The effect of thyme extract on growth performance, digestive organ weights and serum lipoproteins of broilers fed wheat-based diets

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Abstract

The effect of the thyme extract and wheat form of the diet on performance, digestive organ weights and serum lipoproteins was studied in 320 male day old (ROSS 308) chicks. From 1 to 42 d of age, 8 diets arranged factorial with 4 thyme extract level (0.0, 0.2, 0.4 and 0.6%) and 2 wheat forms (ground vs whole) was used. Each treatment was replicated 4 times (10 birds per replicate). Thyme extract had no significant effect on body weight gain, feed intake and feed conversion ratio irrespective of wheat form used over whole trial period (1-42 d). From 1 to 21 d of age, broilers fed the whole wheat diet grew faster than the broilers fed ground wheat based diet (609.06 vs 573.34 g). Relative abdominal fat and gizzard weight was significantly higher (P<0.05) in birds fed the whole wheat diets. Two-way interaction between thyme extract and wheat form were observed for total cholesterol, LDL-cholesterol, HDL-cholesterol and very-low-density lipoprotein (VLDL) in the experiment. The results showed that the extract had no effect on performance of broilers irrespective of wheat form used. Relative gizzard weight was higher (P<0.05) in birds fed the whole wheat diets, but an increase in abdominal fat should be taken into account for carcass quality and processing. The predominant effect of thyme extract on lowering lipid levels in broilers fed on wheat based diets was on triglyceride rather than on cholesterol concentrations.

Materials and methods

A total of 320 (ROSS 308) one-day-old male chicks were randomly allocated to one of eight dietary treatment groups of four replicates each, to make forty chicks per group. The chicks were maintained on a 23-h light and 1-h dark schedules. The birds were reared in floor pens using sawdust as litter at Urmia university poultry farm, Urmia, Iran. The temperature was set at 35°C to 32°C during the first week and gradually declined by 2°C per week. A relative humidity was about 60 to 65%. The trial was conducted as a completely randomized design with 4x2 factorial arrangement with 4 levels of thyme extract (0.0, 0.2, 0.4 and 0.6%) and 2 wheat forms (ground vs whole). The entire experimental Period lasted for 6 weeks (from 0-42 d of age). Thymus vulgaris alcoholic extract was prepared using a standard maceration method (Zhang et al., 2005).

The basal diets were based on local hard wheat (Sardari variety grown in West Azarbaijan) and soybean meal as the main ingredient and formulated according to Ross (308) commercial management guide. The compositions of the diets are shown in (Table 1). To accustom the chickens to whole wheat, grains were coarsely ground for the first 3 days of feeding. The birds were introduced to whole wheat at 3 d of age. Bird performance was measured by measuring feed intake and body weight and body weight gain and feed conversion ratio were calculated. Mortality within per pen was recorded. At 42 days of age, two birds closest from each replicate with body weight closest to mean weight of the pen, were selected, weighed and killed to obtain blood samples and were used for measurement of the digestive tract. Blood samples were collected in heparinized tubes (citrate sodium 3.6% solution as an alternative to heparin) during a forty-minute period; blood plasma was separated and plasma triglyceride, total cholesterol and plasma lipoproteins were determined by enzymatic method using commercial kit technique (Man Co., Tehran, Iran). Body weights and feed intake were recorded on pen basis in weekly intervals. Mortality was observed and recorded daily. Feed conversion values were corrected for mortality.

Introduction

There is a worldwide concern over-use of antibiotics in animal production because of their possible contribution to emergence of antibiotic resistant bacteria, and their transmission from livestock to humans. Accordingly, poultry nutritionists have been exploring alternative specific feed additives or dietary raw materials to favorably affect animal performance and welfare, particularly through the modulation of the gut microbiota which plays a critical role in maintaining host health (Gaggia et al., 2010).

