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Age-Specific Response of Broilers to Dietary Inclusion of a High-Tannin Feedstuff

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Abstract
The aim of this study was to determine whether the age of broilers can influence their response to tannin-rich diets. A total of 340 one-day-old mixed sex Ross 308 broiler chicks were distributed among five experimental groups with four replicates and 17 birds each in a completely randomized design. A high-tannin feedstuff, Oak acorn, was included into diets (at a level of 25%) and fed to birds at different stages of the rearing period. The control group was fed a corn-based diet (without Oak acorn) for the entirety of the study, while the other four groups were fed diets containing Oak acorn during one of the following periods: starter (d 1 to 21), finisher (d 22 to 42), last five weeks (d 8 to 42), or total period of the experiment (d 1 to 42). We found that performance traits (feed intake, body weight gain and feed conversion ratio) and tibia characteristics were similar among the control group and groups fed Oak acorn during the starter and finisher periods. However, feeding chicks with Oak acorn from 8 to 42 or 1 to 42 d of age significantly reduced overall body weight gain and increased overall feed conversion ratio ($P < 0.05$). Tibia characteristics were also negatively affected in chicks that received Oak acorn during the last 5 weeks and entire period of the experiment ($P < 0.05$). In addition, birds fed Oak acorn had higher liver weights at 21 d of age ($P < 0.05$). In conclusion, broilers response to dietary tannins is influenced by age. Oak acorn could be successfully included in broiler diets during the starter or finisher stages up to 25% without adverse effects on performance and tibia characteristics. In contrast, chronic inclusion of Oak acorn (5 or 6 weeks) decreases growth performance and may have deleterious effect on tibia characteristics.

Introduction

Corn is one of the most important feedstuffs in poultry nutrition. It is an expensive ingredient in some regions of the world such as Iran. Thus, finding local, unconventional, and cheap feedstuffs that have potential to serve as alternatives to corn is of great importance in reducing the costs of diets, thereby increasing profits for producers. A common tree in Iran is Oak acorn (*Quercus brantii Lindl*). Seeds of this tree contain high levels of carbohydrates; particularly starch (Saffarzadeh *et al*., 1999). Thus, it could be used as a replacement to corn in poultry diets. There are several studies on the application of Oak acorn in broiler diets (Bouderoua *et al*., 2009; Houshmand *et al*., 2015, Sinaei and Houshmand, 2016). Unfortunately, Oak acorn contains high levels of tannins (Shimada, 2001, Sinaei and Houshmand, 2016). Tannins are water-soluble polyphenolic compounds with a molecular weight between 500

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and 3000 Da. They are usually divided into two main groups: hydrolysable and condensed. A wide range of anti-nutritional effects in animal and poultry are related to these compounds. Their negative effects on vitamin availability (Jansman, 1993), diet palatability, feed consumption (Medugu *et al*., 2012), and protein and starch digestibility (Mahmood *et al*., 2006) are well documented. In addition, tannins adversely influence internal organs such as intestines, liver, and pancreas (Ortiz *et al*., 1994). Deleterious consequences of tannin-rich feedstuffs on broilers have been reported (Mahmood *et al*., 2006; 2008; Houshmand *et al*., 2015).

Mineral availability and utilization are also negatively affected by dietary tannins (Jansman, 1993). Feeding a tannin-rich feedstuff (sorghum) can reduce the absorption of some minerals (Hassan *et al*., 2003). Dietary minerals, particularly calcium, play a vital role in bone structure and health (Rath *et al*., 2000). Because of the negative effects of tannins on mineral availability, it is expected that high tannin diets impair bone structure and health.

Different methods such as physical and chemical processing, use of tannins-binding agents (Medugu *et al*., 2012), and some dietary nutrient manipulation (Houshmand *et al*., 2015) have been suggested to decrease or alleviate the negative effects of tannin-rich feedstuffs. In addition, age of birds can influence their response to tannin-containing diets. Harmful effects of tannins have been shown to reduce with age (Douglas *et al*., 1993). To the best of our knowledge, there is only one report regarding the age-specific responses of broilers to dietary tannins (Nyachoti *et al*., 1996). Hence, the current study was designed and conducted to determine the responses of broiler chicks to dietary inclusion of Oak acorn as a high-tannin feedstuff at different stages of development.

