

Review on Application of Probiotics in Poultry Production

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Abstract: Poultry production is one of the means of satisfying the increased demand for animal protein. Feed is the largest item of outlay in poultry production and it accounts to 70% of total poultry production cost. Poultry production is an innovative and high technology sector producing chicken meat and eggs. For improvement of production performance and health of poultry and human use, probiotics as an alternative feed additives. Probiotics are living microorganisms that can improve chicken health when provision in the diet and can balance the intestinal flora and improve 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 probiotics are competitive exclusion, bacterial antagonism, stimulation of the immune and lowering the activities of the intestinal and faecal α -glucosidase and α -glucuronidase bacterial enzymes. A good probiotic should have different character and functions. Like that of other antibiotics, probiotics have some risk or hazard to the host and environment. Most commonly used probiotics bacteria in poultry production are *Lactobacillus*, *Bifidobacterium* species. 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.

Key words: Microorganisms • Probiotics • Poultry • Intestine • Immunity

INTRODUCTION

The term poultry belong to a category of domesticated birds reserved by humans for the purpose of collecting their eggs and meat. Poultry can also be defined as those species of birds that produce economic service to humans and reproduce freely under their care. Poultry is usually taken by the rural farmer to mean chickens because they are reared more often than any other kind of poultry [1]. The global poultry population has been estimated to be about 16.2 billion, with 71.6% in developing countries, producing 6.7 million metric tons of chicken meat and 5.8 million metric tons of hen eggs [2].

Feed is the largest item of cost in poultry production and it alone accounts to 70% of total poultry production. The steady increase in the cost of poultry feed ingredients and compounded feed is making less profit to poultry farmers. To lessen the cost of feeding, several feed additives like synthetic hormones and antibiotics have been extensively used to promote poultry production in recent years. From the varying additives, like antibiotics have been widely used in livestock diets due to their therapeutic effects [3].

The poultry industry uses antibiotic feed additives and synthetic hormones extensively for disease prevention, growth and enhancing poultry production but due to development of antibiotic resistant bacterial strains and residual effects of these feed additives in eggs and meat, they lead to various health risks to consumers. Therefore, the use of probiotics feed additives for better and intact production in livestock and poultry is compulsory [4].

Probiotics are a dietary supplement that increase the population of the micro flora, which are needed in the intestinal tract in order to process food properly, strengthen the immune system and help chickens to digest their food more efficiently and helping remain healthy and gain weight faster in chickens. The primary purpose of the gastrointestinal tract (GIT) is to digest and engage in absorption of nutrients in order to meet metabolic demands for maintenance, normal growth and development, but it also acts as a vital barrier preventing the entry of several potentially harmful pathogens from the external environment. It is well known that a well-balanced gut microflora is crucial for animal health and performance [5].

To maintain the balance of intestinal microflora in animals and chicken, it is important to prevent diseases by controlling the overgrowth of pathogenic bacteria. Supplementation of fermented foods containing probiotics for improved health [6]. Probiotics are used to improve the health of birds and subsequently result in better production [7].

The major advantage of probiotics is that different from antibiotics, they leave no residues in meat [8]. Probiotics are strain specific, living microbial cultures that produce beneficial results on the host's body. These living organisms may be bacteria, fungi or yeasts. They are isolated from the gut of a healthy adult animal and poultry typically of the same species to which the probiotics will be given [9]. Most commonly used probiotic bacteria in poultry are *Lactobacillus*, *Bifidobacterium*, *Leuconostococcus*, *Enterococcus*, *Lactococcus*, *Bacillus*, *Saccharomyces*, *Aspergillus* and *Pediococcus* spp [29]. In Ethiopia, the knowledge and application of probiotics in poultry production is yet limited.

Therefore, the objective of this paper is to provide general information with regard to the major application of probiotics in poultry production.

Overview of Probiotics: Definition Probiotics are viable bacterial or fungal cultures which are able to enhance the balance of intestinal flora and exercise valuable effects on the individual in which it has been administered. Probiotics are a group of dietary products that can be incorporated in animal and poultry rations to raise performance or reduce pathogenic bacteria [10]. Probiotics defined by the Food and Agriculture Organization and World Health Organization as live microorganisms when administered in sufficient amounts, confer a health benefit to the FAO/WHO [11].

