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# EFFECTS OF SUMAC POWDER *(Rhus coriaria* L.) ON GROWTH PERFORMANCE, SERUM BIOCHEMISTRY AND INTESTINAL MICROBIOATA IN BROILERS AT DIFFERENT STOCKING DENSITIES

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***Abstract***

*This study aimed to evaluate the effects of dietary supplementation of sumac powder (Rhus coriaria) on growth performance, serum biochemistry and intestinal microbiota in broilers reared at different stocking densities. A total of 378 one-day-old Ross 308 male broiler chicks were subjected to a 2 stocking densities (10 and 20 chicks/m$^2$ floor area; normal and high stocking density) x 3 sumac powder levels (0.0, 0.75 and 1.5 g/kg feed) factorial arrangement of treatments. Body weight and feed intake were significantly lower in chickens reared at high stocking density than normal stocking density groups (P<0.05). Moreover, feed conversion rate was negatively affected by high stocking density (P<0.05). Dietary addition of sumac powder had no effect on these variables in both stocking densities (P>0.05). Both stocking densities and the supplementation of sumac powder to the feeds had a reducing effect on intestinal weight (P<0.05). Serum total protein concentration of chickens reared at high stocking density was higher than those of the control normal groups (P<0.05). There was interaction between stocking density and dietary sumac powder supplementation for only body weight and abdominal fat pad variables at the end of the study (P<0.05). However, no differences were observed for the relative weight of liver, spleen, gizzard and proventriculus (P>0.05). In addition, alkaline phosphatase (ALP), aspartate amino transferase (AST) activities and high density lipoprotein (HDL), cholesterol and triglyceride concentration in the serum were not influenced by the any stocking density and sumac powder supplementation (P>0.05). In conclusion, our results showed that broilers exhibited low performance when reared at high stocking density and dietary supplementation of sumac powder has not prevented this decline.*

***Key words**: stocking density, sumac powder, growth performance, serum biochemistry, broiler.*

## INTRODUCTION

Stocking density is the numbers of chickens per unit area reared during grow out. Stocking density has been one of the principal concerns in the welfare of poultry production practices. Presently, there is an ongoing debate at the ideal density for chickens reared on the floor and in the different types of cages. Sorensen et al. (2000) reported that lower growth and fattening performance and higher mortality and prevalence of leg weakness in animals reared in high stocking density. Environmental conditions may have different effects on the productivity of poultry. During the summer season stocking density plays an important in broiler production and low growth performance and high mortality may occur at higher stocking densities in broilers (Türkyilmaz, 2008). High stocking density may cause decreases of growth performance of poultry and can lead to disease or death due to changes in the immune system of animal (Rotllant et al., 1997). Puron et al. (1995) reported that the reduction of feed intake of broiler chickens at high density because of the stress caused by environmental conditions.

Recently, several plant extracts have received considerable attention because of their natural antioxidants effects as feed additives in poultry nutrition.

Sumac *(Rhus coriaria* L.) is a plant, grows widely in Asian countries and it uses as tradetional medicine (Shidfar et al., 2014). Tannins and flavonoids are the main compounds of sumac extracts (Jung, 1998) and it has gallic acid and several group B vitamins (EL Sissi et al., 1972). Some researchers reported that dietary sumac powders improved growth performance in broilers (Gulmez et al, 2006; Ghasemi et al., 2014) and enhanced intestinal characteristics on broiler chicks (Ghasemi et al., 2014).

The aim of this study was to investigate the effects of dietary supplementation of sumac powder on growth performance, serum biochemistry and intestinal microbiota in broilers reared at different stocking densities.

## MATERIALS AND METHODS

This study was performed at the Dicle University, Animal Research Center Unit according to the guidelines for animal experimentation of Dicle University and approved by the Ethical Committee (DUHADEK- No: 01.12.2016-5).

Totally, 378 one-day-old Ross 308 male broiler chicks were randomly divided into 6 experimental groups. The 6 experimental treatments subjected to a 2 x 3 factorial arrangement, in which the 2 variation factors were the 2 stocking densities (10 and 20 chicks/$m^2$ floor area; normal and high stocking density) and 3 sumac powder levels (0, 0.75 and 1.5 g/kg feed).

Sumac powder was purchased from a local market in Mardin province and it added to experimental diets after grinding.

Diets were formulated based on NRC (1994) recommendations to meet the nutrient requirements of broilers from d 1 to 21 (grower diet) and from d 22 to 42 (finishing diet). The composition of the basal diets is presented in Table 1.

