The influence of the phytobiotic tulsi (*Ocimum sanctum*) on broiler production and health

Wafaa A. Abd El-Ghany

Abstract

Various types of phytobiotics have been recently used in poultry production systems to avoid the development of drug resistance and tissue residues. One such phytobiotic is holy basil or tulsi (*Ocimum sanctum*), an aromatic plant with multiple therapeutic functions. The powder or extract of tulsi is rich in essential oils and organic acids, which have positive effects on the physiological functions. It has been extensively used in medicine to treat many health issues. Moreover, in poultry industry, dietary tulsi has been recommended for the enhancement of general health conditions with promising results. Enrichment of broilers diets with tulsi improved the growth rate, carcass characteristics, and gut health, relived stress, and modulated the immune response and some biochemical blood parameters. This review article presents in details the different influences of dietary tulsi on these parameters in broilers.

Key words: *Tulsi (Ocimum sanctum); chickens; growth parameters; carcass characteristics; antimicrobial and antioxidant; immunity*

Introduction

In recent decades, antibiotic growth promoters have been used as feed additives in the poultry industry for the improvement of feed utilisation and maintenance of gut health against infections. However, the development of antibiotic resistance and the presence of tissue residues have become issues of great concern (Wierup, 2001). In 2006, the European Union prohibited the use of antibiotic growth promoters in animal production. There has since been great concern towards finding natural and effective alternatives to antibiotic growth promoters. Herbal-derived phytobiotics play a game-changing role in livestock production. Greater attention has recently been gained with the use of these phytobiotics for their potential effects as alternatives (Abd El-Ghany, 2020; Islam et al., 2023). Herbal formulations have shown promising and encouraging results in terms of improvement of feed efficiency and performance parameters, decreasing mortalities, and increasing immunity.

Among the known phytobiotics, the genus *Ocimum* of the family *Lamiaceae* (Kadian and Parle, 2012) includes nearly

Wafaa A. ABD EL-GHANY, Poultry Diseases Department, Faculty of Veterinary Medicine, Cairo University, Giza, 12211, Egypt, (Corresponding author: e-mail: wafaa.soliman@cu.edu.eg)

30 species of small herbs that are mainly grown in the tropics and warm regions (Paton, 1992). *Ocimum sanctum* is known as holy basil or tulsi, the mother medicine of nature, or the queen of herbs owing to its rich composition of bioactive components (Bhatt, 2014). The name "tulsi" means "the incomparable one" in Sanskrit. It is an aromatic plant and its parts (flowers, stem, root, leaves, seeds, etc.) possess therapeutic and medicinal potential (Singh and Majumdar, 2003; Pandey and Madhuri, 2010; Singh et al., 2010). The leaves of tulsi contain bright yellow volatile oils (eugenol, eugenal, methyl chavicol, limatrol, and caryophylline), organic acids (ascorbic, labiatenic, and palmitic acid), ß-carotene, ß-sitosterol, tannins, and a number of terpenes and monoterpenes (barnyl acetate, ß-elemense, methylengenol, neral, ß-pinene, comphene, pinene etc.) (Eevuri and Putturu, 2013).

Tulsi has displayed antimicrobial (Joshi et al., 2009), antiemetic, antioxidant (Subramanian et al., 2005), antiparasitic (Gupta, 2005; Bihari et al., 2010; Sea et al., 2017), antispasmodic, antidiabetic, antitussive (Maity et al., 2004), anti-infertility, and anti-ulcerogenic properties, as well as cardioprotective, hepatoprotective, analgesic, adaptogenic (Singh et al., 2012), and diaphoretic activity (Mondal et al., 2009). Moreover, the immunomodulatory, anti-stress, anti-inflammatory, anticancer, antipyretic, anti-asthmatic, hypotensive, and hypoglycaemic effects of tulsi have been reported (Gupta et al., 2006; Baliga et al., 2013; Eevuri and Putturu, 2013). The consumption of tulsi has shown no genotoxic or organ toxic effect (Chandrasekaran et al., 2013).

In poultry breeding, tulsi is supplemented as a dry powder in the diet (Nath et al., 2012) or an extract in drinking water (Alom et al., 2015). The different influences of tulsi on broiler production and health are illustrated in Figure 1. Reports indicated that supplementation with tulsi in optimum doses results in an augmentation of performance and biochemical blood parameters, as well as improvement of economic traits and digestibility (Bhosale et al., 2015; Shende et al., 2019, 2020a,b, 2021; Naeem et al., 2022). From the economic perspective, the report of Islam et al. (2021) proved that the dietary addition of tulsi leaf extract for broilers may be useful for safe, economical, and efficient production, while also reducing production costs via reducing the use of antibiotics or vaccines. In addition, Vasanthakumar et al. (2013) revealed that the feed cost per unit weight gain was higher in groups receiving the tulsi extract. Recent studies have indicated that tulsi extract containing terpenoid and polyphenol has potential to combat some viral infections, such as influenza (H9N2 virus) (Ghoke et al., 2018) and coronavirus (Mohapatra et al., 2021; Dahiya et al., 2022).

In light of the above, this article focuses on the different influences of using tulsi (*Ocimum sanctum*) on broiler production regarding growth parameters, carcass characteristics, gut health, oxidative stress, immunity, and the biochemical blood parameters.