Probiotics can be categorized into probiotic drugs, probiotic foods (Food ingredients and dietary supplements) and direct feed microbial (Probiotics for animal use) [12]. They are either single or multiple live microbial cultures which promote health benefits to the hosts. They are non-pathogenic and non-toxic in nature, when administered through the digestive route, are favorable to the host's health [13].

History of Probiotics The characteristics, actions, effects and importance of probiotics have merited a renewed popularity in contemporary culture, but probiotics are ancient history. Thousands of years ago, a Roman naturalist named Pliny the elder recommended drinking of fermented milk to treat intestinal problems.

Fermented foods are also mentioned in the Bible and the sacred books of Hinduism. Climates in the Middle East and Asia favored the souring of milk products, which were recommended for intestinal illness. This represented the therapeutic use of probiotics, even before the bacteria contained within them were recognized. Many of the same soured milk products are still being consumed today [14].

In 1906 Elie Metchnikoff, Russian scientist, at Institute Pasteur in Paris suggested the concept of probiotic in *Bacillus* bacteria. In 1907 he first observed the beneficial role of certain bacteria and suggested that it would be possible to modify the gut flora and replace harmful microbes with useful microbes and in 1908 he has received the Nobel Prize in medicine for his work demonstrating that harmful microbes can be replaced by beneficial microbes to treat intestinal illnesses. Metchnikoff is generally considered to be the "father of probiotics" [15].

Timing and Route of Administration There are various different methods for administering probiotic preparations to chickens. It can be given as a powder, capsule, liquid suspension and spray. The amount and interval between doses may vary. Probiotics may be given only once or periodically at daily or weekly intervals [16]. The way of administration and timing are main factors affecting the effectiveness of probiotics supplementation. Administration via the feed, compared to administration in the drinking water, result in a higher increase of average daily gain; besides the supplementation of probiotics during early life is of great importance to the host because harmful bacteria can modulate expression of genes in intestinal epithelial cells, so this can create a favorable habitat [17].

Features of Ideal Probiotics and Their Mechanism of Action Probiotic bacteria contain a minimum of 30×10^9 Colony Forming Units. They have high survival ability and multiply fast in the conditions within the poultry gut. They have important properties like acid tolerance, bile tolerance and a strong adhesive capability with the digestive tract of the poultry [18]. The effectiveness of a probiotic supplement depends upon what it contains. A good probiotic should have different characteristics and functions like: adherence to host epithelial tissue, elimination or reduction of pathogen, production of acids, hydrogen peroxide, antagonism to pathogen growth, non-pathogenic, non-carcinogenic and improvement of intestinal microflora [19].

Probiotics are free of intermingled antibiotic resistant genes, sufficiently stable while manufacturing, processing and storage and do not undergo recombination with pathogenic strains. These live microorganisms can

preferably be compatible with feed additives and have good sensory properties. Probiotics contain gram positive bacteria and must have a short generation time. They must attach to intestinal epithelium, have the ability to rapidly colonize the intestine edge of pathogenic microbes and constantly present gut microflora [20].

Probiotic supplementations are used to preserve a healthy microbial balance within the intestine to promote gut integrity and prevent enteric disease. This is accomplished through: competitive exclusion, bacterial antagonism, stimulation of the immune system [21] and lowering the activities of the intestinal and fecal α glucosidase and α glucuronidase bacterial enzymes. Competitive exclusion is probiotic strains that have the ability to maintain normal intestinal microflora and inhibit the pathogenic bacteria through competition for space and attachment sites [22].

Probiotic bacteria produce antimicrobial substances like volatile fatty acids and bacteriocins and have the ability to reduce pH that limit the growth or survival of pathogenic microbes [23]. Bacteriocins are a small class of secreted peptides or proteins produced by bacteria that kill closely related bacterial strains by permeabilizing their cellular membranes or delay essential enzymes [24].