Table 1. Composition of experimental diets (%)

| Ingredients | Starter (1-22 day) | Finisher (23-42 day) |
|---|---|---|
| Maize | 58.2 | 57.0 |
| Soybean meal (48 % CP) | 22.0 | 23.0 |
| Full fat soybean | 11.0 | 12.0 |
| Fish meal (60 % CP) | 5.2 | - |
| Sunflower oil | - | 3.7 |
| Dicalciumphosphate[a] | 1.75 | 1.60 |
| Limestone | - | 1.0 |
| NaCl | 0.30 | 0.35 |
| Vitamin premix[b] | 0.10 | 0.10 |
| Mineral premix[c] | 0.15 | 0.15 |
| L-Lysine HCl | 0.15 | - |
| Dl-Methionine | 0.15 | - |
| **Calculated composition** | | |
| Crude Protein | 22.9 | 20.1 |
| ME (kcal/kg) | 2,996 | 3,213 |
| Calcium | 0.90 | 0.98 |
| Available phosphorus | 0.45 | 0.37 |
| L-lysine | 1.43 | 1.10 |
| Methionine+cystine | 0.92 | 0.75 |

[a] Contains 240 g Ca and 17.5 g P/kg;
[b] Provided (per kg of diet): vitamin A, 8,000 IU; vitamin D3, 1,200 IU; vitamin E, 10 IU; vitamin K3, 2 mg; thiamine, 2 mg; riboflavin, 5 mg; pyroxidine, 0.2 mg; vitamin B12, 0.03 mg; pantothenic acid, 10 mg; niacin, 50 mg; biotin, 0.1 mg; folic acid, 0.5 mg; iron, 80 mg; zinc, 40 mg; manganese, 60 mg; iodine, 0.8 mg; copper, 8 mg; selenium, 0.2 mg; cobalt, 0.4 mg
[c] Provided (per kg of diet): Iron, 80 mg; zinc 40 mg; manganese 60 mg; iodine 0.8 mg; copper, 8 mg; selenium, 0.2 mg; cobalt, 0.4 mg.

Feed and water were provided *ad libitum* throughout the experiment. The experiment lasted 42 d, including 21 d on the grower diet and from d 22 to 42 on the finishing diet.

Chickens were weighed individually and feed intake determined by pen from 7 to 42 d (n=7). Mortality was checked daily and recorded throughout the experimental period. Feed conversion rate (FCR) was calculated by pen with dividing total feed intake to body weight.

At the end of the experiment, blood samples (2 mL per bird) were collected from 10 chickens per treatment for serum biochemical determination. Within 1 h, the serum was obtained by centrifugation (2,500 × g for 15 min) and stored at −80°C until further analysis. Serum biochemical parameters were measured by using Architect System Reagents and an automatic clinical chemistry analyzer. The concentration of total protein (TP) was measured by following the Biuret method; uric acid (UA) by following the uricase method; cholesterol by following the cholesterol esterase-peroxidase method; respectively; triglyceride by following the glycerol phosphate oxidase method; and the enzymatic activities of alkaline phosphatase (ALP), aspartate aminotransferase (AST) by using the recommended International Federation of Clinical Chemistry and Laboratory Medicine reference methods. After taking blood samples, chickens were euthanized with an intravenous injection of sodium pentobarbital and immediately intestinal tract, liver and spleen were removed and weighed (data expressed as relative organ weight; grams of organ per 100 g of BW). Small intestine was immediately removed and digesta contents (from final part of small intestine) from 60 chickens (10 chickens per treatment) were collected separately, cooled at once used for microbial assays *(Escherichia coli* and *Lactobacillus).*

The data were analyzed by using the ANOVA with the General Linear Model (GLM) procedure of SPSS 16.0 (2011) by using the following model: $Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$, where $Y_{ijk}$ is the dependent variable, $\mu$ is the overall mean, $\alpha_i$ is the effect of stocking density (i = 1,2); $\beta_j$ is the effect of sumac powder (j = 1, 2, 3); $(\alpha\beta)_{ij}$ is the interaction between stocking density and sumac powder levels; and $\varepsilon \sim N(0,\sigma 2\varepsilon)$ represents the unexplained random error. The α-level used for determination of significance for all the analyses was 0.05. Differences between means were tested by Tukey's least significant difference when an interaction between stocking density and sumac powder was significant. Data are presented as means and SEM.

