The effect of different dietary levels of thyme essential oil on serum biochemical indices in Mahua broiler chickens

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Abstract

A 42-day trial was undertaken to study the effect of different dietary levels of thyme essential oil (TEO) on serum biochemical indices of broiler chickens. Seven hundred and sixty-eight selected one-day-old Mahua broilers were divided into 8 dietary treatment groups with an addition of 0.00, 0.05, 0.10, 0.15, 0.20, 0.25, 0.30 and 0.35 mg/kg of thyme essential oil respectively, with 4 replicate pens per treatment group (24 birds each). The feeding programme included a starter diet until day 21 and a finisher diet from day 22 until day 42. The results suggested that TEO markedly increased serum total proteins and globulins on day 21, significantly decreased alanine aminotransferase activity (P<0.05), the albumin-to-globulin ratio, and serum urea on day 21, significantly decreased alanine aminotransferase activity (P<0.05). However, research on its application in animals in vivo and its mechanisms of action is scanty. The main aims of our study are to investigate the effect of different dietary levels of thyme essential oil (TEO) on serum biochemical indices in Mahua broiler chickens, to explore in more depth its mechanisms of action in animals, to provide part of the theoretical basis for its use as a new growth-promoting agent and antibiotic substitute in feed.

Materials and methods

Experimental design

Our experiments were conducted according to protocols approved by the Shihezi University Animal Care and Use Committee and are based on a single-factor experimental design. We chose 768 healthy one-day-old Mahua broilers with a similar weight and divided them into 8 dietary treatment groups with 4 replicate pens per treatment group (24 birds each). Half were males and half were females. The feeding programme included a starter diet until day 21 and a finisher diet from day 22 until day 42. In control group 1, TEO was not added to the basal feed, whereas, in treatment groups 2 through 8, 0.05, 0.10, 0.15, 0.20, 0.25, 0.30 and 0.35 mg/kg of TEO were added to the basal feed.

Experimental feed and feeding management

For the purpose of these experiments we formulated with basal feed a starter diet fed from day 1 through day 21 and a finisher diet fed from day 22 through day 42 based on standard China (1986) and National Research Council (1994) nutritional requirements. The experimental feed consisted of basal feed (Table 1) and fresh pure TEO, containing carvacrol, thymol, borneol, coriander oleyl alcohol, carvophyllene, nopinene, etc.

The broilers were only kept free-ranging on the net. Every replicate feed net area was 100x150 cubic centimetres. We administered vaccines against various diseases, such as Marek disease, Newcastle disease, infectious bursal disease, infectious bronchitis by standard regular intranasal administration and intramuscular injection. We controlled light temperature and humidity. We regularly removed chicken faeces and had the broilers eat and drink water ad libitum.

The effects of TEO on the growth performance of Mahua broilers are reported in Table 2.

Materials and instruments used

We bought Mahua broiler chickens at the Fuqiang hatchery in the city of Shihezi of Sinkiang. We used TEO produced by Aiwei Chemical Plant in Taiwan. The basal feed was made by the feed additive plant of Shihezi University. We used the Olympus AU2700 (Olympus, Tokyo, Japan) automatic biochemical analyser.

The analysis of serum biochemical parameters

We picked 4 birds from every replicate on...
day 21 and day 42. We collected 3-5 ml of blood by heart punctures from each bird. Subsequently, after letting the blood settle for 30 minutes, we extracted the serum by centrifugation (3000 rounds/15 min). We kept the serum at -30°C to measure alanine aminotransferase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP), total proteins (TP), albumin/globulin (A/G) ratio, triglycerides (TG), total cholesterol (TC), low-density lipoproteins (LDL), high-density lipoproteins (HDL), blood urea nitrogen (BUN), uric acid (UA) and glucose (GLU). We used the Olympus AU2700 (Olympus) automatic biochemical analyser to assess serum biochemical parameters.

Statistical analysis

We initially processed data with Excel and analysed it statistically by the single-factor analysis of variance of SPSS 18.0. The results of the experiment were reported as averages ± standard deviation. When significant differences emerged, we conducted a Duncan’s multiple range test with a multiple comparison and P≤0.05 as statistically significant cut-off.