The different influences of tulsi on broiler production and health

Growth parameters

The different effects of using of tulsi on the growth parameters of broilers are presented in Table 1. Better feed intake and feed conversion ratio in tulsi fed broilers have been demonstrated

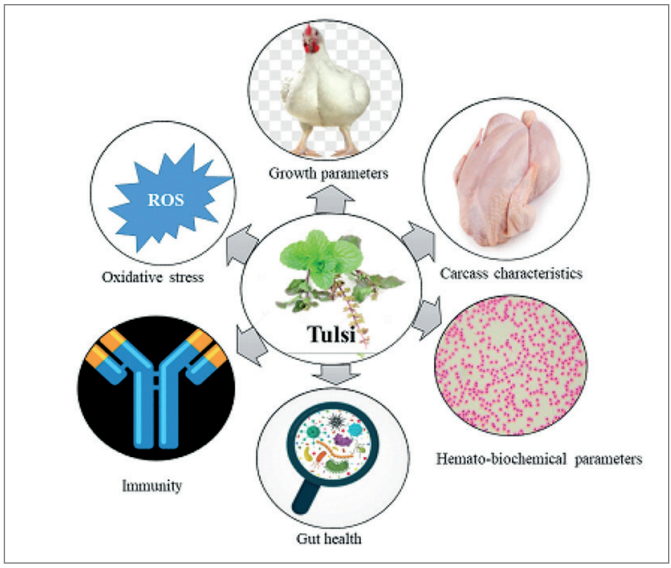

Figure 1. The different influences of tulsi on broiler production and health

Table 1. The effect of tulsi on the growth parameters of broilers

Concentration	Effect	Reference
200 mg in diet/bird	Maximum weight gain without any harmful effects on the haematological, biochemical, and histopathological parameters	Gupta and Charan (2007)
0.5% in diet	Increased feed consumption	Vasanthakumar et al. (2013)
0.5 and 1% in diet	Reduced feed intake	Singh et al. (2014)
2 mL/L drinking water	High live body weight	Alom et al. (2015)
1 mL/L drinking water	High live body weight	Biswas et al. (2017)
0.5% and 0.25% in diet	Enhanced body weight gain	Prajapat et al. (2018)
1% in diet	Improved body weight and increased digestibility of dry matter	Yadav (2018)
0.5% in diet	Improved body weight gain, feed conversion ratio, and return over of feed cost and profit per bird	Gohel et al. (2019)
0.5% in diet	Improved nutrient utilisation	Shende et al. (2019)
1.5% in diet	Increased feed intake, body weight gain, and growth rate	Naeem et al. (2022)
3% in diet	Increased feed intake, body weight gain, and growth rate	Islam et al. (2023)
4% in diet	Decreased feed intake	Islam et al. (2023)

in several studies (Mazhar et al., 2007; Carmona-Fernandez et al., 2009; Sheoran et al., 2017; Hossain et al., 2021; Neem et al., 2022). The augmented feed intake or appetite following supplementation with tulsi might be owing to its antimicrobial activity, increased secretion of digestive enzymes, improved digestive performance, and consequently better intestinal absorbability (Yang et al., 2009). However, other reports have shown an insignificant effect of tulsi leaf powder supplementation on the feed intake of broilers (Lanjewar et al., 2009; Vasanthakumar et al., 2013; Bhosale et al., 2015). This reduction in feed intake has been reported in experiments using tulsi containing eugenol in high concentrations, which resulting in decreased palatability and gut motility (Daniel et al., 2009).

Mixing tulsi leaf extract in drinking water of Cobb broilers significantly increased body weight by 16.97% when compared to the control non-treated broilers (Hasan et al., 2016). Similarly, supplementation with tulsi leaves extract in feed and water resulting in a significant increase (16.43%) in the live body weight compared to the control non-treated group (Islam et al., 2021). In the presence of a bacterial disease condition such as colibacillosis, feeding on tulsi leaf powder at a level of 5g/kg feed resulting in increased body weight gain (Kumara, 2012). The bioactive compounds present in tulsi such as eugenol (Prakash and Gupta, 2007), apigeninursolic acid, rosmarinic acid, carnosol, cirsimaritin, and cirsilineol may act as potent anti-inflammatory and redox/antioxidants which help to improve body weight gain (Kelm et al., 2000). In addition, the antimicrobial, anti-protozoal, and antioxidant properties of tulsi might be reasons for this body weight enhancement (Khatun et al., 2013; Hasan et al., 2016).

Carcass characteristics

Tulsi exerts have a beneficial influence on carcass yield especially at low inoculation levels (Vasanthakumar et al., 2013; Islam et al., 2023). Singh et al. (2014) demonstrated that feeding broiler chickens with 1% tulsi leaf powder induced a significant increase in the muscle weight of breast and thigh, and higher overall body weight compared to control chickens. Incorporation of tulsi is usually accompanied by enhancing the amino acid absorption and nutrient utilisation, improving protein metabolism, and thus increasing carcass yield (Mansoub, 2011). Further, an increase in the relative weight of the heart of broilers given tulsi has been also reported (Hossain et al., 2021; Islam et al., 2023). The higher heart weight of the tulsi-treated could be more useful in terms of an increased ability to tolerate heat stress.

