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Use of antibiotics alternative in poultry

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In India today, poultry is one of the fastest rising sub sectors of the agricultural sector. While the production of agricultural crops has been growing at a rate of 1.5 to 2 percent per annum, that of eggs and broilers has been expanding at a rate of 8 to 10 percent per annum. In order to improve the production performances of the birds a large number of antimicrobials are used worldwide. Over the last 50 years, the use of antibiotics combined with strict biosecurity and hygiene measures has aided the poultry industry to grow by averting the negative effects of several avian diseases. Antibiotics were having a success in decreasing infectious diseases and enhancing feed efficiencies. These are made by lesser fungus or certain bacteria. They are often used in the treatment and prevention of infections at therapeutic and sub therapeutic level in people and animals. However, scientific evidence suggests that the widespread use of these compounds has contributed to an increase in the problem of antibiotic resistance, and the presence of antibiotic residues in feed and the environment. The use of antimicrobials had resulted in the emergence and spread of antimicrobial resistance, which is a cause of worldwide concern now-a-days. The resistant microorganisms can spread between food-producing animals and humans. Further, the use of antibiotics as growth promoters in animal feed has been totally prohibited by the European Union since 2006, owing to the potential harm to human and animal health. The withdrawal of growth boosters has resulted in poor animal performance and an increase in the prevalence of certain animal illnesses. As a result, there is an urgent need to develop antibiotic alternatives.

As a result, there is a rising need to find effective alternatives to manage infectious diseases and to restrict the development of resistant bacteria, consequently, ensuring the birds health and farmers income. Further, these alternatives to antibiotics have been developed to prevent health issues to consumers and possible growth of antibiotic-

resistant bacteria. Recently, various alternative products such as phytogenic, organic acid and probiotics have been used with varied degree of success. So, this overview of the literature summarises the present situation of antibiotic usage, as well as alternative options available for poultry production.

Antibiotics and bacterial resistance

Antibiotic resistance is defined as microorganism's capacity to multiply in the presence of an antibiotic that typically suppresses or kills microorganisms of the same species. Diarra et al. (2014) discovered that more than 43 percent of *Salmonella enterica* isolates collected from poultry farms in British Columbia (Canada) were simultaneously resistant to ampicillin, amoxicillin-clavulanic acid, ceftiofur, cefoxitim, and ceftriaxone. Further, in India, Centre for Science and Environment (2014) found 40% samples of chickens showed the presence of antibiotic when analyzed for six antibiotic samples collected from Delhi, Noida, Gurgaon, Ghaziabad and Faridabad.

Why we need antibiotic alternative?

Antibiotic alternatives are certain natural substances having antimicrobial property and safe to use e.g., organic acid, essential oil, synthesized nano particle etc. World health organisation in 1997 announced that antibiotic resistance is a global health issue. Further, worldwide rising price of antibiotics, and in doing so, keeps hampering smaller raisers, in particular, who are unceasingly searching for a remedy to solve the problem of unaffordability and to guarantee the availability of antibiotics for their birds. Therefore, one way of plummeting the processed antibiotics costs is through utilising the antibiotic properties of herbal trees and other natural antibiotic alternatives. However, there is a need to investigate the possibility of using these as a source of antibiotics for poultry.

Natural antibiotic alternative

The natural antibiotics alternatives including prebiotics, probiotics, organic acids, essential oils, enzymes, immunostimulants. Some phytogenic (phytobiotic) such as herbs, botanicals, essential oils, and oleoresins are the most common feed additives that obtain acceptance in poultry industry following the ban of antibiotic growth promoters (AGPs). They are frequently used globally because of their unique properties and positive impact on poultry production. They can be easily mixed with other feed ingredients, have no tissue residues, improve feed intake, weight gain, feed conversion rate, advance bird immunity, improve digestion. Further, they increase nutrients availability as well as absorbability, have antimicrobial effects, and do not affect carcass characters. Most importantly the natural antibiotic alternatives decrease the usage of antibiotics, acts as antioxidants, anti-inflammatory, compete for stress factors and offers healthy organic products for human consumption. Therefore, there are two ways to reduce our dependency on AGPs involving (a) Management: Improve the animal's condition by using suitable raising methods, minimising overcrowding, and enhancing infection control procedures. In the majority of cases, this may be difficult to achieve.

