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Phytobiotics as an alternative to antibiotics in poultry

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ABSTRACT

In the poultry sector, the use of antibiotics as a growth promoter is widespread but these cause antimicrobial resistance in both humans and animals. The use of phytobiotics as an alternative approach is increasing as they are natural, harmless, and pure rather than synthetic antibiotics. They have positive effects when used as growth promoters, antimicrobials, antioxidants, and immunomodulators in poultry.

1. Introduction:

The poultry sector has been a significant subsector in agricultural and veterinary sciences due to the increasing demand for eggs and meat as affordable protein sources for many decades. In recent decades, the rapid growth of the poultry industry has been accompanied by the widespread use of antibiotics to boost profit and make production economic. The growing and unregulated use of antibiotics may lead to the accumulation of residues in the food products of poultry and the development of resistance in microorganisms against these antibiotics. Therefore, in both humans and animals, treatment of many diseases is becoming very difficult [1]. There have been numerous attempts to find effective alternatives to antibiotics, regardless of the importance of antibiotics in disease prevention and growth promotion such as enzymes, phytobiotics, probiotics, toxin binders, prebiotics, organic minerals, synbiotics, oligosaccharides, organic acids, and other feed additives [2]. Moreover, these alternatives are harmless as they do not pose any toxicity to birds or human beings and do not result in environmental pollution.

2. Phytobiotics and functions of some common herbs

Phytobiotics, known as secondary plant metabolites, are natural feed additives that are growth-enhancing, residue-free, and less toxic. These are composed of plant-derived natural bioactive substances including phenolics, terpenoids, glycosides, and alkaloids called phytogenics or botanicals. Phytobiotics provide many natural benefits and can be categorized as essential oils or extracts, herbs from flowering, oleoresins, non-persistent and non-woody botanicals, and spices from non-leaf parts like fruits, seeds, bark, or root [3]. The benefits of herbs were well known by the Chinese, Indians, Egyptians, and Greeks and were used for centuries as the only accessible means for maintaining health and providing therapy. At least 5,000 years ago, the therapeutic qualities of plants were well-known by Sumerians, and nowadays a significant amount of the global population relies on traditional indigenous medicine. With rising demands for enhancing the productive efficacy of poultry and following the prohibition on antibiotics to enhance growth performance and importance of nutrition research has risen.

The use of herbal plants in animals has been steadily growing over the past two decades, driven by the global concern over the spread of antibiotic resistance among various bacteria due to subtherapeutic applications in livestock [4]. Functions of some herbs are given below.

2.1. Functions of some common herbs

Cinnamon (*Cinnamomum zeylanicum*) features phenolic and polyphenolic substances along with cinnamaldehyde eugenol active compounds in its leaves, cinnamon oil, and bark and it is considered to provide various benefits such as actions antimicrobial and blood purifying, enhances antioxidant status, improves appetite, and digestion, alleviation of the harmful effect of chemopreventive effect and environmental stress. Garlic (*Allium sativum*) is rich in ajoene, flavonoids, allyl disulfide, vinyl dithiin, mucilages, phytosterols, allicin and pectins as active compounds found in its crushed bulbs and these compounds activate the activity of lysozyme, elevates the phagocytic activity of macrophages, chemopreventive effect, enhances immunity by raising the antibodies titers, acts as antiseptic and mitigates harmful effects of environmental stress, boosts digestion and the blood lipid profile, growth and FCR. Moringa (*Moringa oleifera*) possesses bioactive substances that are carotenoids, ascorbic acid, chlorogenic acid, flavonoids, phenolics and caffeic acid in its leaves extract and enhances egg production and has negative effects on FCR, mitigates the harmful impact of environmental stress and antioxidant activity [5].

Peppermint (*Mentha piperita*), in its leave powder, contains menthol and terpenes which result in the reduction of FCR, act as an antiseptic, improve hunger and trigger metabolism, enhance quality and freshness of eggs and color, laying performance along with chemical composition of yolk. Turmeric (*Curcuma longa*) with turmerones and curcuminoids found in its rhizome powder boosts digestion (choleretic), anticarcinogenic, enhances the blood lipid profile, antihepatotoxic, action antioxidative, elevates hunger and immunomodulatory (enhances interferon production along with having chemopreventive properties) [6]. Aloe vera (*Aloe barbadensis*) is packed with amino acids, polysaccharides (mainly Acemannan), enzymes, anthraquinones, vitamins, anthraquinones, lignin, and salicylic acid and it boosts the performance and FCR, triggers the activity of granulocytic enzymes (peroxidase, myeloperoxidase) and granulocytes, acts as antidiabetic, enhances nutrients uptake from the intestine, increases intestinal microflora, mitigates harmful impact of environmental stress, strengthens and supports the crucial organs such as liver and kidney, boosts the antibodies titer and antioxidant (reducing oxidation stress and improving the antioxidant capacity). Ginger (*Zingiber officinale*) containing sesquiterpenes and monoterpenes in its roots/extracted oil, boosts the activity of lysozyme, exhibits chemopreventive benefits, enhances body weight gain by stimulating digestive enzymes and optimizing overall digestion, limits the growth of detrimental bacteria with antimicrobial activity in the intestinal tract which aids in nutrients absorption, enhances carcass attributes and diminishes abdominal fat [7].

