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Use of Probiotics, Prebiotics, and Synbiotic in Poultry Nutrition: A review

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ABSTRACT

Since 2000, there has been a growing trend towards using probiotics, prebiotics, and synbiotics in poultry nutrition. Although the probiotic was first used to bring about early microbial balance in the chicks, current studies have revealed the existence of other great benefits for the use of probiotics, prebiotics, and synbiotics. Including improving the productive performance of flocks of broilers, laying hens, and broiler breeders. It has been proven that probiotics contribute to improving growth and feed conversion ratio and reducing mortality of broiler flocks. It also leads to improving egg production, raising fertility and hatching rates. Reducing level of cholesterol in blood of birds and their products such as meat and eggs, as well as maintaining the effectiveness of liver by removing toxicity of many types of bacterial toxins and some metabolic products of harmful bacteria by process called Detoxification. In addition to increasing the rate of digestion and availability of many nutrients such as proteins, fats, carbohydrates, mineral elements, vitamins, metabolizable energy, increasing effectiveness of immune system, raising level of cellular and humoral immunity and also reducing need for use of antibiotics by impeding speed of growth and settlement of pathogenic bacteria such as Escherichia coli, salmonella and streptococcus and Campylobacter. Finally, reducing the incidence of diseases that threaten the lives of domestic birds and decreasing their productive efficiency, it has been confirmed that the development of intestinal flora plays an effective role in reducing the incidence of respiratory diseases. Based on the benefits mentioned above, this review highlights the importance and benefits of using probiotics, prebiotics, and synbiotics in the diets of domestic birds.

***Keywords*:** Probiotics; Prebiotics; Synbiotics; Poultry nutrition; Gut health; Feed efficiency; Immune response.

INTRODUCTION

Poultry are fed a complete diet of nutrients to obtain high production of meat and eggs [1]. Antibiotics have been used in the poultry industry for more than half a century, in order to prevent bacterial infection and improve the productive performance of poultry, but these sub-therapeutic doses in poultry led to the development of antibiotic-resistant bacterial strains [2]. This raised concerns from consumers and international organizations regarding use of antibiotics, which led to ban on the use of antibiotics by the European Union in the year 2006 [3]. Accordingly, researchers have shown interest in finding effective alternatives to these antibiotics, which have the same positive without negative characteristics, such as improving body weight, weight gain, food conversion ratio, and protection against bacterial infection. Probiotics are among these alternatives to be adopted in the poultry industry [4]. This is due to the possibility of improving the productive performance of poultry [5]. Probiotics have been defined by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) as living microorganisms that, when given in appropriate quantities to the host, confer a health benefit on it [6]. Probiotics is also known as one of the manufactured products that consists of beneficial microorganisms that are isolated from intestinal flora in digestive tract of birds. They cover the receptors of intestinal epithelial cells, thus preventing pathogenic bacteria from obtaining an adhesion site on these cells and excluding them outside the body, as well as its contribution to restoring the microbial balance of intestinal flora when adult birds are exposed to stress factors such as high temperature and disease [7]. While prebiotic is defined as a group of polysaccharides of cell wall of bacteria, yeasts, molds, and some medicinal herbs that have the beneficial medical effect of those herbs, these polysaccharides are consumed by beneficial

intestinal bacteria, which have an important role in closing receptors on the surface of pathological bacteria walls [8]. The Synbiotics is a mixture of probiotic and prebiotic. These products are used as nutritional additives to improve the general health and productive performance of poultry [9]. The competition between international companies interested in feed industry and their additives has become a prominent feature in the manufacture of these products, which is one of the means to protect beneficial microorganisms and ensure their access to the digestive tract of birds with high vitality [9] .In the last decades of the last century, microbial sources became the most important approved sources for obtaining growth in raising commercial chicken flocks [10]. Other current studies in this field have revealed the role of probiotic products in causing morphological changes in gastrointestinal tract, such as thickness of epithelial layer, length of villi, and rate of transformation of epithelial cells of lining layer of intestine .these products affect the creation the microbial balance of intestinal flora, especially when it comes to diversity of microorganisms used in production of probiotics [11].