(b) Feeding: Phyto therapeutic plants, prebiotic and organic acid etc. For directly or indirectly boost the immune health and better performance.

Direct-fed microorganism (Probiotics)

According to world health organisation 2001, probiotics are the beneficial live microorganism which when administered in adequate amount confer general health and disease prevention in birds. The probiotics are also known as direct-fed microbial (DFMs). The positive effects of probiotics include improved performance, modifying the intestinal microbiota, inhibiting pathogens, enhanced intestinal integrity, immunomodulation, and improving microbiological and sensory characteristics of broiler meat. The most often used probiotic bacterial strains include the genera *Lactobacillus, Streptococcus, Bacillus, Bifidobacterium, Enterococcus, Aspergillus, Candida, Saccharomyces, Lactococcus* and Yeast. *Bacillus subtilis* has been a popular bacterium used within the industry and was shown to improve intestinal villus height. The most common probiotic mode of action is by dropping the gut pH through the volatile fatty acids and organic acids produced during the probiotic product breakdown.

Prebiotics

Prebiotics are short-chain carbohydrates (oligosaccharides) found in the diet that are indigestible by host animal but are used by specific population of gut microflora. Prebiotics allows already present microorganisms to increase their numbers, diminish pathogenic bacteria, increase digestibility, increase minerals and vitamins absorbability, maintain optimal intestinal pH, and take full advantage of nutrients. Prebiotics offer various virtues over probiotics, including the fact that they are organic molecules and do not need culture viability, as probiotics do. Prebiotics inability to be digested guarantees that they reach the colon and serve as an energy source for bacteria, as opposed to conventional carbohydrates, which are digested directly by the host. As a result, the microbiota's composition and/or activity are changed, resulting in secondary effects such as increased gas generation and a reduction in pH. Prebiotics can also limit pathogen attachment to the mucosa by competing with its sugar receptors, and multiple studies have demonstrated that supplementing diet with different oligosaccharides reduces susceptibility to *Salmonella* and *E. coli* colonisation. The most commonly available prebiotics are Mannooligosaccharides (MOS), galacto-oligosaccharides (FOS), soybean-oligosaccharides, isomalto-oligosaccharides, xylo- oligosaccharides, lactulose, and inulin are the most popular non-digestible oligosaccharides (NDO) utilised as prebiotics in poultry and farm animals.

Organic acids acidifiers

Organic acids are defined as any organic carboxylic acid with the generic formula R-COOH. The majority of organic acids with specific antibacterial action are short-chain acids (C1–C7, SCFA) with pKa values ranging from 3 to 5. Organic acids are produced by microbial fermentation of carbohydrates, which occurs mostly in the caeca of chicken. Various organic acid-acidifiers used in poultry production system with varied success

are formic, acetic, propionic, butyric, lactic, sorbic, fumaric, tartaric, citric, benzoic, and malic are the most frequent organic acids (also known as acidifiers) used in animal feed.

Phytogenic feed additives

These are plant derived compounds categorized as sensory and flavouring compounds, which consist mainly of plant extracts (essential oils (Eos), oleoresins, and flavonoids) and their active principles, which can be included in feeds as dried, solid, and ground form, or as extracts (crude, concentrated and purified). A wide variety of herbs (Table 1) and spices (thyme, oregano, cinnamon, rosemary, marjoram, yarrow, garlic, ginger, green tea, black cumin, coriander, among others) as well as EOs (from thymol, carvacrol, cinnamaldehyde, garlic, anise, rosemary, citruses, clove, ginger) have been used in poultry, separately or mixed, for their potential application as AGP alternatives. They provide varied degrees of performance, environmental, and nutritional benefits in animal nutrition, based on the combination and concentration by acting on the GIT of the host animal and help to improve the microbial community, which in turn helps resist colonization and take over from pathogenic microorganisms. The efficacy of plants depends on the type and amount of plant secondary metabolites or phytochemicals contained in the plant. The numerous beneficial qualities of PFA are principally derived from their bioactive molecules including carvacrol, thymol, capsaicin, cineole, etc. It is these properties of PFA that project them as appropriate alternatives to AGP. Numerous plant extracts are identified to have antimicrobial, antiviral, anticoccidial, fungicidal, and/or antioxidant properties. The antimicrobial property is due to bioactive substance such as tannic acid and saponin. The tannic acid can endorse iron deprivation, and saponins can bind with sterols to cause microorganism damage and cell destruction.

