ISSN 1533-9211

DOI: 10.5281/zenodo.10049646

PHYTOBIOTIC IN POULTRY NUTRITION AS AN ALTERNATIVE TO INFEED ANTIBIOTICS: A REVIEW ARTICLE

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Summary

Photobiotic are contained a wide range of compounds derived from plants such as essential oils, herbs and oleoresins. These can be used in commercial animals' diets to increase productivity by improving feed characteristics, enhancing the performance of the animals during production, and enhancing the quality of the byproducts produced from these animals(Windisch et al., 2008). Antibiotic growth promoters (AGPs) have been restricted in the EU, and a number of substitute chemicals are being investigated into in their stead. Due to their high concentration of pharmacologically active chemicals, photobiotic are referred to as one potential option. A huge number of in vitro and in vivo studies have confirmed a wide range of activities of photobiotic in poultry nutrition like stimulation of feed intake, antimicrobial, coccidiostatic and anthelmintic effects. Furthermore, it addresses safety concerns which may arise during application of photobiotic (Awaad et al., 2016). Additionally, over the past 20 years, the usage of photobiotic in animal feed has expanded. Studies revealed that the chances of human infections developing a resistance to antibiotics will increase if in-feed antibiotics are used excessively. The use of antibiotics as growth promoters was questioned due to bacterial resistance and antibiotic residues in animal products, which ultimately led to a prohibition on their use in feed in the majority of developed nations. Researchers and dietitians suggested photobiotic as an option. The existing documents generally point to the benefits of photobiotic on the performance of chickens. Further studies and investigations are still required to clarify many nutritional features of photobiotic due to the inconsistencies in published results. The use of particular herbs for the treatment of a given ailment as well as the abolition of the use of plant species that are potentially dangerous or toxic were made possible by numerous observations of the reactions of the animals. Currently, a wide variety of biologically active chemicals in plants that are responsible for their beneficial effects may be identified thanks to the intensive development of analytical tools. Use of plant additions, whether fresh or dried, fermented or freeze-dried, as well as water or alcohol extracts based on them, is permitted in poultry practices (Alagawany et al., 2019). These additives' mechanisms of action are not entirely understood. In addition to influencing digestion and the release of digestive enzymes, several plant extracts also have antibacterial, antiviral, and antioxidant properties (Cross et al., 2007). Therefore, they might perform a variety of tasks for the animal's body. Animals receiving feed supplemented with photobiotic show increased feed intake and secretions from the intestines (Windisch and Kroismayr, 2006). The beneficial interactions among complex active compounds found in photobiotic are likely what causes growth augmentation when they are used (Gauthier and Tarr, 2002).

INTRODUCTION

Food safety, environmental concerns, standardizing welfare standards, the prohibition of nutritional antibiotics, gut health, feeding rich in fiber ingredients, and maintaining high production efficiency are just a few of the challenges facing the poultry industry today. About 70% of the price of producing chicken goes towards the cost of the feed (Cooke et al., 1987) thus this appears to be the poultry industry's biggest obstacle. Farmers must develop a means to make reasonably affordable, high-quality goods with less of an environmental impact when feeding raw materials that do not compete with people if they hope to feed the predicted 9 billion people in the world by 2050. To increase poultry productivity, a variety of plant-derived

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

substances known as photobiotic are added to their diets (Cowan, 1999). Phytogenic feed additives differ greatly in terms of their chemical make-up. They are becoming more popular in the poultry and livestock feed business since they are all-natural, affordable, environmentally friendly, and leave no residues in the finished goods. They have nutrigenomics benefits, anti-stress characteristics linked to lipophilic character, anti-microbial, anti-coccidia, anti-fungal, anti-oxidant, immunostimulant, and modify gut microflora. (Windisch et al., 2008), they split the pathogens' cell membrane, causing ion leakage and membrane disintegration. It exhibits strong antibacterial activity against harmful organisms like E. coli, Salmonella, and Clostridium. They also lower blood cholesterol levels (Singh, 2008). In broiler chickens, photobiotic significantly increased the Hem agglutination Inhibition (HI) antibody titer against the H9N2 strain of the avian influenza virus. Additionally, they increase the performance and digestibility by promoting the synthesis of saliva, digestible enzymes, and bile.(Chowdhury et al., 2018).

Antibiotics are used to treat infectious illnesses in industrial chicken farming, but regrettably, their adverse effects are not limited to pathogenic microbes; they also negatively impact the natural intestinal microflora. In the chicken industry, antibiotics have been used as growth promoters in addition to the prevention and treatment of respiratory and gastrointestinal symptoms. (Skoufos et al., 2020) The frequent and random administration of antibiotics, especially those with a broad spectrum of action, has led to the selection of pathogenic microflora in the environment that are resistant to these medications. New, more potent antibiotics are developed as a result, and more bacterial strains that are resistant to therapy appear. Phytogenic feed additives may possess a variety of chemical compositions depending on what they contain and the impacts of the location, harvest stage, and storage conditions (AlAfifi, 2020). As a result, the consumption of phytobiotics in the poultry and livestock nutrition sector has been on the rise recently. They don't leave any traces in meat, milk, or eggs, are organic, affordable, and sustainable, and could be a great alternative to antibiotic growth promoters (AGP). According to some writers, a low concentration of tannins might raise the feed's palatability and boost an animal's productivity by encouraging feed consumption(Windisch and Kroismayr, 2016) Others suggest that the primary route of action is the induction of the gastrointestinal secretion (Lee et al., 2003). But tannins' primary way of action especially in young animals appears to be their antibacterial properties. Currently, 70–80% of firms apply phytogenic in pig and broiler diets(Singh, 2008). Chemicals from plants help regulate the microbiota-gut symbiosis in a manner that is generally similar to that of antibiotics. Lower expenses of immune protection may emerge from the host animals' subsequent release from harmful microbial activities and their unpleasant metabolites (Windisch and Kroismayr, 2016)

Probiotics

After the ban on antibiotic growing promoters (AGP), probiotics are becoming increasingly popular as feed additives in the chicken sector (Hejdysz et al., 2012). They are one of the more versatile feed additives and are simple to combine with other additives. Above all, probiotics have a variety of advantages, such as regulating the body's immune response or enhancing the

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ISSN 1533-9211

DOI: 10.5281/zenodo.10049646

host's own internal microflora (Al-Fatah, 2020). In the poultry business, probiotics, which serve as antibiotic alternatives, have gained popularity in recent years as dietary supplements and feed additives. Moreover, probiotics are all-purpose feed additives that can be combined with other feed additives to promote enhanced performance and health. Both their direct and indirect favorable effects on the immune system of the bird can be seen(Menconi et al., 2014) in the gastrointestinal tract. Additionally, the quality of meat has improved, this shows that using probiotics can help farmers to achieve better production results., by enabling the body to better withstand stress and illnesses, bird immunity is boosted. (Fuller and Freter, 1992). The bacteria and yeasts that make up probiotics are mostly those that produce lactic acid. Yeasts and bacteria may be present as living microorganisms or as spores. The majority of probiotic products on the market today include strains of Lactobacilli, Bacilli, Streptococci, Bifidobacterium, and Sacharomcyces. Probiotics improve the immune system, lower intestinal pH, produce bacteriocins, lysozyme, and peroxides, and work by competitive exclusion. Prebiotics and probiotics are used in a symbiotic relationship (Panda et al., 2006). AGP is basically the usage of antibiotics outside of their intended application. The practice of encouraging antibiotic development has been around for about 50 years (Salim et al., 2018). Examples of some of the first ones utilized include streptomycin, tetracycline, and avoparcin. According to(Dibner and Buttin,2002), they were intended to result in either an increase in body weight or a drop in the FCR. 2006 was a pivotal year for the raising of livestock because of the EU's restriction on the application of antibiotics and hormone stimulants in the feeding of livestock under Regulation of the Council (EC) No. 2821/98. Countries including Mexico, New Zealand, and South Korea have elected to follow the European Union's lead and ban AGPs. This is the right thing to do, currently certain countries might consider it to be an extreme step. Regulations have been passed in the USA, Australia, Japan, or Canada that partially restrict and exclude some additives produced from antibiotics (Salim et al., 2018).

In the probiotic formulations of the present invention, chemicals or enzymes that stimulate phytases, cellulose proteases, or xylanases are made by probiotic bacterium isolates. Modern probiotic go through a procedure called granulation, which requires temperatures unfavourable to the bacteria. On chicken farms, adding probiotics to the feed is the most popular way to deliver them; however, there are many additional options, including sprays, granules, pills, coated capsules, powdered sachets, gavages (vaccines or injections), and sprayer. In addition to adding probiotics to the nutrition, growers are choosing to distribute formulations through the water.

Probiotics keep the beneficial bacteria population in line in a bird's intestine, which is essential for the animal's growth, production, and efficient feed conversion as well as for the stimulation of its immune system for combating diseases. Probiotics work in poultry farms by creating and preserving a healthy gut flora, enhancing digestion and nutrient utilization, effectively eliminating pathogenic microbes and infectious agents, decreasing pH and releasing a variety of antibacterial substances, and removing toxins.(Hajati and Rezaei, 2010). Beneficial probiotics have been shown to promote the development of normal microbiota in chicks and poultry (Higgins et al., 2007). Salmonella infection in chicks can be treated using probiotic sprays according to the research (Wolfenden et al., 2007).

