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Effects of Cinnamon (*Cinnamomum zeylanicum*) and Turmeric (*Curcuma longa*) Powders on Performance, Enzyme Activity, and Blood Parameters of Broiler Chickens Under Heat Stress

Baghban Kanani P, Daneshyar M & Najafi R

Department of Animal Science, Faculty of Agriculture, Urmia University, Urmia, Iran

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Corresponding author
Mohsen Daneshyar
daneshyar_mohsen@yahoo.com

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Abstract

The effect of cinnamon and turmeric powders on performance, and blood parameters of broiler chickens under heat stress were investigated. 200 one-day-old male chicks (Ross 308) were used in a completely randomized design with four treatments and five replicates with 10 birds in each replicate. All birds were treated with heat stress (32°C) and were either fed no any supplement (control), or 0.5% turmeric, 0.5% cinnamon, and a blend of cinnamon and turmeric (0.25% each) when they were 25 to 42 days of age. We found that supplementation of turmeric, cinnamon, and their combination increased feed intake and body weight gain compared to control birds ($P < 0.05$). Blood uric acid concentration and lactate dehydrogenase activities decreased in the supplemented diets ($P < 0.05$). Blood malondialdehyde also decreased in all diets, but had the most striking reduction in the diets containing both turmeric and cinnamon ($P < 0.05$). Blood aspartate aminotransferase, urea, and creatinine were not affected by the dietary treatments. Similarly, blood sodium, potassium, chlorine, hematocrit and rectal temperature were unchanged by the supplements ($P > 0.05$). In conclusion, dietary supplementation of cinnamon and turmeric either alone or together improve the performance of broiler chickens under heat stress by reducing lipid peroxidation.

Introduction

Heat stress is one of the most important stressors in the broiler industry, particularly in hot regions (Altan *et al.*, 2003). Since broiler chickens lack sweat glands, heat stress increases core temperature and accelerates breathing frequency, thereby increasing alveolar ventilation and cooling the bird by evaporation (Hartlova *et al.*, 2002). Exposure to high ambient temperatures (>30° C) has negative impacts on bird performance by decreasing feed intake (FI), body weight gain (BWG), and increasing the feed conversion ratio (FCR) (Borges *et al.*, 2004a). Heat stress increases the generation of free radicals to levels above the tissue antioxidant capacity, resulting in oxidative stress (Wahab *et al.*, 2010). Chronic heat stress lowers metabolic oxidation capacity. Hence, dietary antioxidants can prevent lipid oxidation in chickens. Therefore, supplementation of dietary antioxidants has been suggested to halt the oxidative reaction in chickens under heat stress condition (Hosseini-Vashan *et al.*, 2012).

Medicinal plants have been proposed as antioxidant feed additives (Sharbati Alishah *et al.*, 2013). Some medicinal plants such as sumac (*Rhus coriaria*) (Sharbati Alishah *et al.*, 2013), peppermint (*Mentha piperita*) (Maini *et al.*, 2007), clove (*Syzygium aromaticum*), and oregano

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(*Syzygium aromaticum*) (Borazjanizadeh *et al*., 2011) have been investigated on heat stress in broilers. Turmeric rhizome is a medicinal herb with antioxidant properties (Case *et al*., 1995; Asai *et al*., 1999; Suvanated *et al*., 2003; Basavaraj *et al*., 2011). Curcumin is the most active ingredient of turmeric and (Quiles *et al.,* 2002) has previously been demonstrated to have antioxidant, anti-inflammatory, antimicrobial, anticoagulant, antidiabetic and antiulcer properties. Moreover, curcumin can improve liver functions and decrease serum triglycerides, low-density lipoprotein cholesterol (LDL-C), and blood glucose levels (Rajput *et al.,* 2013). Curcumin, desmethoxycurcumin, bisdemethoxycurcumin are three main curcuminoids of turmeric with strong antioxidant activity (Daneshyar *et al.,* 2012). Cinnamon (*Cinnamomum zeylanicum*), another medicinal plant, has high levels of cinnamaldehyde (the active polyphenol component), followed by eugenol and carvacrol (Tabak *et al*., 1999). Cinnamon is a spice with wide use in perfumery, flavoring, and pharmaceutical industries (Ranjbar *et al.,* 2007). Cinnamon has intense antimicrobial, antifungal, and antioxidant properties (Faix *et al.,* 2009; Goni *et al*., 2009). Cinnamon has already been used for improving the quality and quantity of animal products. Dietary supplementation of cinnamon improves the growth performance of broiler chickens in certain instances (Daneshyar *et al.,* 2012).