Results

As shown in Table 3, ALT activity in the serum of Mahua broilers in the treatment groups was significantly decreased (P≤0.05) on day 21 and 42 compared with the control group. The AST activity in the serum of Mahua broilers tended to increase on day 21 and 42, but no statistically significant difference was identified (P>0.05). The ALP activity in the serum of Mahua broilers tended to increase on day 21, but no statistically significant difference was identified (P>0.05) on day 42.

As reported in Table 4, total proteins and globulins in the serum of Mahua broilers can be significantly improved (P≤0.05) on day 21 in the treatment groups fed with additional 0.10, 0.15, 0.20, 0.25 g, 0.35 mg/kg of TEO compared with the control group, but no statistical-

| Table 1. Composition of basal feed and nutrient levels (air-dried). |
|---------------------------------------------------------------|
| **Starter diet**                                             | **Finisher diet**                      |
| Crude materials, %                                          |                                          |
| Corn                                           56.08                  | 59                                       |
| Soybean meal                                             28                                 | 32.2                                     |
| Cottonseed meal                                          4                                                 | 0                                           |
| Fish meal                                               3.5                                          | 0                                           |
| Soybean oil                                              2.5                                          | 2.5                                       |
| Wheat bran                                               2                                            | 2                                           |
| Calcium bicarbonate                                     1.15                                         | 1.5                                         |
| Calcium carbonate                                       1.14                                         | 1.14                                       |
| Methionine                                               0.11                                         | 0.16                                       |
| Lysine                                                   0.1                                          | 0.08                                       |
| Choline                                                  0.1                                          | 0.1                                         |
| Salt                                                      0.3                                          | 0.3                                         |
| Trace mineral feed supplement                              1                                            | 1                                           |
| Multivitamin                                             0.02                                         | 0.02                                       |
| Total                                                     100                                          | 100                                        |
| **Nutrients**                                             |                                          |
| ME/MJ/kg                                                  16.54                                         | 17.75                                       |
| Crude protein                                             20.83                                        | 18.83                                       |
| Calcium                                                   0.9                                           | 0.9                                        |
| Total protein                                             1                                            | 0.95                                       |
| Acid phosphatase                                         0.7                                          | 0.04                                       |
| Lysine                                                    1.15                                         | 0.99                                       |
| Methionine                                                0.45                                         | 0.45                                       |
| Cysteine                                                  0.09                                         | 0.09                                       |

ME, metabolisable energy. *The followings per kg of feed were added: vitamin A, 1000 U; vitamin D3, 1500 U; vitamin E, 25 U; vitamin B1, 10 mg; vitamin B2, 5 mg; vitamin B3, 3 mg; vitamin K3, 0.03 mg; choline, 700 mg; nicotinic acid, 40 mg; pantothenic acid, 30 mg; manganese, 120 mg; iron, 100 mg; zinc, 100 mg; copper, 8 mg; iodine, 0.170 mg; selenium, 0.30 mg. *Metabolisable energy, crude proteins, calcium and total proteins are measured values, the other values are estimated.