## RESULTS AND DISCUSSIONS

Results of the effects of sumac powder *(Rhus coriaria* L.*)* on growth performance and intestinal microbiota in broilers at different stocking densities are given in Table 2. Body weight gain and feed intake were significantly lower in chickens reared at high stocking density than normal stocking density groups (P<0.05). These results are in agreement with in previous studies by Dozier et al. (2005), who reported that, the negative effect of high stocking density on cumulative body weight gain in broilers. Negative effects of high density on live performance in broilers might be broilers faced an access difficulties to feed and water difficulties (Sørensen et al., 2000).

On the other hand, dietary supplementation of sumac powder had no significant effect on body weight gain, feed intake and feed conversion rate (P>0.05). In contrast, Ghasemi et al. (2014) reported that addition of different levels of sumac extract (1, 2 and 3 % of diet) at had significant effects on the feed intake. Similarly, Lee et al. (2003) showed that the improvement of feed efficiency in broilers fed diet supplemented sumac extracts. Different results might be partially explained by differences in the sumac extract level supplemented to diet.

*Lactobacillus* spp. may be considered main microorganisms in the gut of broilers 6 weeks of age (Dumonceaux et al., 2006). Our results indicated that an interaction was existed between stocking density and sumac powder supplementation for body weight gain, total aerobs, *E. coli* and *Lactobacillus* population in gut (Table 2).

Table 2. Effects of sumac powder *(Rhus coriaria* L.*)* on growth performance and intestinal microbiota in broilers at different stocking densities

| Treatments[1] | | Growth performance[1] | | | Bacteriacolony | |
|---|---|---|---|---|---|---|
| Stocking density (bird/m$^2$) | Sumac powder (g/kg feed) | BW gain (g) | Feed intake (g) | Feed conversion rate | *E. coli* (logCFU$^{g-1}$) | *Lactic acid bacteria* (log CFU$^{g-1}$) |
| 10 | 0 | 2773.0$^{ab}$ | 4536.8$^{a}$ | 1.66 | 4.73 $^{a}$ | 3.56$^{b}$ |
| 10 | 0.75 | 2863.7$^{a}$ | 4529.4$^{a}$ | 1.63 | 4.08$^{ab}$ | 3.97$^{ab}$ |
| 10 | 1.5 | 2842.9$^{a}$ | 4569.5$^{a}$ | 1.65 | 3.68$^{b}$ | 3.98$^{ab}$ |
| 20 | 0 | 2650.2$^{bc}$ | 4452.9$^{ab}$ | 1.68 | 4.88$^{a}$ | 3.30$^{b}$ |
| 20 | 0.75 | 2481.6$^{d}$ | 4205.3$^{b}$ | 1.66 | 3.87$^{b}$ | 4.14$^{a}$ |
| 20 | 1.5 | 2596.0$^{cd}$ | 4364.8$^{ab}$ | 1.66 | 3.64$^{b}$ | 4.22$^{a}$ |
| SEM | | 16.92 | 30.41 | 0.004 | | |
| Main effect | | *Probability* | | | | |
| Stockingdensity | | ** | ** | NS | * | NS |
| Sumacpowder | | NS | NS | NS | ** | * |
| StockingdensityxSumacpowder | | ** | NS | NS | * | * |

SEM: Pooled standard error of mean
[1]Each value represents the least square mean from 7 pens per each treatment
[a-d]Means within a column without a common superscripts differ statistically (P < 0.05).
NS: No significant (P>0.05), *: P<0.05, **: P<0.01
[1]Results are reported as means for 5 replicates of 3 broilers each.

The effects of stocking density and dietary sumac powder supplementation on serum biochemistry in broilers are presented in Table 3. At the end of the experiment, none of the serum biochemistry variables was affected by dietary sumac powder (P>0.05) (Table 3). Although there was no interaction between stocking density and sumac powder in serum biochemistry variables (P>0.05) Serum uric acid, total protein and albumin concentrations were affected by stocking density (P<0.05). However, ALP, and AST activities, serum HDL, cholesterol and triglyceride concentration of broilers were not affected by any treatment (P>0.05).