Nevertheless, the dressing percentage and the weight of the heart, gizzard, spleen, and pancreas were insignificantly different between chicken groups fed diets supplemented with or without tulsi leaves (Nath et al., 2012). Likewise, insignificant differences have been detected in hot carcass and liver weights, and in the dressing percentage after treatment with tulsi leaf powder (0.5%) and tulsi leaf extract (0.1%), while intestinal length was longer in treated groups than in non-treated ones (Vasanthakumar et al., 2013). The findings of Alom et al. (2015) indicated no differences in the mean weights of the proventriculus, gizzard, intestine, liver, and pancreas of broilers supplemented with dietary tulsi. Comparable results have been also reported by Kohri et al. (2022) who detected an insignificant effect of different tulsi levels on carcass yield,

and on liver, heart, and gizzard weights of chickens. Also, Prajapat et al. (2018) found insignificant differences in the relative heart weights of chickens in the control group and those fed on dietary tulsi leaves.

Gut health

The intestinal villus surface area was increased in broilers supplemented with dietary microencapsulated tulsi oil (Thuekeaw et al., 2022). Recently, a significant improvement in the small intestine villus height and surface area following the dietary addition of tulsi (3%) was detected, while these parameters were mostly not shown in the large intestine (Islam et al., 2023). The increase in the villus absorptive surface area enhances intestinal absorbability and digestibility, and accordingly improves the growth performance (Mohamed et al., 2014). On the other hand, some reports have shown that the intestinal villi height and width and crypt depth were not affected by feeding on tulsi (Chowdhury et al., 2018; Jahejo et al., 2019).

Regarding the antibacterial effect of tulsi, a significant increase in *Lactobacillus* spp. and decrease in *Escherichia coli* (*E. coli*) counts of the caecum were reported in tulsi-supplemented broiler chickens (Islam et al., 2023). It has been found that *Lactobacillus* spp. prohibits the growth of intestinal pathogenic bacteria such as *E. coli*, while enhances the immune response (Xiang et al., 2022). However, *E. coli* is a highly pathogenic bacterial species associated with a high morbidity and mortality rate of poultry (Liang et al., 2021). Eugenol is a major essential oil of tulsi that shows a potent antibacterial effect (Eevuri and Putturu, 2013). The aqueous extract of tulsi leaves has also exhibited prophylactic potential against *Pheretima posthuma* (Joshi et al., 2013) and *Ascaris suum* (Sentana, 2010). Tulsi contains flavonoid, phenolics, and tannin (Karumari et al., 2014), which interfere with energy generation in helminths by uncoupling oxidative phosphorylation and binding to free proteins of the host's gut or glycoprotein on the cuticle of the parasite, thus leading to parasite death (Athanasiadou et al., 2001).

Oxidative stress

Tulsi has been found to combat oxidative stress in broilers by increasing the anti-oxidative enzyme levels (Reddy et al., 2009). Incorporation of tulsi leaf powder (0.5%) with selenium (0.3 ppm) in the diet of broiler chickens increased the levels of superoxide dismutase (SOD) and catalase, which in turn reduced the oxidative stress produced during the rapid growth period (Reddy et al., 2009). Also, the dietary addition of tulsi extract (0.1%) significantly increased glutathione peroxidase activity in chicken's serum (Vasanthakumar et al., 2013). Additionally, Bharavi et al. (2010) indicated that administration of tulsi (0.1%) in the feed of broiler chickens reversed antioxidant enzymes such as SOD and catalase, non-enzymatic antioxidants glutathione, and lipid per oxidation marker (TBARS) produced due to cadmium-induced oxidative toxicity. A comparative study on anti-stressor and anti-oxidative effects of synthetic vitamin C and polyherbal feed premix containing tulsi supplementation in broilers during the summer showed that the antioxidant enzyme glutathione reductase was significantly decreased in treated groups in comparison with the control (Sujatha et al., 2010).

Immunity

The immune modulatory effect of tulsi has been previously reported (Manjunatha, 2002; Batra and Gupta, 2004; Kumar et al., 2012). An early study of Pimprikar (1994) confirmed the immunomodulatory effect

of tulsi leaves in immunocompromised infectious bursal disease infected broiler chickens. Moreover, treatment of broilers with tulsi leaf powder (0.5%) induced a better immune response to Newcastle disease virus as compared to the untreated control group (Vasanthakumar et al., 2013). Supplementing immunosuppressed broiler chickens with dry leaves of tulsi and Indian gooseberry plant at a level of 3g/kg feed for 2 weeks protected the birds from immune suppression, and this effect was positively reflected on the body weight gain (Mode et al., 2009). Tulsi is rich in biologically active compounds, including eugenol, ursolic acid, apigenin, and luteolin which have a chief role in enhancing the mediated immune response. Consequently, feeding of immunosuppressed birds on tulsi may induce an enhancement of their humoral and cell mediated immunity (Sen, 1993; Singh and Doley, 2014).