Various studies in broilers have verified the antimicrobial efficacy of PFA against pathogenic bacteria, such as *Escherichia coli* and *Clostridium perfringens*, potentially demonstrating a reduced risk for the development of colibacillosis and necrotic enteritis. Mitigation of coccidiosis symptoms, including reduction in lesion severity and oocyst shedding, by PFA has also been documented. Further, the effects of EOs on growth performance and poultry productivity due to their antioxidant, antimicrobial, and immunomodulatory effects are shown in the Fig 1. Essential oils are a complex mixture of volatile compounds derived from plants and manufactured via several fermentation, extraction, and steam distillation methods (Table 2).

EOs are categorized into 2 groups of compounds: terpenes and phenylpropenes. The essential quality and efficiency of various EOs depend on the source plant type, physical and chemical soil conditions, harvest time, plant maturity, drying technology used, storage conditions, and extraction time. These EOs contains various antibacterial, antifungal, antiparasitic, and antiviral activities, therefore, they can be used for therapeutic purposes in various situations in broiler production. As these Eos augment poultry production by stimulating the activity of various digestive enzymes, reducing the number of fermentation products, declining the number of pathogenic

microorganisms, intensifying pre-cecal nutrient digestion, ameliorating intestinal accessibility of significant nutrients, and improving antioxidant status and immune response. Normally used EOs in broiler diets contain anize, oregano, cinnamon, garlic, thyme, and turmeric.

Table 1: Herbs and parts there of used in feed additives

Common name	Latin name	Parts utilised
Anise	*Pimpinella anisum*	Seeds
Caraway	*Carum carvi*	Seeds
Cinnamon	*Cinnamomum verum*	Bark
Chamomile	*Matricaria recutita*	Flowers
Citrus	*Citrus sp.*	Peel
Clove	*Syzygium aromaticum*	Buds
Fennel	*Foeniculum vulgare*	Seeds
Garlic	*Allium sativum*	Bulb
Ginger	*Zingiber officinale*	Rhizome
Melissa	*Melissa officinalis*	Leaves
Onion	*Allium cepa*	Bulbs
Oregano	*Origanum vulgare*	Leaves
Peppermint	*Mentha piperita*	Leaves
Rosemary	*Rosmarinus officinalis*	Leaves
Sage	*Salvia officinalis*	Leaves
Thyme	*Thymus vulgaris*	Leaves
Valerian	*Valeriana officinalis*	Root, rhizome

