).

It has been acknowledged that the beneficial effects of probiotics are shared among a vast number of genera and species belonging not only to the human or animal gastrointestinal tract. Many of them have been utilized for many years without causing any problem, but when a probiotic has to be chosen one should take in consideration also that some of these genera, such as Enterococcus and Bacillus, contain species with proven pathogenic effects.

Future research should focus on determining the mechanism of action, evaluating probiotic and prebiotic interaction, and elucidating how the genetic and bacterial profiles of the host can influence treatment responsiveness. The future target is to increase the genomic information on both probiotic and microbiota activities to improve the understanding of the interactions with specific intestinal diseases. Then the goal is to apply the knowledge of GIT health normal microbiota composition in comparison with microbiota present during disease to select the right probiotic, prebiotic or symbiotic combinations.

**References**


