

**Full Length Research**

# Review on the effect of probiotics in poultry production industry

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All the available evidences indicates that the discovery of the growth promoting property of antibiotics led to their use as antibiotic feed additives in animal feed at sub-therapeutic doses. However, the continued and non-judicious use of antibiotics has led to the selection and dissemination of antibiotic-resistant strains of poultry pathogens. The use of probiotics as an alternative to antibiotics in poultry feeding has been suggested. This paper was aimed at reviewing the role of probiotics on the poultry industry. Many authors, reported that probiotics increase feed conversion ratio and improve both economic and biological efficiency of poultry farms. Probiotics is reported to have increased the production performance of chicks and could be used as substitute of antibiotic in poultry feeding. Inclusion of Probiotics in broiler diet, competitively excluded salmonella bacteria from the intestinal tract. Inclusion of probiotics in broilers ration also increased the number of antibodies and effectiveness of macrophages. It was reported that feeding of probiotics or inclusion in drinking water of poultry improved the performance of all animal species of poultry and prevented bacterial diseases conditions. Thus the general tendency is that probiotics are found to be potential substitute for antibiotic feeding.

**Key Word:** Bacteria, Industry, Probiotics, Poultry

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## INTRODUCTION

All the available evidences indicates that the discovery of the growth promoting property of antibiotics led to their use as antibiotic feed additives (AFAs) in animal feed at sub-therapeutic doses. Although this has been beneficial for animal health and productivity, it has been, essentially, a double-edged sword. The continued and non-judicious use of AFAs has led to the selection and dissemination of antibiotic-resistant strains of poultry pathogens such as Salmonella, Campylobacter and Escherichia coli. The rapid spread of drug-resistant pathogens as well as emergence of antibiotic-related environmental pollutants is of global concern. Hence, the identification and development of new and effective alternatives to antibiotics that do not hinder productivity is

imperative. Some researchers suggested the use of probiotics as an alternative to antibiotics in poultry feeding.

According to Kapil .et al (2015), the term 'probiotic' is derived from a Greek word 'probios' means 'for life'. The term 'probiotics' was first used by Lilly and Stillwell in 1965 to designate unknown growth promoting substances produced by a ciliate protozoan that stimulated the growth of another ciliate. Currently the term covers a much broader group of organisms. Parker (1974) defined probiotics as "Organisms and substances which contribute to the intestinal microbial balance", including both living organisms and non-living substances. Fuller (1989) was critical for the inclusion of the word

'substances' in redefining probiotics as "a beneficial live microbial feed supplement which affects the host animal through improving its intestinal microbial balance".

The joint Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) Working Group defined probiotics as "Live micro-organisms which when administered in adequate amounts confer a health benefit on the host" (FAO/ WHO,

2001). This definition is widely accepted and adopted by the International Scientific Association for Probiotics and Prebiotics (Hill et al., 2014). The FAO and WHO definition of probiotics as "Live micro-organisms that, when administered in adequate amounts, confer a health benefit on the host" is the most widely accepted one. Some of the different definitions of probiotics provided before that of the widely accepted ones are summarized in Table 1.

**Table 1:** summary of the definitions of the term probiotics

S.n	Researchers	Description of probiotics
1	Lilley and Still well(1965)	Probably first used the term probiotic to describe substances secreted by one microorganisms which stimulated the growth of another.
2	Sparti (1971)	Used the term to describe tissue extracts which stimulated microbial growth.
3	Parker(1974)	Defined probiotics as organisms and substances which contribute to intestinal microbial balance.
4	Fuller(1989)	Redefined probiotics as a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance. He emphasized the requirement for a probiotic to be viable.

Probiotic are "mono or defined mixed culture of live microorganisms which when applied to animals, beneficially affect the host by improving the properties of the indigenous microbiota" and known as Direct Fed Microbial (DFM). Parker (1974) was the first to coin the term 'probiotic' and described it as "microorganism or substance, which contributes to the intestinal microbial balance". In 1989, Fuller defined probiotic as "a live microbial feed supplement, which beneficially affects the host animal by improving its intestinal balance".