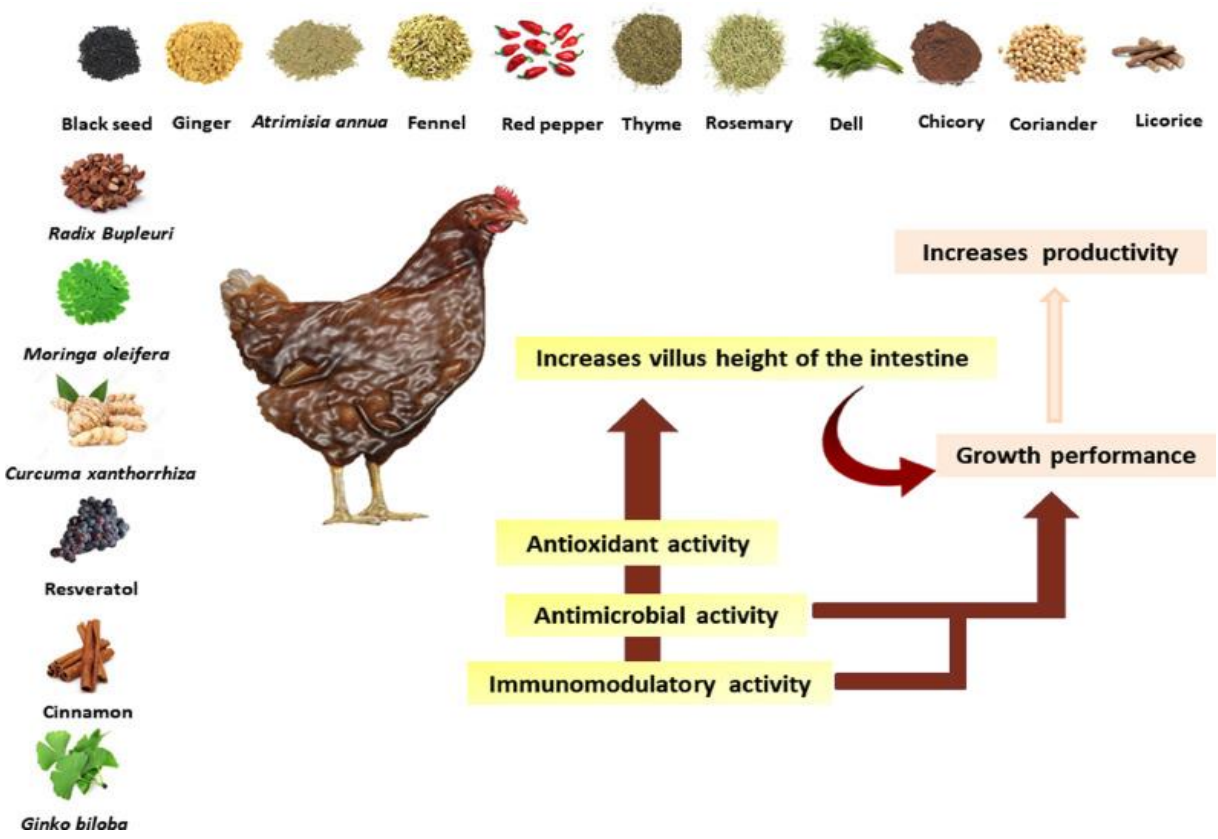

Fig 1. Effects of essential oils on growth performance and poultry productivity due to their antioxidant, antimicrobial, and immunomodulatory effects (Source: ABD El-Hack *et al*., 2021)

Table 2: Essential oils list and typical composition

Source of essential oil	Major components	Typical composition (%)
Cinnamon (*Cinnamomum zeylanicum*)	Cinnamaldehyde Eugenol	77.1 7.2
Chamomile (*Matricaria chamomilla*)	α-bisabole oxide α-bisabolol Chamazulene	30.9 11.3 10.9
Eucalyptus (*Eucalyptus*)	Citronelal Citronellol	72.8 14.5
Clove (*Syzygium aromaticum*)	Eugenol β-caryophyllene	76.8
Garlic (*Allium sativum*)	Diallyl trisulfide Diallyl disulfide	45.9 17.5-35.6
Ginger (*Zingiber officinale*)	Camphene	14.1

	β-bisabolene	22.1
Oregano (*Origanum vulgare*)	Carvacrol	64.5-69.5
	Cymene	10.6-10.9
	Thymol	4.1
Peppermint (*Mentha piperita*)	Menthol	37.4
	Menthon	12.7
	Menthofuran	6.8
Rosemary (*Rosmarinus officinalis*)	1,8-cineole	43.6-50
	α-pinene	7.4-9.9
	Camphor	12.3
Tea tree (*Melalecua alternifolia*)	Terpinen-4-ol	40.1
	γ-terpinene	23.1
	α-terpinene	10.4
Thyme (*Thymus vulgaris*)	Thymol	48.9
	p-cymene	19.0

(Adaszyńska-Skwirzyńska and Szczerbińska, 2017)

CONCLUSIONS

The raising consumer demand for poultry products without antibiotics, generated a greater need for the development of antibiotic alternatives that can improve performance and maintain optimal health of food animals. The phytogenic additives (essential oils and herbs) are proven to be efficient alternative to antibiotic in poultry production as they do not have residual effects, side effects, and are environment friendly.