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Effects of Microencapsulated Medicinal and Aromatic Plants on Growth Performance and Immunity in Chickens

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Abstract

The immune system in poultry is a complex structure influenced by various factors such as age, nutrition, genetic background, environmental conditions, and stress. For many years, antibiotics were used in animal feed as growth promoters to prevent diseases and enhance productivity; however, this practice led to the development of antibiotic resistance and has therefore been banned in many countries. Consequently, natural compounds such as probiotics, prebiotics, organic acids, plant extracts, and essential oils have been investigated as alternative growth-promoting agents. Medicinal and aromatic plants, due to their antimicrobial and immune-supporting properties, have emerged as promising natural feed additives in poultry nutrition. However, the essential oils and bioactive compounds they contain are highly sensitive to heat, light, and oxidation, which can reduce their effectiveness during feed production and storage. At this point, microencapsulation technology enables the controlled release and chemical stability of these active components, allowing the safe and effective use of medicinal and aromatic compounds in poultry feeds. Microencapsulation involves enclosing liquid, solid, or gaseous active substances within suitable coating materials (such as maltodextrin, starch, alginate, or gelatin) to form micron-sized capsules. This method protects volatile compounds from oxidative degradation, extends shelf life, masks undesirable odors and tastes, and facilitates dosage control in feed formulations. In conclusion, microencapsulation technology represents an innovative approach that enhances the bioavailability and efficacy of medicinal and aromatic plant components in poultry nutrition, offering significant potential for improving growth performance and immune functions.

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Keywords: Microencapsulation, Poultry Nutrition, Medicinal and Aromatic Plants

INTRODUCTION

The immune system of chickens is a complex system influenced by numerous factors. Immune function is affected by the age of the bird, nutritional and energy intake, genetic background, diet composition, environmental conditions, and stress. In response to external factors, efforts such as vaccination, reduction or elimination of specific pathogens, use of growth-promoting antibiotics, and immune support through nutrition have been ongoing for many years (Gültepe, 2013; Kırar, 2023).

Continuous use of antibiotics in animal feed to prevent diseases and improve productivity has led to the emergence of antibiotic-resistant microbial strains in animals and humans consuming animal products (Tufan et al., 2024; Irmak et al., 2024). This issue has prompted many countries to ban the use of antibiotics as growth promoters in feed (Bach, 2001). In poultry nutrition, probiotics, prebiotics, humic acid, malic acid, plant extracts, butyrate, propionate, and essential oils are being evaluated as alternative growth-promoting agents (Öztürk, 2009). Research has shown that medicinal and aromatic plants, along with their extracts, possess antimicrobial properties and positively influence animal performance. Therefore, these compounds have been suggested as potential alternatives to antibiotics in feed (Güler, 2013).

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Medicinal and aromatic plants are used as natural growth-promoting factors in poultry nutrition; however, volatile oils and bioactive compounds contained in these plants are highly sensitive to light, heat, and oxidation. This sensitivity may reduce the efficacy of these compounds during feed production and storage. Microencapsulation technology helps mitigate such issues by enhancing the controlled release, chemical stability, and feed durability of active compounds. Consequently, it allows medicinal and aromatic plants to be used more safely and effectively in poultry rations (Cao, 2010).

Microencapsulation is an innovative and promising technology that enhances the efficacy of medicinal and aromatic plants as feed additives. This method involves surrounding biologically active compounds (e.g., volatile oils, organic acids, probiotics, vitamins, and enzymes) with a suitable coating material (such as maltodextrin, caseinate, starch, alginate, gelatin, etc.) to form micron-sized capsules (Pekdoğan et al., 2023).

The aim of this review is to evaluate the effects of microencapsulated medicinal and aromatic compounds on growth performance and the immune system in chickens.

DEFINITION AND TECHNIQUES OF MICROENCAPSULATION

Microencapsulation can be defined as the entrapment of food components, enzymes, cells, and other similar substances in solid, liquid, or gaseous form within one or more coating materials derived from proteins or carbohydrates (Desai & Park, 2005; Koç et al., 2010; Gökmen et al., 2012). Microencapsulation is applied in many areas of food science, including the stabilization of the encapsulated material, shelf-life extension, preservation of biological activity, oxidation control, modification of physicochemical properties, controlled release, and masking of color, taste, and odor (Bakry et al., 2015).

The encapsulation of food components can be achieved through various methods. The selection of the microencapsulation technique depends on the active compound to be used, the characteristics of the coating materials, and the intended purpose of the food components (Nedovic, 2011). Microencapsulation technology allows for the protection of volatile oils by coating them with suitable layers to delay their evaporation, conversion of liquid food forms into dry powders, extension of shelf life, and reduction of potential problems during processing, storage, and transportation (Jackson et al., 1991).

Microcapsules are small particles ranging from 1 to 1000 μm , containing an active ingredient enclosed within a natural or synthetic polymeric membrane. The encapsulation of essential oils in a core-shell system is carried out to protect them against oxidative degradation and evaporation, mask undesirable odors, and facilitate accurate dosing in feed rations (Martins et al., 2014).