The microbial community in the gut of domestic birds:

The digestive system in chickens is a repository for a mixture of many and varied microorganisms, and this gut for newly hatched chicks is devoid of microorganisms [12]. The microorganisms residing in the digestive canal of chickens are constantly changing in terms of their type and number [13]. The microbial balance of the chicks occurs during the first three days of hatching when the natural hatching is adopted by mother as well as when she incubates the chicks, while the ideal microbial balance of the intestinal flora in the newly hatched chicks is delayed until the third week of age when modern breeding is followed [14]. [15] indicated that the digestive system of poultry contains more than (650) types of microorganisms, and that microorganisms are found in all parts of the digestive canal of birds [16], and bacterial aggregations represent the majority of microorganisms in the digestive canal [17]. Gram-positive anaerobic and facultatively anaerobic microbiota species account for most of the microbial community [18]. The composition of the intestinal flora in the gut of birds depends on the pH of each segment of the gut [19]. In the caecum, when the components of the caecum stabilize at the age of 35 days of age, it is noted that Bifidobacteria and Bacteriodes are dominant, but at the beginning of the life of bird, the microbiota in caecum is sometimes dominated by Clostridia and Bacilli in high numbers [20]. It is noted that anaerobic, non-anaerobic bacteria and Spore-forming bacteria outnumber facultative anaerobic bacteria, and the intestinal flora continues to increase and become more complex during the next weeks of the bird's life [19]. [21] found that 80% of the components of the intestinal flora in caecum of a bird at the age of (5) weeks are Gram-negative, anaerobic, non-spore-forming bacteria belonging to the Bacteriodacea family, and the remaining numbers belong to Gram-positive anaerobic, non-spore-forming and bacillus-forming bacteria in addition to Bifidobacterium.

Probiotic:

The word “probiotic” is of Greek origin meaning Pro mean (for) and bios mean (life) meaning “for life” [22]. It is a source of live, beneficial microorganisms, whether they are bacteria, yeasts, or molds isolated from the intestinal flora of the digestive tract of birds .Current studies have indicated that adhesion has a role in promoting general health and growth, and the importance of probiotics has emerged when used as a therapeutic or preventive measure for most health problems [23]. The word of probiotic was originally used by [24] to describe growth-promoting factors produced by the microbiota, but later [25] defined a probiotic as the microorganisms, or metabolites, that contribute to the balance of the Intestinal micro flora, while [26] defined probiotics as a culture of certain live microorganisms, mainly *Lactobacillus spp*, which reside in the intestine of the animal to ensure the rapid and effective settlement of beneficial microorganisms in the intestine .[27] indicated that the early popularity of this hypothesis reached its climax in the United States in the mid-thirties, and then interest in this topic waned, especially after World War II, when antibiotics were used and were very effective at the time, as they destroyed all microorganisms in the gut, since then, antibiotics have been widely used in poultry as catalysts to improve growth and feed conversion efficiency .However, the widespread and long use of antibiotics as therapeutic agents and as growth stimulants since the year (1950) has led to growing concern regarding the development of resistance in microbial colonies, which makes it difficult to treat them with antibiotics later, as well as precipitation of these antibiotics in animal products [28]. Since then (the mid-fifties), there has been a slow increase in studies related to the use of human microorganisms on the one hand and animals on the other hand, but the occurrence of an epidemic (salmonella) in poultry fields in America during the eighties of the last century and the failure of attempts to control it using antibiotics, Interest has again grown with the use of intestinal flora [29].

Components of Probiotic and its types of microorganisms:

The probiotic generally consists of useful microorganisms, carriers, and fillers. [30] explained some of the criteria used to detect the validity of the probiotic, such as studying the characteristics of general and specific microorganisms in terms of strain type, and pathogenicity .As well as studying the environmental characteristics such as tolerating external conditions, carrying capacity, resistance to low pH, resistance to bile salts, adhesion ability, and growth rate inside the gastrointestinal tract. And after the validity of some microorganisms to be used in the production of the probiotic for poultry at the present time has been proven, the following microorganisms have been widely used.

Lactobacillus acidophilus:

This bacterium was isolated for the first time by [31], and its physiological characteristics were summarized as sticky, mostly round ends, non-motile, without flagella, non-spore-forming, Gram-positive, negative for catalase test, anaerobic but tolerant to little air (Microaerophilic), does not produce acid-producing pigments and homofermentative (homo-coagulant), non-ammonia-producing of the amino acid arginine. Its optimal growth temperature ranges between 35-38 °C and the best pH for its growth ranges between 5-6 [32], with complex nutritional requirements due to the fact that its enzymatic systems are simple, which makes it unable to manufacture many amino acids and vitamins necessary for metabolism and growth [33]. *L.acidophilus* bacteria are one of the species of the genus Lactobacilli, which represents the largest proportion of the intestinal flora present in the chicken crop [34]. It can be distinguished between the types of this genus using several tests such as gelatin decomposition, carbohydrate fermentation, production of polysaccharides outside the cell, tolerance of bile salts, Proskauer assay for acetoin production [35]. *L. acidophilus* the bacterium has been widely used in the probiotic because of its good features such as its high adhesion ability, as the first goal of carrying out the microbial exposure process using this type of bacteria is its colonization in digestive system, and the success of this depends on the ability of the strain to adhere to the epithelial cells of the crop and spread from the crop to other parts of the digestive system [36]. In addition to its consumption of cholesterol and the increase in the number of lactobacilli and its high production of acid and factors that inhibit the growth of pathogenic bacteria such as *Escherichia coli* and *salmonella* [37], and its ability to stimulate the immune system and its possession of enzymes that increase the effectiveness of digestion and absorption of essential nutrients [38]. Many studies have shown that the bacteria L.acidophilus has an important role in improving the productive performance of chickens since it was discovered for the first time by Tortuero in (1973) and this improvement may be attributed to the increase in nutritional value of grains used in diets such as wheat, barley and yellow corn as a result of fermentation caused by these bacteria in chicken crops [39], which leads to the availability of some amino acids, vitamins, calcium and zinc [40] and this is what encourages workers in this field to use the probiotic containing *L. acidophilus* bacteria [41].