Materials and Methods

Birds, experimental treatments

All procedures used in this study were approved by the Institution Animal Care Committee of the Yasouj University. A total of 340 day-old unsexed Ross 308 broiler chicks were purchased from a local hatchery and transferred to the rearing place. Upon arrival, birds were randomly assigned to one of five experimental groups. Each group was replicated four times with 17 birds each.

The rearing period was divided into two phases: starter (d 1 to 21) and finisher (d 22 to 42). One group (control) was fed a corn-based diet without Oak acorn throughout the study, while the other four groups were fed diets containing 25% Oak acorn during one of the following periods: starter (d 1 to 21) (STR), finisher (d 22 to 42) (FIN), last five weeks (d 8 to 42) (5wk), or total period of the study (d 1 to 42) (TOT). The experimental diets were formulated to meet or exceed the NRC (1994) nutrient recommendations (Table 1). Birds were weighed on pen basis at d 21 and 42 to calculate body weight gain. Feed conversion ratio (FCR) was calculated by dividing the amount of feed intake by body weight gain.

Oak acorns were collected from the forest of Yasouj, Kohgeluyeh and Bovir Ahmad Province, Iran. The seeds were shelled by hand and fruits were dried in shade, fine grinded, and included in the experimental diets. Proximate analysis of Oak acorn was done according to the AOAC (1995). The content of phenolic components in Oak acorn was measured following the procedure of Makkar (2003).

Sampling and measurements

At the end of starter (d 21) and finisher (d 42) phases of the experiment, two birds (one male and one female) from each pen (8 birds/treatment) were randomly selected and slaughtered by cervical dislocation. Abdominal cavity was opened, the gastrointestinal tract was carefully removed from the carcass, and pancreas and liver weights were determined. The right and left tibia bones were also removed and frozen at –20°C in a plastic bag until later measurements of bone characteristics. Bones were prepared for measurements by first being boiled in water for 10 min. After cooling, adherent tissues were removed and bones were dried for 24 hrs in room temperature. Tibia bone length, weight, and volume were then measured. Tibia density was calculated as the ratio of tibia weight to tibia volume. Right tibia breaking strength was measured using equipment (Instron Universal Machine, Dmg, 7166, Germany) with 50-kg-load cell at 50-kg-load range with a crosshead speed of 50 mm/min with the tibia supported on a 3.35 cm span (Park *et al*., 2003). Left tibia bones were dried at 105°C for 24 hrs. The bones were put in a furnace at 550°C for 24 hrs to detect their ash content relative to the dry weight of the tibia bone (AOAC, 1995). Tibia bone ash weight to tibia bone length index was calculated by dividing the tibia ash weight to its length (Seedor *et al*., 1991). The tibia robusticity index was calculated using the formula described by Reisenfeld (1972): Rubusticity index = tibia length / cube root of tibia weight. Calcium content of tibia bone was determined using flame atomic absorption spectrophotometry and phosphorus content was determined colourimetrically using the molybdo-vanadate method (AOAC, 1995).

Table 1. Ingredients and chemical composition of the experimental diets

Feed (%)	Starter (d 1-21)		Finisher (d 22-42)	
	Control	Oak acorn	Control	Oak acorn
Corn	58.74	29.44	65.56	36.61
Oak acorn	-	25.00	-	25.00
Soybean meal (44% CP)	35.00	37.72	28.73	31.39
Vegetable oil	2.44	4.13	2.38	3.80
Limestone	1.19	1.06	1.27	1.15
Dicalcium phosphate	1.58	1.50	1.18	1.09
Common salt	0.40	0.42	0. 32	0.33
Vitamin premix[1]	0.25	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25	0.25
DL-Methionine	0.15	0.23	0.06	0.13
Chemical composition				
ME (Kcal/kg)	2880	2880	2980	2980
Crude protein (%)	20.17	20.17	18.62	18.62
Calcium (%)	0.90	0.90	0.84	0.84
Available Phosphorus (%)	0.41	0.41	0.33	0.33
Lysine (%)	0.99	0.99	0.93	0.93
Methionine (%)	0.45	0.45	0.35	0.35
Methionine + Cystine (%)	0.81	0.81	0.67	0.67
Sodium (%)	0.18	0.18	0.14	0.14

