

Lemongrass (*Cymbopogon citratus*) as a Phytogetic Feed Additive for Improving Growth Performance, Gut Health and Immunity in Poultry: A Review

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Abstract- The restriction on antibiotic growth promoters in poultry production has increased interest in natural feed additives that can enhance productivity while maintaining animal health. Lemongrass (*Cymbopogon citratus*) is a promising phytogetic additive due to its rich content of bioactive compounds, including citral, geraniol, flavonoids, phenolic acids and terpenoids. These compounds possess antimicrobial, antioxidant, anti-inflammatory and immunomodulatory properties that may improve growth performance, intestinal health and disease resistance in poultry. This review summarizes the effects of lemongrass supplementation on production efficiency, gastrointestinal health, antioxidant status and immune responses in broiler chickens and other poultry species. Available evidence indicates that moderate dietary inclusion of lemongrass or its essential oil improves body weight gain, feed conversion efficiency, antioxidant capacity and immune function, although responses vary depending on dosage, formulation and experimental conditions. Further research is required to standardize supplementation levels and clarify molecular mechanisms. Overall, lemongrass represents a potential natural alternative to antibiotic growth promoters in sustainable poultry production.

Keywords: Lemongrass essential oil, phytogetic feed additive, broiler chicken, growth performance, gut health, immunity, antioxidant activity.

I. INTRODUCTION

Lemongrass (*Cymbopogon citratus*) is an aromatic perennial grass belonging to the family Poaceae and is widely cultivated in tropical and subtropical regions for its essential oil. The plant contains several biologically active compounds responsible for its antimicrobial, antioxidant, anti-inflammatory and growth-promoting activities. The composition of lemongrass essential oil varies according to geographical origin, cultivation practices and extraction methods (Shah et al., 2011).

The major bioactive constituents of lemongrass oil include citral (geranial and neral), geraniol, citronellal, limonene, myrcene, geranyl acetate and terpinolene. In addition, it contains flavonoids such as quercetin, kaempferol and apigenin and phenolic compounds including chlorogenic acid, caffeic acid and hydroquinone (Alagawany et al., 2021). These phytochemicals contribute to its biological activities such as anti-bacterial, anti-diarrheal, anti-fungal, antioxidants and as a growth promoter (Sariozkan et al., 2016).

The antimicrobial activity of lemongrass is mainly attributed to citral, which damages bacterial cell membranes and inhibits microbial growth against both Gram-positive and Gram-negative organisms (Onawunmia et al., 1984; Wannissorn et al., 2005). Phenolic compounds present in lemongrass exhibit cytoprotective and antioxidant effects by scavenging free radicals and reducing lipid peroxidation (Ahn et al., 2004; Ojo et al., 2006). Limonene and other terpenoids contribute to its anti-inflammatory properties by regulating inflammatory responses (De Souza et al., 2019). These biological properties make lemongrass a potential phytogetic alternative to antibiotic growth promoters in poultry production.

II. EFFECT OF LEMONGRASS ON BODY WEIGHT GAIN

Growth performance is one of the major criteria used to evaluate the effectiveness of phytogetic feed additives. Lemongrass supplementation has shown variable but generally beneficial effects on body weight gain in poultry, depending on the form, dose and duration of supplementation.

Mmereole (2010) reported that inclusion of lemongrass leaf meal at 1% improved final body weight of broilers compared with the control group and showed comparable performance with antibiotic growth promoter supplementation. Parade et al. (2019a) also observed significantly higher body weight and weight gain in broilers supplemented with 1.5% lemongrass leaf meal. Positive responses have also been reported with lemongrass essential oil supplementation. Alagbe (2020) observed improved daily weight gain in broiler chicks supplemented with 0.3 and 0.4% *C. citratus* oil.

Alagawany et al. (2021) reported increased weight gain in growing quails supplemented with lemongrass essential oil at 150–450 mg/kg diet. Supplementation of lemongrass leaves and its extract significantly improved the body weight gain in broilers (Yasir and Ali, 2021). Similarly, Khalifah et al. (2021) recorded maximum weight gain at 0.4 g/kg lemongrass essential oil supplementation in Japanese quails.

In contrast, Sariozkan et al. (2016) reported reduced live weight at 3% lemongrass leaf meal supplementation in quails, while Nogueira et al. (2017) observed lower weight gain in broilers supplemented with lemongrass oil compared with antibiotic-treated birds. Ogbonna et al. (2017) and Tiwari et al. (2017) also reported reduced weight gain in broilers receiving lemongrass leaf meal and lemongrass oil respectively.