In this context, antimicrobial activity of several plant extract have been received increased attention as possible antibiotic growth promoters in broiler ration (Hernandez, 2004). In several studies the effect of thymol (alone or mixed) on birds growth performance in corn-based diets has been evaluated, but few have been concerned with whole or ground wheat-based diets. In recent years, whole grain feeding (due to beneficial effects on the digestive microflora) has been proposed as an alternative to antibiotic growth promoters (Gabriel et al., 2003). Moreover those studies with thymol have shown an antimicrobial effect in vitro, but their influence on growth performance of birds has not been sufficiently documented. For example some studies indicated a lack of a positive effect of thymol in the corn-soybean meal based diets (Lee et al., 2003b; Jang et al., 2004; Sengul et al., 2008; Rahimi et al., 2011) on growth performance. In contrast, other authors have reported the beneficial effect of thymol on broiler growth performance (Bassett, 2000; Hertrampf, 2001; Kamel, 2001; Bolukbasi et al., 2005). To accustom the chickens to whole wheat, grains were coarsely ground for the first 3 days of feeding. The birds were introduced to whole wheat at 3 d of age. Bird performance was measured by measuring feed intake and body weight and body weight gain and feed conversion ratio were calculated. Mortality within per pen was recorded. At 42 days of age, two birds closest from each replicate with body weight closest to mean weight of the pen, were selected, weighed and killed to obtain blood samples and were used for measurement of the digestive tract. Blood samples were collected in heparinized tubes (citrate sodium 3.6% solution as an alternative to heparin) during a forty-minute period; blood plasma was separated and plasma triglyceride, total cholesterol and plasma lipoproteins were determined by enzymatic method using commercial kit technique (Man Co., Tehran, Iran). Body weights and feed intake were recorded on pen basis in weekly intervals. Mortality was observed and recorded daily. Feed conversion values were corrected for mortality.

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Key words: Broiler chickens, Thyme extract, Growth performance, Digestive organ weight, Wheat.
Results and discussion

Effects of thyme extract supplementation and wheat form on the performance of broilers fed on wheat-based diets are presented in Table 2. The main effect of thyme extract levels were not significant for any of the performance parameters. Feed conversion ratio was numerically improved at 0.6% thyme extract group in both starter, grower and over the whole trial period compared to other treatment, but the different was not significant. These results are in agreement with previous studies in broilers (Lee et al., 2003a; Jang et al., 2004; Abdolkarimi et al., 2011). In different studies conducted to evaluate the effect of thyme on broiler performance, inconsistent results have been obtained. For example, Bolukbasi et al. (2006) reported increased in feed intake and weight gain but not improvement in feed conversion ratio in broilers fed thyme oil supplemented diets (200 mg/kg); whereas Toghyan et al. (2010) and Cross et al. (2003) reported improvements in weight gain in birds fed thyme powder (5 g/kg) and thyme oil (1 g/kg) respectively, with no change in feed conversion ratio. In the present study the lack of effect of thyme extract on growth performance may relate to the composition of the basal diet and/or the environmental conditions. Growth promoting agents may have more impact when the diet in use is less digestible. In addition, it is known that well-nourished, healthy chicks do not respond to antibiotic supplements provided that they are housed under clean and disinfected conditions (Jang et al., 2004).

Effects of thyme extract supplementation and wheat form used on the relative weight of organs and carcass traits are shown in (Table 3). The proportional gizzard weight (g/kg BW) of the birds offered whole wheat was heavier (P<0.05) than those fed on ground wheat diets. Similar results was observed by (Jones and Taylor, 2001) and (Engberg et al., 2002) who reported that the size of gizzard (g/kg BW) was greater (P<0.05) at 42 d in birds fed on thyme powder (5 g/kg) and thyme oil (1 g/kg) supplemented diets (200 mg/kg); whereas Toghyani et al. (2010) and Cross et al. (2003) reported increased in feed intake and weight gain but not improvement in feed conversion ratio in broilers fed thyme oil supplemented diets (200 mg/kg); whereas Toghyan et al. (2010) and Cross et al. (2003) reported improvements in weight gain in birds fed thyme powder (5 g/kg) and thyme oil (1 g/kg) respectively, with no change in feed conversion ratio. In the present study the lack of effect of thyme extract on growth performance may relate to the composition of the basal diet and/or the environmental conditions. Growth promoting agents may have more impact when the diet in use is less digestible. In addition, it is known that well-nourished, healthy chicks do not respond to antibiotic supplements provided that they are housed under clean and disinfected conditions (Jang et al., 2004).