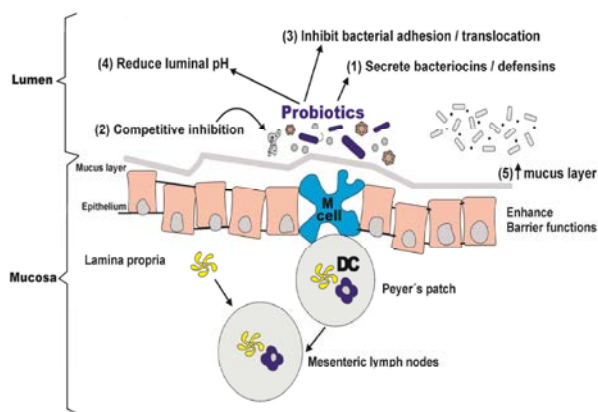


Fig. 1: Inhibition of enteric bacteria and improvement of barrier function by probiotic bacteria.

Source: Adapted *det al.* [25]

Role of probiotics in Poultry Production: The bird intestine is shorter and the gastric juice has lower pH as compared to that to the mammalian Gastro intestinal tract. Populations of microorganisms colonizing the chicken GIT should reveal higher acid tolerance in shorter periods of time [26]. Probiotic bacteria are either anaerobic or facultative anaerobic. The crop, proventriculus and gizzard have very few anaerobic bacteria due to the

presence of oxygen and hydrochloric acid [27]. The small intestine contains a large number of facultative anaerobes such as *Lactobacillus*, *Streptococci* and anaerobes like *Bacteroides* and *Bifidobacterium spp.* Probiotics colonize three different parts within the GIT; enterocyte, caecal and colonic epithelium; the most colonized region is colon and caecum [28].

The effect of probiotic depends on physiological state of the bird type, concentration of probiotic strain, persistence of intestine, ability to survive during feed processing of GIT and compatibility with natural microbial of the intestine [30].

Production Performance and Health Benefit

Of probiotics: The importance of probiotic supplementation in poultry production are: enhancing gut health by increasing a desired equilibrium in its microbial population in digestive enzymes and nutrient absorption, inhibits growth of pathogens, reduces mortality and improves growth rate [32]. The intestinal tracts of newly hatched chickens have no harmful microorganism. Through feeding, microbes slowly colonize the GIT forming a stable microbial association [33]. As harmful microbes are established they could cause localized microbial infections, intestinal putrefaction and toxic production [34].

Microbial infections occur in intestine of chicken resulting in weight loss, death and poor meat quality. Effective probiotics can reduce harmful microbes from the GIT of chickens [35].

Eggs production has been in relation to probiotic application. A combined mixed culture of *Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacterium thermophiles* and *Enterococcus faecium* enhanced egg size and lowered feed cost in laying hens [36]. *Bifidobacterium thermophiles* and *Enterococcus faecium* improved egg production and quality [37]. Probiotics increase egg production, improve egg quality and fall off egg contamination [38]. Supplementation of probiotics increase egg shell weight, shell thickness and decreased broken egg ratio in layers [7].

The highest production and egg weight in layers can be achieved with Liquid Probiotics Mixed Culture (LPMC) containing two types of microorganisms: *Lactobacillus* and *Bacillus* species. Probiotics supplementation improve meat quality of broilers and intramuscular lipid content involved in determining meat quality particularly nutrition, tenderness, odor, tastes and flavor characteristics [39].

Many researchers stated that there is a greater tendency to higher ratio of unsaturated fatty acids to saturated fatty acids in pectoral and thigh meat of broilers fed with probiotics diet containing *Bacillus*, *Lactobacillus*, *Streptococcus*, *Clostridium* and *Saccharomyces*. Their results concluded that the fat in meat was converted into favorable fat in the presence of probiotics, which contributed to smoother meat texture in chicken [40]. Probiotics like *Clostridium butyricum* added in diet of broiler have sensory attributes of the meat appearance, texture, juiciness and acceptability [41].

Probiotic role on Control of the Diseases And immune Response: Probiotic supplementation in feed is considered to be the potential for controlling necrotic enteritis and *Eimeria acervulina* and *Eimeria tenella* infection with effective reduction of oocyte [31].

