Characteristics and Functionality of Probiotic Bacteria's Supplemented in the Ration of Country Chickens

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***Abstract*— *The objective of this article is to present, in the form of a bibliographic review, the main characteristics and functionalities of probiotics, highlighting their importance in the dietary management of country chickens and the innumerable benefits that the inclusion of this additive in the diet can provide for animal health. The use of antimicrobial additives (antibiotics) contributed to the development of industrial and colonial poultry; however, the reflection of the indiscriminate use of these additives has raised concerns regarding the development of bacterial resistance in birds. Probiotics emerged as a viable and reliable alternative, to promote sanitation and poultry production, which favored its application in the feeding management of large or small batches of poultry.*

Keywords*— *Additives. Country Chickens. Animal Health. Yield.

I. INTRODUCTION

Poultry production is based on high productivity and production of quality chicken meat products, for which the industry uses food additives, whose primary function is to promote growth and maintain the health of poultry. The search for a safer additive, which allowed the establishment of a protective intestinal microbiota in the animal, made the use of probiotics an effective alternative and aggregator of beneficial actions for the bird (LODDI et al., 2000).

One of the main problems that directly interfere with the development of poultry is the stress to which they are subjected in a grange, a fact related to the requirements imposed by the increasing increase in poultry productivity. This stress causes a decrease in food consumption, which is reflected in energy deficiency and consequent mobilization of body reserves as a way to supply the lack of nutrients, leaving the animal susceptible to infections and changes in the digestive tract. Faced with these disorders, growth promoters act prophylactically(ALLIX, 2010).

Country chicken is an alternative source of income for producers who want to start in poultry production, either because of low maintenance costs (facilities and inputs) or guarantee of financial returns, often immediately. The "organic" creation of broiler chickens established a new model of industrial production, aimed at the use of management practices based on observation and understanding of the functioning of the organic systems of the bird, adding value to the final product. The scope of these differentiated food management practices becomes possible and accessible with the use of alternative growth biological promoters (BALOG NETO et al., 2007).

The use of probiotics as an alternative to the additives traditionally used in the nutrition of cutting birds has led to the development of new researches, whose data on zootechnical performance provide a better decision on the application of the additive.

The objective of this article is to present, in the form of a bibliographic review, the main characteristics and functionalities of probiotics, highlighting their importance in the dietary management of country chickens and the innumerable benefits that the inclusion of this additive in the diet can provide for animal health. The results obtained with the use of probiotics in experimental research were also presented.

II. POULTRY FARMING IN BRAZIL

Poultry farming is one of the most profitable economic holdings when compared to other types of agricultural production in Brazil. Due to its own characteristics, this activity presents a high degree of biological control, being able to develop in any type of climate or soil. Another differential of poultry, especially in the cutting, is the high conversion of grains to meat, which guarantees the establishment of high rates of productivity and economic return in the short term (EMBRAPA, 2003).

https://dx.doi.org/10.22161/ijaers.5.5.25 ISSN: 2349-6495(P) | 2456-1908(O)

In Brazil, poultry farming began to develop in the late 1950s, more specifically in the state of São Paulo, where a small-scale production system was used to sell live or slaughtered chicken at the regional market. Subsequently, the national poultry began to industrialize with the appearance of the first large slaughterhouses, which allowed the expansion of the activity to other regions. In 1970, the reorganization of meat production in Brazil shifted poultry production to the South. During the same period, the integration system was created (VIOLÀ e TRICHES, 2013).

Currently the production chain of the cutting poultry is formed by main and auxiliary links, which act as a cycle. The main links are composed by the shed of chickens grandparents, core of matrizes, hatchery, aviary, refrigerator and retailer. The chain begins with the chickens grandparents, whose function is to produce the matrices (second link) that will provide the commercial chicks for slaughter. The third link in the chain is represented by the hatcheries, which are units commonly belonging to the slaughterhouses and responsible for hatching the eggs and sending the chicks to the aviaries after a few hours of their birth. In the aviary (fourth link), the birds will undergo growth and fattening processes and will be sent for slaughter in a refrigerator (fifth link). After slaughtering, in the industry, the whole frozen or chilled chicken or pieces, goes to the retail market (sixth link). The auxiliary links, composed of the inputs, research, equipment, medicines and packaging, guarantee the operation of the entire production chain (ARAÚJO et al., 2008).