| Table 2. Effect of thyme essential oil on the growth performance of Mahua broilers. |
|-----------------------------------------------|
| **Indices** | 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 | 0.35 |
| Daily feed intake, g | 28.06 ±0.67ab | 28.94 ±0.63ab | 25.57 ±1.71b | 27.14 ±1.01ab | 28.48 ±0.47ab | 29.43 ±1.29ab | 28.80 ±0.71ab | 26.52 ±1.37ab |
| 1-21 d | 80.71 ±2.97 | 84.23 ±1.77 | 86.42 ±1.75 | 83.28 ±2.96 | 86.08 ±1.14 | 86.23 ±2.78 | 87.14 ±1.18 | 88.84 ±3.89 |
| 22-42 d | 54.38 ±1.66 | 56.58 ±0.92 | 55.99 ±1.52 | 55.21 ±1.92 | 57.28 ±0.79 | 57.83 ±1.05 | 57.97 ±0.69 | 56.68 ±2.44 |
| Daily gain, g | 15.31 ±0.35ab | 15.41 ±0.52ab | 13.91 ±1.88b | 15.26 ±0.699ab | 15.52 ±0.25ab | 16.97 ±1.00a | 15.46 ±0.50ab | 15.04 ±0.24ab |
| 1-21 d | 32.83 ±2.23ab | 37.32 ±0.44ab | 38.27 ±1.81ab | 38.57 ±0.74ab | 38.50 ±0.18ab | 38.46 ±1.71ab | 37.87 ±1.16ab | 36.82 ±2.00ab |
| 22-42 d | 24.15 ±0.82ab | 26.43 ±0.14ab | 27.02 ±0.72ab | 27.22 ±0.30ab | 27.10 ±0.07ab | 27.30 ±0.74ab | 26.88 ±3.99ab | 26.05 ±9.99ab |
| Feed/gain | 1.83 ±0.02 | 1.87 ±0.02 | 1.91 ±0.18 | 1.78 ±0.03 | 1.84 ±0.02 | 1.74 ±0.04 | 1.86 ±0.03 | 1.76 ±0.07 |
| 1-21 d | 2.46 ±0.09ab | 2.30 ±0.01ab | 2.28 ±0.04ab | 2.23 ±0.03ab | 2.26 ±0.01ab | 2.31 ±0.07ab | 2.27 ±0.08ab | 2.40 ±0.05ab |
| 22-42 d | 2.14 ±0.03ab | 2.08 ±0.01abc | 2.00 ±0.01c | 2.05 ±0.05bc | 2.05 ±0.04ab | 2.04 ±0.05ab | 2.11 ±0.01ab | 2.21 ±0.05bc |

* Means within the same line and column with different superscript letters differ significantly (P≤0.05). *Means within the same row with different superscript letters differ very significantly (P≤0.01).
ly significant difference was identified (P<0.05) on day 42. The A/G ratio in the serum of Mahua broilers can be significantly decreased (P<0.05) in the treatment groups fed with additional 0.10, 0.15, 0.20, 0.25, 0.30 mg/kg of TEO on day 21. In the treatment groups fed with an addition of 0.10, 0.20, 0.25 mg/kg of TEO, serum A/G can be significantly decreased (P<0.05) also on day 42.

As reported in Table 5, in the treatment groups no statistically significant effect (P>0.05) was recorded on TG, TC and LDL in the serum of broilers on both day 21 and 42. However, HDL on day 21 showed a statistically significant improvement (P<0.05) by 38.83, 24.42, 23.25 and 20.54% in the treatment groups fed with additional 0.10, 0.15, 0.20, 0.35 mg/kg of TEO compared with the control group. In the treatment groups fed with additional 0.10 and 0.15 mg/kg of TEO, HDL on day 42 showed a statistically significant improvement (P<0.05) by 12.08 and 13.91% respectively.

As reported in Table 6, BUN in the serum of Mahua broilers showed a statistically significant decrease (P<0.05) on day 21 in all treatment groups compared with the control group. Serum BUN of Mahua broilers showed a statistically significant decrease (P<0.05) on day 42.