The aim of this experiment was to investigate the effects dietary supplementation of *Cinnamomum zeylanicum* and *Curcuma lunga* powders on performance, blood enzyme activities (alanine aminotransferase (ALT), aspartate aminotransferase (AST), and lactate dehydrogenase (LDH)), rectal temperature, and blood metabolites of broiler chickens under heat stress condition.

Materials and Methods

Birds, diets and experimental design

The experimental protocols were reviewed and approved by the Animal Care Committee of Urmia University, Uremia, Iran. 200 one-day-old male Ross chicks were used in a completely randomized design with four treatments and five replicates with 10 birds in each replicate. The control group did not receive supplements, but experimental birds were fed either 0.5% turmeric, 0.5% cinnamon, or a blend of cinnamon and turmeric (0.25% each). All the birds were weighed (38±2 g) on arrival and fed the same starter (from day one to day 10 of age) and grower (from day 11 to day 24 day of age) diets in mash form, but received different finisher diets (different dietary treatments from day 25 to 42 day of age). The basal diet was formulated according to the Ross Nutrition supplement (2009; Table 1).

House temperature tried to keep constant around 22±1°C during finisher period (25-42 days), except when birds exposed to heat stress (32±1°C) from 9 AM to 5 PM. Fresh Indian turmeric and cinnamon (containing 27.91 and 41.24 mg total phenolic compounds per g, respectively) were grounded and mixed with the diets. The standard extraction method of Seevers and Daly (1970) was used for estimation of total phenols. One gram turmeric rhizome was crushed in 10 mL of 80% methanol in a pestle and mortar. The extract was filtered and centrifuged at 1000 × *g* for 5 min and the supernatant was collected and used to determine phenolic compounds, using the colorimetric method at an absorbance of 720 nm with 20% Na_2CO_3 and in Folin-Ciocalteau reagent. Gallic acid was used as the standard (Daneshyar *et al*., 2012). Average ambient relative humidity inside the house was kept at 45%. The light regime of 23 hours and an hour dark was used. Birds were allowed to consume feed and water *ad libitum*.

Measurements

Cumulative weight gain (BWG) and feed intake (FI) were recorded at the end of 42 d of age to calculate feed conversion ratio (FCR). At the end of the experiment, one bird per replicate was randomly selected and weighed after feed deprivation for 2 hrs. At slaughter, two sets of blood samples were collected in tubes containing anticoagulant (EDTA). Blood samples were immediately transferred to the laboratory: one set of blood samples were centrifuged at 2991 x *g* for 5 min to separate and isolate the plasma, which was then stored at -20°C along with the other set was used for measurement of blood hematocrit: blood was taken up in heparinized capillary tubes and centrifuged in a Hettich Microliter Centrifuge (NT 715, Finland) and expressed as the percentage of the height of the red blood cell column relative to the total blood column. After blood collection, the birds were scarified, de-feathered and eviscerated.

Table 1. The composition of basal diet

	Starter (1-10 d)	Grower (11-24 d)	Finisher (25-42 d)
Ingredients (%)			
Maize	32.91	34.55	38.66
Wheat	20.00	25.00	25.00
Soybean meal (44% CP)	39.35	33.50	28.35
Soybean oil	3.00	2.80	3.18
Dicalcium phosphate	2.10	2.15	2.15
Limestone	1.10	0.86	0.86
Lysine-HCL	0.29	0.22	0.20
DL-Methionine	0.38	0.08	0.26
Vitamin premix[1]	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25
Sodium chloride	0.37	0.34	0.34
Sand [#]	-	-	0.5
Calculated analysis			
Metabolizable energy (Kcal/kg)	2860	2930	3000
Crude protein (%)	21.99	20.00	17.99
Calcium (%)	1.00	0.90	0.89
Available phosphorus (%)	0.45	0.45	0.44
Sodium (%)	0.16	0.15	0.15
Lysine (%)	1.43	1.24	1.09
Methionine (%)	0.70	0.38	0.53
Methionine + Cystine (%)	1.07	0.73	0.86
Threonine (%)	0.85	0.77	0.69

[1]Supplied per kilogram of diet: vitamin A, 9000 U; vitamin D_3, 2000 U; vitamin E, 18 U; vitamin B_{12}, 0.15 mg; riboflavin, 6.6 mg; calcium pantothenate, 10 mg; niacin, 30 mg; choline, 500 mg; biotin, 0.1 mg; thiamine, 1.8 mg; piridoxin, 3 mg; folic acid, 1 mg; vitamin K_3, 2 mg; antioxidant (Ethoxyquin), 100 mg.
[2]Supplied per kilogram of diet: zinc, 50 mg; manganese oxide, 100 mg; copper, 10 mg; Fe, 50 mg; I, 1 mg; Se, 0.2 mg.
[#]Different levels of turmeric and cinnamon powder or blend of each were replaced by sand in the finisher diets.