According to the United States Department of Agriculture (USDA), Brazil's poultry industry is the number one export position, second in production and fourth in poultry consumption among the influential market countries poultry, as can be seen in Tables 1, 2 and 3. Expected a 4% increase in Brazilian exports is expected for 2018 (USDA, 2017).

Between the years of 2013 and 2017, Brazil presented a progressive increase in exports, which gave it a prominence in the sector and the retention of leadership, unlike the United States and China, which had oscillations in their results in this same time cut; the European Union and Thailand also developed, but far from the reach reached by Brazil (Table 1).

Table.1: Main countries exporting of chicken meat

Export of Chicken Meat (1.000 Tonnes)						
Países	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Brazil	3,482	3,558	3,841	3,889	4,000	4,150
United States	3,332	3,310	2,867	3,014	3,091	3,189
European Union	1,083	1,133	1,179	1,276	1,250	1,280
Thailand	504	546	622	690	770	800
China	420	430	401	386	400	385
Total	8,821	8,977	8,910	9,225	9,511	9,804

Source: USDA (2017)

Regarding the production of chicken meat, for the period from 2013 to 2017, it is observed that Brazil became the second largest producer in the year 2016, due to the retraction of Chinese production. The European Union has progressively increased and is expected to surpass China in 2018. The United States remains the largest producer of chicken meat in view of the progressive growth of its productivity over the last 5 years

Table.2: Main countries producers of chicken meat

Production of Chicken Meat (1.000 Tonnes)						
Countries	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
United States	16,976	17,306	17,971	18,261	18,596	18,970
Brazil	12,308	12,692	13,146	12,910	13,250	13,550
European Union	10,050	10,450	10,890	11,533	11,700	11,880
China	13,350	13,000	13,400	12,300	11,600	11,000
India	3,450	3,725	3,900	4,200	4,400	4,600
Total	56,134	57,173	59,307	59,204	59,546	60,000

Source: USDA (2017)

https://dx.doi.org/10.22161/ijaers.5.5.25 ISSN: 2349-6495(P) | 2456-1908(O)

In the last five years, the United States has maintained a steady growth in domestic consumption of chicken meat, a fact not observed in Brazil, which suffered a deceleration in consumption between 2015 and 2016, remaining in the fourth position. The forecast for 2018 is that China consumes less than the European Union, falling to the fifth position (Table 3).

Table.3: Main countries consumers of chicken meat

Consumption of Chicken Meat (1.000 Tonnes)						
Countries	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
United States	13,691	14,043	15,094	15,331	15,576	15,838
European Unior	9,638	10,029	10,441	11,018	11,170	11,320
China	13,174	13,267	12,344	11,650	11,650	11,095
Brazil	8,829	9,137	9,309	9,024	9,252	9,402
India	3,445	3,716	3,892	4,196	4,397	4,597
Total	48,777	49,652	51,080	51,219	52,045	52,252

Source: USDA (2017)

Brazilian poultry farming generates 3.6 million direct and indirect jobs, besides having skilled labor, favorable climatic conditions, guaranteed inputs and natural resources needed by industry. The poultry segment moves 36 billion reais and has a 1.5% share of GDP. The southern states are responsible for most exports. The high level of this sector is attributed to the country's production characteristics, based on the integration system (UBABEF, 2012).

According to Oliveira (2016), the integration system consists of a partnership between producers / poultry producers (integrated) and poultry companies (integrators), where the poultry farmer is responsible for facilities, labor, management and access to the aviary. It is the responsibility of the companies to provide the matrices, the medicines, supplies, the technical assistance and to take charge of the slaughter. At the end of the creation, the integrator pays to the integrated its participation in the production of the batches delivered for slaughter. This system is widely used by companies of the sector.

Garcia (2004) states that the expansion of poultry production — first established in the South and Southeast Regions — to the Central West region, between 1990 and 2001, was influenced by the adoption of the production system in "agricultural partnership". States such as Goiás, Mato Grosso, Mato Grosso do Sul and Bahia were able to benefit from the implementation of poultry projects that promoted the installation of chicken slaughterhouses, facilitating the growth of live chicken production and consequently the partnerships between producers and industry.