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

Probiotics are a class of growth promoters that have been found to enhance immunological responses, increase feed conversion efficiency, and enhance growth in livestock (particularly cattle and swine) and poultry (Guillot, 2000,)

Prebiotic

Prebiotics are primarily oligo- and polysaccharides that are not digestible and decrease the pH in the gut to prevent the colonization of harmful microorganisms. They also boost immunity and neutralize poisons. Beneficial bacteria present naturally in the body's intestines use it as a source of energy. According to (Roberfroid, 2004), nondigestible plant fibers like fructooligosaccharides of the inulin type, mannooligosaccharides, and transgalactooligosaccharides (TOS) are of particular interest in the field of prebiotics. Prebiotics may have positive physiological benefits on animals by specifically increasing the digestive system's beneficial microbiota. The prevalence of enteric pathogens may decline as a result of this (Roice, 2021).

Prebiotics have already been shown in certain studies to be effective as an alternative feed addition, and as a result, they have begun to play a significant part in the nutrition of chickens. The advantages of MOS are based on certain characteristics, such as altering the intestinal microflora, slowing down the rate at which the intestinal mucosa changes, and modifying the immune system in the intestinal lumen. These characteristics may improve growth rate, feed efficiency, and livability in poultry species (Parks et al., 2001). However, the inclusion of prebiotics that in chicken feed has boosted productivity and improved the immunity of poultry. Prebiotics have been shown in a number of studies to be an alternative growth enhancer, and as a result, they are beginning to play a significant part in poultry nutrition, a complete information of the physiological reaction is hampered by the lack of studies, though. Consequently, the purpose of this study was to present a summary of prebiotics' definition as food additives, their chemical composition and way of action, and their application in feed, with a focus on how prebiotics affect poultry yield characteristics, nutrient digestion, carcass requirements, and the microbiota in the intestines. The advantages of MOS are based on certain characteristics, such as altering the intestinal microflora, slowing down the rate at which the intestinal mucosa changes, and modifying the immune system in the intestinal lumen. These characteristics may improve growth rate, feed utilization, and livability in poultry specie(Parks et al., 2001). However, several studies have demonstrated that prebiotics can be utilized as supplementary growth boosters, and as a result, they are now starting to play a significant role in poultry nutrition.

Prebiotics might be able to have an impact on the pathogen or the host without needing to involve the gut microbiome. Another method of action is the ability and persistent competition of represents colonization in the gastrointestinal mucous membranes to prevent pathogens from expanding and from replacing those that have already included, which is a significant performance parameter (Patterson and Burkholder, 2003). Many studies were conducted to support the benefits of prebiotics. In terms of productive performance, feed intake, body mass gain, and feed conversion ratio were primarily examined and analyzed. The majority of the trials had modestly beneficial effects, although significant outcomes were uncommon. More

DOI: 10.5281/zenodo.10049646

study is still required because there are practically endless options for prebiotic doses and products. The prebiotic composition employed in investigations must therefore be declared and specified. Prebiotics have the potential to be a replacement to AGPs in poultry feeding, it can be said in general. To determine the ideal quantity and exact mechanism of action, more research under more standardized circumstances is still necessary (Abdel-Wareth, 2016). Prebiotic components have a possibility of being considered as an alternative to in-feed antibiotics for increasing chicken performance and health, as well as to maintain healthy birds and improve nutrient digestion.

Organic acids

The word "organic acid" describes a large group of substances that are essential to the body's basic metabolic functions. Chemically, all organic acids share the characteristics of being soluble in water, having a certain pH, and not having any either secondary or primary amines. The majority of amino acids are excluded from the phrase, although it is commonly thought to encompass all carboxylic acids, whether or not they have hydroxyl, keto, or other non-amino functional groups. Included are some compounds with nitrogen like pyroglutamate and amino conjugates like Hippocrates (benzoyl glycine)(Hajati, 2018). Organic acids as solidified added to the feed for chickens results in lowering the pH in the crops in birds, this prevents fungal growth in the diet (Hajati, 2018). In addition, sprayed on the birds' housing, this reduces the quantity of ammonia released by inhibiting the microorganisms that help the uric acid break down (Hajati, 2018). Utilized to destroy bacteria in the water, help chlorine destroy bacteria, and reduce the pH of the crops the birds eat. If the organic acid is not separated the impact on gram-negative bacteria increases, due to this method of action, acidifiers must contain organic acids that are indissociably at various pH levels in order to extend the antimicrobial effect over a wider pH range (Suryanarayana et al., 2012). Poultry producers have suffered significantly as a result of growing output and health requirements. It is a well-known scientific fact that organic acid is an important source for fostering the development and prevention of numerous infectious diseases. Organic acids are antibiotic alternatives. Organic acids present potent and sustainable options for future barbecue production and health maximization. The immense future potential of organic acids can be enhanced by modern molecular, biotechnological, and Nano technological research and technology. In order to confirm and broaden the useful applications of organic acids, future research should concentrate on enhancing the quantity, duration, concentration, and exact way of action of organic acids (Khan et al., 2022).

Classifications and uses of organic acid

Chemical carboxylic acids, such as the amino acids and fatty acids having a structure called R-COOH, belong in the category of organic acids. These stomach acids only have a small influence on the bacteria in the intestines. Organic acids have been utilized as food additives for a long time to prevent food from spoiling and increase the expected lifespan of food items, particularly perishable food components. Saturated straight-chain monocarboxylic acids or derivatives thereof represent most acid compounds (Ricke, 2003). Animals' digestive systems, which are predominately bacterial environments, are where various acids are created, including butyrate, propionate, and acetate. Although other acids, like formic acid and the acid propionic, have been shown to have been employed for antimicrobial action against polluted pathogenic bacteria, particularly Salmonella, in the past, they were initially supplied to the animal food business as an antifungal substance (Ricke, 2003).

Table: Example of type of organic acid, dose, and effect against different pathogens in broilers

Organic acid	Dose	Effects	References
Formic acid + sodium format	0.9%	Antimicrobial effect against *Salmonella typhimurium*	(Adhikari et al., 2020b)
Mainly formic acid	0.5 kg/ton	Antimicrobial effects against *Campylobacter coli*	(Mortada, 2020)
Formic + propionic acids and their salts	0.1, 0.02, 0.04%	Antimicrobial effect against *E. coli* K88	(Emami et al., 2017)
Wheat bran fermented fatty acids	0.1%	Antimicrobial against *Salmonella*	(Dienstmann et al., 2017)
Medium chain fatty acids	Unknown	Antimicrobial effect against *Salmonella typhimurium*	(Abudabos et al., 2017)
Short and medium chain fatty acids	0.5–2.5 g/kg	Antimicrobial effect against	(Kumar and Nayar, 2021)

The increased grill efficiency in response to organic acid supplements is brought on by increased energy absorption and protein content in feed as well as decreased bacterial infections, enhanced immunity, decreased pathogenic levels, and decreased urea and other harmful metabolites (Khan and Iqbal, 2016). The higher FCR brought on by the reduced feed intake and improved nutrient usage may be the cause of the broilers injected with organic acids' enhanced growth in weight. The fatty acid bi-layers of the cell membranes of bacteria and fungi are also porous to undissipated organic acids and, therefore ripe for penetration. When an alkaline environment is present, the organic acid inside the cell emits a proton, bringing the internal pH down (Hernandez et al., 2006). Following this action, a chemical reaction results in the release of a proton from a bacteria cell and the buildup of internal anion. Digestive secretion, enterocyte expansion, enzymes from digestion release, and microbiological action of phytase are additional positive impacts (Dibner and Buttin, 2002).

Antimicrobial effect of organic acid

Organic acids have been employed in poultry farming as a method to decrease harmful microorganisms. Salmonella, Campylobacter, and Escherichia coli are some of the significant pathogenic bacteria that live in the gastrointestinal tract. Numerous studies have shown the favorable effects of organic acids by reducing these harmful bacteria in drinking water and the gastrointestinal tract (GIT), which ultimately enhances feed utilization and growth performance. (Khan et al., 2016) found a reducing in *Salmonella* in feed treated for 5 days with 1% formic acid.(Gonzalez-Fandos et al., 2020)found that citric acid solution decreased growth of *Listeria monocytogenes* on chicken legs stored at 4 °C for 8 days.(Adhikari et al., 2020a)found that The colonization of broiler chickens with Salmonella typhimurium was