The blood metabolites and the activity of ALT, AST and LDH enzymes were measuredwith a spectrophotometer using commercial kits (Alcyon 300, USA and Pars Azmon Kits, Iran). Plasma sodium, potassium, and chloride contents were determined photometrically using a Toshiba flame photometer (AOAC, 1990) and titration with $AgNO_3$ (LaCroix *et al*., 1970). Plasma malondialdehyde (MDA) concentration was determined by MDA reaction with thiobarbituric acid followed by extraction with butanol (Ohkawa *et al*, 1979).

Statistical analysis

The data were analyzed based on a completely randomized design using the GLM procedure of SAS (2004). Tukey's range test was used to separate the means when treatment means were significant ($P < 0.05$).

Results

Performance

Supplementation of turmeric, cinnamon, and their combination increased the FI and BWG compared to the control group ($P < 0.05$; Table 2).

Table 2. Effect of cinnamon, turmeric and their mixture on BWG, FI, and FCR during the whole experimental period (days 1 to 42 of age) in broiler chickens under heat stress conditions (32±1°C)

Treatment	BWG (g)	FI (g)	FCR
Control	1890.75[b]	3591.18[b]	1.89
Turmeric (0.5%)	2472.46[a]	4432.88[a]	1.80
Cinnamon (0.5%)	2429.70[a]	4260.05[a]	1.81
Cinnamon + Turmeric (0.25%+0.25%)	2516.31[a]	4375.27[a]	1.74
Pooled *SEM*	66.65	89.24	0.03
P-value	0.0001	0.0001	0.19

[a,b] The means with different superscripts in each column are significantly different ($P < 0.05$).

Blood, enzyme, and antioxidant parameters

Effect of turmeric, cinnamon, and their combination on activities of various blood enzymes (ALT, AST, LDH) and the concentrations of creatinine, uric acid, urea and malondialdehyde (MDA) in broiler chickens under heat stress condition at day 42 of age are shown in Table 3. Blood LDH activity, uric acid and MDA concentrations decreased in broilers that had diets supplemented with turmeric, cinnamon or their mixture ($P < 0.05$). Blood MDA was most reduced in diets containing both turmeric and cinnamon ($P < 0.05$). Blood AST, urea, and creatinine were not affected by the dietary treatments.

Table 3. Effect of turmeric, cinnamon and their mixture on aspartate aminotransferase (AST), alanine aminotransferase (ALT), lactate dehydrogenase (LDH), uric acid, urea, creatinine, malondialdehyde in broiler chickens under heat stress (32±1°C) at day 42 of age

Treatments	AST (U/L)	ALT (U/L)	LDH (U/L)	Uric acid (mg/dL)	Urea (mg/dL)	Creatinine (mg/dL)	MDA (nmoL/mL)
Control	328.20	6.80^{a}	2796.7^{a}	10.72^{a}	4.4	0.13	4.76^{a}
Turmeric (0.5%)	280.40	4.20^{b}	1300.0^{c}	4.74^{c}	4.4	0.14	3.57^{bc}
Cinnamon (0.5%)	271.60	5.00^{ab}	2015.0^{b}	5.40^{c}	4.0	0.12	3.85^{b}
Cinnamon + Turmeric (0.25%+0.25%)	288.20	4.00^{b}	1910.0^{b}	5.98^{bc}	4.6	0.13	2.85^{c}
Pooled *SEM*	9.77	0.39	150.47	0.76	0.28	0.02	0.23
P-value	0.16	0.14	0.001	0.007	0.39	0.80	0.003

$^{a-c}$ The means with different superscripts in each column are significantly different ($P < 0.05$).

There were also no changes in blood sodium, potassium, hematocrit, and rectal temperature with any of the dietary treatments ($P > 0.05$; Table 4).