III. USE OF GROWTH PROMOTERS IN POULTRY FARMING

Antimicrobial growth promoters, such as antibiotics and chemotherapeutics, began to be employed on a large scale in the 1990s in commercial broiler breeding where the indiscriminate inclusion of antibiotics became associated with induction of bacterial resistance, of hypersensitivity and to cases of cancer. The deleterious effects caused by these promoters have forced the European Union to ban most of the antimicrobial growth promoters in animal feed (MENTEM, 2002; FARIA et al., 2009).

Other types of growth promoters, applied to food management, offer good results for poultry farming, among which we can mention organic acids, enzymatic complexes, symbiotic, prebiotic and vegetable extracts. The study of these new alternatives was driven by the desire to find additives that had the capacity to balance the microbiota and ensure the biosecurity of the meat(ALMEIDA, 2012).

Various types of additives, such as prebiotics and organic acids, also contribute to the balance of the microbiota, favoring the development of desirable bacteria or eliminating the undesirable ones. Prebiotics consist of substances that can not be hydrolyzed or absorbed in the upper gastrointestinal tract and should serve as a substrate for beneficial bacteria that will bring improvements at the intestinal and systemic levels. The function of short chain organic acids (SCOA) is linked to the reduction of the bacterial load in the digestive tract, since it interferes in the physicochemical characteristics of the medium, in order to establish a greater heterogeneity of the microbiota (DIONÍSIO et al., 2002; DIBNER and BUTTIN, 2002; RICKE, 2003).

Campestrini et al. (2005) argue that birds, because they are omnivorous animals, have difficulty digesting non-amidic carbohydrates, found in soluble or insoluble fiber, impairing the utilization of nutrients present in ingredients of plant origin, commonly applied in the diet of birds. The use of supplemental (exogenous) enzymes in food improves the digestibility of food in order to increase animal performance. A good example is the enzyme phytase, which when added to the diet releases the phosphorus that is associated with the phytic acid of the vegetables, making it available to non-ruminants. Cellulase, xylanase and glucanase are other examples of exogenous enzymes important for animal nutrition.

Prebiotics are additives (food compounds) that have the ability to select bacterial species beneficial to the animal's organism without being degraded by digestive enzymes or absorbed by the intestinal mucosa. The action of prebiotics is to stimulate growth and activate the metabolism of bacteria important for sanity and intestinal balance (eg, bifidobacteria and lactobacilli). For this, these substances must arrive intact in the intestine and undergo the fermentation process, carried out by the microbiota desirable (BRITO et al., 2013).

According to Silva et al. (2000), the use of probiotics in feeding has the function to improve the balance of the microbiota, inhibiting the development of pathogenic microorganisms, through the production of organic acids, antibiotic substances or pH reduction. Among the alternative additives available on the market, probiotics have characteristics and functionalities that allow their use as growth promoters in poultry.

IV. PROBIOTICS AS GROWTH PROMOTERS

The effects of probiotics have been known for quite some time. The term was established by Lilly and Stillwell (1965), when they found that certain microorganisms acted as growth promoters. The action of these additives is twofold, since at first they contribute to the increase of the weight of the animal, the improvement of the zooeconomic indexes and feed conversion. In a second moment, they promote intestinal protection, provided by their bactericidal action (SILVA and ANDREATTI FILHO, 2000).

Probiotic microorganisms can be classified as colonizers (example of *Lactobacillus spp*. and *Enterococcus*) or non-colonizers (free-flowing), such as bacteria of the genus *Bacillus spp.* and yeast *Sacharomyces cerevisiae*. The ideal probiotic should have rapid proliferation and resistance to the effects of acidity, bile salts and digestive enzymes present in the gastrointestinal tract (HUYGHEBAERT et al., 2011). These additives are used in animal production as performance/productivity enhancers, which differs from that employed in humans (KURITZA et al., 2014).

Pelicano et al. (2002) reports that probiotics are classified by the Food and Drug Administration (FDA) as Generally Regarding As Safe (GSRA) substances, which makes them safe for use in animal feed, since these are beneficial microorganisms that establish equilibrium of the intestinal microbiota. The authors also indicates that probiotics must have essential characteristics such as: being a normal inhabitant of the gastrointestinal tract, developing and setting in the intestinal epithelium, resisting adverse situations (eg effects of bile) and acting as an antagonist of pathogenic microorganisms.