DOI: 10.5281/zenodo.10049646

prevented by adding 0.9% organic acid (mostly sodium salt) to their feed.(Mortada et al., 2020)concluded that its impact on cercal load and carcass surface remained insignificant, organic acid (formic acid, cinnamaldehyde) substantially decreased the development of Campylobacter coli population in the in vitro investigation. In addition of all above, numerous investigations on organic acids have shown that they have a stimulating influence on poultry's natural immunity.(Lohakare et al., 2005) In his research, postvaccination IBD titer measurements showed noticeably increased IBD titers in the Vitamin C (0.2%) supplement group. It's possible that the increased titer in the vitamin C group is caused by the hexose monophosphate pathway's increased activity, which speeds up the development of lymphoid organs and, as a result, increases the amount of circulating antibody. The immune system's reaction to foreign antigens is mediated by CD4 and TCR-II cells, which increase the synthesis of Interleukin-2 and activate CD8, the natural killer (NK), and B cells. The 0.1% Vitamin C sample had a considerably higher number of these cells compared the control sample. In a study by(Ghazalah et al., 2011) Birds fed an organic acid-supplemented diet had heavier immune system organs such the bursa of Fabrice's and the thymus, as well as larger globulin serum levels.(Houshmand et al., 2012) observed that when organic acids was added to the feed of broilers, their antibody levels against Newcastle disease considerably rise. Organic acids have an antibacterial effect, just like antibiotics. Certain kinds of bacteria, such as Salmonella spp., E. coli, Clostridia spp., Listeria spp., and some coliforms, can have their cell walls penetrated by the acids, which can then interfere with their usual functions. Therefore, livestock supplied organic acids could observe a reduction in the quantity of some species of both pathogenic and normal gut flora (Suryanarayana et al., 2012)., each acid has an exclusive range of antibacterial properties, lactic acid is more while the acid sorbic is more widely recognized for its antibacterial qualities, it is also efficient over bacteria. HMB, propionic acid, and formic acid all have wider antimicrobial effects and may destroy yeast as well as mycoses and microbes (Doerr et al., 1995). Combinations of certain acids have been found to have synergistic antibacterial action in vitro. 12 E. coli has a MIC of less than 4 g/l for acetic, butyric, lactic, and caprylic acid, but the same bacteria is roughly 10-times more resistant to malic, tartaric, and citric acid (Hsiao and Siebert, 2002).

Enzymes

Enzymes are easily approved by the poultry industry as a basic nutritional element, particularly in rations made of barley and wheat. Nevertheless, there are still a lot of unresolved issues, for example do enzymes function? Do varied preparation of enzymes potencies reflect changes in growth rates? What is the relationship between growth rates, enzyme activity, and gut viscosity? And do all poultry diets demand enzymes? This review article intends to provide background knowledge on enzymes and their role in poultry nutrition as well as provide answers to some frequently asked questions concerning enzymes (Khattak et al., 2006)., a variety of protein types exist in ecosystems, including enzymes. They do not change themselves as a result of the reaction; their primary function is to catalyze its rate. All of the digestive and metabolic processes' stimulating and catabolic pathways include enzymes (Khattak et al., 2006). For less than twenty years, enzymes have been utilized economically as a feed additive. Since this time, the feed enzyme business originated and has passed through several stages of

DOI: 10.5281/zenodo.10049646

growth. In the first stage, the nutrient bioavailability of diets consisting of viscous grains like wheat, rye, barley, or triticale was improved by removing non-starch polysaccharides (NSP), which have an anti-nutritive effect. In the beginning of the 1990s, the use of enzymes was expanded to protect nutrients besides NSP and benefits besides increased digestibility. An excellent illustration is the use of phytase, which not only improved the utilization of phytate P but also reduced P excretion in waste, resulting in reducing the negative environmental effect. As a result, livestock producers started to advocate for the inclusion of enzymes in chicken diets consisting of non-viscous grains like barley and maize (Bedford and Apajalahti, 2001). The most popular feed additions include exogenous enzymes. Enzymes are proteins that interact on certain substrates and accelerate in specific chemical processes. The two enzymes that are most frequently used by the sector are bacterial phytases, which degrade phytate-complexes in plant components, and non-starch polysaccharides (NSPases), which degrade non-starch polysaccharide (NSP) in viscous cereal (wheat, barley, and triticale). (Ravindran and Son, 2011). The most nutritionally significant NSPs in barley are mixed linked beta-D-glucans, the majority of NSPs in grain and rye, however, are arabinoxylans (pentosans). The physical and chemical features of the soluble in water, higher-molecular-weight NSP are related to increased digesta the viscosity which is linked to decreasing avian productivity (Pirgozliev et al., 2006). In instance, liquid viscous NSPs reduce the bioavailability of protein, carbohydrate, and fat in grill diets; however, this impact is easily remedied by using the right enzymes (Bedford, 2006). The ability to break down the NSP in meals is not produced by any vertebrate species. Dietary Spaces have the ability to dissolve the links between NSP sugar units and significantly lessen the viscosity of the gut contents. A reduction in gut viscosity will result in enhanced gut health, more thorough absorption of nutrients, and microbial growth suppression.(Abdulla et al., 2017). A few oligosaccharides can also be produced by the enzymes that break down NSP, and these oligosaccharides may act as prebiotics in hens' digestive tracts (O'Neill et al., 2014). Additionally, dietary spaces can increase broilers' vascular antioxidant activity (Pirgozliev et al., 2015a).

Since enzymes are organic byproducts of fermentation and therefore pose no hazards to the animal or the customer, they have been permitted to use in poultry feed. Enzymes will not only make it easier and less costly for livestock and poultry farmers to use new feed ingredients, but they will also show to be more environmentally beneficial because they reduce the pollutants associated with livestock farming. In addition to helping to increase chicken production, feed enzymes can benefit the environment. The output of phosphorus is frequently very high in regions where chicken production is intense, resulting into environmental concerns like eutrophication. This occurs as a result of the majority of phosphorus in standard feedstuffs existing in phytate, a plant storage form that chickens cannot digest. The use of enzymes in chicken feed has been approved since they are natural byproducts of fermented which pose no risk to the animal or the consumer. Because they lower the pollutants associated with animal husbandry, enzymes will not only make it more inexpensive for poultry and livestock farmers to adopt new feed ingredients. They will also prove to be more environmentally friendly. Feed enzymes have a positive effect on the natural world in addition to increasing poultry productivity. In locations where poultry production is intensive, the output of phosphorus is

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

frequently very high, leading to environmental issues like eutrophication. This occurs as a result of the majority of phosphorus being present in normal food products as the plant store form phytate, which is insoluble to poultry (Khattak et al., 2006).

Essential oil

EOs are mixtures of fragrant and volatile substances that often originate from plants and are termed with the aromatic properties taking into consideration the origin of the plant(Oyen and Nguyễn, 1999). In his theory of the "Quinta essentia," Paracelsus introduced the concept of the "essential," which he claimed might be a useful component in medicine(Oyen and Nguyễn, 1999). But, the term 'volatile oil' had been proposed in medieval pharmacy(Hay and Waterman, 1993). However, the phrase "volatile oil" was first suggested in mediaeval pharmacy(Hay and Waterman, 1993). The usage of EOs to increase productivity may have positive impacts as a growth and health enhancer. EOs can vary in concentration and chemical make-up, utilizations of Essential Oils in Chicken Feeding Numerous physiological effects of EOs include antibacterial, antioxidant, absorption-promoting, hypolipidemic, growth-promoting, immunomodulator, antimycotic, antiparasitic, antioxygenic, antiviral, and pesticide properties. However, this piece examines the most important applications of EOs. Aromatic oils are now employed as feed or water additives in the breeding of chickens. Onions (Allium cepa), cinnamon (Cinnamomum zeylanicum), rosemary (Origanum vulgare), and ginger (Zingiber officinal) make up the majority of the EOs used in poultry, eucalyptus, mountain savory (S. Montana), fennel (Foeniculum vulgare), Australian tea tree, peppermint, garlic (Allium sativum), sage (Salvia offiinalis), turmeric (Curcuma longa), thyme (Thymus vulgaris), and clove (Syzygium aromaticum) etc.(Akbarian et al., 2014). The primary constituent found in EOs could be related to an aromatic, aliphatic, or terpene sequence, and their chemical composition is extremely variable. Ternion-based chemicals exist in EOs, rarely quaternary ones. Esters, phenols, terpenes, aromatics, volatile acids, ketones, and aldehydes are among the constituents of these volatile chemicals. After harvest, sanitation or treatment of the plant portion that is exposed to hydrokinetics is not necessarily required(Zerkaoui et al., 2018). Exception from lavender, cinnamon, and lime blossoms, which serve best when used dry, fresh plants typically have a more potent medicinal effect and a pleasant perfume when added to solutions. According to(Bozhanska, 2018), when dried plants are utilized, less aromatic urine is frequently observed due to chemical and morphologic changes brought on by the accumulation of grams, warming, and the environment, probably as a result of variances. Onion, thyme, oregano, aniseed, myrtle, ginger, cinnamon, etc., among the oils that are essential used to treat or stimulate development for poultry husbandry is turmeric.

The initial supply' homogeneity, whose properties can be influenced by a wide range of factors, essentially determines the composition of essential oils. For instance, the total percentage of alcohol terpenes (mostly thymol and carvacrol) and mono hydrocarbons (mainly -terpinene and -cymene) varies from 57.3% to 62.5% of the essential oils from a plant. The total amount of phenol in thyme (Thymus pulegioides L.) remains generally consistent over the course of several collecting periods, although it begins to climb towards the start of the blooming phase and reaches its peak during the entire blooming phase of the plant's life (Senatore et al., 1996).