[1]The vitamin premix supplied the following per kilogram of diet: vitamin A (retinyl acetate), 8,000 IU; vitamin D_3, 1,000 IU; vitamin E (dl-α-tocopherol), 30 IU; vitamin K_3, 2.5 mg; vitamin B_1, 2 mg; vitamin B2, 5 mg; vitamin B_6, 2 mg; vitamin B_{12}, 0.01 mg; niacin, 30 mg; d-biotin, 0.045 mg; vitamin C, 50 mg; d-pantothenate, 8 mg; folic acid, 0.5 mg.
[2]The mineral premix supplied the following per kilogram of diet: Mn, 70 mg; Fe, 35 mg; Zn, 70 mg; Cu, 8 mg; I, 1 mg; Se, 0.25 mg; Co, 0.2 mg.

Statistical analysis

Data were analyzed using the General Linear Models (GLM) procedures of SAS software (2005). The model for data analysis was as follows: $Y_{ij} = \mu + t_i + \varepsilon_{ij}$, where Y_{ij} is the observation, μ is the general mean, t_i is the treatment effect and ε_{ij} is the experimental error. The means were compared by Duncan's Multiple Range Test. The level of statistical significance was set at $P < 0.05$.

Results

Chemical composition and the content of phenolic compounds of Oak acorn

Chemical composition and content of phenolic compounds of Oak acorn are presented in Table 2. Oak acorns used in this study have high levels (71.17%) of nitrogen free extract (NFE) but low levels of crude protein (5.99%). This suggests that the content of the phenolic components of Oak acorn is high with 6.31% total tannins. Therefore, Oak acorn can be considered a tannin-rich feedstuff.

Table 2. Proximate analysis and phenolics components of oak acorn

Component*	DM	ash	CP	EE	CF	NFE	TP	TT
Value (% DM)	95.07	1.09	5.99	11.01	4.99	71.17	7.99	6.31

* DM: dry matter, CP: crude protein, EE: ether extract, CF: crude fiber, NFE: nitrogen free extract, TP: total phenols, TT: total tannins

Performance

The results of performance traits (body weight gain, body weight, feed intake and FCR) showed that all parameters were significantly influenced by experimental treatments (Table 3). Birds fed diets containing Oak acorn during the starter phase (STR group) gained less body weight and hence, had lower body weight than the control group at the end of this phase (d 21). Higher body weight gain was observed in the STR group from 22 to 42 d of age but this difference was not significant. Thus, the final body weight between this group and the control group were similar. Feeding chicks with Oak acorn from 8 to 42 d (5wk) or entire period of the experiment (TOT) significantly decreased body weight gain. Therefore, birds in the 5wk and TOT groups had lower final body weights than the control group. Interestingly, application of Oak acorn in broiler finisher diets did not impair finisher body weight gain. Thus, the final body weight in the FIN group was similar to the control.

Table 3. Effects of experimental treatments on body weight, body weight gain, feed intake, and FCR of broilers at different developmental phases

Parameter	Experimental treatments*					*SEM*	*P*-value
	Ctrl	STR	FIN	5wk	TOT		
Body weight (g)							
d 21	641^{a}	516^{b}	660^{a}	466^{b}	492^{b}	37	0.007
d 42	2050^{a}	1986^{a}	1906^{a}	1418^{b}	1613^{b}	93	0.002
Body weight gain (g)							
d 8-21	527^{a}	404^{b}	545^{a}	357^{b}	380^{b}	34	0.004
d 1-21	600^{a}	474^{b}	619^{a}	424^{b}	451^{b}	37	0.007
d 22-42	1409^{ab}	1471^{a}	1245^{abc}	952^{c}	1121^{bc}	90	0.011
d 1-42	2009^{a}	1944^{a}	1865^{a}	1375^{b}	1571^{b}	93	0.002
Feed intake (g)							
d 8-21	765	768	802	745	819	34	0.594
d 1-21	868	865	904	843	916	36	0.656
d 22-42	2635^{b}	2614^{b}	2473^{b}	2585^{b}	3028^{a}	71	0.0009
d 1-42	3502^{b}	3479^{b}	3376^{b}	3428^{b}	3944^{a}	90	0.004
FCR							
d 8-21	1.458^{b}	1.946^{a}	1.483^{b}	2.101^{a}	2.162^{a}	0.10	0.0005
d 1-21	1.453^{b}	1.858^{a}	1.469^{b}	2.000^{a}	2.036^{a}	0.08	0.0005
d 22-42	1.872^{c}	1.778^{c}	2.062^{bc}	2.737^{ab}	2.828^{a}	0.22	0.013
d 1-42	1.747^{b}	1.792^{b}	1.830^{b}	2.506^{a}	2.573^{a}	0.14	0.001

Means within a row with different superscript are significantly different at $P < 0.05$.