**Table 3. Effect of thyme essential oil on enzymatic activity in the serum of Mahua broilers.**

| Treatment groups, mg/kg | ALT, U/L | AST, U/L | ALP, U/L |
|-------------------------|----------|----------|----------|
|                         | 21st d    | 42nd d   | 21st d   | 42nd d   | 21st d   | 42nd d   |
| Control                 | 3.44±0.42<sup>a</sup> | 3.2±0.35<sup>b</sup> | 188.8±7.4<sup>ab</sup> | 179±15.1 | 1921.2±277.0 | 1988.8±273.8 |
| 0.05                    | 2.53±0.27<sup>b</sup> | 2.21±0.23<sup>bc</sup> | 183.7±7.2<sup>ab</sup> | 178.0±5.9 | 2070.7±408.8 | 1977.4±421.2 |
| 0.1                     | 2.38±0.20<sup>c</sup> | 2.19±0.26<sup>c</sup> | 189.8±4.9<sup>b</sup> | 185.9±7.4 | 2553.8±494.2 | 1889.3±421.9 |
| 0.15                    | 2.5±0.22<sup>b</sup> | 2.38±0.25<sup>bc</sup> | 197.5±7.2<sup>ab</sup> | 191.8±6.5 | 2574.3±340.0 | 1890.6±377.2 |
| 0.2                     | 2.5±0.24<sup>bc</sup> | 2.44±0.15<sup>bc</sup> | 202.2±14.2<sup>bc</sup> | 192.3±8.5 | 2549.9±386.9 | 1394.2±338.2 |
| 0.25                    | 2.53±0.23<sup>c</sup> | 2.69±0.19<sup>bc</sup> | 177.8±5.7<sup>b</sup> | 192.0±6.9 | 28247.7±489.3 | 1966.8±485.9 |
| 0.3                     | 2.75±0.25<sup>ab</sup> | 2.50±0.28<sup>bc</sup> | 207.7±12.4<sup>ab</sup> | 186.3±5.6 | 2297.5±269.5 | 1444.3±261.6 |
| 0.35                    | 1.53±0.13<sup>c</sup> | 1.81±0.13<sup>c</sup> | 190.2±8.0<sup>ab</sup> | 181.3±5.6 | 214.5±282.1 | 1644.5±287.3 |

**Table 4. Effect of thyme essential oil on blood serum protein content of Mahua broilers.**

| Treatment groups, mg/kg | TP, g/L | Globulin, g/L | A/G, % |
|-------------------------|---------|---------------|--------|
|                         | 21st d  | 42nd d        | 21st d | 42nd d | 21st d | 42nd d |
| Control                 | 24.59±0.74<sup>c</sup> | 28.35±1.45<sup>bc</sup> | 14.37±0.80<sup>bc</sup> | 17.10±1.23<sup>bc</sup> | 75.31±5.7<sup>d</sup> | 68.90±3.80<sup>d</sup> |
| 0.05                    | 24.19±0.67<sup>c</sup> | 27.20±0.38<sup>bc</sup> | 14.15±0.56<sup>d</sup> | 16.46±0.69<sup>d</sup> | 72.40±3.3<sup>ab</sup> | 66.14±2.24<sup>ab</sup> |
| 0.1                     | 27.28±0.86<sup>bc</sup> | 27.16±0.31<sup>bc</sup> | 16.60±0.70<sup>ab</sup> | 17.13±0.56<sup>bc</sup> | 65.58±2.8<sup>bc</sup> | 59.39±2.12<sup>bc</sup> |
| 0.15                    | 28.18±0.88<sup>c</sup> | 29.26±0.55<sup>bc</sup> | 17.15±0.62<sup>c</sup> | 17.82±0.37<sup>bc</sup> | 64.82±1.5<sup>c</sup> | 66.40±2.19<sup>c</sup> |
| 0.2                     | 27.53±0.56<sup>bc</sup> | 30.28±1.20<sup>bc</sup> | 16.96±0.31<sup>c</sup> | 19.07±0.97<sup>bc</sup> | 62.37±1.59<sup>bc</sup> | 60.08±2.32<sup>bc</sup> |
| 0.25                    | 26.54±0.78<sup>ab</sup> | 31.06±1.14<sup>bc</sup> | 16.23±0.61<sup>ab</sup> | 19.37±0.88<sup>ab</sup> | 64.24±1.77<sup>ab</sup> | 61.25±1.54<sup>ab</sup> |
| 0.3                     | 25.66±0.57<sup>c</sup> | 29.22±1.94<sup>c</sup> | 15.68±0.40<sup>ab</sup> | 18.03±0.87<sup>ab</sup> | 64.06±2.38<sup>ab</sup> | 63.20±1.98<sup>ab</sup> |
| 0.35                    | 27.29±1.01<sup>bc</sup> | 29.78±1.07<sup>bc</sup> | 16.45±0.70<sup>bc</sup> | 18.25±0.79<sup>bc</sup> | 66.97±2.25<sup>bc</sup> | 63.86±1.40<sup>ab</sup> |

**Table 5. Effect of thyme essential oil on serum enzyme activity in Mahua broilers.**

**Discussions**

Serum biochemical indices directly express the status of metabolism, nutrition and health of the animals. Therefore, these indices can be used to assess the effect of TEO on growth conditions, food metabolism, immunity and mechanisms of broilers.