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

In vivo trials with bacteria are significantly influenced by the chemical makeup of essential oils.

Since essential oils make up only a small portion of the total wet weight of plant substances (typically less than 1%), it is required to improve the quantity of essential oils through continuous advancements in vital areas like genetic engineering and extraction procedures. Both the concept of essential oils and our knowledge of the biological roles of essential oils were challenged by these changes. For instance, the essential oils from the orchid vulgare showed mild antioxidant effects and significant antibacterial activity against standard strains. As seen by the ethanol extract's lack of antimicrobial characteristics but considerable antioxidant activity, the biological effects of the essential oils may actually rely on the technique of separation (Bouhaddouda et al., 2016).The usage of chemically synthesized essential oils in the feed sector is also on rising.

Growth performance

According to (Zhang et al., 2014), essential oils are viewed as growth promoters in poultry diets. Results from animal trials, however, can vary greatly. A review of the variables that can affect the effectiveness of essential oils for both poultry and pigs is provided in the table below. These components concern the climate, nutrition, livestock, and synthetic essential oils.

Factors that impact the performance of essential oils

Factors	Essential oils	Results or speculations	Species	Reference
Dietary form	Menthol, cinnamaldehyde	A pelleting temperature of 58 °C led a recovery of 17% to 56% of the indicator substances	Pigs	(Maenner et al., 2011)
Dietary nutrient density	Buckwheat, thyme, curcuma, black pepper, ginger	Benefits of essential oils are more dramatic with high nutrient density diets	Pigs	(Yan et al., 2010)
Dietary composition	Thymol, cinnamaldehyde, CRINA Poultry	Highly digestible diet may diminish the efficacy of essential oils	Broilers	(Lee et al., 2003)
Essential oils composition	Menthol, cinnamaldehyde	The essential oil mixture with menthol, not cinnamaldehyde, as the primary component improved gain to feed	Pigs	(Maenner et al., 2011)
Essential oils composition	Caraway, fennel	Caraway oil, not fennel oil, at 100 mg/kg feed, tended to decrease feed intake	Pigs	(Schöne et al., 2006)
Essential oils composition and quality	Thyme, oregano, marjoram, rosemary, yarrow	Various herbs and oils have different effects, which may be primarily related to differences in their terpene composition	Broilers	(Cross et al., 2007)
Dosage	Cinnamon, thyme, oregano	The absence of benefit could be due to improper doses	Pigs	(Namkung et al., 2004)
Dosage	Oregano	Feed intake and weight gain responded to the supplementation of oregano quadratically	Broilers	(Abdel-Wareth et al., 2012)

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

Environment	Menthol, cinnamaldehyde	Feeding trials under simulated research station or commercial farm conditions gave similar results	Pigs	(Maenner et al., 2011)
Environment	Anis, citrus, oregano, flavors	The supplementation of phytobiotics was not beneficial in research facility without sufficient disease challenges	Pigs	(Kommera et al., 2006)
Environment	Caraway, fennel	A positive effect of fennel and caraway oil seems to occur only during gastrointestinal disorders	Pigs	(Schöne et al., 2006)
Environment	Thymol, cinnamaldehyde, CRINA Poultry	A clean environment led to diminished efficacy	Broilers	(Lee et al., 2003)
Age of animals	Thymol, cinnamaldehyde, CRINA Poultry	The effect on endogenous enzyme activities decreased with increasing age	Broilers	(Lee et al., 2003)
Growth performance level	Oregano	Little or no response to oregano oil can be expected at high performance levels, but at low poor performance levels the response may increase	Broilers	(Botsoglou et al., 2002)

Antimicrobial effects on particular essential oils

1) Carvacrol and thymine induce bacteria's membranes break down, releasing membranes-associated substances from the cells into the outside media.
2) Because terpenoids and phenylpropanoids are lipophilic, they can cross the bacteria's membrane and enter the inside of the cell(Kurita et al., 1979).
3) Restriction of division of cells and subsequent disruption of metabolism in cells could result from the development of electric charge complexes with donors of electrons in the fungal cell.
4) Cinnamaldehyde was found to inhibit the enzymes responsible for producing fungal cell walls (Bang et al., 2000)
5) The bacteria burden on the intestine was reduced as a result of the probiotic and essential oil combination.
6) In vitro tests against Salmonella Typhimurium and E. coli have demonstrated the inhibitory effects of garlic oil(Ross et al., 2001)

In addition, to all above, essential oils are utilised in human food as a flavour ingredient. According to(Furia and Bellanca, 1975), Caracole can be added to beverages without alcohol up to a dose of 26 ppm and in heated products up to a rate of 120 ppm. According to (Furia and Bellanca, 1975), the amount of cinnamonaldehyde used in ice cream products can range from 8 parts per million to 4900 parts per million. Beta-ionone and thymol are additional food flavourings. To ensure that piglets' feed consumption does not change after the weaning process the diet can be standardised using the distinctive aroma of essential oils. Because chicken may not react to odours as sharply as pigs do, particular flavour effects on poultry achievement have not received a lot of attention (Moran, 1982). Some evidence from the limited research(Deyoe

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

et al., 1962) that tastes can impact the consumption of feed. However, according to (Moran, 1982), the impact of flavour on the efficiency of poultry is considered to be insignificant. The role of essential oils as flavouring agents in poultry nutrition must be studied, their toxicological effects only become apparent at very high amounts. Chicken has been used in studies on antioxidant and hypocholesterolemic activities. Further research is needed to determine how essential oils' distinct aroma and stimulation of the digestive system impact poultry efficiency. Entrepreneurs in the poultry industry are becoming more interested in the hypolipidemic and immunomodulatory implications of these oils. These oils' anti-oxidant qualities offer efficient protection against loss of drips during extended low-temperature preservation, which raises consumer approval and decreases loss for meat processing. To summarise up, the poultry diet's essential oils might be utilised as a substitute for antibiotics, growth efficiency, and added-value products like low-cholesterol meat, sensitivity, greener eggs, etc. Additionally, it is becoming more significant in terms of how it might enhance the shelf life and flavour of raw and processed meat as well as nutritional products. Essential oils are predicted to be extremely important in the development of poultry farming in the next few years. The Biochemical System's Essential Oils' Antioxidant Activity In biological systems, essential oils play a significant antioxidant impact. According to (Youdim and Deans, 2000), EOs have a strong anti-free particle impact. EOs affect SOD, glutathione peroxidase, and vitamin E, which are in vivo antioxidant defense systems. According to (Bauer et al., 2008) and (Botsoglou et al., 2002), oregano essential oil compensates for the increased degree of unsaturated fat and has significant antioxidant activity, which increases the oxidative stability of animal goods containing fat, like meat and eggs.

Symbiotic

Symbiotic are mixes of prebiotics, which not digestible substances aid in the development of probiotics (beneficial gastrointestinal microorganisms). Probiotic are specifically mixtures of these two components that interact (synergistically). Symbiotic assist in the probiotics' development in the intestinal tract, according to the symbiotic theory, Immune system, metabolism, and gut health are all considered to be enhanced in maintaining gut bacteria. Probiotic and prebiotic are combined synergistically to create symbiotic, which benefit the host by boosting the absorption of microbial feed supplements in the intestines (Andersson et al., 2001). Injurious bacteria like Campylobacter jejune can be reduced due to symbiotic relationships, according to researchers (Baffoni et al., 2012) and Salmonella typhimurium(Markazi et al., 2018) lately it was found that laying hens' microbiome in their intestines and immunological responses to a Salmonella infection were positively influenced by drinking water supplemented with symbiotic bacteria. According to(Collins and Gibson, 1999), A combination of prebiotics with probiotics is the most basic definition of a symbiosis. This mixture may improve the probiotic organism's chances of survival because it contains the particular source needed for fermentation. This may be advantageous for the host because it contains living bacteria and prebiotics. According to recent studies, symbiotic chemicals increased the immune condition of broiler chicks.(Zhang et al., 2006). Symbiotic could result in improved absorption of glucose in chickens, according to research (Awad et al., 2008)., according to research by(Mohnl et al., 2007), a synthetic chemical exhibited a similar ability to avilamycin, an antibiotic growth promoter, to enhance

DOI: 10.5281/zenodo.10049646

chickens performance. It has been proven that adding symbiotic organisms and consuming them lowers cholesterol levels and modifies the quantity of organic acids in broilers. In addition to excluding competitive flora, fructooligosaccharides were used in(Bailey et al., 1991) study to reduce Salmonella colonization in chickens. A competing probiotic or different bacteria acting together dramatically lowered the quantities of fructooligosaccharide produced by Salmonella colonisation.