Microencapsulation is a technique in which core materials are physically entrapped within a protective matrix or wall material to protect sensitive components from reactive, abrasive, or external environmental factors, while also allowing controlled release behavior (Sobel et al., 2014). Microencapsulation methods vary depending on the structure of the core and coating materials. The selection of the coating material takes into account its physical and chemical properties as well as the intended application of the food component.

Coating materials are generally classified as carbohydrates and proteins. Common carbohydrates used include maltodextrin, hydrolyzed starch, modified starch, cyclodextrins, and gums, while widely used proteins include milk proteins, whey proteins, and soy proteins. Since no single coating material provides optimal benefits on its own, combinations of different groups of coating materials are often preferred (Başyigit and Çam, 2017).

Some common microencapsulation techniques and their important steps are as follows; Spray drying involves preparing the dispersion, homogenizing it, atomizing the nutrient distribution, and dehydrating the atomized particles. Liposome extrusion includes microfluidization, ultrasonication, and reverse-phase

evaporation. Coacervation is characterized by the formation of three chemical phases, the precipitation of the coating, and the solidification of the coating material. In lyophilization (freeze-drying), the core is mixed within a coating solution followed by freezing and drying of the mixture. The spray-cooling method shares similar steps with spray drying, such as dispersion preparation, homogenization, and atomization of nutrient distribution. Lastly, fluidized bed coating involves preparing the coating solution, fluidizing the core particles, and coating the core particles effectively (Başıyigit et al., 2017).

THE USE OF MICROENCAPSULATED MEDICINAL AND AROMATIC PLANTS IN POULTRY

With the ban on antibiotic use, efforts to maintain consistent production efficiency have led to the adoption of advanced technologies, such as the microencapsulation of organic acids and essential oils—either individually or as mixtures—for use in nutrition (Lippens et al., 2006). Several studies in the literature address the microencapsulation of medicinal and aromatic plants.

Kan (2019), conducted a study to evaluate the effects of coated and uncoated essential oils on feed intake, feed conversion ratio, live weight, egg production, egg weight, eggshell quality, and yolk characteristics in laying hens. The results indicated that the inclusion of microencapsulated and non-encapsulated essential oils containing at least 12% cinnamaldehyde, 2.5% carvacrol, and 2.5% thymol in the diet did not have a statistically significant effect on performance indicators, egg production, or internal and external egg quality parameters—except for yolk color and shell thickness.

Rozmehr et al. (2018), investigated the effects of microencapsulated thyme and cinnamon essential oils on growth performance, specific blood biochemical parameters, and carcass characteristics in broiler chicks. Their findings demonstrated that the application of microencapsulated essential oils reduced cholesterol levels, increased glutathione peroxidase enzyme activity, and positively impacted liver and abdominal fat mass by reducing their amounts.

Elolimy (2025), conducted a study to evaluate the effects of a microencapsulated essential oil blend (consisting of cinnamaldehyde, eugenol, and thymol) combined with seaweed (*Ascophyllum nodosum*) supplementation on growth performance, digestive enzymes, intestinal morphology, liver gene expression, and plasma biomarkers in broiler chickens. The results showed that the addition of microencapsulated essential oils and seaweed to broiler diets improved feed conversion ratio, supported digestive system functions, positively influenced intestinal structure, and benefited metabolic parameters at the liver and plasma levels.

Hafeez et al. (2016), supplemented broiler diets with 150 mg/kg powdered and 100 mg/kg microencapsulated essential oils. Their findings indicated that powdered essential oils (menthol and anethol) had no significant effects at these levels, whereas the inclusion of microencapsulated essential oils (carvacrol, thymol, and limonene) at 100 mg/kg improved nutrient digestibility at the ileal level and enhanced growth performance.

Cao et al. (2010), investigated the combined use of a microencapsulated essential oil blend with various enzymes such as phytase and xylanase on broilers fed corn-soybean-based diets with reduced phosphorus and apparent metabolizable energy (AME) content. The study results indicated that there was no significant interaction between essential oils and enzymes in terms of growth performance. However, the inclusion of essential oils and feed enzymes in diets with lowered phosphorus and AME levels was reported to enhance the efficient utilization of nutrients, thereby improving the overall effectiveness of the ration.

CONCLUSION AND FUTURE PERSPECTIVES

Our country is rich in medicinal and aromatic plants. In recent years, studies on the use of these plants as alternative feed additives in animal nutrition have increased. Microencapsulation is a promising technology that enhances the efficacy of bioactive compounds derived from medicinal and aromatic plants when used as feed additives in poultry diets. Factors such as the type of active compound, encapsulation material, and capsule size play a crucial role in determining growth performance, feed utilization, and immune response, particularly in broilers and laying hens. In the future, it is recommended that the effects of nanoencapsulation and controlled-release systems on performance and immunity in poultry nutrition be investigated more comprehensively.

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