Table 4. Effect of cinnamon, turmeric and their mixture on blood chlorine, sodium, potassium, hematocrit and rectal temperature in broiler chickens at day 42 of age under heat stress (32±1°C)

Treatment	Chlorine (mmol/L)	Sodium (mmol/L)	Potassium (mmol/L)	Hematocrit (%)	Rectal temperature (°C)
Control	140.18	133.80	2.24	30.00	41.52
Turmeric (0.5%)	123.71	143.80	2.92	38.20	41.34
Cinnamon (0.5%)	122.33	143.20	3.13	37.00	41.50
Cinnamon + Turmeric (0.25%+0.25%)	120.28	140.80	3.02	37.60	40.54
Pooled *SEM*	2.80	1.85	0.16	1.66	0.14
P-value	0.12	0.19	0.29	0.60	0.20

Discussion

Heat stress and other oxidative pressures increase the activities of LDH, AST, and ALT (Daneshyar *et al.,* 2009; Radakovic *et al.,* 2009). In the current experiment, the activities of ALT and LDH enzymes were suppressed by the dietary supplementation of turmeric powder to heat stressed birds. Consistently, the lower activities of ALT, AST, and LDH have been reported by curcumin consumption in iron-injected broilers (Hosseini-Vashan *et al.,* 2012). Turmeric supplementation have been shown to reduce oxidative stress in broilers by reducing levels of plasma and serum MDA and TBARS (Suvanated *et al.*, 2003; Hosseini-Vashan *et al.,* 2012). Similarly, Mehdipour *et al.* (2013) reported lower levels of TBARS in the meat of quails fed cinnamon oil (200 g/kg). Cinnamon contains antioxidant compounds, which may be useful against free radical damage to cell membranes (Dragland *et al.*, 2003). 0.1% cinnamon oil in broiler chickens reduced MDA in both plasma and duodenal mucosa and also enhanced glutathione peroxidase activity (Faix *et al.*, 2009).

Uric acid is a potent scavenger of free radicals in poultry (Lin *et al.,* 2006). Elevated plasma corticosterone concentrations may increase blood uric acid concentration. Sahin *et al.* (2002) reported that increasing concentrations of ACTH (Adrenocorticotropic hormone) was associated with increases in uric acid concentration.

The lowered blood uric acid concentration of birds fed the phytogenic supplements may be related to their ability to depress ACTH and uric acid production. It has been reported that both cinnamon and turmeric can reduce the blood ACTH concentration (Lee *et al*., 2003). We show that turmeric and cinnamon – either alone or together did not change levels of blood electrolytes (sodium, potassium and chlorous), hematocrit, or rectal temperature. Similarly, Hosseini-Vashan *et al*. (2012) reported no changes in hemoglobin and hematocrit values of broilers fed up to 8 g/kg turmeric powder. This is the first study to investigate these plants on the blood electrolytes in broilers. Heat stress may decrease the urinary but increase plasma Cl^- concentration (Borges *et al*., 2004a). Ahmad and Sarwar (2006) reported lower retention and greater excretion of potassium, and consequently, a higher demand for potassium under heat-stress conditions. Heat stress may cause the panting, resulting in the loss of the carbon dioxide (CO_2), HCO_3 and cations, particularly potassium (Ahmad and Sarwar, 2006). As ambient temperature rises, blood potassium and sodium concentrations decrease, while chlorine increases (Borges *et al*., 2004b), resulting in low blood electrolyte balance. High ambient temperatures negatively influence performance of broilers (Sahin *et al*., 2002) through decreasing the FI, live weight gain, and feed efficiency (FE) (Donkoh, 1989).

In the current experiment, dietary turmeric, cinnamon, or both combined improved the performance. This enhanced performance may be due to reduced levels of peroxidation (blood MDA), liver damage (lower ALT and LDH activities) and protein catabolism (lower blood uric acid concentration). These improvements may also be due to the active components of turmeric and cinnamon that enhance digestion and absorption of dietary nutrients. Hussein (2012) reported that curcuminoids and curcumin of turmeric increased utilization of feed, resulting in enhanced growth. Similarly, several studies have been reported that the turmeric at levels of 0.5–1% in the broiler diets improved BWG, FI, and FE (Gowda *et al*., 2009). Durrani *et al.* (2006) found that broilers fed 0.5% turmeric had improved BWG and FE and decreased FI compared to control. In contrast, El-Hakim *et al*. (2009) did not find any beneficial effects of adding turmeric to the feed of poultry birds.

Conclusion

Dietary supplementation of cinnamon and turmeric either alone or together can effectively attenuate the negative effects of heat stress on the performance of broiler chickens by decreasing lipid peroxidation.

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