Currently, there is not much information available concerning the usage of symbiotic in poultry. According to studies, symbiotic material may be as effective as antibiotics in enhancing broiler performance. It has been demonstrated that adding GOS and B. subtilis to broiler diets improves ADG and FCR while decreasing diarrheal mortality and incidence. In additional broiler trials, a symbiotic supplement that combined E. faecium with a prebiotic derived from barley and sea algae significantly raised live weight, ADG, carcass yield, and FCR. Mixing probiotics and prebiotics may be an effective technique for enhancing poultry gut health and preventing the spread of infections in the environment. Symbiotic as well as other nutritional supplements have recently been recognized as essential resources for maintaining the health of humans and livestock, for avoiding illness, and replacement for reducing the risk of certain diseases. The importance of symbiotic in maintaining the health of mammals is currently highlighted by studies investigating the relationships between the microbiota of the human and animal guts and immunity. There is data that suggests symbiotic may impact on the microbiology of both human and animal gut and aid in the treatment of a number of diseases. The majority of research on symbiotic has been done on people, while studies on animals have been conducted as well. After administering symbiotic to farm animals. Improvements in the number of helpful bacteria and a reduction in the loads of possible pathogens were observed. The best and most effective method for preventing colonization and infection by intestinal pathogens, especially bacterial pathogens, is to consume symbiotic. The positive effects of symbiotic are typically associated with the contribution of probiotics, the advantages of prebiotics, and their synergistic efficiency. Extensive research is still needed to fully comprehend how predesigned symbiosis may improve human gut health and avoid infections. There have been proposed several symbiotic mechanisms for preventing the growth and spread of intestinal bacterial infections. This theory has been supported by a number of mechanisms, including rivalries for nutrient sources, the release of antimicrobial byproducts by probiotics, prebiotics or probiotics effectively occupying gastrointestinal receptors, and rivalries for nutrient sources. The accessibility and effectiveness of symbiotic approaches are typically limited by a variety of distinctive host genetic characteristics, such as the imbalanced gut microbiota and malfunctioned nutrient absorption or metabolism. Symbiotic methods are, therefore, attractive but not decisive.

Specification of Photobiotic:

Growth promoting effect

Over the previous 20 years, many studies have been looked into. The majority of studies have discovered that pigs and poultry increase more rapidly when herbal products are included in a meal (Wenk, 2003) . The gain in weight and the crude protein content and dry matter

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DOI: 10.5281/zenodo.10049646

digestibility were both increased by 10.3, 2.9, and 5.9%, as well, in pigs fed diets supplemented with essential oils, according to an analysis of the results. (Yan et al., 2010) conducted a study offering essential oil-supplemented diets to growing-finishing pigs (thyme, rosemary, oregano extracts), with the theory being that improved intestinal structure, which consequently increased nutritional digestibility, lead to higher achievement among pigs. Indicated a significant rise in the feed conversion ratio (FCR) and average daily gain (ADG) during the course of the growing season. Researchers have suggested a variety of methods for how photobiotic work. One of the main mechanisms of action that may have attributed to the improved efficiency of growth is the stimulation of the release of gastrointestinal enzymes of pigs and poultry (Czech et al., 2009). Improving feed intake and making feed taste better and more palatable are two more potential ways. They reached the conclusion that feeding the birds meals including antibiotic substitutes helped reduce the adverse effects of the withdrawal of antibiotics from the diet on industrial chicken.

Influence on palatability and gut function

(Windisch et al., 2008) reveal that improved feed quality and digestibility as well as higher production efficiency are the most significant advantages of probiotics. Researchers found that essential oils from fennel and caraway or mint and oregano were fed to pigs and had a negative effect on accessibility that was dose-related (Jugl-Chizzola et al., 2006) Other research have shown that feeding broiler chickens and laying hens' phytobiotics reduced their feed intake significantly (Roth-Maier et al., 2005). The addition of PFA to a swine diet, however, appears to increase feed consumption (Kroismayr et al., 2008b). According to (Platel and Srinivasan, 2004), phytobiotics may encourage digestive secretions like saliva and bile. They suggest that increasing enzyme function is the main way PFA affects nutrition.(Ramakrishna Rao et al., 2003) found that exposure to various spices and spices extracts significantly enhanced the in vitro activity of rat pancreatic lipase and enzyme. These chemicals and essential oils have been shown to slow the rate at which the stomach empties when added to swine feed. (Manzanilla et al., 2004). According to(Jamroz et al., 2006), Broilers fed diets supplemented with PFA had intestinal mucus that broke down quickly, this procedure was designed to lessen pathogen compliance and keep the degree of microbial eubiosis in animal stomachs at a healthy level.A review found that poultry, as opposed to animals, may respond by producing more fluids for digestion and substantially resisting little amounts of spice in their feed (i.e., limiting feed intake).

Antimicrobial action

Several studies (Chao et al., 2000) examined into the antimicrobial effects of phytogenic substances (either bactericidal or bacteriostatic) against food-borne organisms like bacteria and fungi. The majority of these studies indicates that phenolic substances including thymol, carvacrol, phenylpropane, limousine, geraniol, and citronellal are the most effective antibacterial agents. According to (Yang et al., 2015), PFAs' The relative position of their functional phenol or alkyl bonds can influence their antibacterial action. Studies reveal that the hydroxyl group and delocalized electrons are necessary for the antibacterial activity of phenolic terpenoids. For instance, studies have demonstrated that while a few prevalent terpenoids, such

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DOI: 10.5281/zenodo.10049646

as carvacrol and thymol, have comparable antimicrobial effects, their actions against G+ or G bacteria differ according to the locations of a number of functional structures in their elements (Lambert et al., 2001). The plants that are that are most commonly used in the plant family Labiatae, which have attracted the most investigations, include thyme, oregano, and sage. They suggested a single explanation for how PFA works to combat bacteria, the capacity of hydrophilic essential oils to disrupt the cell membranes of pathogens, ultimately fracturing their membrane structures and resulting in ion leakage. The amount of benevolent bacteria, such as Lactobacillus, can increase in the stomachs of host animals if the quantity of pathogenic organisms, such as Escherichia coli, is decreased.

Antioxidant and anti-inflammatory action

Another biological trait of particular interest in phytobiotics is their antioxidant activity. Their capacity to destroy radicals that are harmful may be crucial in preventing various conditions including cancer and heart disease that are induced by free radicals (Kamatou and Viljoen, 2010). In numerous studies, essential oils, especially those from the plant family Labiatae, have been employed successfully as natural antioxidants in human and pet food (Cuppett and Hall, 1998). According to previous studies (Fernandez-Panchon et al., 2008, Giannenas et al., 2013), the primary processes of protecting other biological molecules against oxidation are the ability to provide hydrogen or an electron to free radicals and also delocalize the unpaired electron within the aromatic structure. According to research that examined the effects of PFAs from the Labiatae plant family that include phenolic compounds on boosting the resistance to oxidation of pork and chicken meat, a number of plants and their extracts have been discovered to have possible antioxidant activities (Janz et al., 2007) especially those products derived from the plant family *Labiatae* such as rosemary, oregano, and thyme. According to (Stevenson and Hurst, 2007), Some essential oils have the power to remove free radicals from the body. Inflammation is a typical protective response brought on by tissue damage or infection that helps the body fight off intruders (microorganisms) and remove damaged or dead host cells. Additionally, they may have an anti-inflammatory effect because oxidative burst is one of the signs of inflammation in several cell types. Several essential oils have been shown to have anti-inflammatory properties. For instance, chamomile essential oil has been used as an anti-inflammatory for a very long time to treat the signs of contact dermatitis eczema, and other severe irritations (Kamatou and Viljoen, 2010). Similar to human beings and other living things, pharmaceutical residues in poultry products may lead to the growth of germs that are resistant to antibiotics. The widespread use of antibiotics in cattle to boost growth rate, increase feed efficiency, and prevent intestinal infections has resulted in the gastrointestinal system becoming infested with resistant bacteria, biological nutrients, with probiotics having the best results, exert a considerable positive impact on growth performance, haematological parameters, and gut microbial load in broiler chicken. One of the best options for replacing antibiotics as a growth expansion in feed for safe broiler production is the inclusion of probiotics. Probiotics, prebiotics, probiotics, and acidifiers are examples of alternative antimicrobial replacements that are often used and have the same purpose and functionality as antibiotics. Phytobiotics, a novel approach to nutritional research, are drugs with antibacterial activity generated from plant compounds that are being utilised for human and animal nutrition.

DOI: 10.5281/zenodo.10049646

The quality of phytobiotics can be improved by the method of fermentation.

Table: Relative organ weight of broiler supplemented with phytobiotic, probiotic and their combination (at 28th day)

Groups	Liver (gm)	Gizzard (gm)	Heart (gm)	Proventriculus (gm)
A (Control)	27 ±1.48	21.20±0.75	4.40±0.60	6.40±0.50
B (Antibiotic)	25.80±0.86	20.27±1.39	4.60±0.50	5.60±0.50
C (Phytobiotic)	25 ±1.01	20.20±0.87	5±0.70	6.80±0.37
D (Probiotic)	40.20 ±0.37	23.20±0.86	6.20±0.58	7.20±0.58
E (Phyto+Probi)	41±0.71	25±0.95	7.10±0.54	7.80±0.58

Data are express as mean ± SE (n = 10).

Unexpectedly, the weight gain for the abdominal organs was highest in the combined group (E) (Table). In contrast to the final live weight gain, where group D had the largest weight growth and the lowest feed conversion ratio, this is obviously different. The combination group outweighed the probiotic group in terms of visceral organ weight (Ferrous and others, 2019).