It is believed by most investigators that there is an unsteady balance of beneficial and non-beneficial bacteria in the tract of normal, healthy, non-stressed poultry. When a balance exists, the bird performs to its maximum efficiency. When stress is imposed, the beneficial flora, especially lactobacilli, have a tendency to decrease in numbers and an overgrowth of the non-beneficial ones seems to occur. This occurrence may predispose disease condition resulting in reduced production parameters, such as growth and feed conversion efficiency. The use of probiotics is reported to contribute to the intestinal microbial balance of the birds. This being the cases, the objective of this paper is to review the role of probiotics on the poultry production industry.

## LITERATURE REVIEW

### Classification of probiotics

There is an array of micro-organisms used as probiotics,

which can be classified as follows.

1. Bacterial and non-bacterial probiotics: With the exception of certain yeast and fungal probiotics, most of the micro-organisms used as probiotics are bacteria.
2. Spore forming and non-spore forming probiotics: Although non-spore forming *Lactobacillus* and *Bifidobacterium* strains predominated initially, spore forming bacteria are now used.
3. Multi-species (or multi-strain) probiotics and Single-species (or single-satrain) probiotics: The microbial composition of probiotic products ranges from a single strain to multi-strain or species compositions.
4. Allochthonous probiotics and autochthonous probiotics: The micro-organisms used as probiotics which are normally not present in the GIT of animals are referred to as allochthonous (e.g. yeasts), while the micro-organisms normally present as indigenous inhabitants of the GIT are referred to as autochthonous probiotics (e.g. *Lacto- bacillus* and *Bifidobacterium*).

### Common species of bacteria in the production of probiotics

Various species are used in probiotic preparations i.e. *Lactobacillus bulgaricus*, *L. acidophilus*, *L. casei*, *L. helveticus*, *L. salvarius*, *L. plantarum*, *L. faecalis*, *Streptococcus thermophilus*, *Enterococcus faecium*, *Enterobactris faecalis*, *Bifidobacteria species*, *Saccharomyces cerevisiae* and *Touloopsis sphaerica*. However, *Lactobacilli* and *Streptococci* are most

commonly used treatments of bacteria in the production of probiotics (Kapil J. *et al.*, 2015). Most commonly used probiotics bacteria in poultry production are *Lactobacillus*, *Bifidobacterium* species (Wondwesen *et al.*, 2017).

## Manufacturing of probiotics

### Selection of microbial strains

In addition to being non-pathogenic to animals, micro-organisms used as probiotics are selected on the basis of their survival in the gastro-intestinal environment and ability to withstand low pH and high concentrations of bile acids. The strain, chosen should tolerate the manufacturing, transportation, storage and application processes, maintaining its viability and desirable characteristics (Collins, Thornton and Sullivan, 1998). The capacity of potential probiotic micro-organisms to withstand the gastro-intestinal environment can be tested with the use of *in vitro* method challenged with low pH (Hood and Zoitola, 1988; Collado and Sanz, 2006).

The capacity to tolerate an acidic environment and bile

salts varies among strains (Mishra and Prasad, 2005). The other desirable characteristic of the strain to be selected is its ability to adhere to the intestinal epithelium, enabling the probiotic strain(s) to colonize the intestine (Guarner and Schaafsma, 1998). The ability of the strain to grow rapidly on an inexpensive media is a requisite (Collins, Thornton and Sullivan, 1998) for economically viable production. Spore forming bacteria particularly that of the genus *Bacillus*, are increasingly being used as probiotics.

*Bacillus* spores are resistant to physical and environmental factors, such as heat, desiccation and UV radiation (Mason and Setlow, 1986; Nicholson *et al.*, 2000; Setlow, 2006; Cutting, 2011) enabling them to maintain their viability during feed pelleting, storage and handling. *Bacillus lavolacticus* DSM 6475, and two other species (total four strains) of *Sporolactobacillus* (*Sp. Inulinus* and *Sp. laevis*) were reported to be resistant to pH as low as 3. *B. racemilacticus* and *B. coagulans* were also found to be tolerant bile salt (Hyronimus *et al.*, 2000). Some of the criteria used in selection of microbial strains to be used as probiotics are indicated in Figure 1.