Bifidobacterium*:*

This bacterium was studied with great interest, and the years between (1955-1957) were counted as the first historical phase that focused mainly on its relationship with the host and its nutritional and immunological importance [42]. It is rod-shaped bacteria, gram-positive, non-motile, and anaerobic. It plays an important role in maintaining the homeostasis in the gut and promoting the health of the host [43]. Physiologically, they are an obligate anaerobes, non-spore-forming, also they are heterofermentative producing acetic and lactic acids as the main end products [44]. The temperature for optimal growth is 37 °C, and the typical pH is between 6.5-7.0 [45]. They present in the human intestinal microbiota as well as in the gastrointestinal tracts of various animals, and in fermented dairy products [46]. Some of the common species include *Bifidobacterium bifidum, B. breve, B. longum*, each have a probiotic property [47]. Certain strains enhance the immune system by producing the IgA, also the assist in digest and improve the lactose tolerance by the activity of beta galactosidase, they also compete with some pathogens for adhesion sites and nutrients, and inhibit the harmful bacteria [48].

Bacillus subtilis:

Bacillus subtilis is characterized as gram-positive, motile and with peritrichous flagella, with high tolerance to salinity, obligatory aerobic or facultative anaerobic, its colonies are frothy or coarse, convex, produce lactic acid in a simple way, do not produce indole from tryptophan, do not hydrolyze casein, starch and gelatin, do not produce lecithinasee enzyme, and the optimum temperature for its growth is 37 °C [49]. This bacterium was discovered by Cohn in the year (1872), and the most important characteristic of it is that it is spore-producing and its location is medial or close to the end with a slight swelling of the sporangia sc , according to what was indicated by [50] which facilitates the process of giving it to chickens as a result of its spore-forming ability in difficult external conditions. The spores of this bacterium can be used as probiotics that act through competitive exclusion in humans and animals. When given in form of spores and by oral administration they will grow and multiply in the gastrointestinal tract, thus

competing with pathogenic bacteria and restoring the microbial balance of intestinal flora, which is reflected in improvement of productive performance of chickens [51]. Bacillus subtilis does not exist in an endemic manner in the gastrointestinal tract, so it is a transitional microorganism. It supports lactobacilli in getting rid of pathogenic bacteria and establishing or restoring the microbial balance of the intestinal flora through its many benefits, as it secretes many secondary metabolites such as antibiotics such as Bacitracin and important enzymes in the digestive process, such as beta-glucanase and amylase [52].

Saccharomyces cerevisiae:

This yeast belongs to the genus Saccharomyces and species cerevisiae, the first means sugar fungi, while the second means a participant in brewer's yeast. This yeast is characterized as single-celled organisms that appear in an oval shape with a white or brown color. It tolerates acidic conditions and multiplies vegetatively by budding and sexually by ascospores [53]. The biomass of S. cerevisiae consisted of 50-52% protein, 4-7% fat, 30-37% carbohydrates and 7-8% minerals [54] when it was hydrolyzed after the addition of degradative enzymes. The cell is surrounded by a strong cell wall that contributes more than 30% of the weight of the yeast composed of protein, fat, and polysaccharides including Fructooligosaccharides and Mannanoligosaccharides and they are used as food additives for poultry diets [9]. S. cerevisiae yeasts are present freely in the lumen of the gastrointestinal tract and do not stick to the epithelial cells, and it has a synergistic effect when accompanied by lactobacilli bacteria as a result of its high consumption of oxygen, which provides anaerobic conditions for that bacterium .It secretes some enzymes into the intestines that increase the availability of nutrients for the diet, as well as increasing the digested protein in the digestive tracts of chickens .Also, the presence of B complex vitamins in balanced proportions in yeast stimulates the growth of lactobacilli and thus lowers the pH of the intestine which inhibits the growth of pathogenic bacteria such as Escherichia coli and Salmonella bacteria, and reduces the chance of their adhesion to epithelial cells in the bird's intestine and their adhesion to the walls of yeast cells [55]. The structural function of yeast are evident in their positive effects on cells lining the intestines, quickly rebuilding them after their damage as a result of disease or the use of antibiotics to restore their function in the absorption of digested food, as well as containing digestive enzymes for food compounds to break them down and transform them into a simpler form that enables birds to benefit from them and their ability to remove mycotoxins such as aflatoxin B1 and reduce their toxic effects by sticking to the cell wall and then leaving the body without affecting the birds [56].