After a 28-day experimental period, phytobiotic supplementation and its combination with a probiotic supplement significantly influenced growth performance, carcass yield, and dressing %. However, phytobiotic (0.1%) alone inhibited pathogenic Salmonella Sp. development and significantly decreased intestinal pH and the entire coliform bacteria count. This result indicates that the intestinal health of broilers has improved. In order to preserve food safety, it might be determined that phytobiotic might serve as an effective growth booster in place of antibiotics in the broiler sector. The quantity of active compounds and the chemical makeup of phytobiotic in the finished product may vary greatly depending on the plant components employed (seeds, branches, etc.), the sources of the plants, and the harvesting season (Windisch et al., 2008). The effects of using oregano essential oils have also been said to vary frequently because they depend on all of the components working (Giannenas et al., 2013). Nevertheless, numerous research have demonstrated that phytobiotic have qualities that promote development as well as antibacterial, antioxidant, and anti-inflammatory effects. Several ideas suggest (Stein and Kil, 2006), PFA's most likely route of action involves altering the gut environment and intestinal design in pigs and poultry. Reviewing published records, however, has shown that certain findings are equivocal (Table (Franz et al., 2010).

Phytogenic feed additives on the composition of digesta and its consequents on health status and performance of birds

According to (Gustafson and Bowen, 1997), antibiotic growth promoters improve growth performance and stabilize an animal's state of health. Since the European Union banned antibiotic growth promoters in 2006, efforts to find acceptable all-natural replacements with comparable positive effects have increased. Phytogenic feed additives (PFA), which could improve the health and production of chicken, are one approach. According to several writers (Lee et al., 2003), the usage of PFA-containing compounds, such as essential oils or spices,

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DOI: 10.5281/zenodo.10049646

stimulates the development and activity of digestive enzymes and increases bile acid secretion. According to and (Jang et al., 2004), the addition of essential oils to broiler feed improved the activities of trypsin and amylase., in recent study (Prakash and Srinivasan, 2010), the accessibility and fluidity of membranes in cells may be changed by dietary spices, resulting in an increase in the absorption of nutrients from the intestinal tract. Additionally, active plant chemicals may have an impact on microbial populations (Dorman and Deans, 2000) as a result, they might serve as an alternative to traditional antibiotics in the control of the bacteria population in the intestine. Numerous investigations have found that PFA feeding tests with broiler chicken have produced erratic results. Hens' daily weight gain and the FCR (feed conversion ratio) were shown to rise when both (300 mg/kg of feed) spicy chemicals, cinnamaldehyde, and carvacrol, were added to the meal (Jamroz, 2002). According to (Ciftci et al., 2005), the daily live gain in weight was increased by almost 15% when 400 mg of anise oil/kg of feed was given. Contrarily, it was reported by (Botsoglou et al., 2002) that adding 50 or 100 mg/kg of oregano oil to the feed had no influence on broilers' ability to grow. No variations in feed intake or FCR were seen in broilers fed either 5,000 mg/kg of diet containing a Labiatae extract of sage, thyme, and rosemary or 200 mg/kg of diet containing essential oils derived from oregano, cinnamon, and pepper (Hernandez et al., 2004). Two commercial PFAs comprising sanguinarine and chelerythrin, two alkaloid compounds, and 5% carvacrol, 3% cinnamaldehyde, and 2% capsicum oleoresin had no effect on the growth efficiency of broiler chicks, according to (Muhl and Liebert, 2007). Additionally, (Cross et al., 2007) discovered that the effects of dietary thyme on weight gain and body mass varied depending on whether it was consumed as an herb or an oil, which may be mostly due to changes in the terpene level. Only a small number of studies have previously examined the effects of PFA on apparent ileal nutritive digestibility. However, (Hernandez et al., 2004) revealed that adding essential oils and a Labiatae extract to a starting meal increased the apparent ileal digestibility (AID) of nutrients. (Jamroz et al., 2005) showed that the inclusion of a plant extract in broiler diets had no impact on the measures of ileal DM and starch digestibility, but not CP digestibility (P 0.01). The phytogenic chemicals have the potential to be interesting feed additives, but their efficacy must first be evaluated for each specific product, taking into account efficacy features and likely modes of action.

On the impact of PFA on broiler immunity and performance, more research is required. According to studies, cutting crude protein by 1.7% decreased BWG while keeping FCR constant (Ullrich et al., 2018), however reducing the amount of various meals in broiler diets by 2% decreased both FI and BWG (Liu et al., 2017) summarized 26 different types of studies and found that dietary protein level was a significant positive a contributor to broiler BWG and feed utilization. However, broiler performance and nutrition protein level are also influenced by ingredient protein content, amount of destruction, and agricultural environment (Sadek et al., 2014), PFA increased the feed efficiency of broilers. According to (Paraskeuas et al., 2016), broiler growth performance was unaffected by the addition of PFA, although FCR rose when feed protein was reduced by 1.32% and ME by 0.8 MJ/kg. It's possible that different plant sources and extraction techniques play a role in how phytogenic chemicals affect grill performance. Recent research is more likely to demonstrate positive effects on growth

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

performance, which may be related to advancements in the extraction and purification of those active chemicals (Zumbaugh et al., 2020). PFAs, or phytogenic feed additives, have been fed to broilers in trials to improve AMEn and protein from crude sources digestibility (Pirgozliev et al., 2019). PFA mechanisms may be related to the various effects of feeding PFAs to various species of poultry. PFAs typically have an impact on broilers through the anti-oxidation, promoting digesting enzymes, or controlling immunological response mechanisms. In addition, PFA had no impact on digestive enzymes in broilers fed a regular protein-level diet in the current investigation, and identical findings were observed when turkey poults were fed PFA with the exception of a decrease in aminopeptidase activity (Zumbaugh et al., 2020).

Impact of phytoadditive on digestibility of nutrients

It has been demonstrated that a variety of microbes and bioactive compounds improve the health and productivity of animals. According to (Stanacev et al., 2011) examples include probiotics, prebiotics, enzymes, organic acids, and phytogenic substances. According to (Windisch et al., 2008), The term "phytogenic compound" refers to the essential oils extracted from a variety of aromatic herbs and spices, including garlic, oregano, thyme, rosemary, coriander, and cinnamon, as well as their seeds, fruits, roots, and leaves. Many of the beneficial properties of phytogenic compounds are due to the bioactive molecules present in them, including thymol, cineole, linalool, allicin, capsaicin, allyl isothiocyanate, and piperine. The biological functions of these phytomolecules, and also their capabilities as antioxidants and antibacterials, are extensively reported (Windisch et al., 2008). Additionally described by are their antiviral, antitoxigenic, antiparasitic, and insecticidal capabilities. Given that they have a significantly higher level of biological activity than the raw material from which they were obtained, essential oils are currently gaining popularity for use in animal feeding. Examples of aromatic plants and the compositions of their main active ingredients are shown in the table. Essential oils constitute a problem due to the intricate combinations of plant bioactive components, as well as their varying chemical composition and amounts. Essential oils are mainly made up of two chemical groups: terpenes and phenylpropenes (Lee, 2002). The interaction of each of the numerous components in the plant's raw material with the manufacturing process determines the volume and composition of essential oils. For instance, the essential oil content and structure of the raw extract will be influenced by the types of plants and their developmental stages, environmental factors (such as the time of year, the weather, and any stressors), farming practises (such as plant density per produced area, fertilisation, and irrigation level), and developing area (Mert et al., 2002). Because of this, there are a lot of variances in both the raw materials used to make essential oils and the final products produced from them. The quantity and composition of the extracted oil can be significantly impacted by the processing techniques used in the manufacturing of essential oils, such as solvent or hydro distillation extraction (Russo et al., 1998). The potential for phytoadditive chemicals to replace antibiotic growth promoters in animal nutrition has received a lot of attention during the last fifteen years. During that time, feed additives known as phytoadditive substances have increased popularity in broiler diets.

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DOI: 10.5281/zenodo.10049646

Inclusion levels of phytoadditives in chicken feed

There have been reports of various levels of phytogenic feed incorporation. Depending on the use of fragrant plants or their related essential oils, feed inclusion levels have changed up to 10 times. When aromatic plant sections were used, feed inclusion amounts varied from 0.01 to 30 g/kg of diet. One example is the addition of oregano at a rate of 30 or 10 grammes per kilo of feed Cross et al., 2007) and garlic at 1.5 to 2 grammes per kilogramme of diet (Stanaćev et al., 2011), rosemary at 5-10 g/kg feed (Govaris et al., 2007) and rosemary powder at 0.5 g/kg feed(Spernakova et al., 2007). The use of essential oil inclusion levels in feed that are lower than those mentioned above have been documented. Salve and rosemary extracts at 500 mg/kg of feed are two examples (Lopez-Bote et al., 1998), oregano essential oil at 50-100 mg/kg of feed (Govaris et al., 2005)or 300 mg/kg feed(Giannenas et al., 2003). thymol at 100 mg/kg feed(Lee and Evert's) and essential oils from other herbs at various levels. The inclusion levels previously mentioned should only be taken as suggestive because the actual plant or essential oil compositions of the active components may vary greatly across research.