*Ctrl: Control was fed a corn-based diet (without oak acorn) entire the study, other treatments were fed diets containing 25% oak acorn during one of the following periods: starter (d 1 to 21) (STR), finisher (d 22 to 42) (FIN), last five weeks (d 8 to 42) (5wk) or total period of the study (d 1 to 42) (TOT).

Significant differences in feed intake were not observed across experimental groups in the starter period. However, the birds in TOT group ate more feed than the other groups during the finisher phase and therefore they had the highest overall (d 1-42) feed intake. Feeding with Oak acorn impaired starter FCR. However, birds fed diet containing Oak acorn from 22 to 42 d of age had similar FCR compared to the control group. Therefore, dietary inclusion of Oak acorn during finisher phase did not have adverse effects on FCR. There was no significant difference in overall FCR between the groups fed Oak acorn during the starter or finisher periods and the control group. Feeding Oak acorn for longer times (from d 8-42 or 1-42 d) increased FCR compared to the control group.

Tibia characteristics

Feeding Oak acorn during the starter phase significantly influenced tibia bone characteristics at 21 d of age (Table 4). In fact, tibia weight, length, volume, ash, strength and bone ash weight/bone length index were lower in birds fed Oak acorn compared to those fed the control diet. Dietary inclusion of Oak acorn during the last 5 weeks and the entire period of the study had negative effects on some tibia characteristics on d 42. Birds fed Oak acorn throughout the experiment had lower tibia weight, length, volume, strength and bone ash weight/bone length index than the control group. In contrast, on d 42, tibia characteristics were similar across birds fed Oak acorn during the starter or finisher periods and the control group. Also, the content of tibia calcium on d 42 was lower in 5wk and TOT groups than the control, which indicated that feeding with Oak acorn negatively influenced calcium content. However, tibia phosphorus content remained unaffected.

Table 4. Effects of experimental treatments on tibia bone characteristics of broilers at 21 and 42 d of age

Parameter	Experimental treatments*					*SEM*	*P*-value
	Ctrl	STR	FIN	5wk	TOT		
Tibia Weight (g)							
d 21	1.7[a]	1.2[b]	1.8[a]	1.3[b]	1.3[b]	0.1	0.001
d 42	6[a]	5.9[a]	5.6[ab]	5[ab]	4.7[b]	0.3	0.021
Tibia Length (cm)							
d 21	6.2[a]	5.5[b]	6.5[a]	5.6[b]	5.7[b]	0.1	0.019
d 42	9.3[a]	9.1[a]	9.1[a]	9[ab]	8.7[b]	0.1	0.012
Tibia Volume (mL)							
d 21	2.1[a]	1.7[bc]	2.3[a]	1.4[c]	1.8[b]	0.1	0.0001
d 42	6.3[a]	5.9[ab]	5.3[ab]	5.1[ab]	4.7[b]	0.4	0.021
Tibia Density (g/mL)†							
d 21	0.81	0.71	0.78	0.93	0.72	0.1	0.251
d 42	0.95	1.00	1.06	0.98	1.00	0.2	0.307
Tibia Ash (%)							
d 21	55.7[a]	45.9[cd]	53.9[a]	49.3[bc]	44.9[d]	1.3	0.0003
d 42	44.0	43.3	44.5	43.6	43.5	0.7	0.681
Tibia Strength (kg/m^2)							
d 21	15.8[a]	12.8[b]	16.0[a]	12.0[c]	12.9[b]	1	0.011
d 42	35.6[a]	33.9[a]	31.7[a]	22.9[b]	24.1[b]	1.5	0.0001
W/L (mg/mm)‡							
d 21	12.7[a]	8.5[b]	11.4[a]	10.7[ab]	9.9[b]	0.9	0.048
d 42	27.0[a]	25.6[a]	24.4[ab]	21.6[bc]	19.4[c]	1.1	0.013
Robusticity index#							
d 21	5.1	5.2	5.3	5.2	5.2	0.2	0.870
d 42	5.1	5. 1	5. 2	5.3	5.2	0.1	0.708
Tibia Calcium (% of tibia ash)							
d 42	25.8[a]	24.8[a]	23.6[ab]	20.9[bc]	18.4[c]	0.97	0.014
Tibia Phosphorus (% of tibia ash)							
d 42	12.0	11.2	11.4	10.6	10.8	0.62	0.210

Means within a row with different superscript are significantly different at $P < 0.05$.