III. EFFECT OF LEMONGRASS ON FEED INTAKE

Feed intake responses to lemongrass supplementation differ among studies due to variations in inclusion level, essential oil concentration and bird species. Mmereole (2010) reported reduced feed intake in broilers supplemented with 1% lemongrass leaf meal, while maintaining improved growth performance. Parade et al. (2019a) and Alagbe (2020) also observed decreased feed intake with lemongrass supplementation. Khalifah et al. (2021) reported lower feed consumption in quails supplemented with 0.4 and 0.8 g/kg lemongrass essential oil. The

reduced feed intake may be associated with improved nutrient utilization and enhanced digestive efficiency rather than reduced performance.

Conversely, Sariozkan et al. (2016), Alzawqari et al. (2016) and Samant et al. (2021) reported no significant effect of lemongrass supplementation on feed intake. Differences among findings may be due to variation in the chemical composition of lemongrass products, dietary formulation and experimental conditions.

IV. EFFECT OF LEMONGRASS ON FEED CONVERSION RATIO

Feed conversion ratio is a key indicator of economic efficiency in poultry production. Several studies have demonstrated improved FCR following lemongrass supplementation. Mmereole (2010) reported better FCR in broilers supplemented with lemongrass leaf meal compared with control birds. Parade et al. (2019a) and Alagbe (2020) also observed improved FCR following dietary supplementation of lemongrass. Similarly, Alagawany et al. (2021) and Khalifah et al. (2021) reported significant improvements in FCR in quails supplemented with lemongrass essential oil. Alagbe and Oluwafemi (2019) observed superior FCR in broilers supplemented with lemongrass and garlic extract.

However, several studies reported no significant effect of lemongrass on FCR (Thayalini et al., 2011; Sariozkan et al., 2016; Nogueira et al., 2017; Tiwari et al., 2017). Improved feed efficiency may result from enhanced nutrient digestibility, modulation of intestinal microbiota and reduced metabolic stress.

V. EFFECT OF LEMONGRASS ON CARCASS PARAMETERS

Carcass characteristics are important indicators for evaluating the influence of dietary additives on production efficiency and meat yield. Most studies have reported that lemongrass supplementation does not adversely affect carcass traits and may improve selected parameters.

Sariozkan et al. (2016) observed no significant effect of lemongrass leaf meal supplementation on slaughter weight, carcass weight, dressing percentage, liver, gizzard and heart weights in quails. Similarly, Tiwari et al. (2017) reported no significant changes in dressing percentage, liver weight, heart weight, gizzard weight or abdominal fat in broilers supplemented with lemongrass oil.

Conversely, Alagbe (2020) reported improved dressing percentage and increased liver and gizzard percentages in broilers receiving *C. citratus* oil supplementation. Khalifah et al. (2021) also recorded increased liver, gizzard and heart weights with 0.4 g/kg lemongrass essential oil supplementation and reduced abdominal fat deposition in Japanese quails. Alzawqari et al. (2016) and Samant et al. (2021) observed no significant effects of lemongrass supplementation on carcass yield and relative organ weights.

VI. EFFECT OF LEMONGRASS ON IMMUNE RESPONSE

Improving immunity is an important objective of phytogenic feed additives, particularly under intensive poultry production systems where birds are exposed to environmental and microbial stress. Alagawany et al. (2021) reported increased plasma immunoglobulin concentrations (IgG, IgM and IgA) in quails supplemented with lemongrass essential oil, indicating improved humoral immunity. Ghanima et al. (2021) also observed enhanced cellular immunity in broilers supplemented with lemongrass essential oil under different stocking densities.

However, changes in lymphoid organ weights have been inconsistent. Nogueira et al. (2017) and Alzawqari et al. (2016) reported no significant effects of lemongrass supplementation on spleen and bursa weights, suggesting that lemongrass improves immune function mainly through functional modulation rather than structural changes.

VII. EFFECT OF LEMONGRASS ON SERUM CHOLESTEROL

Serum lipid profile is an important indicator of metabolic health and dietary responses. Several studies have reported cholesterol-lowering effects of lemongrass supplementation. Alagbe (2020) observed significantly reduced serum cholesterol concentrations in broilers supplemented with 0.3 and 0.4% lemongrass oil. Similarly, Ghanima et al. (2021) reported lower cholesterol levels in broilers supplemented with lemongrass essential oil.