Phytoadditive effects on gut function and nutrient digestibility

Mechanisms proposed to modify gut function include transit time, digestive secretions, and increased digestive enzyme activity because the combined effect of all these effects would affect nutritional digestibility. According to Lee and Evert's study findings, phytochemicals increase the digestive enzymes trypsin, lipase, and amylase synthesis in broilers. According to (Jamroz et al., 2005), adding plant extracts to feed mixes for 41-day-old broiler chickens increased lipase activity by 38–46%. likewise (Jamroz et al., 2006) reported on potential impacts of phytoadditives on gut morphological features. The findings of a study using female Cobb broilers fed a diet based on corn-soybean meal augmented with thyme, the drug nicotine, or an approved essential oil preparing at 100 mg/kg diet show no variations between the non-supplemented control and the phytoactive treatments with regard to the noticed ileal digestibilities of crude proteins and starch as well as for the majority of tract fat digestibility at ages 21 and 40 days (Lee and Evert's)., when corn-soybean nourishment or wheat-barley-soybean meal diets for male Hubbard broilers were supplemented with plant-derived products containing carvacrol, cinnamon and spice turmeric oleoresin, the predominant ideal digestibility of vital nutrients like crude protein, petroleum fibre, and the amino acids was not extensively increased. None of the five botanicals or their matching essential oil treatment affected the visible metabolizable activity and the overall tract perceived solubility coefficient of both wet and organic materials examined that were utilized in the study by (Cross et al., 2007).

Additionally, none of the nutritional methods that decreased intestinal endogenous wastes were impacted by the content of sialic acid in the excreta.Theron and (Lues and Van Tonder, 2007) observed that Male Cobb broilers' ileal appearance fat and digestion increased while rosemary, anise, and tangerine essential oils were added to corn-soybean feed diets at a rate of 125 mg/kg, and (Stanacev et al., 2011) discovered a similar result while they studied the effects of rapeseed oil on broiler diets.

DOI: 10.5281/zenodo.10049646

Phytobiotics preparation as feed and water additives

The medicinal value of plants is interesting in light of recent scientific advancements due to their little toxicity, pharmacological properties, and economic viability (Candan and Bağdatlı, 2017). one of the most frequently utilised ingredients in agricultural and food production nowadays are natural antioxidants. According to one explanation, plants' antioxidant properties developed over a period of history based on their photosynthetic activities. In light of this, each plant species, subspecies, and variety can serve as a test subject for determining their antioxidant capacity (Candan and Bağdatlı, 2017). Easy absorption and the ability to prevent the creation of free radicals at physiologically meaningful levels are essential characteristics of the ideal antioxidant. Anti-inflammatory properties of compounds from summer savoury (Satureia montana L.) in general and its polyphenolic fraction in particular have been demonstrated in animal studies (Pashtetsky et al., 2020). Catalase and superoxide dismutase, two enzymes that resist free radicals and protect against oxidative damage, were twice as active in vitro after the addition of an aqueous savoury extract. The findings of the research demonstrate that the action of carvacrol and thymol is due to the degradation of the membrane of the cytoplasm, which increases its permeability and depolarizes its ability to act

There are four categories into which the broad category of biologically derived compounds known as "phytobiotics" might be divided: According to (Mohammadi Gheisar and Kim, 2018), there are four types of plant extracts:

1) Herbs.

2) Plant parts (whole or processed, such as roots, leaves, or bark).

3) Essential oils (hydrodistillated extracts of volatile plant chemicals).

4) Oleoresins are non-aqueous solvent-based extracts.

The effectiveness of phytobiotics is influenced by terpenoids (mono and sesquiterpenes, hormones), phenols (tannins), and glycosides, as tannins (found in various kinds of alcohols, acids, ketone bodies, ethyl and lactones), flavonoids, and glucose. Phytobiotics are typically herbal treatments with antibacterial properties. Primary and secondary plant chemicals are found in phytobioticsEssential nutrients including proteins, lipids, and carbohydrates are categorised as primary compounds, whereas secondary components include phenolic compounds, bitter chemicals, dyes, and EO. According to (Windisch et al., 2008), some of the processes that might be in charge of phytobiotics' beneficial characteristics are as follows, even though their precise antimicrobial action mechanisms are still not completely understood: Pathogens' cell membranes are destroyed, their cell surfaces are changed to make them more hydrophobic and thus more virulent, The lymphocytes, phagocytes, and natural killer cells (NKC) receive stimulation as part of the immune response, and the mucosa of the intestine is shielded from bacterial infections as a result (Mohammadi Gheisar and Kim, 2018). For the purpose of improving the sustainability and efficiency of livestock and poultry, compounds of various origins are collectively referred to as additives. According to(Diaz-Sanchez et al., 2015), the majority of feed additives contain antibiotics. Antibiotics are gradually given to feed

DOI: 10.5281/zenodo.10049646

in relatively tiny dosages to increase the effectiveness of fattening. Antibiotics are drugs that are used to follow all internal guidelines and maintaining a balanced and nutritious diet with biologically active feed additives are essential for developing the full genetic potential of poultry productivity. Feeding poultry will promote production, growth, a higher feed conversion rate, and better egg incubation, in 1940s featured the first use of antibiotics in chicken. Still, there was initially not much trust in their ability to provide results. It wasn't until the middle of the 1940s that it became obvious that their use enhanced livestock farms' output capabilities. In this sense, the use of antibiotics has elevated significantly, although their exact mechanism of action on animal bodies is still unknown(Karásková et al., 2015). It would be incorrect to claim that antibiotics were solely responsible for the increase in the productivity of chicken farms at the time. There were additionally new developments in genetics, modified production management, enhanced feeding parameters, improved equipment quality, etc. Furthermore, studies performed out in Denmark in the 1990s suggested that the elimination of antibiotics did not have the anticipated detrimental effect on poultry production. Similar outcomes were seen on several American farms. The researchers there not only supported the earlier findings from Denmark but also demonstrated the negative trend in production rates following antibiotic use(Karásková et al., 2015). It rapidly became obvious that the unregulated consumption of antibiotics had an adverse effect on the health of animals and birds. For instance, some microbes have the potential to develop and grow antibiotic resistance, which would reduce the pharmaceutical product's beneficial effects. Additionally, antibiotics can be harmful and have a cumulative effect.

24 kg of vancomycin were used for medicinal purposes by the population of Denmark in 1994. The same class of antibiotic, avoparcin, was consumed by animals in quantities of 24 tonnes. Because their methods of action are analogous, resistance to one of them is equivalent to resistance to the other. Antibiotic resistance can be passed from animals to humans, as DNA analysis of bacterial infections has demonstrated during the previous ten years. When chickens were given ox tetracycline, enterococci (also known as E. coli) developed tetracycline resistance, and this resistance was transferred from the chickens to the service members (Agyare et al., 2018).

Oxytetracycline was substituted with streptotricin (an antibiotic) in East Germany in 1983. Only animal husbandry was the usage of this antibiotic across the nation. It faced little resistance in 1983. Two years later, resistant bacteria started to show up in meat products and pig intestines. 1990 saw the discovery of bacteria resistant to streptotricin in the intestines of farmers, members of their families, local residents, and urogenital infection patients. The ingestion of animal products was likely the cause of this resistance. Enterococci have drawn a lot of attention as a result of the advent and spread of antibiotic resistance. In 1987, it was also revealed that resistance to other diseases, including Shigella (a bacterium that only affects humans), had also been observed.

Additionally, a study was done to see how carvacrol supplements at four different dosages (0, 120, 200, and 300 mg/kg diet) affected the amount of Escherichia coli and species of Campylobacter found in the cecum. Carvacrol was consumption linearly reduces the intake of

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

feed, feed rate of converting, and body mass increase at all amounts of supplement treatment, revealed to research by Awaad M. H. H. and colleagues. This implies an alternative for the use of medicines. The addition of 240 mg/kg of a solution containing 25% thymus and 25% the drug carvacrol as active components improved the intestinal histomorphology of broiler hens. when confronted with C. perfringens, stronger particular immune system reactions and a decrease in inflammatory reactions occur. Following a feeding of 300 mg/kg, the number of E. coli as a disease microorganism in the chicken gut decreased, and the small gastrointestinal histomorphological properties (height and size of the villi) were also improved.

Broiler hens' immunity to feed supplements including thymol was examined by Zeng Z. et al. The immunological response was stimulated by this ingredient (Zeng et al., 2015). Anne Orchard et al. examined the effects of thymol on the smooth muscles in the trachea and the bowel as well as the movements of the epithelium in rats' respiratory systems as an indication. According to (Orchard and van Vuuren, 2017), they discovered that thymol has a dose-dependent antispasmodic effect and promotes mucosal transport.

Salmonella levels in the cecum were decreased when a low dose of Na-butyrate (1 g/kg) and a thymol-containing essential oil (50 mg/kg) were combined. Recent years have seen an increase in the food industry's interest in natural substances, whether for usage alone or in combination with other compounds (İlhak et al., 2017). For instance, Garca-Garca et al. found that carvacrol and thymol were the most effective binaries combinations against L. innocua. Carvacrol, thymol was and a compound known as the three compounds' most powerful elements, were identified as well (Chouhan et al., 2017).

