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NATURAL AND INEXPENSIVE NUTRITIONAL HERBAL SOLUTIONS TO ALLEVIATE HEAT STRESS IN POULTRY

Gabriela Maria CORNESCU[1], Tatiana Dumitra PANAITE[1], Arabela Elena UNTEA[1], Petru Alexandru VLAICU[1], Mara-Ioana MUNTIU-RUSU[1], Teodor GAVRIS[2]

[1]National Research-Development Institute for Animal Biology and Nutrition, 1 Calea Bucuresti, Balotesti, Ilfov county, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 MărăștiBlvd,District 1, Bucharest, Romania

Corresponding author email: gabriela_cornescu@yahoo.com

Abstract

Heat stress represents a real menace of the poultry industry all around the world. The World Meteorological Organization (WMO) predicts an increasing temperature by 1.5°C as early as 2024. The normal body temperature of a chicken is about 41°C, and its thermoneutral comfort zone ranges between 18-25°C. To avoid the overheating and to dissipate the excess heat the poultry's body conducts a demanding struggle, therefore it affects production and immune parameters, and also eggs' quality. Reduced appetite and feed intake due to an impaired digestion and metabolism caused by intestinal morphology damage requires different strategies against the negative impacts of heat stress. Dietary herbal supplementation with natural and inexpensive ingredients can be considered an efficient strategy. There are globally available, with scientific demonstrated thermoregulatory effects, and also with antioxidant properties that enhances the production parameters and the health status of poultry. Herbal utilization offers medium and long-term economic and natural potential to minimize the negative effects of heat stress in local and global poultry industry

Key words*: diet, heat-stress, herbal, poultry, temperature.*

INTRODUCTION

The aim of this review is to gather various data about natural, affordable but efficient tested and proved herbal solutions with pharmacological and nutritional values within poultry diets to alleviate the negative effects of heat stress. The heat stress negative effects in poultry industry were already stated on international forums, becoming a real public awareness and concern. It is critical for an optimal poultry production and welfare to understand, find solutions and alternatives to control high environmental temperatures since birds possess no sweat glands and must find other means of dissipating heat. The productive parameters are visible affected: a decreasing body weight, a reduced feed intake and consequently a lower egg production (Mehaisen et al., 2018). Heat stress causes serious physiological, metabolic and genetic changes, such as oxidative stress, acid-base imbalance, and a suppressed immune response, which leads to increased mortality (Wasti et al., 2020) According to several authors, our understanding of basic mechanisms connected to the observed effects, as well as regarding poultry behaviour and welfare under heat stress conditions, is limited, therefore a great point of interests must be still accorded since the data of most stress heat experiments had been variable, inconsistent or scarce (Lara & Rostagno, 2013). Modern poultry genotypes are thought to create more body heat due to their increased metabolic activity (Setar et al., 1999; Deeb & Cahaner, 2002). The shell egg quality is affected due to the increase levels of carbon dioxide that obstructs the bioavailability of bicarbonate into blood therefore results a poor egg mineralization (Marder & Arad, 1989). An increased concentrations of reactive oxygen species (ROS) were observed under heat stress condition which causes an increase intestinal permeability (Quinteiro-Filho et al., 2012). The intestinal barrier is weakened and as a consequence the susceptibility to infections is increasing due to a reduced protection against microbial pathogens from the gastrointestinal tract (Gupta et al., 2017). An increased

intestinal permeability was noticed in broilers, a decreased villus height and villus height:crypt depth were observed in laying hens (Garriga et al., 2006; Bozkurt et al., 2012). Heat stress affects also food safety allowing those foodborne pathogens as Salmonella and Camphylobacter to disseminate into human food chain (Eisenberg et al., 2012). The circulating cells amount and the heterophil:lymphocyte ratio by reducing the lymphocytes and increasing the heterophils was noticed when stress heat was experienced in poultry (Deng et al., 2012). Excretion of minerals and vitamins concentrations increases under heat stress conditions, therefore decrease their concentration from serum and liver (Sahin et al., 2009). This review aims to bring into readers attention about ordinary herbal ingredients for us but with important properties when using them under stress conditions in poultry diet.

