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Toxicology

Influence of Nano Encapsulated Essential Oils on Broiler Performance: An Overview

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ABSTRACT:

In an intensive management approach, herbal essential oils (EOs) can be utilized as an antibiotic substitute to improve animal performance. Eos possesses antibacterial, antioxidant, digestion-stimulating, enzymatic enhancer, growth-promoting, immune-stimulating, hypocholesterolemic, and hypolipidemic properties. However, due to specific features such as being very sensitive to environmental elements such as oxygen, light, and temperature, there are some restrictions on their use in poultry diets. During preparation, use, and storage, they are also volatile, evaporative, and unstable. In addition to a high sensitivity to peroxidation, which resulted in decreased palatability and feed intake, particularly when utilized in large quantities. Microencapsulation or Nano-encapsulation technology is one approach for keeping active substances in order to increase effective delivery and controlled release. Chitosan is a water-soluble natural carbohydrate polymer (made by the partial N-deacetylating chitin of crustacean shells and some microorganisms) has been employed as a polymeric carrier for nanoparticles as it is biocompatible, biodegradable, non-toxic and affordable. Eos Nano encapsulation improves broiler performance by boosting body weight, growth, feed intake, and feed conversion ratio compared to the non-encapsulated form.

Key words: Broiler growth performance, Chitosan Nano particles, Eos and Nano encapsulation.

INTRODUCTION:

Antibiotics have been widely utilized in the poultry to protect chickens against pathogenic enteric bacteria, boosting growth performance and feed efficacy. Also used in animal feed as a growth promoter (Dibner and Richards, 2005). Recently, they have a number of hazards, including pathogen resistance to antibiotics, antibiotic residues in chicken products, and an imbalance of natural gut microbiota as a result of their repetitive use (Kareem et al., 2016). As a result, several international organizations have pushed for a ban and reduce the use of antibiotics in animal production and search for other substitutions (Hosseini et al., 2016). The use of herbs and spices in traditional veterinary and human remedies is widespread in many countries. Natural products, dried powder, extracts, or phytochemicals with considerable bioactivity, such as antioxidant, antibacterial, immune-modulatory, anti-inflammatory, palatable, and gastroprotective properties, are referred to be phytogenic (Johannah et al., 2018). Eos' capacity to boost intestinal health and combat microbial risks allows it to optimize chicken growth performance and profitability. Ginger, black cumin, thyme, garlic, coriander, and turmeric have all been utilized as feed additives in poultry diets (Murugesan et al., 2015). Eos' characteristics have some drawbacks that have limited their direct usage in poultry diets.As a result, the efficiency of oils, tastes and quality may be harmed as a result of such unfavorable responses, which can reduce palatability and feed intake, particularly when used with large amounts (Lee et al., 2004). One method for keeping active chemicals safe is to use microencapsulation or Nano-encapsulation technique to achieve effective distribution and controlled release through capture in the core of the wall structure of Nano capsules or introducing onto a carrier (Allemann et al., 1993). Furthermore, Hosseini et al. (2013) revealed that Encapsulation helps to prevent degradative processes in EO and promotes their action. This can result in improved feed flavour, easier handling, less dustiness, increased stability, increased bioavailability and delayed EO release in the digestive tract .

Essential oils:

EOs are "colourless, highly volatile hydrophobic liquids containing complex combinations of organic chemicals," according to the International Organization for Standardization (ISO). They are secondary plant metabolites synthesized in flowers, stems, seeds, and leaves and kept in plant secretory cells and cavities. Their density is less than water, there mass is less than 300 molecular weight and highly soluble in organic solvents (Baser and Buchbauer, 2015).Essential oils are extracted from plants using steam distillation and supercritical fluid carbon dioxide (Bilia et al., 2014). The antioxidant activity of EOs extracted by steam distillation was higher than that of EOs extracted by hydro distillation, therefore steam distillation wasa preferable method for extraction (Babu and Kaul, 2005).