A mechanism linked to the competitive exclusion characteristic of probiotics is that found in yeast Sacharomyces cerevisiae, where the microorganism presents molecules of mannanoligosaccharides (MOS) on its surface, whose main function is to impair the ability of pathogenic bacteria to install on the wall intestinal, by the adhesion of these microorganisms to the wall of the yeast. The formed yeast-bacteria complex facilitates the action of the bird's defense mechanisms (GRAÑA, 2006).

Several experiments indicate that the presence of probiotic bacteria in the gastrointestinal tract of birds induces the expression of CD4 and CD8 cells. The very structure of the bacterial cell wall is already capable of producing this effect. There is also a greater proliferation of mucus-producing cells, which will ensure an important natural barrier against viral and bacterial pathogens that try to attack the wall of the intestinal mucosa (GABRIEL et al., 2006; CHICHLOWSKI et al., 2007).

In birds the development of general and nonspecific immunity is in charge of the gastrointestinal tract, since these animals do not present lymph nodes like the other species. The lymphoid organs are represented by Peyer's plaques, cecal tonsils and the Fabricius pouch. The tissues of these organs recognize the antigen delivered by the digestive tract, stimulating the release of B and T cells. Humoral immunity, on the other hand, when it is stimulated, releases IgA-like antibodies via the mucosa, whose function is to block the receptors and reduce the number of pathogenic bacteria in the intestine (JIN et al., 1998).

The higher height of intestinal villi present in some birds led Petrolli et al. (2012) to relate this factor to good performance results. This characteristic confers to the animal considerable area of absorption and digestion capacity, as there is a wide surface of contact and the increase of the enzymatic activity in the mucosa and intestinal lumen.

Fernandes (2012) states that although prebiotics, probiotics and symbiotics are viable and interesting alternatives to poultry farming, the results are still very contradictory. Differences in the results are due to the innumerable factors that can interfere in the action of these products, since there are several compositions of microorganisms and strains, concentrations, inclusion levels and preparation methods that end up changing their functionality. More research will be needed for a better understanding of the mechanisms of action.

V. RESULTS OBTAINED IN EXPERIMENTAL RESEARCH

Flemming and Freitas (2005) verified in their experiments that, at 28 days of age, chickens from treatment with probiotics inserted in the diet had greater weight gain than chickens that received other types of growth promoters (example: avilamycin) food. According to the authors, in the initial stages of breeding, probiotics establish a good balance in the intestinal microbiota and promote good zootechnical indexes.

Corrêa et al. (2003), when using the probiotic Estibion, observed an increase in feed conversion in early stage birds (1 to 20 days), after comparing with the same parameter obtained with the use of antibiotics, a fact not found by Rigobelo et al. (2011), who, in a similar work, analyzed the feed conversion in the initial phase and did not obtain satisfactory results with the use of the alternative additive.

Petrolli et al. (2014), in a research carried out in the poultry industry facilities of the University of the West of Santa Catarina, sought to evaluate the benefits of inclusion of probiotics on the performance and intestinal integrity of the birds. In order to perform the experiment, 600 animals of the Cobb lineage were obtained, distributed from the first day of breeding in five treatments, in which only three probiotics were included in the feeding. The probiotic, composed of strains of *Lactobacillus plantarum* and *Pediococcusacidilactici* and added to the diet, did not have a significant effect on the feed intake variable, which caused the authors to relate this result to the absence of a microbiological challenge in the environment where the birds were inserted.

Ramos et al. (2014), using a reused bed, verified that, up to 42 days of age, the birds of the treatment without additives (control) did not obtain a good average in the food conversion and weight gain variables, besides having low feed intake, when compared to those who received the probiotic.

Alva (2014), after including the probiotic *Paennibacillus sp.* in the ration of three treatments, in a progressive way, it obtained good results in the variables of feed consumption and feed conversion, when compared with the values acquired without the use of the additive, at 42 days of creation.

Meuer et al. (2010), when establishing five treatments for 1.200 birds, aiming to analyze the use of the probiotic *Bacillus Subtilis* on zootechnical performance, verified that the use of the diet with additive promoted a better productive efficiency, when compared to the control diet (without additives), during 42 days of creation.