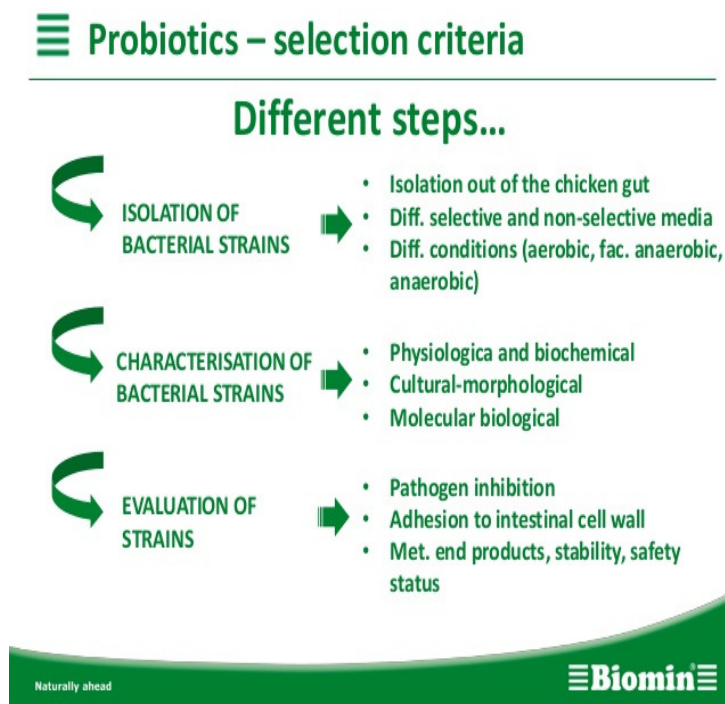
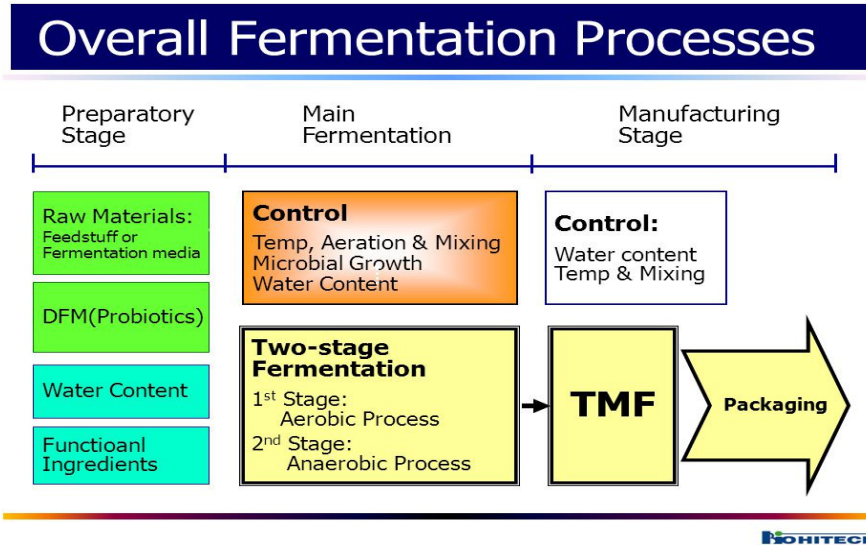


Figure 1. Probiotics selection criteria (Luca Vandl, 2013)

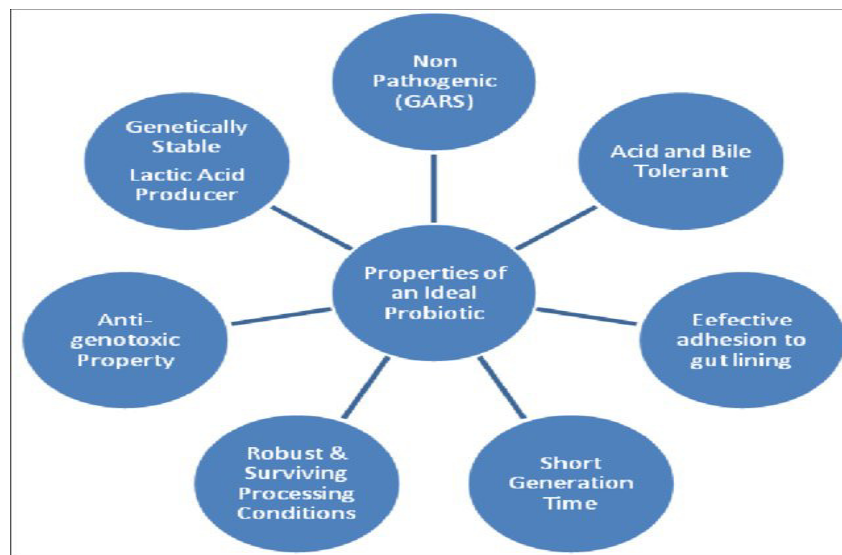
## Fermentation

Fermentation techniques (Figure 2) are used either to produce microbial cells in large quantity or to produce extracellular microbial products (e.g. food-grade lactic acid), enzymes, amino acids, vitamins and other