EOs are divided into two groups based on their chemical compositions: I oxygenated chemicals and (ii) hydrocarbons. Whereas, terpenes and sesquiterpenes32 have hydrogen and carbon atoms in their structures. Monoterpenoids, sesquiterpenoids, phenylpropanoids, short-chain aliphatic hydrocarbon derivatives, glucosinolates, and isothiocyanate derivatives are all types of phytochemicals (Guenther, 1972). In general, EOs contain roughly 20-100 unique components in varying amounts. Nearly 2-3 primary constituents with relatively substantial proportions (20–70%) are responsible for their biological actions whereas, others are trace constituents. Carvacrol (30%) and thymol (27%) are the two primary ingredients of Origanum species EOs, for example (Guenther, 1972).

Eos has been shown to have antibacterial, antioxidative, anticoccidial, and immunogenic properties. They also improve the feed's palatability, protect feed from oxidative degradation, and enhancethe digestibility of feed and nutrient absorption in stomach. Reduced bacterial colony numbers, reduce fermentation products, less activity of the gut-associated lymphatic system, and promote preceacal food digestion that lead to optimizing gut health. Furthermore, some phytogenic chemicals appear to increase the synthesis of intestinal mucus (Madhupriya et al., 2018). They are utilized as feed and drinking water additives, as well as for facility sanitation, such as fogging or inhalation. Environmental variables such as oxygen, light, and high temperatures are extremely harmful to EOs. During preparation, use, and storage, they are volatile, evaporative, and unstable. The rate at which plant EOs are released is frequently influenced by ambient factors, so that too little or too much release results in inefficiency or unpleasant emotions, respectively. As a result, developing new formulations that result in consistent EO release under various environmental conditions has been viewed as a major problem in recent years (El Asbahani et al., 2015).

Nano encapsulation of essential oils:

Nano encapsulation is a new technology that keep EOs against harsh environmental conditions such as temperature,humidity and drying. Furthermore, Nano encapsulation is a type of encapsulation that control the release of the constituents under particular situations (Hosseini and Meimandipour, 2018). Nano encapsulation serves two purposes: (1) to improve stability for peroxidation, temperature and light (2) to ensure their delivery to the lower intestine of animals (Turek and Stintzing, 2013). (Gallardo et al., 2013; Walia et al., 2017).Processing, storage conditions, triggers, mechanisms of release, cost and scale of manufacturing all influences the choice of an acceptable encapsulation technology, carrier material and size. The process conditions for the targeted delivery of carriers in feed to the lower intestine include matrix thermal stability at animal body temperature and slow carrier matrix digestion (Stevanovi'c et al., 2018).

Natural polymers, such as protein-polysaccharide hydrogels are commonly used for making polymer-based particles. They're rigid enough to keep particles mechanically stable when combining with granular feed. Wheat proteins (Qiu et al., 2015), milk proteins (Hebishy et al., 2017), whey proteins (Zhang et al., 2014; Zhang et al., 2016), soy proteins, and gelatin are some of the most commonly utilized proteins. Alginate (Chan, 2011), chitosan-alginate (George and Abraham, 2006), alginate-cashew gum (De Oliveria et al., 2014), alginate-xanthan gum (Zhang et al., 2013), xanthan gum-pectin (Qiu et al., 2015), and alginate-pectin (Qiu et al., 2015) are some of the polysaccharides (Wang et al., 2013). Chitosan a copolymer of approximately 80% D-glucosamine and 20% N-acetyl-D-glucosamine units, linear polysaccharide produced by alkaline deacetylation of chitin (prepared by shells of crustaceans, insects, many fungi, algae, and yeasts). chitosan used as a matrix in making some drugs and EOs due to its not toxic, film-making capacity, higher permeability, high muco-adhesivity and high tensile strength (Pedro et al., 2009; Zaru et al., 2009). Furthermore, the interaction of charges between the amino groups of chitosan's polycationic form and cell walls of microbes makes it have efficient antibacterial role (Menconi et al., 2014). Ducks' performance and immune functions were boosted by dietary chitosan according to research (Shi-Bin and Hong, 2012). Antibacterial properties of chitosan nanoparticles (CNPs) have been conducted (Esmaeili and Rafiee, 2014; Raphael and Meimandipour, 2017). Chitosan has a lot of potential for being a good EO carrier for controlled release (Natrajan et al., 2015). Therefore, Nano encapsulation could optimize growth efficiency by delivering EO and chitosan's antibacterial characteristics more effectively (Meimandipour et al., 2017). Hafeez et al. (2016) assuredthe need of selecting adequate food dosages in regulating poultry performance for the effectiveness of these drugs was underlined.