Table 1. Composition and nutrient levels of the experimental diets.

| Ingredients, % | Starter, 0-21 d | Finisher, 22-42 d |
|----------------|-----------------|------------------|
| Wheat          | 56.75           | 64.28            |
| Soybean meal   | 34.20           | 25.96            |
| Soybean oil    | 4.78            | 5.25             |
| Dicalcium phosphate | 2.50        | 2.75             |
| Limestone      | 0.87            | 0.55             |
| DL-methionine  | 0.25            | 0.22             |
| Lysine         | 0.10            | 0.20             |
| Salt           | 0.30            | 0.29             |
| Vitamin mix    | 0.125           | 0.25             |
| Mineral mix    | 0.125           | 0.25             |

Calculated analysis

| Metabolizable energy, Kcal/g | 2950 | 3050 |
| Crude protein, %             | 21.81 | 19.00 |
| Calcium, %                   | 0.99  | 0.90  |
| Phosphorus, %                | 0.44  | 0.46  |
| Chloride, %                  | 0.25  | 0.26  |
| Sodium, %                    | 0.16  | 0.16  |
| Lysine, %                    | 1.17  | 1.05  |
| Methionine, %                | 0.54  | 0.47  |
| Methionine +cystine, %       | 0.89  | 0.78  |

Vitamins supplied per kilogram of diet: vitamin A, 18,000 IU; vitamin D3, 4000 IU; vitamin E, 15 mg; vitamin K3, 4 mg; thiamine, 1.8 mg; riboflavin, 11.2 mg; pyridoxine, 6 mg; niacin, 49 mg; calcium pantothenate, 20 mg; folic acid, 2 mg; biotin, 0.2 mg; chlorine chloride, 500 mg. *Mineral mix supplied per kilogram of diet: Mn, 55 mg; Zn, 50 mg; Fe, 80 mg; Cu, 5 mg; Se, 0.1 mg; I, 0.18 mg.

Table 2. Influence of dietary Thymus vulgaris on wheat-based (whole vs ground) diet on performance of broiler chickens.

| Age, 0-21 d | FI | BWG | FCR |
|-------------|----|-----|-----|
| FI          | 963.89 | 595.65 | 1.62 |
| 1.2         | 949.62 | 574.83 | 1.66 |
| 0.4         | 975.18 | 595.64 | 1.64 |
| 0.6         | 960.89 | 598.67 | 1.61 |
| SEM         | 13.84  | 10.32 | 0.03 |
| P value     | 0.64  | 0.35 | 0.62 |

| Wheat form | FI | BWG | FCR |
|------------|----|-----|-----|
| WW         | 967.32 | 609.06 | 1.59 |
| GW         | 957.47 | 573.34 | 1.67 |
| SEM        | 9.79  | 7.30  | 0.02 |
| P value    | 0.46  | 0.00  | 0.01 |

| Interactions | FI | BWG | FCR |
|--------------|----|-----|-----|
| WW+0.0 TE    | 956.96 | 608.72 | 1.58 |
| GW+0.0 TE    | 970.82 | 582.58 | 1.67 |
| WW+0.2 TE    | 976.37 | 604.08 | 1.62 |
| GW+0.2 TE    | 922.88 | 545.57 | 1.69 |
| WW+0.4 TE    | 975.49 | 606.18 | 1.61 |
| GW+0.4 TE    | 974.86 | 585.11 | 1.67 |
| WW+0.6 TE    | 960.48 | 617.25 | 1.56 |
| GW+0.6 TE    | 961.30 | 580.10 | 1.66 |
| SEM          | 6.77  | 5.96  | 0.01 |
| P value      | 0.35  | 0.39  | 0.94 |