pharmaceutical compounds. Animal studies have used in probiotics culturing in the laboratory (Zhou *et al.*, 2010; Shim *et al.*, 2012), or in commercial probiotics production. Scaling up from the laboratory to a commercial product is not a trivial process, and quality control is paramount for a beneficial product outcome (Figure 2).



**Figure 2.** Fermentation process of probiotics (Muller et al., 2009)



**Figure 3.** Ideal characteristics of probiotics (Rajni Kant, 2018)

Growth media Micro-organism-specific growth media, either synthetic or dairy based, are generally used to grow probiotics in an economically viable way (Muller et al., 2009). Approximately 30% of the total cost of fermentation is that of media cost (Rodrigues, Teixeira and Oliveira, 2006). Dairy based media have been preferred for production of human probiotics, with the use of dairy-based foods such as yoghurt used as carrier. Some countries have legal requirements preventing the use of synthetic media for the production of human probiotics.

### Characteristics of an Ideal Probiotics

As shown in Figure 3, an ideal probiotic should have the

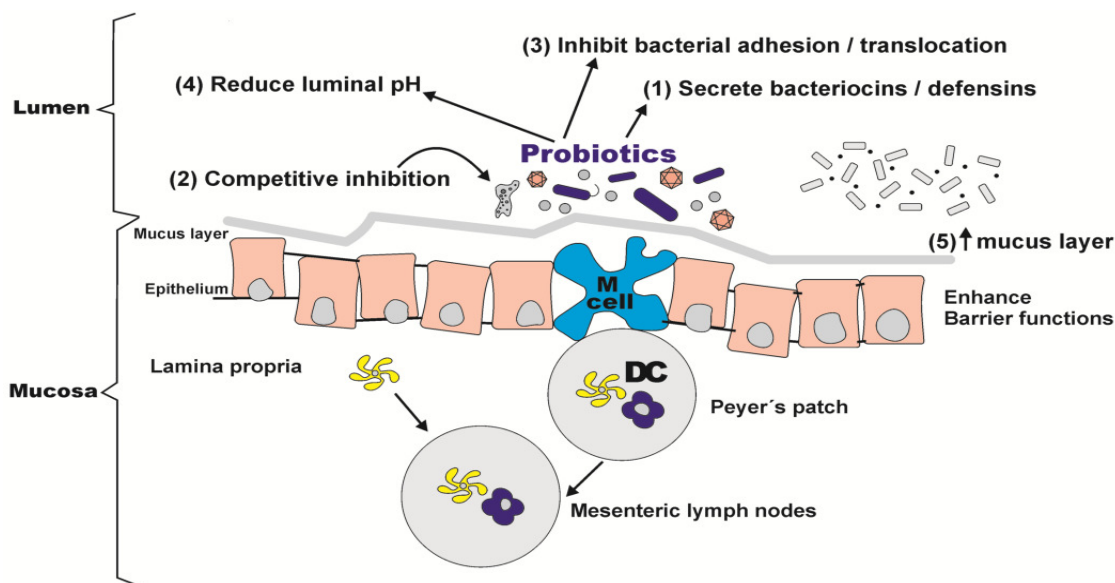
following characteristics (Kapil J,et al,2015):-,Capability of exerting beneficial effects on the host animal viz. increased growth or resistance to disease, on-pathogenic and non-toxic to animals and human ,should be present as viable cells, preferably in large numbers although the minimum effective dose is not fully defined ,ability to withstand processing and storage, high tolerance to bile and gastric acid (low pH),ability to adhere to epithelium or mucus ,persistency in intestinal tract ,ability to modulate immune response, ability to produce inhibitory compounds ,capability of altering microbial activity .