MATERIALS AND METHODS

To accomplished the review's objective, by consulting and mentioning 56 of bibliographic sources from the literature. Relevant articles were consulted by identifying scientific databases with keywords as heat-stress, poultry, herbal, temperature, diet. Also, we searched through literature specifically herbal ingredients with demonstrated thermoregulatory effects such as fennel, thyme, parsley, dill, rosemary, coriander.

RESULTS AND DISCUSSION

According to Panossian (2013) herbal ingredients are considered metabolic regulators able to help the poultry organism to adapt and resist when temperature exceeds the thermo-neutral zone (16-25°C). Inexpensive and natural herbal ingredients with thermoregulatory effects such as fennel, thyme, parsley, dill, rosemary, coriander with their pharmacological and nutritional values improved production and performance in poultry under heat stress conditions (Wang et al., 2008).

Fennel (*Foeniculum vulgare* Mill.) is an aromatic wild edible plant, well appreciated flavouring agent, which is also cultivated extensively in Mediterranean region, used in traditional medicine with a wide range of therapeutic properties, that exhibits hepatoprotective, antioxidant (due to its phenolic compounds), antimicrobial and antifungal activities (Renna et al., 2015). The alleviating effects of fennel seeds were tested on broilers exposed to chronic heat stress (32±2°C) for seven hours using a dietary inclusion rate of 1.6, and 3.2%. The study showed that dietary fennel seed powder 3.2% improved the growth rate of broiler between 19-41 days, enhanced breast meat redness and reduced temperature under chronic heat stress. In conclusion, 3.2% of fennel seed powder could be used as an agent for enhancing the broiler's tolerance during chronic heat stress condition from 19 to 41 days of age (Al-Sagan et al., 2020). Other authors declared that an inclusion rate in broilers diet of 2% or even 1% fennel seeds was enough to improve feed intake, meat breast (%) and leukocytes (Ragab et al., 2013). An inclusion rate of 10 and 20 g/kg dietary fennel fruits were tested in White Leghorn laying hens' diets under 34°C. The results showed that fennel due to its antioxidant properties reduced the MDA and carbonyl egg content values, also registered lower cholesterol and triglyceride yolk concentrations (Gharaghani et al., 2015) A concentration of 0.5% fennel seeds can be added to the laying hens' diets with beneficial effects on egg quality, laying performance, and serum biochemical parameters (Abou-Elkhair et al., 2018). The improvement of egg quality when heat stress is experienced can be attributed to the anethole antioxidant compound of fennel (Oktay et al., 2003). Dietary supplementation with 1, 2, and 3 g fennel/kg diet registered significant improvement ($p<0.05$) of body weight, feed efficiency, red blood cell concentration, haemoglobin, and packed cell volumes (PCV), without heat stress factor (Mohammed & Abbas, 2009).

Thyme (*Thymus vulgaris* L.) is an aromatic herb with a distinctive aroma and flavour often used in the food and pharmaceutical industries. Thyme has many therapeutic properties: antimicrobial, hypocholesterolemic, antioxidative, antiviral, antifungal, immunostimulants (Fachini-Queiroz et al., 2012). Thyme essential oil added into broilers diet as 100, 150 and 200 mg TEO/kg of diet, 22 to 42 days of age, under heats-stress exposure (23.9-38°C daily) improved growth performances and immune