For performance, pen means and for digestive tract and carcass measurements, individual birds were considered as the experimental unit. Statistical analysis was carried out using the GLM procedure of SAS Statistical Analysis Software (2002) using a two-way factorial experiment. Tukey’s multiple range test was used to separate the means when differences between treatment means were significant (P<0.05).
Table 3. Influence of *dietary Thymus vulgaris* on wheat-based (whole vs ground) diet on internal organ weights of broiler chickens.

| Thyme extract level, % | Carcass yield, % | Breast, DP | Liver | Pancreas | Spleen | Heart | Abdominal fat | Gizzard |
|-----------------------|------------------|------------|-------|----------|--------|-------|----------------|---------|
| 0                     | 71.55            | 33.34      | 2.09  | 0.21     | 0.09   | 0.50  | 2.01           | 1.59    |
| 0.2                   | 70.08            | 34.91      | 2.17  | 0.20     | 0.09   | 0.51  | 1.92           | 1.67    |
| 0.4                   | 72.46            | 35.88      | 2.14  | 0.22     | 0.11   | 0.52  | 1.97           | 1.67    |
| 0.6                   | 72.10            | 36.37      | 2.00  | 0.19     | 0.09   | 0.47  | 1.96           | 1.66    |
| SEM                   | 0.78             | 0.99       | 0.06  | 0.01     | 0.006  | 0.02  | 0.07           | 0.06    |
| P value               | 0.17             | 0.17       | 0.18  | 0.50     | 0.10   | 0.45  | 0.87           | 0.74    |

Wheat form

| WW                    | 70.89            | 34.28      | 2.14  | 0.21     | 0.09   | 0.50  | 2.10           | 1.83    |
| GW                    | 72.21            | 35.97      | 2.06  | 0.20     | 0.10   | 0.50  | 1.83           | 1.46    |
| SEM                   | 0.55             | 0.70       | 0.04  | 0.01     | 0.004  | 0.01  | 0.05           | 0.04    |
| P value               | 0.10             | 0.10       | 0.14  | 0.21     | 0.17   | 1.00  | 0.01           | 0.00    |

Interactions

| WW+0.0 TE | 71.27            | 33.50      | 2.07  | 0.21     | 0.10   | 0.52  | 2.19           | 1.75    |
| GW+0.0 TE | 71.83            | 33.18      | 2.11  | 0.20     | 0.09   | 0.49  | 1.83           | 1.44    |
| WW+0.2 TE | 69.79            | 32.93      | 2.29  | 0.21     | 0.08   | 0.50  | 2.10           | 1.90    |
| GW+0.2 TE | 70.37            | 36.89      | 2.04  | 0.20     | 0.10   | 0.51  | 1.75           | 1.44    |
| WW+0.4 TE | 70.78            | 34.34      | 2.18  | 0.21     | 0.10   | 0.50  | 2.01           | 1.88    |
| GW+0.4 TE | 74.14            | 37.43      | 2.10  | 0.22     | 0.12   | 0.54  | 1.93           | 1.46    |
| WW+0.6 TE | 71.71            | 36.34      | 2.03  | 0.21     | 0.09   | 0.49  | 2.11           | 1.79    |
| GW+0.6 TE | 72.49            | 36.40      | 1.97  | 0.18     | 0.09   | 0.46  | 1.81           | 1.52    |
| SEM                   | 0.41             | 0.53       | 0.03  | 0.00     | 0.00   | 0.01  | 0.04           | 0.04    |
| P value               | 0.52             | 0.34       | 0.35  | 0.58     | 0.18   | 0.46  | 0.51           | 0.58    |

DP, dressing percentage; WW, whole wheat; GW, ground wheat; TE, thyme extract. *a,b* Means in a row without common superscript are significantly different (P<0.05).