**The effect of thyme essential oil on serum enzyme activity in Mahua broilers**

Alanine aminotransferase is mainly distributed in the liver, followed by skeletal muscles, kidney, myocardial tissue, etc. Alanine aminotransferase can catalyse the transmutation between alanine and α-oxoglutarate, and between oxalo-acetic acid and glutamic acid. Alanine aminotransferase can influence the intermediate metabolism of glucose and amino acids. Aspartate transaminase is mainly distributed in myocardial cell, liver tissue, etc. Serum ALT and AST are very low under normal conditions. When liver damages or an increase in the permeability of liver cells are present, ALT and AST are released into the blood to increase their activity. Therefore, their serum levels are sensitive indicators of liver cell damage (Zhang, 2011). This experiment shows that TEO can significantly decrease the ALT level, but it has no significant effect on AST. Therefore, the addition of TEO will not damage liver cells, probably because it is derived from a natural herbaceous plant, therefore it is beneficial to animals. Sertel et al. (2011) found that the cytotoxic activity of TEO can influence the transcription of the genes that control cell cycle, cell death and cancer. The main regulation pathways of TEO are the interferon signalling pathway, the N-oligosaccharide synthesis pathway and the ERK5 signalling pathway.
Alkaline phosphatase can catalyse the hydrolysis of some compounds, such as phosphomonoesters and nucleoside phosphates, and its activity is an important indicator of bone metabolism (Xu et al., 2013). Our experiment demonstrated that, as a result of the addition of TEO, ALP levels in the serum of Mahua broilers tended to show a statistically significant increase (P<0.05) on day 21. Consequently, it can be inferred that TEO can improve bone metabolism in broilers and therefore their growth. However, Sharma and Gangwar (1986) suggested that, as broilers grow and age, the ALP activity tends to decrease, as shown in our experiment. In particular, ALP in the serum of Mahua broilers in the treatment groups tended to decrease significantly (P<0.05) on day 42 compared with the control group.

### The effect of thyme essential oil on total serum proteins in Mahua broilers

Serum total proteins consist of albumin and globulin. Their content can effectively reflect protein metabolism, feed condition and growth of animals. γ-globulins are responsible for humoral immunity. The A/G ratio can reflect spleen functions and partly the immune and physiological status of animals (Xie et al., 2010).

In the treatment groups, in the earlier stages total proteins and globulins in the serum of broilers increased significantly (P<0.05) and at all stages the A/G ratio significantly decreased (P<0.05). This shows that TEO can improve protein metabolism and immune function in broilers. This effect can be probably explained by two reasons. Firstly, TEO can promote protein deposition in broilers in vivo, keep the colloid osmotic pressure stable, improve the transportation of metabolic products in vivo, improve feed conversion rate and promote growth. Mathlouthi et al. (2012), Weber et al. (2012), Garcia et al. (2007) and other authors proved that TEO can improve feed conversion rate and promote growth. Anad et al. (2011) added 0, 150, 750, 1500 mg of plant extracts and thyme and anise essential oils to the basal ration to feed male Cobb broilers and found a statistically significant increase (P<0.05) in the efficiency of use of crude proteins. Hernández et al. (2004) added 5000 μg/mL of an essential oil blend consisting of sage, thyme and rosemary from labiate and found a significant increase in the efficiency of nutrient use in the intestine and in the apparent digestibility of dry matter and crude proteins on day 22-42. Secondly, thyme can have antimicrobial, anti-inflammatory and antiviral actions. In the meantime it can also improve resistance to disease and promote the immune response. A research demonstrated that the major component of TEO was carvacrol, which can lower the expression of COX-2 mRNA and proteins induced by lipopolysaccharides. Because it is an inhibitor of PPAR-α, γ-regulator and COX-2, it has various effects, including an anti-inflammatory action (Hotta et al., 2010). Burt et al. (2007) suggested that the components of TEO can induce bacterial HSP60 and inhibit the synthesis of O157:H7.