responses, and lowered the heterophile concentration of birds Rafat et al., 2019). During the Egyptian hot summer season dietary thyme dried leaves supplementation with 1 and 2% did not influenced the productive parameters and the thermoregulatory responses of broilers according to Ragab et al. (2013). Some authors experimented 250 mg/kg thyme essential oil on broilers in thermoneutral conditions and observed a significantly lower plasma uric acid and triglyceride levels (Noruzi et al., 2022). Others researchers noticed no effects on body weight gain, feed conversion ratio, cholesterol concentration heterophils: lymphocytes ratio when added 0.5 and 1% thyme into broilers diet under heat stress at 34°C ± 2 (Behboudi et al., 2016). Dietary thyme oil (1.0 g/kg feed, 1.5 g/kg feed, 2.0 g/kg feed) was experimented on broilers as a natural growth promoter in hot climate conditions and the best obtained results (white blood cells were noticed for 1.0 g/kg diet during 1-28 rearing days. According to Marino et al. (1999), *in vitro* studies demonstrated the thyme is delaying growth properties of *E. coli* and *S. typhimurium* as stated by Aktuğ et al. (1986).

Parsley (*Petroselinum crispum* Mill.) is a powerful antioxidant plant that belongs to family Apiaceae or Umbelliferae, most appreciated as medicinal adjuvant, food and spice with a rich phytonutrients content of the whole plant: leaf, stem and root (Agyare et al., 2017). Its phenolic content is hold responsible for antioxidant and antibacterial activities (Wong & Kitts, 2006). The valuable antioxidant properties of parsley are due to flavonoid, ascorbic acid, tocopherol and essential oils content (Zhang et al., 2006). Parsley essential oils were used in poultry feeding to improve productive performances and health, as heat stress alleviator with a high antioxidant activity (Gopi et al., 2014). Effect of parsley oil (0.3, 0.6, 0.9 ml/kg diet) in Japanese quail males testicular histomorphometric evaluation and semen quality were tested for 14 weeks in heat stress condition and a significant improvement were observed at a dietary inclusion rate of 0.9 ml parsley oil/kg (Razooqi et al., 2019). Researchers stated that a parsley-rich diets supports the antioxidant system at cellular level therefore reducing stress-induced gastric injury (Akıncı et al., 2017).

Adding 80 g/d parsley, 160 g/d parsley, 240 g/d parsley to local Iraqi geese diets, a significant increase of haematological parameters (haemoglobin, packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, thrombocytes, white blood cells, lymphocytes increase) was noticed, as well as a decrease in heterophile: lymphocytes ratio and eosinophils concentration (Al-Daraji et al., 2012). As we studied the previous literature concerning parsley utilization in poultry diets we noticed a shortcoming experiments, concerning its dietary supplementation.

Dill (*Anethum graveolens* L.) is an important aromatic herb of Apiaceae family with multiple utilization: medicinal, foods and beverages flavouring. It is used to treat gastrointestinal disorders, to lower blood total cholesterol, glucose and as antioxidant agent (Oh et al., 2022). Supplementation of 15 ml/100 kg dill essential oil within heat stress conditions (12 h of 18-22°C, 3 h of 20-31°C, 5 h of 31°C, 4 h of 31-20°C) improved production performance and antioxidant activity (glutathione peroxidase) in heat-stressed laying hens according to Torki et al. (2018). Dietary supplementation with 1% dill and combination between pennyroyal (0.5%) and dill (0.5%) in broilers' under thermoneutral conditions registered a significant malondialdehyde content decrease and an antioxidant capacity increasing (Mohammadi, 2020). Also, other authors testing 1% of dill plant powder in broiler diets recorded growth performances improvement under normal temperature conditions (Mohasesi et al., 2021). Under normal temperature conditions but different inclusion rate of dill seeds (0.3%) in combination to hemp seed (0.2%) were tested in broilers' diets. This seeds combination led to triglyceride, LDL and total cholesterol concentration significant serum reduction while gut health was significant improved by caecum and jejunum *Lactobacilli* proliferation (Vispute et al., 2019). A lack of literature information about dill utilization in poultry nutrition under heat stress conditions affects the overall understanding of this plant addition effects on physiological and production performances.

