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Influence of Artichoke (*Cynara scolymus*) Leaf Powder on Growth Performance, Carcass Traits and Blood Parameters in Broiler Chickens

Research Article

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ABSTRACT

The objective of this study was to investigate the effects of dietary artichoke supplementation on performance, carcass traits and some blood parameters of broiler chickens. A total of 300, one day old broiler chicks (Ross-308) were randomly allocated to 1 of 4 dietary treatments including: basal diet (control), basal diet supplemented with 1.5 or 3 percent of Artichoke powder and also with 300 mg/kg diet vitamin E. Each diet was offered to 5 replicates of 15 birds each for 42 days. Supplementation of 3 percent artichoke powder significantly ($P<0.05$) decreased body weight compared to control. A higher ($P<0.05$) feed intake was observed in group fed 1.5 percent artichoke powder resulted in higher feed conversion ratio (FCR) compared to control. The blood plasma concentrations of total protein and globulin were lower ($P<0.05$) in 1.5 percent artichoke treated group and higher ($P<0.05$) in control group on the 21st day of trial. The blood plasma albumin concentration remained non significant throughout the experiment. However, the blood plasma total protein, albumin and globulin concentrations remained non significant between experimental groups on the 42nd day of trial. Significant differences in heterophil and lymphocytes percentage and H:L ratio were observed between dietary treatments at 28 days of age, showing that the birds fed a diet supplemented with artichoke powder had higher heterophil and lower lymphocytes percentage and consequently a higher H:L ratio than control. Artichoke supplemented birds showed significantly ($P<0.05$) lower breast and thigh weight. Pancreases weight was higher and lower in 1.5 percent artichoke and 300 mg vitamin E treated groups, respectively. The weight of heart, abdominal fat, gizzard and proventriculus were non significant between dietary treatments. In general, this study revealed that artichoke powder as natural antioxidant may have beneficial effects on chicken growth performance and carcass traits, but further research is needed.

KEY WORDS artichoke, blood parameters, broiler chicken, carcass traits, H:L.

INTRODUCTION

During the past 50 years, the growth rate of broiler chickens increased substantially. Feeding antibiotics as growth promoters had a substantial role in the development of poultry industry. However, researchers are looking to natural means of reducing classical feed additives such as antibiotics in poultry nutrition (Genedy and Zeweil, 2003; Ibrahim *et al.* 2005). Consequently, there is considerable research interest in the possible use of natural products such as essential oils and extracts of edible and medicinal plants, herbs and spices, for the development of new additives in animal feeding (Lavinia *et al.* 2009). Most of these were found to contain secondary plant metabolites like isoprene derivatives and flavonoids having suggested functions or as antioxidants (Shin *et al.* 1995). Artichoke (*Cynara scolymus*) is

a member of the Composite (daisy) family that is widely grown in Mediterranean countries and is rich in natural antioxidants. The major bioactive components of artichoke leaves are cynarin, flavonoids, phenolic acids and caffeic acid (Joy and Haber, 2007). Artichoke leaf has been used in traditional medicine for its antioxidant properties. The effects of adding artichoke leaf meal in livestock feeds and obtain definite positive effects on performance of broiler, duck, guinea fowl, rabbits and rat (Gebhart, 1997; Liorach *et al.* 2002; Jimene *et al.* 2003). Gul *et al.* (2001) reported that the nutrient content and feeding energy value of artichoke silage made from stalks and leaves (refuse parts) were comparable with other forms of silage. Related studies have indicated that application of green forage from artichoke in feed for rabbit, pig and poultry as part of a balanced diet including cereals and other sources of fiber was beneficial (El-Sayaad *et al.* 1995; Bonomi, 2001; Abdo *et al.* 2007). Due to lack of information regarding dietary supplementation of artichoke on broiler chicks, the present study was undertaken in broiler chickens.

MATERIALS AND METHODS

Preparation of artichoke powder

Fresh artichoke leaves were collected in summer, from the research farm of Gorgan university of agricultural science and natural resources, Gorgan, Golestan, Iran. Collected artichoke leaves were sun dried, and ground with a laboratory hammer mill. The active constituents of artichoke leaves were determined, using procedures of Constantinescue *et al.* (1967).