3. Influence of phytobiotics on different parameters

3.1. Influence of phytobiotics as growth promoters

Herbal extracts exhibit growth-promoting attributes that aid in digestive enzyme secretion, enhance the intake of feed, enhance the taste and appeal of feed, and boost antimicrobial activity which can improve the gut function in poultry. It was observed that birds fed on different kinds of essential oils components, polysaccharides, or herbs showed better growth parameters. Synergistic mechanisms within the bioactive molecular complex found in phytobiotics supplementation may be the reason for the improvement of the growth performance parameters. Phytobiotics can enhance the villus length improve the surface area for intestinal absorption and help maintain or enhance the normal structure of the intestinal. It has been observed that phytobiotics can activate the secretion of digestible enzymes, bile production, and saliva synthesis ultimately playing a crucial role in enhancing digestibility and performance. Additionally, the digestion and utilization of protein in the intestine can be improved by the use of phytobiotics. Poultry diets often include a variety of herbs and spices such as coriander, garlic, black cumin ginger, oregano, marjoram rosemary, green tea, and yarrow are used as a substitute for antibiotics. Furthermore, herbs are known to have growth-promoting properties that are cinnamon, black pepper, and nishyinda. Enhancements in egg production, thickness, and eggshell strength as well as internal egg quality are shown by laying hens following the administration of a blend of herbs and essential oils [8].

3.2. Influence of phytobiotics as antimicrobial agent

Phytochemical compounds of phytobiotics are thought to have a potent antimicrobial activity against both Gram-positive and Gram-negative bacteria whether in vitro or in vivo environment. Some herbal compounds inhibit DNA synthesis and form saponin complexes with the cell membrane (sterols), one of the examples is alkaloid which leads to cell damage and collapse. Essential oils possess the potential to penetrate through the membrane of bacteria and their chemical structure which refers to their antimicrobial effect. Extracts of oregano, echinacea, garlic, cinnamon, thyme, and sage are rich in polyphenols, so they are among the various plant additives recognized for their exceptional antifungal and antibacterial properties. Plant bioactive compounds (such as coumarins, isoprene derivatives, triterpenoids, glucosinolates and alkaloids, polyphenols particularly flavonoids and tannins) undergo antimicrobial action by degrading cell membrane structures of pathogens, that cause moving out of vital ions from the pathogen's cell to the

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surrounding environment, therefore decreasing their disease-causing ability [9].

3.3. Influence of phytobiotics as immunomodulator

Beyond improving the production performance and displaying antimicrobial activity, plant products are extensively applied in the poultry industry as an immune modulator to reduce disease outbreaks when they are provided. Phytobiotics contain a very vital immunoreactive component named Polysaccharides. Immunomodulatory effects are induced by phytogenic compounds via enhanced increasing cytokines expression, proliferation of immune cells, and raising titers of antibodies. Phytobiotics can enhance the immunostimulatory effect by enhancing lymphocytes, macrophages, and enhancement of interferon production coupled with natural killer cell activities. Plants can enhance the immune system as they contain vitamin C, carotenoids, and flavonoids. Echinacea, ginseng, aloe, arnica, nettle, cinnamon, garlic, oregano, and plantain are examples of immunostimulatory herbs. Furthermore, sulfur compounds, polyphenols, alkaloids, terpenes, essential oils, tannins, and saponins are examples of substances that boost immunity. Liquid, lipophilic, and volatile components i.e. ketones, aldehydes, terpenes esters, ethers, alcohols, and phenols form key building blocks of essential oils [10].

3.4. Influence of phytobiotics as antioxidant agent

Plant antioxidants contribute to good health by protecting both the generation and the effect of reactive oxygen species. Antioxidant properties of herbs can lower the risk of hypertension, cancer, stroke, and heart disease as shown by previous studies. Moreover, it can mitigate the development of harmful oxidation in products, reduce the rancidity process, and maintain the nutritional integrity of animal-origin food products. The generation of free radicals which is known as the oxidation process, occurs constantly in the animal body. However, they are offset by intricate antioxidant pathways (both enzymatic and non-enzymatic) that reduce the harmful effects of reactive oxygen species (ROS). ROS plays a role in disturbing immune defense, degrading lipids as well as proteins and DNA. This plays a role in reducing the quality of animal-based products (milk, meat, and eggs), reducing their shelf life, leading towards the changes in attributes of animal tissues as well as compromising their health. Antioxidant properties such as ensuring the balanced amount of glutathione in cells and the prevention of the peroxidation of lipids membrane, components such as polyphenols, particularly phenols, hydrolyzable proanthocyanins, flavonoids, terpenes, and tannins.

Oregano and thyme are rich in the number of monoterpenes, carvacrol, and thymol that promote the activity of specific antioxidant enzymes like glutathione peroxidase and superoxide dismutase that play a critical role in controlling the metabolism of lipids in animals. In contrast, other plant varieties like rosemary, sage, and mint directly act as antioxidants [11].

4. Conclusion

As discussed, there are many reasons to look for other options than synthetic antibiotics in poultry feed as they are responsible for antibody resistance. Based on the knowledge above, phytobiotics are a clear alternative to antibiotics that is natural and harmless for both humans and animals. Phytobiotics are proven to have beneficial effects on growth performance, and they can efficiently act as antimicrobials, antioxidants, and immunomodulators.

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