Coriander (*Coriandrum sativum* L.) aromatic herb of Apiaceae family indigenous from southern Europe widely distributed and mainly

cultivated for its edible seeds and leaves characterized by a high content of vitamins C, A, K, and minerals I, Mn, Zn, and dietary fiber. It is an antibacterial agent for *B. subtilis* and *E. coli.* (Kumar et al., 2016). The plant is rich in petroselinic acid and high in linalool isolated from the seeds and the aerial parts (Mandal & Mandal, 2015). According to Hamodi et al., (2010), testing different inclusion levels of coriander seeds (1%, 2%, 3%) in broilers' feeding under heat stress conditions (32-36°C) a rate of 2% registered significant higher feed consumption and feed conversion and a general improvement of production performances. Other authors added the same inclusion rate of 2% coriander seeds in broilers aged 14 to 42 days old under 34°C and observed a significant improvement in feeding behaviour, productive performances, dressing percentage, concomitant with a decreasing of corticosterone level (El-Shoukary et al., 2014). Other authors tested different inclusion rates of coriander seeds (1.5%, 2.5%, 3.5%) in broiler feed, under normal temperatures, as growth promoter on productive performances and blood profile. Optimum rate inclusion based on dressing percentage without skin, biochemical blood parameters, and immune response results was 1.5% coriander seeds (Khubeiz et al., 2020). Better results on performance and physiological parameters were obtained using 2% coriander seeds inclusion rate on one day-old Arbor Acer broiler chick under high ambient temperature by Al-Jaff, (2011). Coriander oil inclusion at levels of 0.5% and 1% in broilers' diet decreased significantly plasma cholesterol and glucose and improved production performances during summer conditions (Al-Mashhadani et al., 2011).

Rosemary (*Rosmarinus officinalis* L.) a well-known aromatic plant of Lamiaceae family, widely consumed as fresh and dried leaves, as extract or as essential oil in traditional Mediterranean cuisine and in folk medicine Ribeiro-Santos *et al*., 2015). Its major components of polyphenolic profile are carnosic acid, carnosol, rosmarinic acid and hesperidin (Tai et al., 2019). Related to this polyphenolic compounds, rosemary extracts include anti-inflammatory, hepatoprotective, antidiabetic, and antimicrobial activity. According to some authors rosemary extract antimicrobial activity was considerably higher compared to commonly additives used in food industry (Nieto et al., 2018). Due to antioxidant properties of rosemary (isoprenoid quinones) its inclusion in animal feed as extract was beneficial, especially in broilers' where a delayed lipid oxidation was registered in a diet with 200 mg/kg a-TAc, 500 mg/kg rosemary, 500 mg/kg sage combination, as some authors reported (Lopez-Bote et al., 1998). Also, there are contrary results obtained by other authors that stated that dietary rosemary inclusion had no effect on meat or eggs lipid stability (Galobart et al., 2001). The purified rosemary extract was evaluated in vivo on myocardial cell model to assess its effect on heat stress response by analysing broilers' heat shock proteins profile. The results confirmed that its alleviation heat stress effects in broiler chickens (Tang et al., 2018). Different combination of essential oils of rosemary and other plants were tested as 45 ppm of *Lippia origanoides* with 45 ppm of *Rosmarinus officinalis* and 300 ppm of beetroot with 700 g/ton feed dietary inclusion; or 45 ppm *Lippia origanoides* and 45 ppm *Rosmarinus officinalis* and 300 ppm of Natural Betaine with feed 700 g/ton of feed dietary inclusion. A significant improvement of all productive parameters was noticed concomitantly with a significantly improved bone mineralization, which a reduction of negative effects of heat stress (Ruff et al., 2021). Other studies on Japanese quails showed that a supplementation of 125 mg/kg rosemary oil supplementation reduced heat stress induced oxidative stress due to its potent antioxidant activity (Ozcelik et al., 2014). Positive impact on productive performances, and microbiological cecal composition was observed at an inclusion rate of 0.4% rosemary powder in broilers' feeding (Petricevic et al., 2018).

CONCLUSIONS

These commonly used aromatic herbs, consumed worldwide ameliorate the negative effects of heat stress in poultry without any adverse effects. There are safe and healthy to use them as supplements especially taking into consideration the increasing consumer's preoccupation for natural ingredients addition in animal feed to obtain quality products.

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