Aspergillus niger:

It is one of the microorganisms that belongs to the kingdom of fungi, phylum Ascomycota, order Eurotiales, family Trichocomeceae genus Aspergillus and species niger, [57]. Since 1923, the fungus A.niger has been used to produce citric acid [58], and it also produces a group of organic acids such as lactic, malic, gluconic, succinic and oxalic [59], while many of scientific studies indicated that there is very wide range of enzymes secreted by A. niger which are used for various purposes [60] as Gluco-amylase, Cellulase, , B-Glucosidase and Hemicellulase, these enzymes help digest starch, cellulose, and other polysaccharides. Beta-glucanase enzyme hydrolyzate of beta-glucan found in barley, thus increasing the nutritional value of diets rich in barley. Also Lipase enzyme, which breaks down triglycerides and its temperature range of 30-43 °C and an ideal pH within 4-7 .Protease enzyme which breaks down dietary proteins in poultry diets .Phosphorases, such as Phytase enzyme which hydrolyzes phytate and affects to increase the availability of phosphorus and mineral elements.

Steps to produce Probiotic:

The process of producing the probiotic includes several successive steps as it begins with the isolation, purification and identification of the selected beneficial bacteria. Usually, the isolation takes place from areas in which bacteria prefer to exist within the gastrointestinal tract. It may be isolated from waste or from standard pure strains of the same bacteria present in birds gastrointestinal tract. many bacteria possess host specificity .For example, Bifidobacterium isolated from humans has the ability to stick to the epithelial cells lining the digestive canal of humans and loses this specificity when used for birds or other farm animals [61]. The selected bacterial strain must also have high stability during production, processing, lyophilization or freeze-drying and exposure to environmental until it reaches to digestive canal of the host [62]. Bifidobacterium is one of the species included in the GRAS list issued by the American Organization for Quality Control of Feed, which includes dozens of strains, species and bacterial species allowed for use in probiotics [63]. The methods of isolating it from birds varied, so some researchers isolated it from the cecum and its contents [64], and recently it was isolated from the crop [65]. Focus has been placed on the cecum region because of the dominance of this bacteria when the intestinal flora stabilizes and the pH in that region reaches 6 under normal conditions despite the diversity of the microbial content there [66]. The method of washing with buffers was commonly used to isolate Bifidobacterium from the ceca of chickens, which was conducted by [64]. In this method,

the two ceca are taken and their contents are emptied, washed with a washing buffer solution, and then cut into small pieces, and the decimal scales are grown on solid culture medium (Agar MRS) and incubated in anaerobic conditions for two days, then the colonies that appear convex, white, soft in touch, whole rims, are picked. When examined under a microscope, the bacteria of this genus appear as a pleomorphism, where it is curved in shape, in form of a bat, with terminal branches, or in a swollen spherical form, its clusters are single or bilateral, regular in the form of letter (V), and they may gather in rosette or chain formations and gram positive .There are many culture media that can be used to isolate promising Bifidobacterium, such as breast milk, tomato juice, meat or liver extract, and horse or sheep blood, after adding some antibiotics such as Neomycin and other compounds such as Sodium Azide and Ascorbic acid to improve their selective characteristics [67], the efficiency of some selective culture media for these bacteria was found, such as solid medium Agar MRS which the antibiotics Nalidixic acid and Neomycin sulfate were added at a concentration of 15 and 100 mg / L, respectively, and lithium chloride at a concentration of 3 g / L [68]. To increase the biomass of the microorganisms used in the production of the probiotic, a multiplication process begins for the microorganisms with high vitality by growing them in artificial culture media that have growth-encouraging factors. The liquid culture medium (MRS-broth) fortified with cysteine or cystine and sorbitol alcohol are used as a suitable medium for growth of Bifidobacterium and L.acidophilus compared with other culture media [69]. Other studies also indicated that fortifying the culture medium with 2% of casein hydrolyzed by trypsin, yeast extract, lactalbumin and β-lactogolobulin was better compared to meat extract or barley extract to obtain biomass for Bifidobacterium species [70], while nutrient broth culture was used to obtain large numbers of S.cerevisiae [71] to stop the increased growth and facilitate the delivery of microorganisms used in probiotic to all parts of the digestive canal in abundant numbers. The drying process of microorganisms is carried out with the carrier as a means to mitigate the effect of drying on it [72], and it has been scientifically proven that the use of Skimmed milk as a carrier is scientifically proven as a protective cover and a nutrient rich in important nutrients such as vitamins and amino acids for the microorganisms in probiotics [73] Thus, it is possible to ensure the safety, effectiveness and availability of microorganisms in the required numbers for obtaining expected benefits from them .The last step of the probiotic production process is mixing with the filler, where many studies indicated the diversity and different sources of it, may be legumes at a rate of 30% of the probiotic product [74], or sugar cane molasses at a rate of 20 kg per ton of feed [75], and soybean meal can also be used as a filler to improve the manufacturing qualities of probiotic products. And the factories producing probiotic are producing probiotic for humans by introducing beneficial bacteria into foodstuffs to produce therapeutic food or by lyophilizing bacteria and putting them on the market in form of pills, as well as other types of probiotics for farm animals, the most important of which is poultry. there is an urgent need to use these products in order to reduce high drug uses that cost developing countries a lot of hard currencies [76].