However, Parade et al. (2019b) found no significant effect of lemongrass leaf meal on serum cholesterol. Alzawqari et al. (2016) also reported no cholesterol-lowering effect of dried lemongrass leaves alone or in combination with sweet orange peel.

VIII. EFFECT OF LEMONGRASS ON ANTIOXIDANT RESPONSE

Oxidative stress negatively affects growth, immunity and production efficiency in poultry. Lemongrass possesses strong antioxidant properties due to its phenolic compounds, flavonoids and essential oil constituents. Alagawany et al. (2021) reported increased activities of superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and total antioxidant capacity in quails supplemented with lemongrass essential oil. Khalifah et al. (2021) similarly observed increased antioxidant enzyme activities and reduced malondialdehyde (MDA) levels following lemongrass supplementation.

Ghanima et al. (2021) reported reduced MDA concentration in broilers receiving lemongrass essential oil under stocking density stress, indicating reduced lipid peroxidation. However, Alzawqari et al. (2016) observed no significant improvement in antioxidant capacity with dried lemongrass leaves, suggesting that essential oil preparations may provide stronger antioxidant effects due to higher bioactive compound concentration.

IX. EFFECT OF LEMONGRASS ON HETEROPHIL AND LYMPHOCYTE RATIO

The heterophil-to-lymphocyte (H/L) ratio is a useful indicator of physiological stress and immune status in poultry. Lower H/L ratio generally reflects improved stress tolerance and immune stability. Al-Awadi and Al-Nadawi (2020) reported significantly reduced H/L ratio in broilers supplemented with lemongrass leaves and extracts through feed and drinking water. Similarly, Alagbe and Oluwafemi (2019) observed improved hematological responses in broilers supplemented with lemongrass and garlic extract.

X. EFFECT OF LEMONGRASS ON INTESTINAL HISTOMORPHOMETRY

Intestinal morphology is an important determinant of nutrient absorption and growth performance. Parameters such as villus height, crypt depth and villus height-to-crypt ratio reflect intestinal functional capacity. Thayalini et al. (2011) evaluated dried lemongrass leaf supplementation in broilers and observed reduced ileal crypt depth compared with control birds, although villus height and villus height-to-crypt ratio were not significantly affected. Reduced crypt depth suggests improved epithelial stability and lower tissue turnover. Ardiarini and Lase (2021) reported numerical improvements in villus height, width and crypt depth in hens supplemented with a herbal mixture containing lemongrass, although differences were not significant.

XI. RESEARCH GAPS AND FUTURE PERSPECTIVES

Although numerous studies have demonstrated the beneficial effects of lemongrass (*Cymbopogon citratus*) as a phytogetic feed additive, several research gaps remain. Variations in plant origin, chemical composition, extraction method and supplementation level contribute to inconsistent results among studies. Standardization of lemongrass products based on major bioactive compounds, particularly citral and phenolic constituents, is essential for obtaining consistent biological responses.

Most available studies have focused on growth performance, feed efficiency and basic physiological parameters, while limited information exists regarding the molecular mechanisms involved. Future investigations should evaluate the effects of lemongrass on antioxidant gene expression, inflammatory pathways, intestinal barrier proteins and lipid metabolism-related genes.

The interaction between lemongrass supplementation and intestinal microbiota requires further attention. Although antimicrobial effects are well documented, advanced microbiome studies are needed to determine its influence on beneficial and pathogenic bacterial populations and microbial metabolites.

Further research should also evaluate the role of lemongrass during disease challenges, vaccination and environmental stress conditions. Long-term safety studies, meat quality assessment and economic evaluations are necessary before large-scale commercial application. Comparative studies with other phytogetic additives, probiotics and organic acids may help establish effective alternatives to antibiotic growth promoters.

XII. CONCLUSION

Lemongrass (*Cymbopogon citratus*) is a promising phytogetic feed additive with potential applications in sustainable poultry production. Available literature indicates that lemongrass supplementation can improve growth performance, feed conversion efficiency, antioxidant status and immune responses in poultry. Lemongrass represents a valuable natural alternative to antibiotic growth promoters and may contribute to healthier, more sustainable and environmentally friendly poultry production systems.

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