Biochemical blood parameters

Supplementing broiler feed with tulsi leaf powder resulted in a significant reduction in serum triglyceride and total cholesterol levels (Lanjewar et al., 2009; Shende et al., 2020a). Similar results were also obtained by Kohri et al. (2022) who reported a significant reduction in serum triglyceride and cholesterol levels in broiler chickens treated with 0.5% tulsi in the diet. In addition, Sujatha et al. (2010) showed that plasma cholesterol and stress hormones, particularly cortisol and thyroxine, were significantly lowered after treatment of heat-stressed broiler chickens with vitamin C and a polyherbal feed premix containing tulsi and other herbal plants. Higher values of red blood cell counts in broiler chickens (Hasan et al., 2016) and white blood cell and platelet counts in quails (Neem et al., 2022) have been obtained by feeding on tulsi, which may help in enhancing the immunity levels against infectious diseases. Tulsi powder (0.5%) significantly increased the ascorbic acid level in the serum of chickens (Vasanthakumar et al., 2013).

An opposite finding was reported by Gupta and Charan (2007) who found an insignificant effect of tulsi leaf powder on haemoglobin and packed cell volume values of broilers. Also, no differences in the levels of total protein, albumin, globulin, haemoglobin, and packed cell volume were found in a tulsi treated group and the untreated control group (Kohri et al., 2022).

Conclusion

It is clear that supplementation of broilers with tulsi induced positive influences on bird health in terms of improved performance parameters, carcass characteristics, gut health, and immune status, as well as alleviation of stress, and modifications of important blood parameters. However, the mechanisms by which these parameters are stimulated have not yet been fully investigated. Therefore, more studies are required in this area to elucidate the mechanisms behind this.

References

1. ABD EL-GHANY, W. A. (2020): Phytobiotics in poultry industry as growth promoters, antimicrobials and immunomodulators – A review. J. World's Poult. Res. 10, 571-579. 10.36380/jwpr.2020.65
2. ALOM, F., M. MOSTOFA, M. N. ALAM, M. G. SORWAR, J. UDDIN and M. M. RAHMAN (2015): Effects of indigenous medicinal plant tulsi (*Ocimum sanctum*) leaves extract as a growth promoter in broiler. Res. Agric., Livest. Fish. 2, 97-102. 10.3329/ralf.v2i1.23034
3. ATHANASIADOU, A., I. KYRIAZAKIS and F. JACKSON (2001): Direct anthelmintic effect of condensed tannins towards different gastrointestinal nematodes of sheep: *In vitro* and *in vivo* studies. Vet. Parasitol. 99, 219-205. 10.1016/s0304-4017(01)00467-8