Mechanism of Probiotic action:

With the increasing importance of the use of probiotics in improving the health status and productive performance of domestic birds through the significant role it plays in maintaining the microbial balance within the gastrointestinal tract, the specificity of its action can be attributed to the specificity of microorganisms and the ability to stick. Scientific research has indicated that the microorganisms used in the probiotic have a broad-spectrum against pathogenic and spore-forming bacteria [77] through its two mechanisms, antagonistic activity and competitive exclusion. The following is explanation of these two mechanisms:

Antagonistic activity:

Antagonism between microorganisms is a common condition in nature. The beneficial microorganisms produce one of the most important antibiotic activities that they carry out, such as the production of acids during the process of catabolizing carbohydrates, which leads to an increase in the lag phase of acid-sensitive bacteria [78]. Also, the entry of acids into the bacterial cell will affect the substrate transport and oxidative phosphorelation processes, disrupting them and lowering the pH of the bacterial cell [79]. In addition to the production of antibiotic-like substances that contribute to an antibacterial effect against the rest of the types of microbes, and it was given a general name, which is (Bacteriocine), which is secreted by most lactic acid bacteria, and both Bifidobacterium and Enterococcus facium. Bacteriocins include many types of these antibodies, such as Reutrin, secreted by L ruteri, Bifidin, secreted by Bifidobacterium, Enterococcin, secreted by Enterococcus facium found in Biomin [80], and Enterococcin A-2000 secreted by Enterococcus faecium, which acts against Streptococcus, Bacillus, Closteridum perfringes and E. coli [81].

Competitive exclusion:

The importance of microorganisms used in the probiotic is highlighted by their ability to inhibit intestinal bacteria by competing with pathogenic microorganisms in occupying receptor sites on the epithelial cells lining the

gastrointestinal tract and thus facilitating their excretion and excretion with waste to the outside of the body [38], and this is one of the mechanisms of competitive exclusion. And as shown in Figure (1) [82]. It also creates a biological environment that determines the presence of a special type of beneficial microorganisms, while being harmful to other types of unwanted bacteria, such as the production of volatile fatty acids such as Propionic and Butyric by Bifidobacterium, which works to raise pH to 6.6, which is important to Inhibiting the growth and killing of bacteria belonging to the *Enterobacteriaceae*, such as Salmonella [83], as well as the production of some metabolites that contribute to killing and inhibiting the growth of pathogenic bacteria [84].

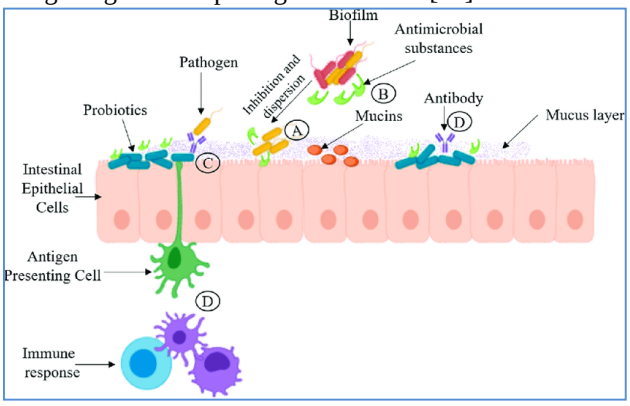

Fig. 1. Mechanisms of action of probiotics. (A) Competitive exclusion of pathogenic microorganisms. (B) Production of antimicrobial substances. (C) Increased adhesion to the intestinal mucosa and improvement of the epithelial barrier. (D) Stimulation of the immune system

Recently, materials have been produced that help in the process of competitive exclusion, such as (Kefir), which is formed from fermenting milk at room temperature after sterilizing it with (GAMA) rays, so that its pH is 4.8 .It is given to the chicks immediately after hatching and before the first meal of feed, either by oral dosing or in drinking water. It has been proven that this substance is highly effective in terms of chicks resistance to pathogenic bacteria and accelerates the colonization of the intestinal flora in digestive tract of chicks treated with it [84]. What is produced by the microorganisms used in the production of probiotics is not only required to be inhibitors of the growth of pathogenic organisms, but the produced substances may be beneficial to the host .It has been scientifically proven that Bifidobacterium present in colon produces of vitamin K and B complex vitamins, as it is absorbed in this region and thus reduces the appearance of symptoms of vitamin deficiency in people of advanced age [86].