### Effect of Probiotics in the poultry Industry

The mode of action of probiotic bacteria are shown in Figure 4. Poultry production is one of the means of satisfying the increased demand for animal protein. Feed is the largest items in poultry production accounting for about 70% of total poultry production cost. Poultry production is an innovative and high technology sector producing chicken meat and eggs. Poultry rearing is considered to create rural employment, improve nutritional status of the people, generate family incomes and play a significant role in the social, cultural and religious lives of the society (Tadelle and Ogle, 2001; Halima *et al.*, 2009). Poultry and

poultry products are affordable compared to that of large animals. Despite the huge poultry population the per capita egg and chicken meat consumption in Ethiopia is very low.

Some of the major problems of poultry production in developing countries 'like Ethiopia include high prevalence of disease, low nutritional status, poor management practice and poor genetic makeup of the indigenous chickens (Tadelle and Ogle, 2001; Halima *et al.*, 2009). The use of probiotics is a good alternatives for the improvement of production performance and health of poultry. Probiotics are living microorganisms that could be used to improve chicken health through the provision in the diet. It could also results in balanced intestinal flora and improved nutrient digestion and absorption (Wondwesen *et al.*, 2017).



**Figure 4.** Inhibition of enteric bacteria and enhancement of probiotic bacteria ( Ng *et al.*, 2009)

The use of probiotics for human and animal health is continuously increasing. The probiotics used in humans commonly come from dairy foods, whereas the sources of probiotics used in animals are often the animals' own digestive tracts. Probiotic could be considered as a substitute for antibiotic growth promoters in broiler diets (J. Biernasiak, *et al.*, 2009). Antibiotics have been used as feed additives in poultry diet for many decades by veterinarians and poultry farmers before they were banned in many countries due to concerns with increased antibiotic resistance in pathogens and antibiotic contamination in food.

According to Jones and Ricke (2003), about 30 different kinds of antibiotics are used in poultry feed as additives or administered as drugs, and it is estimated

that more than 13.7 % of the antibiotics used in animal production are used at sub therapeutic (growth promoting) levels. The prohibition of antibiotic use is because of the residues of these drugs present in meat and eggs constitute a potential public health hazard to consumers. Probiotic have been described as opposite of antibiotics. While antibiotics destroy life, probiotics build up or promote life.

The major health risks associated with antibiotics feeding include the development of antibiotic resistance strain of pathogen. Hypersensitivity reactions, and the development of microorganisms resistant to antibiotics in humans (Dipeolu *et al.* 2005). When tetracycline is provided at 200 mg/kg of feed of birds, it is eventually released in the eggs, while the metabolism of

tetracycline continues in the body of the layer. Birds provided with an antibiotic-supplemented diet produced eggs with a tetracycline residue level of about 0.017 µg/g. These tetracycline residues started appearing in the egg from the second week after the birds were fed a tetracycline-supplemented diet. The tetracycline residues continued to present in the eggs even after 1 week of supplementation.

The Codex's recommended maximum residue level (MRL) for tetracycline in eggs is 0.02 µg/g. In the search for an alternative to antibiotics in poultry feed, the addition of probiotics has been proposed (Fuller 1989, 2001). Among all the probiotics utilized in poultry production, lactic acid bacteria (LAB) are the most commonly used. The addition of LAB replaces enteric pathogens by means of competitive exclusion in the poultry intestinal tract and subsequently reduces bacterial contamination in poultry products, thereby increasing the safety of chicken meat and eggs (Widodo Hadisaputro, 2015).

Probiotics are living microorganisms that can improve chicken health when provision in the diet and can balance the intestinal flora and improving nutrient digestion and absorption. This probiotic can be administered via a powder, capsule and in liquid suspension in adequate amount. The modes of action of probiotic are competitive exclusion, bacterial antagonism, stimulation of the immune and lowering the activities of the intestinal and faecal  $\alpha$  glucosidase and  $\alpha$  glucuronidase bacterial enzymes.

A good probiotic should have different character and functions. Like that of other antibiotics, probiotics have some risk or hazards to the host and environment.

Supplementation of probiotics to poultry production is mandatory for stimulating appetite, improve intestinal microbial balance, stimulate the immune system, decrease pH improve egg and meat quality and feed conversion ratio in poultry (Wondwesen et al, 2017).

According to Lutful, 2009, scientists now are triggering effort to establish the delicate symbiotic relationship of poultry with their bacteria, especially in the digestive tract, where they are very important to the wellbeing of man and poultry. Since probiotics do not result in the development and spread of microbial resistance, they offer immense potential to become an alternative to antibiotics. Probiotics can be successfully uses as nutritional tools in poultry feeds for promotion of growth, modulation of intestinal microflora and pathogen inhibition, immunomodulation and promoting meat quality of poultry.