4. BALIGA, M. S., A. R. SHIVASHANKARA, A. AZMIDAH, V. SUNITHA and P. L. PALATTY (2013): Gastrointestinal and hepatoprotective effects of *Ocimum sanctum* L. Syn (holy basil or tulsi): Validation of the ethnomedicinal observation. Page 325-335 in Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease: Bioactive Foods in Chronic Disease States. R. R. Watson and V. R. Preedy, eds. Academic Press, Cambridge, MA.
5. BATRA, M. and R. P. GUPTA (2004): Effect of *Ocimum Sanctum* (Tulsi) leaf powder on clinicopathological and immune response in chickens. Haryana Veterinarian 43, 48-50.
6. BHARAVI, K., A. G. REDDY, G. S. RAO, A. R. REDDY and S. V. R. RAO (2010): Reversal of cadmium-induced oxidative stress in chicken by herbal adaptogens *Withania Somnifera* and *Ocimum Sanctum*. Toxicol. Int. 17, 59-63. 10.4103%2F0971-6580.72671
7. BHATT, K. J. (2014): *Ocimum sanctum*: The Indian medicinal plant. Int. J. Chemtech. Appl, 3, 53-57.
8. BHOSALE, D. S., S. R. BHAGWAT, M. M. PAWAR and R. C. KULKARNI (2015): Comparative efficacy of dietary addition of tulsi (*Ocimum sanctum*) leaf powder and vitamin E on broiler performance. Indian J. Anim. Nutr. 32, 348-350.
9. BIHARI, C. G., N. B. SHANKAR, J. P. KUMAR, P. S. KESHARI and P. ELLAIAH (2010): Phytochemical investigation and screening for anthelmintic activity of leafy extracts of various *Ocimum* (Tulsi) species. J. Pharm. Res. 3, 2140-2141.
10. BISWAS, A. K., M. M. RAHMAN, M. Z. HASSAN, S. SULTANA, M. M. RAHMAN and M. MOSTOFA, (2017): Effect of tulsi (*Ocimum sanctum*) leaves extract as a growth promoter in broiler production. Asian J. Med. Biol. Res. 3, 226-232.
11. CARMONA-FERNANDEZ, R., O. D. LOPEZ-HERNANDEZ, M. L. G. GONZALEZ-SANAVIA, E. G. FERNANDEZ-NUNEZ and P. BARZAGA FERNANDEZ (2009): Optimizing a process to obtain *Ocimum sanctum* L. (albacamorada) aqueous extract. Rev. Cuba. Plantas Med. 14, 14-22.
12. CHANDRASEKARAN, C. V., H. S. SRIKANTH, M. S. ANAND, J. J. ALLAN, M. M. VIJI and A. AMIT (2013): Evaluation of the mutagenic potential and acute oral toxicity of standardized extract of *Ocimum sanctum* (OciBest™). Hum. Exp. Toxicol. 32, 992-1004. 10.1177/0960327112472992
13. CHOWDHURY, S., G. P. MANDAL, A. K. PATRA, P. KUMAR, I. SAMANTA, S. PRADHAN and A. K. SAMANTA (2018): Different essential oils in diets of broiler chickens: 2. Gut microbes and morphology, immune response, and some blood profile and antioxidant enzymes. Anim. Feed Sci. Technol. 236, 39-47. 10.1016/j.anifeedsci.2017.12.003
14. DAHIYA, R., S. K. PUNEET, DHIMAN and A. PRIYADARSHANI (2022): A comprehensive review on potential and prospects of traditional medicinal plants for management of coronavirus disease (COVID-19). Vantage: Journal of Thematic Analysis. 3, 88-103. 10.52253/vjta.2022.v03i02.08
15. DANIEL, A. N., S. M. SARTORETTO, G. SCHMIDT, S. M. CAPARROZ-ASSEF, C. A. BERSANI-AMADO and R. K. CUMAN (2009): Anti-inflammatory and antinociceptive activities A of eugenol essential oil in experimental animal models. Rev. Bras. Farmacogn. 19, 212-217. 10.1590/S0102-695X2009000200006
16. EEVURI, T. R. and R. PUTTURU (2013): Use of certain herbal preparations in broiler feeds-a review. Vet. World. 6, 172-179. 10.5455/vetworld.2013.172-179
17. GHOKE, S. S., R. SOOD, N. KUMAR, A. K. PATERIYA, S. BHATIA, A. MISHRA, R. DIXIT, V. K. SINGH, D. N. DESAI, D. D. KULKARNI, U. DIMRI and V. P. SINGH (2018): Evaluation of the antiviral activity of *Ocimum sanctum* and *Acacia arabica* leaves extracts against H9N2 virus using embryonated chicken egg model. BMC Complement. Altern. Med. 18, 174. 10.1186/s12906-018-2238-1
18. GOHEL, B. C., D. D. GARG, S. S. PATIL, H. H. SAVSANI, S. P. TRIVEDI and S. J. KADAM (2019): Efficacy of *Ocimum sanctum* (Tulsi) and *Aloe vera* leaves powder as phytogenic growth promoter in diet of broiler chickens. J. Entomol. Zool. Stud. 7, 379-383.
19. GUPTA, S. (2005): Efficacy of 'Tulsi' (*Ocimum sanctum*) leaf powder on growth rate and development of *Trogoderma granarium*. Fl. & Fauna (Jhansi) 11, 237-243.
20. GUPTA, G. and S. CHARAN (2007): Exploring the potentials of *Ocimum sanctum* (Shyama Tulsi) as a feed supplement for its growth promoter activity in broiler chickens. Indian J. Poult. Sci. 42, 140-143.
21. GUPTA, S., P. K. MEDIRATTA, K. SINGH, K. SHARMA and R. SHUKLA (2006): Antidiabetic, antihypercholesterolaemic and antioxidant effect of *Ocimum sanctum* (Linn) seed oil. Indian J. Exp. Biol. 44, 300-304.
22. HASAN, M. N., M. MOSTOFA, M. G. SORWAR, M. T. HASAN, K. DAS and D. M. N. HOSSAIN (2016): Effects of tulsi leaf extract on body weight gain in broiler production. Bangl. J. Vet. Med. 14, 21-25. 10.3329/bjvm.v14i1.28818
23. HOSSAIN, M. S., M. A. Z. FARUK, D. DAS and S. DAS (2021): Effects of neem (*Azadirachta indica*) and tulsi (*Ocimum sanctum*) extract in the growth performance of broiler with economics of production. J. Vet. Med. Anim. Sci. 4, 1066.
24. ISLAM, T., A. Z. FARUK, S. HOSSAIN and D. DAS (2021): Efficacy as a growth promoter of tulsi leaves extract in broiler production with carcass characteristics and hematological profile. World J. Adv. Res. Rev. 11, 272-279. 10.30574/wjarr.2021.11.3.0452
25. ISLAM, R., N. SULTANA, S. BHAKTA, Z. HAQUE, A. HASAN, M. P. SIDDIQUE and M. R. ISLAM (2023): Modulation of growth performance, gut morphometry, and cecal microbiota in broilers by clove (*Syzygium aromaticum*) and tulsi (*Ocimum sanctum*) supplementation. Poult. Sci. 102, 102266. 10.1016/j.psj.2022.102266