Methods in providing Probiotics for birds:

The effect of probiotics, especially on improving growth in broiler chickens, is determined by several factors, including the type of product, the percentage added, age of birds, and the method of application [87]. Therefore, several methods have been used to administer or deliver probiotic preparations into the digestive tract of chickens, and the most important of these methods are:

With drinking water: The first this method is [88] as this method is the closest to practical reality in fields of commercial breeding [89]. Researchers who used probiotics with drinking water are [90]. The probiotics used with water may be in the form of a liquid preparation as in case of the probiotic called Active Elements™ [91]. Or it is in the form of a powder that is dissolved in water and offered to birds, as is the case with the Iraqi probiotic dissolved in water [92].

With feed: Many researchers used this method such as [93] who added a probiotic consisting of several types of bacteria (Lactobacillus and Bifidobacterium) and [94] who used two types of probiotics with feed, one of which was composed mainly of Enterococcus faecium and the other of Bifidobacterium, [95] who used the probiotic called (Primalac) with feed.

By Oral administration: The dose in this method is calculated accurately, as each bird receives an equal amount of the prescribed dose .However, one of the disadvantages of this method is that it is costly and induces stress, and it is used in the scope of scientific experiments only. This method is done by pumping the preparation directly through a tube with a non-pointed end through which the preparation passes directly into the crop [96] and the preparation is given by injection into the beak using a special syringe pumped in form of drops into the mouth, or by allowing birds to drink from a pipette tip in an equal dose as well. Dipping the beak into the preparation may be used but it is not

guaranteed that all birds will receive the same dose [12]. [97] made probiotic consisting of *Bifidobacterium adolescentis* and gave it to birds by oral administration.

By Spraying: This method was applied for the first time by [98] as the chicks were sprayed with special sprayers with a fine mist containing the probiotic preparations, a method that ensures the distribution of the preparations with high efficiency [99]. [100] used it to treat newly hatched chicks, either inside hatchery or in boxes that transport chicks.

Prebiotic:

It is an oligosaccharide of non-starch polysaccharides (NSP), obtained by breaking down cell wall of some types of yeasts, bacteria, the mycelium of some molds, or from some types of plant herbs rich in them. Among the most important types of these sugars (NSP), which were included in studies and used as a prebiotic are Fructooligosaccharide (FOS), Mannanoligosaccharide (MOS), and Glucooligosaccharide (GOS). These sugars cannot be hydrolyzed or digested inside gastrointestinal tract due to the lack of digestive enzymes [101]. These sugars are consumed by beneficial bacteria, such as Lactobacilli and Bifidobacterium, which have digestive enzymes, and thus their numbers and dominance will increase at the expense of harmful or diseased bacteria. These sugars have another important role by closing receptors on the surface of walls of pathological bacteria, thus preventing their adhesion to the epithelial cells lining intestine, as well as their role in addressing the negative effects of mycotoxins through the complexes they form with them and making them non-absorbable [102].

Prebiotic components:

The prebiotic consists of a group of oligosaccharide extracted from cell wall of bacteria, yeasts and mycelium of molds, in addition to its abundance in some medicinal plants and herbs .These oligosaccharides are non-digestible by birds and animals with simple stomachs because there are no enzymes for their digestion. After they are dried, they are mixed with diet as a prebiotic [103].

Steps to produce Prebiotic:

Nowadays, researchers have turned to stimulate growth in birds through the use of prebiotics, which means adding nutrients that the host's digestive system cannot digest and absorb to feed the beneficial microorganisms within the intestinal flora such as lactobacillus bacteria [104]. Numerous researches have been conducted to identify the best beneficial microorganisms that contribute nutrients and that can alter the microbial community within gut .Most of researchers agreed that *S. cerevisiae* yeast has amazing synthetic and many benefits [105]. The submerged culture method using a shaking incubator was used to obtain large numbers of *S. cerevisiae* yeast with high vitality. Yeast Extract Pepton Dextros (YEPD) and Nutrient broth were used as a growth medium [106], and for the purpose of obtaining biomass of *S. cerevisiae,* the culture is centrifuged. To stop the increased growth of yeast cells, biomass was washed with a buffer solution with a pH value of 7 [107], then the cell wall of *S. cerevisiae* was broken by one methods used .There were many methods used to break the wall of *S.cerevisiae* yeast, and they varied among them to extract the internal contents, but they participate in process of tearing the cell wall and liberating its nutritional components to the culture medium. [108] used extraction method by chemical solvents for its ability to dissolve lipids within cell wall and creating paths for the passage of cytoplasmic contents to the fermentation medium and thus disrupting the cell wall and liberating the rest of its components into the medium, while the method of extraction by ultrasonic waves is one of the most common methods for breaking cell walls and obtaining their cellular components [109]. Current scientific appointed that the use of crushing by glass granules with chemicals, which works to cause disruption in the cell wall, and through continuous stirring, the cell walls are broken and the contents of cytoplasm are released to the medium [110], while the extraction method by freezing and crushing causes disruption in the cell wall by freezing the cytoplasmic content and subjecting them to thawing and then grinding with sand, this leads to tearing cell wall and making cellular components to exit into the medium [111]..In addition, the yeast cell itself, upon its death, will secrete a enzymes that dissolve wall and contents of cell itself, thus removing its contents of nutrients and biological substances such as proteins, B complex vitamins, salts, sugars, fats, and other substances that have a vital effect on both the host and the intestinal flora [112]. After breaking down the yeast wall, it is dried and mixed with bird diets, or it may be mixed with soybean meal as a carrier material that contributes to the quality of prebiotic qualities [113].

Mechanism of Prebiotic action:

Most scientific studies have demonstrated that the mechanism of action of prebiotics is due to the action of its components, including cell wall and polysaccharides extracted from the walls of some bacteria, yeasts, molds, and some medicinal plants and herbs [9]. Also, the aim of using the prebiotic is to increase numbers of both lactic acid bacteria and Bifidobacterium, which are among the most abundant in the colon, as well as competing with harmful

bacteria in obtaining receptor sites on the colon epithelium and producing primary metabolites such as lactic acid and hydrogen peroxide that lower pH of medium. In addition to the fact that these two types of microorganisms convert toxic ammonia NH_3 into a non-transferable NH_4^+ ion through the walls of gastrointestinal tract which is less permeable and toxic. Thus, these beneficial microorganisms regulate the activity of other bacteria in colon, especially the diseased ones, which differ in their pathogenic effect if its grown in an unusual way, these pathogenic organisms remain under control of beneficial bacteria that prevent them from occurrence of several diseases resulting from the imbalance in the gastrointestinal tract [114]. One of studies conducted by [115] summarized the mechanism action of prebiotic in the host, where the beneficial bacteria present in intestinal flora ferment polysaccharides that are added with diet as a prebiotic to be used as a source of energy to increase their number and thus their dominance at the pathological bacteria causing intestinal disorders and injury with damage to commensal bacteria, through their competitive inhibition and displacement, and reducing chance of their adhesion to the receptors on epithelial cells of gastrointestinal tract, especially bacterial species that analyze proteins that produce harmful and dangerous substances to the health of the host, such as amines and indoles, as most of these substances are carcinogenic. Types of beneficial bacteria produce some bacterial proteins that work to reduce production of ammonia in intestine, thus reducing exposure to factors that cause hepatitis, as well as increasing their secondary metabolic products such as butyric acid which is a source of energy for colonocytes, which increases their synthesis and renewal continuously. Also, these produced acids lower the pH of intestine which increases solubility of minerals, improves their absorption, and reduces the re-absorption of bile acids, while reducing the formation and secretion of secondary bile acids, in addition to their action by regulating process of synthesis fats in liver and thus reducing concentration of fats and cholesterol in the blood serum. With the final result of all these data, mechanics, and vital actions by prebiotics, the risk of colon cancer will decrease [113]. .

Synbiotic:

It is a special combination that is a mixture of both the probiotic and the prebiotic to increase their efficiency through synergistic effect, greater than when each is consumed separately, as it mixes different types of beneficial microorganisms, whether they are bacteria or yeasts, molds, or a mixture of them with selected foodstuffs such as Oligosaccharides. These preparations are used as nutritional additives to bird diets to influence the host, in order to promote a healthy digestive tract to the best microbial balance, and thus improve health of birds, and this is reflected in productive activities of host [116].

Synbiotic components:

Current studies showed that the product called Synbiotic is a mixture of both probiotic and prebiotic to perform a common and beneficial action for the host by adding it to diet of birds in different proportions and at any age stage. Despite the scarcity of information available in this field and and the mechanism of synbiotic action in the gastrointestinal tract has not been extensively studied or explained, [117] showed that adding 1 kg of commercial synbiotic per ton of final diet for Ross broilers, improved weight gain and feed conversion ratio at 42 days, as well as a decrease in mortality compared with control .[118] compared two diets that were introduced during the first three days of turkey chicks'. The first was added Synbiotic, while the second was added probiotic. It was noted that the treatment of adding the Synbiotic led to an increase in body weight by more than 15% compared with second treatment and control on 7th and 14th day of age, It was found that the synbiotic combines the positive characteristics of both probiotic and prebiotic in one product, improving the general health and gastrointestinal tract of birds more effectively than when they are used separately [116].