Silva (2008), to included the probiotic Gallipro® (*Bacillus subtilis*) in broiler feed, did not observe differences in the productive efficiency index between the treatment with the additive and the that did not received the aditive (control treatment) on the 41 days period.

Dalólio et al. (2015) established six treatments with the objective of analyzing the effect of the alternative additives as a substitute for antimicrobial developmental promoters in the feeding of 480 chickens of the Cobb 500 strain. At the end of the experiment, at 42 days, the authors did not find any difference between the treatments that received probiotic, enzymatic complex, antibiotic, garlic extract and the basal diet, with regard to carcass yield and noble cuts.

Another experiment, carried out by Caliman and Couto (2010), aimed to establish comparisons between the results from the use of probiotic BACSOL-VT as an additive in the ration of 2 treatments and the ad libitum supply of feed without additives in only one treatment. The lots were distributed according to a completely randomized design (DIC). The statistical analyzes of weight gain, comparing the different concentrations of the additive in the diet, showed no differences in the results. The authors attribute this absence of differences to the creation in good hygienic sanitary conditions, capable of alleviating the occurrence of microorganisms that cause diseases. On farms with precarious sanitary conditions, the product would probably have positive effects as it would help restore the balance of the animal's intestinal microbiota.

In another study, Santos et al. (2008), in an experiment involving 750 broilers of Ag Ross 308 strain, sought to observe the effects of the probiotic Colostrum avis® — composed of bacteria of the genus *Enterococcus*, producers of lactic acid, mannanoligosaccharides and lactose — on the development of birds. Zinc Bacitracin, a dehydrated product precipitated from the fermentation of *BacilusLicheniformis Tracy*, was also used to support growth. Additives added directly to water and feed did not provide greater weight gain, increase in feed conversion or feed intake, in the analyzed phases (initial/growth/final). Significant results were due to the reduction in mortality and intestinal bacterial microbiota.

Traldi et al. (2009), in three experiments, sought to evaluate the influence of probiotic on zootechnical performance and carcass yield of broilers housed in a new

https://dx.doi.org/10.22161/ijaers.5.5.25 ISSN: 2349-6495(P) | 2456-1908(O)

or reused bed. The 42 days after slaughter were submitted to a change of carcass yield.

Gonzales et al. (1998), when providing probiotic consisting of *Enterococcus faecium* and the antibiotic Avorpacin to broiler groups, obtained superior results in the parameters related to feed intake, weight gain and feed conversion in groups of birds that did not receive the probiotic additive. This result was also observed by Henrique et al. (1998) after the use of probiotic formed by a mixture of *Enterococcusfaecium*, *Lactobacillus acidophylus* and *Saccharomyces cerevisiae*.

Rocha et al. (2010) added probiotics, prebiotics and organic acids in the diet of broiler chickens, aged 8 to 21 and 22 to 43 days, in order to analyze the yield and performance of the cuts. During the experiment, the authors verified that the feed additives had effect only on the feed conversion and breast yield of the growing animals. In the other phases, supplementation did not influence performance. The results below the expected were determined by the low microbial challenge to which the birds were submitted, since the facilities that received them were clean and unoccupied.

For DemattêFilho (2004), probiotics ensure that chicks, raised in alternative (colonial) systems, acquire resistance against harmful microorganisms in the first seven days of life. These pathogens produce metabolites, which in contact with the mucosa, generate irritative effects, decreasing the absorption of nutrients. The action of probiotics is precisely to mitigate or prevent these problems that affect the bird from the first days of life, because there is the stimulation in the production of B vitamins, important in inducing the immune response to aggressions.

VI. FINAL CONSIDERATIONS

Probiotics, elaborated from beneficial microorganisms, contribute to the establishment of a protective microbiota in the intestine. Can be used in the feeding of birds raised in unhealthy (exposeds to the challenge, ie, to harmful bacterias) or salubrious environments, including country chickens, in order to promote growth. The disadvantage of the probiotics use in broiler breeding lies only in the cost and difficulty of acquisition (depending on the region). It is suggested the development of new research in which the microbiological challenge to birds be imposed.

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