26. JAHEJO, A. R., N. RAJPUT, T. WEN-XIA, M. NAEEM, D. H. KALHORO, A. KAKA, S. NIU and F. J. JIA (2019): Immunomodulatory and growth promoting effects of basil (*Ocimum basilicum*) and ascorbic acid in heat stressed broiler chickens. Pakistan J. Zool. 51, 801-807. 10.17582%2Fjournal.pjz%2F2019.51.3.801.807
27. JOSHI, B., S. LEKHAK and A. SHARMA (2009): Antibacterial property of different medicinal plants: *Ocimum sanctum*, *Cinnamomum zeylanicum*, *Xanthoxylum armatum* and *Origanum majoran*. Kathmandu University J. Sci, Engineering & Technol. 5, 143-150. 10.3126/kuset.v5i1.2854
28. JOSHI, K. C., D. NANDA, P. NAINWAL and P. SAINI (2013): *In vitro* anthelmintic activity of *Ocimum sanctum*. Int. J. Pharmacol. Sci. 3, 287-288.
29. KADIAN, R. and M. PARLE (2012): Therapeutic potential and phytopharmacology of tulsi. Int. J. Pharm. & Life Sci. 3, 1858-1867.
30. KARUMARI, R. J., K. VAJAYALAKSHMI and S. E. BALASUBRAHMANIAN (2014): Preliminary phytochemical analysis and anthelmintic activity of the aqueous extract of *Ocimum sanctum* (Linnaeus, 1767) Leaves (Green and Black) against *Cotylophoron cotylophorum* (Fischoeder, 1901). Int. J. Pharm. Biol. Sci. 5, 580-587.
31. KELM, M. A., M. G. NAIR, G. M. STRASBURG and D. L. DEWITT (2000): Antioxidant and cyclooxygenase inhibitory phenolic compounds from *Ocimum sanctum Linn*. Phytomedicine, 7, 7-13. 10.1016/s0944-7113(00)80015-x
32. KHATUN, S., M. MOSTOFA, F. ALOM, J. UDDIN, M. N. ALAM and N. F. MOITRY (2013): Efficacy of tulsi leaves and neem leaves extract in broiler production. Bangl. J. Vet. Med. 11, 1-5. 10.3329/bjvm.v11i1.17728
33. KOHRI, A., K. A. SHENDE, R. K. DHURIA and D. GOKLANEY (2022): Effect of tulsi (*Ocimum sanctum*) leaf and synbiotic powder on growth performance, nutrient utilization, carcass and blood biochemical parameters in broilers. Indian J. Anim. Nutri. 39, 63-72. 10.5958/2231-6744.2022.00009.3
34. KUMAR, S., H. N. SINGH and A. BHATTACHATYYA (2012): Comparative efficacy of antibiotic and tulsi leaf powder supplement on the growth, immune response and carcass characteristics of commercial broilers. Commercial and rural poultry production: Novel concepts and strategies to meet growing demand and changing consumer needs. pp. 32. Proceedings of XXIX Annual conference and national symposium of Indian poultry science association. Hyderabad.
35. KUMARA, M. (2012): Clinico-pathological and Immunological studies in *Escherichia coli* infected broiler chicks fed on *Ocimum sanctum* leaf supplemented feed. M.V.Sc. Thesis. Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India, pp. 46.
36. LANJEWAR, R. D., A. A. ZANZAD, B. N. RAMTEKE and G. B. DESHMUKH (2009): Effect of dietary supplementation of tulsi (*Ocimum sanctum*) leaf powder on the growth performance and serum lipid profile in broilers. Indian J. Anim. Nutri. 25, 395-397.
37. LIANG, W., H. LI, H. ZHOU, M. WANG, X. ZHAO, X. SUN, C. LI and X. ZHANG (2021): Effects of *Taraxacum* and *Astragalus* extracts combined with probiotic *Bacillus subtilis* and *Lactobacillus* on *Escherichia coli*–infected broiler chickens. Poult. Sci. 100, 101007. 10.1016/j.psj.2021.01.030
38. MAITY, T. K., S. C. MANDAL and M. PAL (2004): Assessment of antitussive activity of *Ocimum sanctum* root extract. Indian J. Nat. Prod. 20, 9-13.
39. MANJUNATHA, B. P. (2002): Managing immunity. Feed Mix. 10, 8-11.
40. MANSOUB, N. H. (2011): Comparison of effects of using nettle (*Urtica dioica*) and probiotic on performance and serum composition of broiler chickens. Global Vet. 6, 247-250.
41. MAZHAR, I., C. R. JANGDE, H. ARUN, S. P. WAGHMARE and H. AJIT (2007): Some pharmacological and phytochemical investigations on aqueous extract of *Ocimum sanctum Linn*. leaves. R. Vet. J. India. 3, 137-139.
42. MODE, S. G., S. T. FUNDE, S. P. WAGHMARE and A. Y. KOLTE (2009): Effect of herbal immune modulator on body weight gain in immunesuppressed broiler birds. Vet. World. 2, 269-270.
43. MOHAPATRA, P. K., K. S. CHOPDAR, G. C. DASH, A. K. MOHANTY and M. K. RAVAL (2021): In silico screening and covalent binding of phytochemicals of *Ocimum sanctum* against SARS-CoV-2 (COVID 19) main protease. J. Biomol. Struct. Dyn. 41, 1-10. 10.1080/07391102.2021.2007170
44. MOHAMED, M. A., E. F. EL-DALY, N. A. ABD EL-AZEEM, A. W., YOUSSEF and H. M. A. HASSAN (2014): Growth performance and histological changes in ileum and immune related organs of broilers fed organic acids or antibiotic growth promoter. Int. J. Poult. Sci. 13, 602. 10.3923/ijps.2014.602.610
45. MONDAL, M., B. R. MIRDHA and S. C. MAHAPATRA, (2009): The science behind sacredness of Tulsi (*Ocimum sanctum Linn*.). Indian J. Physiol. Pharmacol. 53, 291-306.
46. NAEEM, H., S. Z. H. NAQVI, J. HUSSAIN, N. ABBAS, S. HAYAT, L. ARSHAD, A. GHAYAS and A. REHMAN (2022): Efficacy of tulsi (*Ocimum Sanctum*) plant powder on health, growth and carcass traits of Japanese quail (*Coturnix Japonica*). Braz. J. Poult. Sci. 24, 1-8. 10.1590/1806-9061-2021-1453
47. NATH, D. D., M. M. RAHMAN, F. AKTER and M. MOSTOFA (2012): Effects of tulsi, black pepper and cloves extract as a growth promoter in broiler. Bangl. J. Vet. Med. 10, 33-39.
48. PANDEY, G. and S. MADHURI (2010): Pharmacological activities of *Ocimum sanctum* (Tulsi): A Review. Int. J. Pharm. Sci. Rev. Res. 5, 61-66.