### Table 5. Effect of thyme essential oil on blood fat content of Mahua broilers.

| Age   | Treatment, mg/kg | TG, mmol/L | TC, mmol/L | LDL, mmol/L | HDL, mmol/L |
|-------|------------------|------------|------------|-------------|-------------|
| Day 21 | Control          | 0.40±0.03  | 3.41±0.11ab| 0.68±0.06bc| 2.58±0.13c  |
|       | 0.05             | 0.38±0.02  | 3.11±0.14ab| 0.59±0.02c | 2.59±0.12c  |
|       | 0.10             | 0.45±0.03  | 3.64±0.14ab| 0.72±0.03bc| 3.06±0.13c  |
|       | 0.15             | 0.42±0.03  | 3.54±0.17ab| 0.78±0.05c | 3.21±0.13c  |
|       | 0.20             | 0.40±0.03  | 3.93±0.17ab| 0.76±0.09bc| 3.18±0.08c  |
|       | 0.25             | 0.41±0.04  | 3.58±0.14ab| 0.73±0.04bc| 2.94±0.11c  |
|       | 0.30             | 0.38±0.02  | 3.62±0.23ab| 0.75±0.06bc| 2.90±0.13c  |
|       | 0.35             | 0.40±0.02  | 3.88±0.16ab| 0.85±0.06bc| 3.11±0.11c  |
| Day 42 | Control          | 0.45±0.04  | 3.35±0.18  | 0.69±0.03  | 2.73±0.05c  |
|       | 0.05             | 0.39±0.02  | 3.09±0.10  | 0.62±0.02  | 2.93±0.13c  |
|       | 0.10             | 0.43±0.04  | 3.41±0.18  | 0.63±0.03  | 3.06±0.12c  |
|       | 0.15             | 0.41±0.03  | 3.45±0.08  | 0.72±0.03  | 3.11±0.08c  |
|       | 0.20             | 0.45±0.03  | 3.31±0.10  | 0.69±0.03  | 2.97±0.07c  |
|       | 0.25             | 0.47±0.03  | 3.40±0.13  | 0.73±0.04  | 2.88±0.07c  |
|       | 0.30             | 0.41±0.02  | 3.32±0.12  | 0.68±0.02  | 2.81±0.10c  |
|       | 0.35             | 0.41±0.02  | 3.36±0.08  | 0.67±0.03  | 2.83±0.08c  |

TG, triglyceride; TC, total cholesterol; LDL, low-density lipoprotein; HDL, high-density lipoprotein. *Means within the same column with different superscript letters differ significantly (P<0.05).

### Table 6. Effect of thyme essential oil on blood urea nitrogen, uric acid and glucose in the serum of Mahua broilers.

| Treatment groups, mg/kg | BUN, mmol/L | UA, mmol/L | GLU, mmol/L |
|-------------------------|-------------|------------|-------------|
|                         | 21st d      | 42nd d     | 21st d      | 42nd d     | 21st d      | 42nd d     |
| Control                 | 0.95±0.11c  | 0.68±0.05c | 355.85±60.0| 259.72±22.2| 13.89±0.58  | 13.48±0.39 |
| 0.05                    | 0.68±0.06bc | 0.54±0.04bc| 385.13±38.2| 300.93±22.0| 13.11±0.26  | 13.67±0.39 |
| 0.1                     | 0.63±0.04cd | 0.51±0.02sc| 305.59±29.2| 388.56±52.3| 12.47±0.28  | 13.03±0.31 |
| 0.15                    | 0.57±0.02cd | 0.49±0.03  | 345.69±29.2| 304.69±32.6| 12.33±0.75  | 13.35±0.43 |
| 0.2                     | 0.53±0.02cd | 0.60±0.02ab| 297.19±24.2| 339.25±23.6| 12.32±0.32  | 13.47±0.49 |
| 0.25                    | 0.58±0.03cd | 0.60±0.02ab| 401.20±35.0| 336.63±30.4| 0.23±0.25   | 13.31±0.28 |
| 0.3                     | 0.72±0.02   | 0.55±0.02sc| 382.63±33.2| 290.56±38.3| 13.40±0.35  | 13.29±0.24 |
| 0.35                    | 0.50±0.03   | 0.51±0.01  | 363.88±28.8| 290.25±28.4| 13.91±0.44  | 13.12±0.24 |