*Ctrl: Control was fed a corn-based diet (without oak acorn) entire the study, other treatments were fed diets containing 25% oak acorn during one of the following periods: starter (d 1 to 21) (STR), finisher (d 22 to 42) (FIN), last five weeks (d 8 to 42) (5wk) or total period of the study (d 1 to 42) (TOT).

†The density was calculated as the ratio of tibia weight to its volume.

‡this index was calculated by dividing the tibia ash weight to its length.

#Rubusticity index = tibia length / cube root of tibia weight.

Table 5. Effects of experimental treatments on relative weight (%)[1] of liver and pancreas of broilers at 21 and 42 d of age

Parameter	Experimental treatments*					*SEM*	*P*-value
	Ctrl	STR	FIN	5wk	TOT		
Liver							
d 21	3.06[b]	4.00[a]	2.81[b]	3.24[b]	3.73[a]	0.2	0.0001
d 42	2.30	2.21	2.23	2.18	2.17	0.1	0.915
Pancreas							
d 21	0.400	0.438	0.413	0.438	0.413	0.1	0.831
d 42	0.275	0.250	0.325	0.313	0.275	0.1	0.121

Means within a row with different superscript are significantly different at $P < 0.05$.

[1]Relative weights of liver and pancreas were expressed as percentages of body weight.

*Ctrl: Control was fed a corn-based diet (without oak acorn) entire the study, other treatments were fed diets containing 25% oak acorn during one of the following periods: starter (d 1 to 21) (STR), finisher (d 22 to 42) (FIN), last five weeks (d 8 to 42) (5wk) or total period of the study (d 1 to 42) (TOT).

Pancreas and liver weight

On d 21, liver weight was heavier in birds fed Oak acorn than birds in the control group (Table 5). However, liver weights were similar across all treatments at 42 d of age. Experimental treatments had no effects on pancreas weight on d 21 and 42 of the study.

Discussion

Our findings on the chemical composition and content of phenolic compounds in Iranian Oak acorn are in line with recent reports (Houshmand *et al.*, 2015; Sinaei and Houshmand, 2016). In another study, seed of this species had 91.67% DM, 3.93% CP, 0.37% CF, 7.7% EE, 1.5% Ash, 75.17% NFE and 58.80% starch (Saffarzadeh *et al.*, 1999). In addition, Shimada (2001) reported that the content of NFE and tannins in three investigated species of Oak acorn were 87.4 to 90.3 and 7.28 to 11.72%, respectively.

Consumption of high-tannin Oak acorn for longer periods (5 and 6 weeks) impaired broiler performance. These findings are in agreement with previous reports (Hassan *et al.*, 2003; Mahmood *et al.*, 2008; Houshmand *et al.*, 2015). The main effect of tannins is related to protein-binding ability by coagulating or precipitating proteins, thereby reducing the digestibility of protein and amino acids (Jansman, 1993). Due to interactions with dietary protein, digestive enzymes, or both, consumption of high-tannin feedstuffs increases fecal nitrogen excretion (Ahmed *et al.*, 1991). Affinity of tannins to carbohydrates, particularly starch, and their deleterious effects on absorption of vitamins A (retinol), thiamin, and B_{12} have been previously reported (Jansman, 1993). Histological changes in ileal mucosa and atrophy, shortening of villi, and hydropic degeneration of hepatocytes were observed in chicks and rats fed faba beans (*Vicia faba*) tannins (Ortiz *et al.*, 1994). Thus, it is not surprising that performance is reduced by dietary tannins, as observed in the birds of 5wk and TOT groups in the current study.