49. PRAKASH, P. and N. GUPTA (2007): Therapeutic uses of *Ocimum sanctum Linn* (Tulsi) with a note on eugenol and its pharmacological actions. A short review. Indian J. Physiol. Pharmacol. 49, 125-131.
50. PATON, A. (1992): A synopsis of *Ocimum* (labiate) in Africa. Kew Bull. 47, 403-436.
51. PIMPRIKAR, N. M. (1994): Immunomodulatory effect of *Ocimum sanctum* leaves in poultry naturally induced with IBD virus. Thesis submitted to the Dr. Panjabrao Deshmukh Krishi Vidypeeth, Akola.
52. PRAJAPAT, J. D., T. SHARMA, R. K. DHURIA, B. B. RAJESH and M. KUMAR (2018): Effect of dietary supplementation of tulsi (*Ocimum sanctum*) and fenugreek (*Trigonella foenum-graceum* L) on carcass characteristics of heat stressed broilers in arid zone. Int. J. Livest. Res. 8, 247-251. 10.5455/ijlr.20180317050254
53. REDDY, L. S. S. V. P., A. THANGAVEL, V. LEELA and K. V. S. R. NARAYANA (2009): Antioxidant enzyme status in broilers: role of dietary supplementation of tulasi (*Ocimum sanctum*) and selenium. Tamilnadu J. Vet. Anim. Sci. 5, 251-256.
54. SEA, O., M. HARIADI, S. KOESDARTO, M. YUNUS, K. NGAKAN and R. W. MADE (2017): Anthelmintic activity of basil leaves (*Ocimum sanctum Linn*.) infusion against *Ascaris suum in vitro*. J. Parasite Sci. 1, 47-50. 10.20473/jops.v1i2.16285
55. SEN, P. (1993): Therapeutic potentials of tulsi from experience to facts. Drugs News Views, 1, 15-21.
56. SENTANA, O. M. (2010): Antihelmintic effect of ethanol extract of basil leaves (*Ocimum americanum* l.) on death of *Ascaris suum goeze* sp *in vitro*. Fakultas Kedokteran. Universitas Sebelas Maret. Surakarta.
57. SHENDE, K. A., DHURIA, R. K., MEEL, M. S. (2019): Effect of supplementation *Ocimum sanctum* (tulsi) leaf and *Zinziber officinale* (ginger) powder as feed additives on nutrient utilization of broiler chicks. Int. J. Sci Environ. Technol. 8, 1129-1134.
58. SHENDE, K. A., R. K. DHURIA and T. SHARMA (2020a): Effect of *Ocimum sanctum* (tulsi) leaf and *Zinziber officinale* (ginger) powder as feed additives on growth performance of broiler chicks. Vet. Pract. 21, 139-141.
59. SHENDE, K., R. K. DHURIA, D. GOKLANEY and Y. K. BAROLIA (2020b): Effect of tulsi (*Ocimum sanctum*) leaf and ginger (*Zingiber officinale*) powder as feed additives on haemato-biochemical parameters of broiler chicks. J. Anim. Res. 10, 1057-1062. 10.30954/2277-940X.06.2020.27
60. SHENDE, K., R. K. DHURIA, D. GOKLANEY and Y. K. BAROLIA (2021): Effect of supplementation of tulsi (*Ocimum sanctum*) leaf and ginger (*Zingiber officinale*) powder as feed additive on daily weight gain, comparative economics and mortality percent of broiler chicks. Int. J. Bio-Resour. Stress Manag. 12, 001-006. 10.23910/1.2021.2175
61. SHEORAN, N., R. KUMAR, A. KUMAR, K. BATRA, S. SIHAG, S. MAAN and N. S. MAAN (2017): Nutrigenomic evaluation of garlic (*Allium sativum*) and holy basil (*Ocimum sanctum*) leaf powder supplementation on growth performance and immune characteristics in broilers. Vet. World. 10, 121-129. 10.14202/vetworld.2017.121-129
62. SINGH, A. and P. DOLEY (2014): Immunomodulatory effect of tulsi (*Ocimum Sanctum*) leaves powder supplemented in broilers. Int. J. Sci. Res. 3, 1564-1565.
63. SINGH, S., D. K. MAJUMDAR (2003): *Ocimum sanctum* phytochemical and pharmacological evaluation. Phytochem. Pharmacol. 1, 81.
64. SINGH, V., S. AMDEKAR, and O. VERMA (2010): *Ocimum sanctum* (Tulsi): Bio-pharmacological activities. Webmed Central Pharmacol. 1, 1046. 10.9754/journal.wmc.2010.001046
65. SINGH, N., P. VERMA, B. R. PANDEY and M. BHALLA (2012): Therapeutic potential of *Ocimum sanctum* in prevention and treatment of cancer and exposure to radiation: An overview. Int. J. Pharm. Sci. Drug Res. 4, 97-104.
66. SINGH, A., D. PRANAV and P. JAGDISH (2014): Effect of *Ocimum sanctum* (Tulsi) on productive performance and blood biochemistry of broilers. Res. Opin. Anim. Vet. Sci. 4, 142-144.
67. SUBRAMANIAN, M., G. J. CHINTALWAR and S. CHATTOPADHYAY (2005): Antioxidant and radioprotective properties of an *Ocimum sanctum* polysaccharide. Redox Rep. 10, 257-264. 10.1179/135100005x70206
68. SUJATHA, V., J. P. KORDE, S. K. RASTOGI, S. MAINI, K. RAVIKANTH and D. S. REKHE (2010): Amelioration of heat stress induced disturbances of the antioxidant defense system in broilers. J. Vet. Med. Anim. Health. 2, 18-28.
69. THUEKEAW, S., K. ANGKANAPORN and C. NUENGJAMNONG (2022): Microencapsulated basil oil (*Ocimum basilicum Linn*.) enhances growth performance, intestinal morphology, and antioxidant capacity of broiler chickens in the tropics. Anim. Biosci. 35, 752-762. 10.5713/ab.21.0299
70. VASANTHAKUMAR, P., P. SASIKUMAR, B. PANGAYARSELVI, D. CHANDRASEKARAN, K. A. DORAISAMY, S. SENTHILKUMAR and M. R. PURUSHOTHAMAN (2013): Performance of broiler chicken fed tulsi leaf powder and leaf extract supplemented diets during summer to alleviate heat stress. Indian J. Anim. Sci 83, 930-931.
71. WIERUP, M. (2001): The Swedish experience of the 1986 year ban of antimicrobial growth promoters, with special reference to animal health, disease prevention, productivity, and usage of antimicrobials. Microb. Drug Resist. 7, 183-190. 10.1089/10766290152045066
72. XIANG, L., Z. YING, M. XUE, P. XIAOXIAN, L. XIAORONG, L. CHUNYANG, W. YU, L. MINGCHENG and L. BINXIAN (2022): A novel *Lactobacillus bulgricus* isolate can maintain the intestinal health, improve the growth performance and reduce the colonization of *E. coli* O157: H7 in broilers. Br. Poult. Sci. 63, 621-632. 10.1080/00071668.2022.2062220