BUN, blood urea nitrogen; UA, uric acid; GLU, glucose. *Means within the same column with different superscript letters differ significantly (P<0.05).
flagellin of Escherichia coli. Ausra et al. (2006) showed that β-cymene, thymol and carvacrol in the thyme extracting solution characterising water-solubility and TEO significantly suppresses the proliferation of aspergillus, ten bacteria and eight yeast strains. Zu et al. (2010) investigated ten essential oils and suggested that thyme, cinnamon and rose essential oils display the best antibacterial activity against propionibacterium acnes and inhibit its diameter respectively by 40 mm, 33.5 and 16.5 mm. Schnitzler et al. (2007) indicated that plant essential oils, like TEO, have a more powerful antiviral activity against acyclovir-sensitive strain KOS, and acyclovir-resistant herpes simplex virus. Maximum concentration of TEO with no cytotoxicity is 0.005%.

The effect of thyme essential oil on blood fat content in the serum of Mahua broilers

Cholesterol is an important part of animal cell membranes and nerve myelin sheath and is a precursor of the synthesis of biliary acids, steroid hormones, adrenal hormones and vitamin D₃, therefore it has some important physiological functions. Low-density lipoproteins carry endogenous cholesterol to every cell in the body and promote cholesterol deposition. High-density lipoproteins make cholesterol from the surrounding tissue reach the liver to metabolise it by reverse transportation and decompose it into bile acid. Total cholesterol in blood reflects the degree of lipid absorption and metabolism. Low- and high-density lipoproteins reflect the state of lipid transportation in vivo.

In our experiment HDL of Mahua broilers was significantly (P<0.05) improved on day 42 in the groups fed with an addition of TEO, thus showing that thyme can enhance lipid catabolism and reduce fat deposition. This is probably due to an anti-oxidant effect of TEO and its ability to regulate and control levels of some hormones in vivo, inhibit the activities of some lipases in vivo, promote protein deposition in the body and decrease fat deposition. Rana and Soni (2008) fed daily rations with 0.5% of thymus extract to rats with oxidative stress induced by N-nitrosamine and found that it can influence the levels of superoxide dismutases, peroxidase and catalase and improve their anti-oxidant power, thus contributing to oxidative stress prevention. Berkan et al. (2010) studied 18 wrestling athletes, who drank tea with thyme leaves three times a day. After 35 days, athletes in the treatment group showed a significant improvement of total anti-oxidant capacity, a very significant decrease of malondialdehyde and a significant decrease of thiol group RSH compared with the control group.

The effect of thyme essential oil on blood urea nitrogen, uric acid and glucose in the serum of Mahua broilers

Serum urea level is an index which reflects the status of protein metabolism, renal function and nutrition of the body. Uric acid is mainly generated by protein and nucleic acid degradation and is the main form of ammonia excretion in chicken. Serum uric acid directly reflects the level of protein catabolism in animals. Glucose is a substance that in animals directly oxidises to provide energy. Seventy percent of the energy in the body comes mainly from the decomposition of glucose. In our experiment, the BUN level in the serum of Mahua broilers significantly decreased (P<0.05) in the treatment groups, thus showing that thyme improves protein synthesis in broilers, decreases protein decomposition speed and increases the efficiency of nitrogen use. This is probably due to the ability of thyme to promote the growth of animals, improve feed conversion and therefore increase absorption and utilisation of feed proteins and increase protein deposits.

Conclusions

Thyme essential oil can promote protein metabolism of Mahua broilers, enhance lipolysis and improve the immune status. On the basis of the comprehensive analysis of the effect of TEO on serum biochemical indices of Mahua broilers, the optimal range of TEO addition proved to be between 0.10 and 0.25 mg/kg. Thyme essential oil can be considered a potential growth enhancer for broilers, because it can meet the demand of both producers for increased broiler performance and consumers for more environmental-friendly farming conditions. Thyme essential oil is also cost-effective, if one takes into account costs of antibiotics and other commercially available products on the market (Alicicek et al., 2009).

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