Birds fed Oak acorn from 1 to 21 d of the study had lower body weight than the birds in the control group at d 21. Development of pancreatic enzyme activities can endure an initial lag phase at ~14 days in young turkeys (Krogdahl and Sell, 1989), suggesting that digestive processes are not completely developed in newly hatched birds. On the other hand, due to formation of tannin-enzyme complexes, digestive enzymes activities are inhibited by dietary tannins. This condition is likely more critical in newly hatched birds when the digestive processes are not fully developed (Douglas *et al.*, 1993). Hence, poor performance of chicks in STR group could be linked to the inhibitory effects of tannins on digestive enzymes. It is interesting to note that there was no significant difference in final body weight between STR group and the control group at the end of the study (d 42), suggesting that birds fed Oak acorn in the starter phase had greater weight gain (1471 g) than the control group (1409 g) during the finisher phase. This demonstrates compensatory growth (Zubair and Lesson, 1996).

Performance traits were similar between birds in the FIN group and the control group, which means that in contrast to starter period, Oak acorn had no negative effect on finisher performance. Therefore, the age of bird is an important factor in reducing the negative effects of dietary tannins. There is only one report on the age response of broilers to dietary tannins though more information is available in turkeys. Nyacotti *et al.* (1996) fed broilers high-tannin sorghum during d 1-9, d 10-21 or d 1-21 and found that although the ME value of tannin-containing diets was lower than the control group, overall (d 1-21) body weight gain and feed efficiency were not influenced by dietary treatments. Due to inhibitory effects of tannins on digestive enzyme activity (trypsin, α-amylase, and lipase) and incomplete development of digestive processes in young turkeys, dietary tannins impaired the performance of birds during the first weeks of age. The developed digestive system of older birds probably overcame the anti-nutritional effects of tannins, suggesting that deleterious effects of tannins can be reduced with increasing the age of chicks (Douglas *et al.*, 1993).

Bone status is a common indicator of mineral adequacy in poultry diets (Onyango *et al.*, 2003). Different parameters such as bone weight, bone volume, bone ash, and bone breaking strength are used to assess bone mineralization in poultry (Rao *et al.*, 1993). There are also two important tibia bone indexes: robusticity index (where a lower index indicates stronger bone structure; Reisenfeld, 1972) and bone ash weight/bone length index (where a higher index means denser bone; Monteagudo *et al.*, 1997). Our findings suggest that Oak acorn negatively influenced tibia bone traits.

Tannins have the ability to form insoluble complexes with divalent ions such as iron, thereby reducing mineral availability and absorption (Jansman, 1993). Hassan *et al.* (2003) reported that high-tannin sorghum significantly reduced the absorption of dietary minerals such as Ca, P, Mg, Na, K, Fe and Co in broilers.

Mahmood *et al*. (2014) reported that consumption of sorghum tannins significantly reduced mineral absorption (calcium, phosphorus, sodium, potassium, magnesium and iron) in White Leghorn layers. Considering the important role of minerals, particularly calcium, in bone structure and health (Rath *et al*., 2000), it is expected that skeletal system and tibia bone are negatively influenced by dietary tannins.

Consumption of high-tannin diets will increase the activity of pancreatic enzymes (trypsin and α-amylase), resulting in an enlarged pancreas (hypertrophy) (Ahmed *et al*., 1991). We found that pancreas weight remained unaffected, which is in agreement with previous studies (Longstuff and McNab, 1991; Nyacotti *et al*., 1996). In contrast, Oak acorn increased liver weight on d 21. This increase could be attributed to the toxic effects of high levels of tannins. There is a threshold-limit beyond which tannins may become toxic (Al-Mamary *et al*., 2001).

Different factors such as the source of tannins and feedstuffs, tannin concentration, animal factors (species, age, and production level), length of the test period, and diet composition (level and source of protein) can influence the biological effects of tannins (Jansman, 1993). These factors should be considered as important factors leading to different and/or inconstant results.

Conclusion

Our study shows that Iranian Oak acorn contains high levels of tannins. Developmental time of administrating a high-tannin diet plays an important role in the response of broilers to dietary tannins. Adverse effects of tannins will reduce with age. Also, up to 25% Oak acorn could be included into diets of starter or finisher broilers without negative consequences on their performance and tibia characteristics. Dietary inclusion of Oak acorn for longer periods (5-6 weeks) will impair performance and tibia bone characteristics, and is therefore not recommended.

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