Table 3. Effects of sumac powder *(Rhus coriaria* L.*)* on serum biochemistry in broilers at different stocking densities

| Treatments[1] | | Measurements | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Stocking density (bird/m$^2$) | Sumac powder (g/kg feed) | ALP (U/L) | AST (U/L) | CHOL (mg/dL) | UA (g/dL) | TP (g/dL) | HDL (mg/dL) | ALB (mg/dL) |
| 10 | 0 | 1744.6 | 392.5 | 121.1 | 3.46 | 3.65 | 64.8 | 0.56 |
| 10 | 0.75 | 1757.0 | 344.1 | 126.7 | 4.28 | 3.78 | 69.65 | 0.53 |
| 10 | 1.5 | 1470.0 | 362.6 | 122.0 | 3.63 | 3.65 | 64.33 | 0.48 |
| 20 | 0 | 1467.3 | 313.5 | 129.7 | 4.17 | 4.13 | 73.08 | 0.48 |
| 20 | 0.75 | 1626.8 | 274.0 | 127.2 | 4.93 | 4.24 | 69.68 | 0.47 |
| 20 | 1.5 | 1811.0 | 311.2 | 131.0 | 5.06 | 4.11 | 74.03 | 0.49 |
| SEM | | 68.71 | 14.92 | 1.91 | 0.21 | 0.62 | 1.20 | 0.008 |
| Main effect | | *Probability* | | | | | | |
| Stocking density | | NS | NS | NS | * | ** | NS | * |
| Sumac powder | | NS | NS | NS | NS | NS | NS | NS |
| Stocking density x Sumacpowder | | NS | NS | NS | NS | NS | NS | NS |

SEM: Pooled standard error of mean,ALP:Alkaline phosphatise, AST: Aspartate amino transferase, CHOL:Cholesterol, UA: Uric acid, TP: Total protein: HDL: High density lipoprotein, ALB: Albumin

[1]Each value represents the least square mean from 7 pens per each treatment

[a-d]Means within a column without a common superscripts differ statistically (P < 0.05).

NS: No significant (P>0.05), *: P<0.05, **: P<0.01

[1]Results are reported as means for 5 replicates of 3 broilers each.

Our findings demonstrate that stocking density had significant effects on spleen, proventriculus, intestine weight and abdominal fat pat (P<0.05) (Table 4). However, internal organ weights of broilers were not affected by any levels of supplemental sumac powder. A higher stocking density significantly decreased percentage gizzard, intestine weight and abdominal fat pad at 42 days (P<0.05). Thaxton et al. (2006), similarly, observed that lower internal organ weight of broilers reared at high stocking density. However, the interaction of sumac powder supplementation and stocking density was not significant for the internal organ weights checked.

Table 4. Effects of sumac powder *(Rhus coriaria* L.*)* on internal organ weights in broilers at different stocking densities

| Treatments[1] | | **Measurements** (g/100 g body weight) | | | | | |
|---|---|---|---|---|---|---|---|
| Stocking density (bird/m$^2$) | Sumac powder (g/kg feed) | Liver weight | Spleen weight | Gizzard weight | Proventriculus weight | Intestine weight | Abdominal fat pad |
| 10 | 0 | 2.27 | 0.136 | 1.91 | 0.38 | 4.69 | 0.81 |
| 10 | 0.75 | 2.18 | 0.129 | 1.70 | 0.42 | 4.59 | 1.20 |
| 10 | 1.5 | 2.26 | 0.127 | 1.92 | 0.41 | 4.18 | 0.95 |
| 20 | 0 | 2.20 | 0.136 | 1.72 | 0.39 | 3.94 | 0.72 |
| 20 | 0.75 | 2.42 | 0.126 | 1.57 | 0.36 | 3.95 | 0.75 |
| 20 | 1.5 | 2.11 | 0.112 | 1.56 | 0.32 | 3.44 | 0.77 |
| SEM | | 0.51 | 0.005 | 0.05 | 0.01 | 0.08 | 0.04 |
| Main effect | | *Probability* | | | | | |
| Stocking density | | NS | NS | * | NS | ** | * |
| Sumac powder | | NS | NS | NS | NS | NS | NS |
| Stocking density x Sumac powder | | NS | NS | NS | NS | NS | * |

SEM: Pooled standard error of mean

[1]Each value represents the least square mean from 7 pens per each treatment

[a-d]Means within a column without a common superscripts differ statistically (P < 0.05).

NS: No significant (P>0.05), *: P<0.05, **: P<0.01

[1]Results are reported as means for 5 replicates of 3 broilers each.

## CONCLUSIONS

In conclusion, our results showed that broilers exhibited low performance when raised in high stocking density and dietary supplementation of sumac powder has not prevented this decline.


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