The immune modifying effect in poultry happens as the live microbials move along the wall of the intestine and multiply to a limited extension and the dead organisms are absorbed and stimulate the immune system [42]. Continuous use of probiotics has a noticeable effect on the immune system. Stimulation of humoral and cell mediated immunity through enhanced production of natural interferon/cytokines, increased macrophage, lymphocyte, natural killer cell activity, up regulated oxidative burst in heterophils and increased immunoglobulin (IgG, IgM and IgA) [43].

Supplementation of probiotics in layers increases cellularity of Payer's patches in the ileum; it is an indication of stimulation of the mucosal immune system, which secrete IgA in response to antigenic stimuli. Probiotic treated birds have significantly more serum antibody IgM than birds that are not treated with probiotics [44].

Probiotics produce a gut stabilizing effect and immune regulation, particularly through balanced control of pro-inflammatory and anti-inflammatory cytokines. Probiotics increases the number of lymphocytes and lymphoid cells in lamina propria and intra epithelial lymphocytes in the small intestine and inhibit the growth of infectious organisms. Probiotics can enhance the resistance of birds and partially protect against the negative growth effects associated with pathogenic microbes and also considerably lowers the pathogenic microbial load in the intestine, lowering the risk of their spreading in the housing through fecal contamination [20].

Feeding probiotics could improve antibody titers against viral diseases like Newcastle disease and Infectious bursal disease. By increasing the immune status it is possible to prevent enteric infections and help reduce the losses due to secondary infections in birds observed commonly during viral diseases or immunosuppressive conditions [45].

Influence of Probiotics On intestinal Development: Supplementation of dietary treatment with probiotic *Lactobacillus spp*, influence the villi height and crypt depth in the small intestine of broiler chickens. Probiotics can enhance gut development and length of intestinal villi and decrease the depth of crypts in poultry. Increased cellular turnover requires a substantial amount of energy utilized towards growth. Longer villi and shallower crypts are related to decreased cell replacement and longer enterocyte lifespan [46]. The intestinal crypt in enterocytes undergo continuous proliferation in order to replace cells lost at the villus tip due to normal sloughing or inflammation from pathogens [47].

The Effect of Probiotic on Feed Intake and Feed Efficiency: The improvement in performance and productivity of poultry production due to the use of probiotics in feed has increased feed intake and improved feed efficiency [48] and increase feed intake along with significant improvement in feed conversion ratio [49]. Probiotics help in metabolism of minerals and synthesis of vitamins (Biotin, Vitamins-B1, B2, B12 and K), which are essential for proper growth and metabolism in chicken [50].

The use of *Enterococci* as probiotics in chickens prolonged feeding with *Eimeria faecium* improved egg laying intensity and feed conversion efficiency [51]. Rise in feed and water consumption is recorded in laying hens fed with LPMC containing two types of microorganisms: *Lactobacillus* and *Bacill* spp, [39]. The investigator found that inclusion of probiotic (*Lactobacilli* and *Bacillus subtilis*) in diet enhance feed efficiency and growth performance in broilers. Broilers probiotic supplemented diet had better weight gain and feed efficiency when compared to the broilers feed without probiotic supplement [52].

CONCLUSION

Feed is the major constraint of the total cost for meat and egg production. It accounts for 70% of total cost poultry production. Probiotics are live microorganisms,

when administered in sufficient amounts; confer with a health benefit on the host. Use of probiotics is better for quality production of egg and meat than any other growth promoters. Supplementation of probiotics is effective in newly hatched chickens rather than the adult. Probiotics have numerous roles in poultry production and health. Although the intake of probiotics has been associated with many beneficial effects in poultry production, the exact mechanism through which they produce these beneficial effects is still not completely understood. In Ethiopia, the usage of probiotics in poultry feed supplementation is very limited.

Based on the above conclusive remarks, the following points are forwarded as recommendation.

- In Ethiopia, researches should focus on the advantage of supplementing poultry with probiotics.
- Awareness creation to people and farmer's on the usage of probiotics in poultry production should be exercised.
- To improve the poultry production and productivity, the government and private investors should participate in the establishment of probiotic feed processing.

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