According to the research report of M.Midilli et al, 2008, the addition of the probiotics in the poultry diet improve the feed conversion ratio. This may be due to it improve the microflora of the gut in the birds. The probiotics improve economic and productive efficiency of poultry farm and it also constitutes small cost portion from total or variables costs of poultry production (Mohammed A.E.Omar, 2014). This may be increase the feed conversion efficiency which reduces the cost of feed and increase the productivity of the farm (egg and meat produced per birds). It increases the performance of chicks and can be used as antibiotic growth promoter substitution in broiler diet (Mehdi T., 2011). In line with this report, according to Eman R. et al, 2011, probiotics improve productive and economic efficiency of broiler chicks. This may be due to it increase the feed conversion efficiency and reduces the cost of feed as the highest cost of the poultry is feed cost. The summary of the effect of the use of probiotics in poultry feeding are shown in Table 2.

**Table 2.** Uses of probiotics in poultry industry

S.N	Uses of probiotics	References
1	Improve feed conversion ration	M.Midilli <i>et al</i> , 2008
2	Improve economic and productive efficiency of poultry farm Constitutes small cost portion from total or variables costs of poultry production	Mohammed A.E.Omar, 2014
3	Increases the performance of chicks and can be used as antibiotic growth promoter substitution in broiler diet	Mehdi T., 2011
4	Improve productive and economic efficiency of broiler chicks	Eman R. <i>et al</i> , 2011
5	Competitively exclude the salmonella bacteria from the intestinal tract of the treated chicken, Increase the number of antibodies Increase the effectiveness of macrophages	G.S.Ghadban, 2001
6	Serve as alternatives to antibiotic in broiler starter feeds	Murshad MA and Abudabos AM, 2015
7	Used as non-antibiotic growth promoter feed additives	A.Ashayerizadeh, 2011
8	Improve the performance of all animal species	Ezema C., 2013
9	Uses for prevention of bacterial diseases in poultry	S.M.Lutful Kabir, 2009
10	Growth promoting effect	Natasha DuToit, 2011
11	Used as substitute of antibiotics	Irshad Ahmad, 2006
12	Supplementing indigenous chicken with probiotics in drinking water significantly improve the weight gains	Atela J.A., 2015

According to G.S.Ghadban (, 2001), scientific finding, probiotics competitively exclude the salmonella bacteria from the intestinal tract of the treated chicken .This means it increase the number of antibodies in the birds body. Probiotics serve as alternatives to antibiotic in broiler starter feeds (Murshad MA and Abudabos AM, 2015). In the poultry production, probiotics could be used as non-antibiotic growth promoter feed additives (Ashayerizadeh, 2011). According to the research report, probiotics improve the performance of all animal species (Ezema, 2013). In poultry diet, inclusion of the probiotics is done uses for the prevention of bacterial diseases (Lutful , 2009). Probiotics could also be used as vaccine in the poultry farm especially for the broiler production. In line with this scientific report (findings) according to the report of Irshad(2006), probiotics could substitute antibiotics in the poultry farm. It might reduce the negative impact of the antibiotics in the poultry product and public health issues.

According to the findings of Atela (2015) ,supplementing indigenous chicken with probiotics in drinking water significantly improved body weight gains. According to the finding of Natasha DuToit (2011) ,probiotics improved the growth promoting effect in the poultry farm. This may be uses as the catalyst to produce meat production from the broiler farm.

## CONCLUSION AND RECOMMENDATION

According to the different authors and organization, the role of probiotics on the increment of poultry productivity and product quality is very high. In the previous decade, to increase the product from the poultry production sector, antibiotics had great role. But the residue effect of the antibiotics on the human health is very dangerous. To mitigate this problem, it is suggested to the use of probiotics and other feed additive in poultry industry. Unlike the antibiotics, probiotics have no residual effect on the human health issues through the egg and meat of poultry.

In Ethiopia, there is a huge gap of demand and supply of the meat and egg production from the poultry production industry. There is also a problem of the availability of the balanced diet for the poultry sector both in quality and quantity. In addition to the problem of feed, there is also the serious problem of poultry disease. To bridge this gap, we should have to use different probiotics in the poultry diet and increase the productivity of the sector. The use of probiotics could also increase the availability of the protein source for human consumption.

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