Table 4. Effects of thyme extract supplementation to diets based whole or ground wheat on lipid concentrations of broiler chickens at 42 d of age.

| Triglyceride, mg/dL | Cholesterol, mg/dL | LDL-c, mg/dL | HDL-c, mg/dL | VLDL-c, mg/dL |
|---------------------|--------------------|--------------|--------------|--------------|
| Thyme extract level, % |                   |              |              |              |
| 0                   | 56.93c             | 113.14c      | 57.06c       | 44.70c       | 11.39c     |
| 0.2                 | 46.25c             | 150.88c      | 87.80c       | 53.84c       | 9.25c      |
| 0.4                 | 45.83c             | 165.05c      | 57.99c       | 97.90c       | 9.17c      |
| 0.6                 | 52.50c             | 139.32c      | 67.67c       | 57.54c       | 10.50c     |
| SEM                 | 1.60c              | 3.00c        | 1.38c        | 3.15c        | 0.32c      |
| P value             | 0.0001             | 0.0001       | 0.0001       | 0.0001       | 0.0001     |

Wheat form

| WW                   | 43.44c             | 151.82c      | 71.05c       | 70.27c       | 8.69c      |
| GW                   | 57.32c             | 132.38c      | 64.20c       | 56.72c       | 11.47c     |
| SEM                 | 1.13d              | 2.12d        | 0.97d        | 2.23d        | 0.23d      |
| P value             | 0.0001             | 0.0001       | 0.0001       | 0.0002       | 0.0001     |

Interactions

| WW+0.0 TE | 43.19d             | 121.35d      | 56.15d       | 56.57d       | 8.64d      |
| GW+0.0 TE | 70.68d             | 104.94d      | 57.98d       | 52.83d       | 14.14d     |
| WW+0.2 TE | 40.61d             | 180.66d      | 85.88d       | 86.66d       | 8.13d      |
| GW+0.2 TE | 51.90d             | 121.11d      | 89.72d       | 21.02d       | 10.38d     |
| WW+0.4 TE | 42.97d             | 158.77d      | 63.91d       | 86.26d       | 8.60d      |
| GW+0.4 TE | 48.68d             | 171.33d      | 52.08d       | 109.52d      | 9.74d      |
| WW+0.6 TE | 46.98d             | 146.48d      | 70.29d       | 51.58d       | 9.40d      |
| GW+0.6 TE | 58.03d             | 132.15d      | 57.04d       | 63.51d       | 11.61d     |
| SEM                 | 1.81d              | 4.68d        | 2.55d        | 5.15d        | 0.36d      |
| P value             | 0.0004             | 0.0001       | 0.0001       | 0.0001       | 0.0004     |

WW, whole wheat; GW, ground wheat; TE, thyme extract. *a,b* Means in a row without common superscript are significantly different (P<0.05).
found no significant effect of thymol (10 g/kg) on total cholesterol, LDL-cholesterol and HDL-cholesterol.

The increased in cholesterol concentration in the present study could be due to the phenolic compounds of carvacrol and thymol that exhibit considerable antimicrobial activity (Basilico and Basilico, 1999; Hernandez et al., 2004) that may depress fat absorption due to bile acid deconjugation (Engberg et al., 2000).

Conclusions

The results showed that neither the thyme extract nor wheat form affected the growth performance and internal organ size but whole wheat birds had a higher gizzard and abdominal fat pad. Broiler given combination of ground wheat plus 0.2% thyme extract significantly decreased serum triglyceride without affecting cholesterol level. Thus, further study is needed to clarify the mechanism of hypolipidemic actions of thyme in wheat-based diets.

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