73. YADAV, A. (2018): Effect of tulsi (*Ocimum sanctum*) and organic acid supplementation on performance of broiler chickens. M.V.Sc. thesis submitted to RAJUVAS, Bikaner.

74. YANG, Y., P. A. IJI and M. CHOCT (2009): Dietary modulation of gut microflora in broiler chickens: A review of the role of six kinds of alternatives to in-feed antibiotics. World's Poult. Sci. J. 65, 97-114. 10.1017/S0043933909000087

Utjecaj fitobiotičkog svetog bosiljka (*Ocimum sanctum*) na proizvodnju i zdravlje tovnih pilića

Wafaa A. ABD EL-GHANY, Poultry Diseases Department, Faculty of Veterinary Medicine, Cairo University, Giza, 12211, Egypt

Različite se vrste fitobiotika odnedavna rabe u sustavu proizvodnje peradi i da bi se izbjegao razvoj otpornosti na lijekove i njihovih ostataka u tkivu peradi. Jedan od tih fitobiotika je *sveti bosiljak* ili tulsi (*Ocimum sanctum*), aromatična biljka s višestrukim terapijskim djelovanjem. Prah ili ekstrakt *svetog bosiljka* bogat je esencijalnim hlapljivim uljima i organskim kiselinama koje imaju pozitivne učinke na fiziološke funkcije tjelesnih organa, stoga je raširen u uporabi u medicini za liječenje brojnih zdravstvenih problema. U peradarskoj industriji, prehrambeni *sveti bosiljak* preporučen je za poboljšanje općeg zdravstvenog stanja s dobrim rezultatima. Uporaba *svetog bosiljka* u prehrani tovnih pilića rezultirala je poboljšanjem stope rasta, kvalitetom mesa, zdravlja želudca, smanjenjem stresa, kao i moduliranjem imunološkog odgovora i nekih hemato-biokemijskih parametara. Stoga, ovaj pregledni članak detaljno predstavlja različite utjecaje prehrambenog svetog bosiljka na navedene parametre u tovnih pilića.

Ključne riječi: *sveti bosiljak (Ocimum sanctum), pilići, parametri rasta, svojstva trupla, antimikrobni i antioksidativni, imunitet*