The effect of nano encapsulated essential oil on broiler growth performance:

The principal active constituents of EOs (terpenoids and phenolic acids) are labile and volatilethus, direct integration of EOs into animal diets is limited. Micro- and Nanoencapsulation of EOs by biopolymers to solve this problem (Riberio et al., 2014).

The effect of thyme oil encapsulated with chitosan on broiler performance. clearly showed by Hosseini and Meimandipour, (2017) who revealed E-TEO and CNPs has a significant effect on BWG and FCR allover rearing period. in addition, the mentioned that is due to the effective delivery of TEO capsules and its protection from the gut microorganisms (Hosseini et al. 2013).furthermore, Huang et al. (2005) demonstrated that addition of chitosan powder in broiler diet improving BWG and FCR through increasing ileal digestibility. Also, Wang and Li (2011) showed that CNPs significantly enhance BWG and FCR in tilapia. Moreover, the effect of Chitosan Nano-encapsulation of mint, thyme, and cinnamon essential oils on broiler chickens showed by Nouri (2019) who concluded that there was significant increase on BWG and FCR of broiler chickens. TEO had much more positive benefits than the other EOs. Furthermore, Heydarian et al. (2020) studied the effect of encapsulated and non-capsulated thyme and oregano essential oils on growth performance and carcass traits, they found Encapsulation of the EOs could increase BWG in comparison with non-capsulated form on days 24 and42. Moreover, the addition of 50 and 100 mgkg-1 of both Cur and CurNPs improved BW and WG during starter (1-21 d), grower (22-35 d) and overall (1-35 d) periods. Feed consumption was decreased by diet supplementation of Cur and CurNPs at level 50 mg.kg-1during starter and overall periods and at 50 and 100mg.kg-1 during the grower one. Also the addition of Cur in levels 50 and 100 mg.kg-1enhanced FCR during starter, grower and overall periods (Badran et al., 2020).

Ibrahim et al. (2021) investigated the effect of Thymol Nano emulsion on broiler chicken growth and discovered that dietary thymol and thymol Nano emulsion addition altered body weight gain (BWG) and feed conversion ratio (FCR) When compared to the negative control (NC) group, broilers given 0.5 and 1 percent thymol Nano emulsion had the better significant increase ($p > 0.05$) in BWG (approximately 7%)

during the grower period in thymol Nano emulsion groups, followed by groups given thymol, the BWG was not affected by S. Typhimurium exposure during the finisher period compared to the positive control (PC) group. Moreover, Amiri et al. (2020) investigated the effects of Nano encapsulated cumin essential oil on broiler chicken growth performance and revealed that including 200 mg/kg of Nano encapsulated cumin EO in a diet increased body weight gain when compared to the antibiotic group. The FI and FCR of birds was reduced by feeding diets supplemented with Nano encapsulated cumin EO. While, El-Gogary et al. (2019) reported that the effects of dietary garlic extract and Nano garlic supplementation on broiler chicken performance at 21 and 42 days of age were not significant, but feeding the Nano garlic 1 g/kg produced significantly lower means of LBW, BWG, and FI as compared to other groups in the starter period. Furthermore, Barbarestani et al. (2017) studied the Effects of Encapsulated Peppermint (Mentha piperita) on the Growth Performance and concluded that there were no significant differences in BWG and FI between treatments. While, FCR was significantly affected at finisher period.

CONCLUSION

Nano encapsulation protecting Eos from adverse environmental effects, prolonged their action and improving broiler growth performance (body weight, body weight gain, feed intake and FCR) in relation to non-encapsulated form.

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