Safety issues of phytobiotics

The most significant elements influencing consumer decisions is currently the safety of food. The utilization of alternatives to traditional antibiotic therapy is becoming more and more important, not only due to the rise in drug resistance but also due to the possibility of residual human-harming chemicals. Some of the most prevalent and, most importantly, effective types of financial assistance for traditional antibiotics and their decrease in livestock animals are phytobiotics.

At present, phytobiotics is an increasingly prevalent reproductive method for broilers. Research studies indicate the efficacy of antibiotics as enhances to conventional antibiotic therapy (one of the conditions that permit No Antibiotics Ever (NAE) flocks), and also as ingredients that improve production conditions and the well-being of animals, similar to the effects of antimicrobial growth promoters (AGPs), which have been forbidden in several countries (Alghirani et al., 2021, Chodkowska et al., 2022, El-Ghany, 2020, Jutzi, 2004). Antibiotic growth promoters were defined as medicines by the National Office of Veterinary Medicine(Shanoon et al., 2012) as "supporting developing animals digest their food effectively, get the most benefit from it, and allow them to develop into healthy and strong animals.". AGPs are usually administered at insufficient, subtherapeutic concentrations as well (Plata et al., 2022). Due to the controversy surrounding the use of AGP and the extreme actions taken by many nations, the requirements of quality documents led to bans on the use of AGP. These bans included not only the addition of antibiotics to feed but also their use in prophylaxis, metaphylaxis, and administering them in subtherapeutic doses, which is seen most frequently during the pre/post-thinning period of time.

Safety issues of photobiotic

Antibiotics have been demonstrated to dramatically improve growth performance and feed conversion efficiency in the chicken sector. However, a high level of antibiotic use during the poultry production cycle can result in both human and bird's antibiotic resistance. The majority of developed countries have forbidden the use of antibiotics in all animal diets due to concerns about safety in food. Therefore, it could be important to look into extra preventive methods to help chickens grow quickly and to prevent sickness. Because phytobiotics are natural, residue-free, and less harmful than synthetic antibiotics, there is growing interest in employing them as an alternative feed ingredient in poultry diets. As a result, this review clarified the effects of adding probiotics as a feed additive to commercial chicken diets, as well as how these consequences affected the birds' health and productivity. Green tea, garlic, fenugreek, pepper, ginger, and other plant mixes were discovered to include growth-promoting characteristics that improve digestibility, increase feed intake, and promote growth in chicken. Other phytobiotics included thyme, rosemary, sage, rosemary, oregano, and green tea, among others. As value-added products, the carryover effect results in increased carcass traits and meat quality.

Many studies have been carried out to comprehend the biological functions of different phytogenic compounds. The majority of plant extracts exhibit lipophilic characteristics together with antibacterial, anti-coccidial, anti-fungal, anti-oxidant, and anti-stress effects. Alkaloids, for example, prevent the production of DNA (Karou et al., 2006) and combine with sterols in the cell wall to produce saponin complexes, which harm and kill cells (Morrissey and Osbourn, 1999). It is also known that when hydrophobic essential oils enter infections' cell membranes, their membranes break down and allow ions to flow out. Antibacterial properties of phytobiotics like oregano, thyme, and cinnamon are widespread against bacteria including Salmonella, E. coli, and Clostridium. However, there is a paucity of evidence regarding the method of action of currently available phytobiotic feed additives. a number of factors including the plant parts used (seeds, leaves, etc.), the area of origin, and the harvesting seasons, the amount of the active principle and phytobiotic composition in the finished product may differ significantly. If the experimental substance's composition is variable or undetermined assessing its biological effects might be complicated. As a result, phytobiotics need to be standardised using carefully chosen raw ingredients and subjected to stringent quality control procedures, while considering consideration variables such as feed availability and calibre (sensory aspects), growth enhancement (better weight gain and feeding conversion ratio, fewer mortality), gut function and digestibility of nutrients (improved growth), intestinal microflora (fewer GIT diseases, greater development, reduced mortality), the immune system's performance (improved Page | 20 health), and the carcass meat production in terms of safety and quality (reduced microbes load, enhanced the sensory aspects), phylogenetic effects are quite extensive (Mountzouris et al., 2010). Antioxidant herbs are safe, environmentally friendly, and offer a number of health benefits; as a result, they are frequently utilised today to

The Seybold REPORT
ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

treat oxidative stress and a variety of illnesses. Plant-derived anti-oxidants are more common in the chicken nutrition business due to the greater amount of poly-unsaturated lipids found in poultry meat that make it more susceptible to lipid oxidation. Although many plants have powerful antioxidant capabilities, rosemary and olive oil are particularly popular in the poultry feed industry. Gooseberry, oregano and sage, marjoram, and garden thyme , etc. (Rahal et al., 2014). In addition to these, fruits like plum, grape seed extract, pomegranate, bearberry, canberry, and pine bark extract, among others, offer excellent alternatives to synthetic antioxidants because they contain significant levels of phenolic compounds (Karre et al., 2013).

LIMITATION OF PHYTOBIOTICS

a) Due to their complicated makeup, which restricts their extensive use as additives, phytobiotics are difficult to quantify and standardise.

b) The location, kind of soil, weather, altitude, growing season, collection, and storage practices, as well as environmental variables affect the composition of bioactive substances in plants.

c) Most herbals are stable, but certain of their constituents are photo- and thermo-labile, making them less stable.

d) Anti nutritional elements, contamination by bacteria, and potentially synergy or adverse effects are some other photobiotic limiting variables.

e) Some plants contain irritants that are bad for both people and animals. Additionally, undesirable residue from natural products cannot be eliminated and may be absorbed by tissues. Some of them contain cyanide, carvacrol (found in oregano), glycosides, and capsaicin, which might cause cancer.

CONCLUSION

In order to produce poultry meat, Birds have to confront a variety of difficulties that impair the body's standard processes, including (climate, nutrition modifications, bacterial burden, pressure during raising them, etc.). The gastrointestinal system may be most severely impacted, which could impede the digestion of nutrients and, as a result, lead to lower performance and a boost in fatality. Therefore, in past centuries, antibiotics were added to diets that assisted birds in surviving the challenging conditions they experienced during the raising process. Farmers missed an effective instrument to assist birds in achieving their performance potential with the restriction of antibiotics as infeed promoters of growth (AGPs).

In the meanwhile, the potential to replace AGPs with a variety of substitute substances from extremely distinct additives classes is currently examined. Phytobiotics appear to be the most advantageous options because they come from organic sources and are generally accepted as safe (GRAS), despite the fact that they contain a variety of pharmacologically active compounds with poorly understood mechanisms of action. It was possible to treat certain diseases with certain herbs thanks to extensive observations of how animals reacted to different

ISSN 1533-9211
DOI: 10.5281/zenodo.10049646

treatments, as well as by avoiding the use of plant species that could be toxic or hazardous. Currently, a wide variety of biologically active chemicals in plants that are responsible for their beneficial effects may be identified thanks to the intensive development of analytical tools. Use of plant additions, whether fresh or dried, fermented or freeze-dried, as well as water or alcohol extracts based on them, is permitted in poultry practices (Alagawany et al., 2019).

With the inclusion of the phytogenic feed supplements, the feed utilization ratio of broiler diets significantly increased. Modifications in digestive secretions, the antimicrobial characteristics of essential oils, and greater gut absorptive surface are only a few of the potential causes of the observed improvement in feed conversion ratio.The most promising ones appear to be photobiotic since they are derived from natural sources and are generally accepted as safe (GRAS), despite the fact that they contain a variety of medicinally active chemicals with poorly understood mechanisms of action.

Broiler chicken performance as well as development can be improved by changing the structure of the microbiota in the intestines, improving intestinal morphometry, and dramatically improving digestive and nutrient absorption.

Promote physiological processes, particularly those related to immunity, but they also favorably alter the blood cholesterol levels, raise the body's antioxidant defense, and raise adaptation to stress.

They enhance the weight of significant carcass components like the thoracic and muscles of the legs while stimulating egg laying, all while enhancing the quality of the meat and eggs.

Probiotics, prebiotics, symbiotic, acidifiers, and phytogenic additions are additional growth enhancers. By facilitating the evolution of good bacteria or by reducing and eradicating harmful diseases, other possibilities to IFAs may be able to enhance the health and performance of birds. However, the gastrointestinal physiology and growth are intricately entwined with their impacts on intestinal micro flora. Various additional elements, such as the sufficiency of the diet and any alternatives, hygienic standards, and animal husbandry practices, could further influence or even be directly connected to this relationship.

There may still be many outstanding challenges and restrictions that need to be removed in order for alternative approaches to be used (more) effectively in this industry in the future. The effectiveness of phytogenic treatments in chicken depends on a number of factors, with feed inclusion levels, bird genetics, and diet composition as a whole being the most crucial ones to consider. In order to fully analyze the specific mechanisms of action of phytogenic chemicals, the manufacture of highly effective phytogenic products obviously necessitates the extension of knowledge and comprehension of the thorough poultry gut ecology. Despite the fact that phytoadditives generally have positive effects, further research is needed to evaluate the results of the many chemicals present in phytogenic feed additives and to identify their exact mechanisms of action.

ISSN 1533-9211
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