Steps to produce Synbiotic:

The steps for producing Synbiotic include three steps, the first is the production of probiotic according to selection microorganisms by competent authority, the second step is the production of prebiotic, either by breaking down the microbial cells to obtain Nondigestible oligosaccharides (NDO) that are included in formation of their cell wall, or through Introducing roots or grains of some medicinal herbs that are rich in these sugars, such as (MOS), (FOS) and (GOS), the third step is to mix both together to produce a manufactured product called a synbiotic according to what indicated by [116].

Mechanism of Synbiotic action:

The increased interest in production of Synbiotic is due to the outcome of synergistic action of each of probiotic and prebiotic in promoting public health [119], as the first, which is a source of beneficial live microorganisms, closes the receptors on epithelial cells lining the gastrointestinal or respiratory tracts in manner that it prevents pathogenic microbes from reaching these receptors, such as *Salmonella* and *Escherichia coli*, from gaining a foothold on these cells, and thus they are eliminated from the body with the waste .It also leads to beneficial effects on health of host as

well as its role in maintaining the normal balance of intestinal flora [120]. While the second blocks receptors on the surface of pathogenic bacterial cells, thereby excluding them and facilitating their removal from the body, as well as being sugary substances that feed a wide spectrum of beneficial bacteria that are able to ferment and consume them as an energy source [101].

Conclusion

We can conclude from this study that the use of probiotics, prebiotics, or synbiotics in poultry diets, or through drinking water, spraying, or oral administration can improve productive performance and raise immune function, and thus improve the general health of poultry. Overall, incorporating probiotics, prebiotics, and synbiotics into poultry diets not only improves productivity and bird welfare but also supports the development of a healthier and more sustainable poultry industry.

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استخدام البروبيوتك، البريبيوتك والسنبيوتك في تغذية الدواجن: مراجعة

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الخلاصة

منذ العام 2000 كان هنالك نزعة نحو التوجه الى استخدام البروبيوتك، البريبيوتك والسنبيوتك. بالرغم من ان استخدام البروبيوتك في البدء كان الغرض منه هو التوازن الميكروبي المبكر في الافراخ، الا ان الدراسات الحالية كشفت عن وجود فوائد اخرى كبيرة لاستخدام البروبيوتك، البريبيوتك والسنبيوتك. من هذه الفوائد هي تحسين الاداء الانتاجي لقطعان دجاج اللحم، دجاج البيض ودجاج التسمين. قد اثبت علميا بان البروبيوتك يساهم في تحسين النمو ومعامل التحويل الغذائي ويقلل من حالة الوفيات في قطعان دجاج اللحم. وادى كذلك الى التحسين من انتاج البيض، زيادة معدل الخضوبة والفقس وزيادة بيض الوضع في قطعان الدجاج. ادى الى انخفاض مستوى الكولسترول في دم الطيور ومنتجاتها مثل اللحم والبيض. بالاضافة الى المحافظة على صحة الكبد عن طريق ازالة المواد السمية لكثير من انواع البكتيريا السامه وبعض المنتجات الايضية المؤذية للبكتريا بعملية تسمى ازالة السموم. تؤدي كذلك الى زيادة معدل الهضم ووفرة العديد من العناصر الغذائية مثل البروتين، الدهون، الكربوهيدرات، العناصر المعدنية، الفيتامينات، الطاقة الايضية وزيادة فعالية الجهاز المناعي ومستوى الخلايا المناعية والتقليل من الحاجه لاستخدام المضادات الحيوية عن طريق اعاقة سرعة نمو المستعمرات البكتيرية الممرضة مثل السالمونيلا والاشريشيا كولاي والستربتوكوكس كامبيلوباكتر. واخيرا، يساعد في التقليل من احتمالية الامراض التي تهدد حياة الطيور المحلية ويقلل من كفاءتها الانتاجية، ولقد اثبت بان تطور الميكروبات المعوية يلعب دورا مؤثرا في خفض احتمالية الامراض التنفسية. بالاعتماد على الفوائد العديدة التي تم الاشارة لها اعلاه، فان هذه المراجعة سلطت الضوء على الاهمية والفوائد من استخدام البروبيوتك، البريبيوتك والسنبيوتك في غذاء الطيور المحلية.

الكلمات المفتاحية: البروبيوتك، البريبيوتك، السنبيوتك، تغذية دواجن، صحة الامعاء، كفاءة التحويل الغذائي، الاستجابة المناعية.