Birds, diets and management

A total of 300 one-day-old broiler chicks (Ross-308) were obtained from a local commercial hatchery and raised over a 42 d experimental period. Throughout the study, the birds were brooded following standard temperature regimens, which gradually decreased from 32 to 24 ˚C and under a 23L:1D light cycle. The chicks were weighted and distributed randomly into four dietary groups with five replicates in each group. Each replicate was housed separately in pens under the same environmental conditions and offered. One of the 4 diets, namely: corn-soybean meal basal diet without any additive (control), basal diet supplemented with 1.5 and 3.0 percent artichoke powder and basal diet supplemented with 300 mg vitamin E per kg diet. Basal diets were formulated to meet or exceed Ross 308 broiler nutrition specifications for macro and micronutrients (Table 1). All experimental diets were formulated to meet NRC (1994) requirements. A 2-phase feeding program was used, with a starter diet from d 1 to 21 and a grower diet from d 22 to 42.

Chicks were allowed to have free access to diets and water. Birds were routinely vaccinated with Lasota on the 5th and 21st day and also IBD on the 14th day.

Table 1 Composition and calculated analysis of the growth and finisher diets

Ingredients (%)	1-21 days	22-42 days
Corn grain	57.25	63.30
Soybean meal	37.37	31.49
Oil	1.65	1.97
Dicalcium phosphate	1.41	1.04
$CaCO_3$	1.26	1.33
Mineral premix[1]	0.25	0.25
Vitamin premix[2]	0.25	0.25
Common salt	0.42	0.32
DL-methionine	0.14	0.05
Nutrients composition		
Metabolize energy (kcal/kg)	2900	3000
Crude protein	20.84	18.75
Calcium	0.91	0.84
Available phosphorous	0.41	0.33
Na	0.18	0.14
Lysine	1.15	1.00
Methionine + cystine	0.82	0.68
Methionine	0.47	0.36

[1] Each kilogram of mineral supplement contains: Mn: 32 gr; Zn: 11 gr; Fe: 25 gr; Cu: 4 gr; I: 0.16 gr; Se: 0.2 gr; Choline chloride: 50 gr.

[2] Each kilogram of vitamin supplement contains: vitamin A: 900000 IU; vitamin D_3: 200000 IU; vitamin E: 1800 IU; vitamin K_3: 0.4 gr; vitamin B_1: 0.18 gr; vitamin B_2: 0.825 gr; vitamin B_3: 1 gr; vitamin B_5: 3 gr; vitamin B_6: 0.3 gr; vitamin B_9: 0.125 gr and vitamin B_{12}: 0.15 gr.

Performance variables

At 42 d of age, group body weight and pen feed consumption was determined. Dead birds were weighed for adjustment of feed utilization. Feed conversion (g feed/g BW gain) was determined for each pen. Birds were deprived of feed overnight before being weighed, for reducing the effects of gastrointestinal tract feed contents (Crespo and Esteve Garcia, 2001).

Digestive traits

On d 42, the 2 chicks from each pen were sacrificed; the weight of the carcass, breast, thigh, heart, abdominal fat, gizzard, pancreas, proventriculus and liver were measured.

Sample collections and laboratory analyses

On d 21 and 42, the 2 chicks from each pen were selected and blood samples were collected in heparinized tubes by puncturing the brachial vein to measure the plasma total protein, albumin and globulin, using enzymatic related kits (Pars-Azmoon Co., Tehran, Iran). On d 28 and d 42, 2 chicks from each pen were bled to determine the heterophil:lymphocytes ratio (H:L). Briefly, 3 mL blood samples were collected in EDTA tubes. The H:L was determined after fixation by methanol, and stained with May-Grunwald-Gimsa stain (Robertson and Maxwell, 1990).

About one hundred cells (heterophil+lymphocytes) from each slide were counted based on their morphological characteristics. The H:L ratio was determined by dividing the number of heterophil by the number of lymphocytes (Gross and Siegel, 1983).

Statistical analysis

This study was conducted as a completely randomized design. A GLM procedure was performed (SAS, 2002) and the difference among the mean values was tested, using the Duncan multiple range test at $P < 0.05$. Mean values and SEM are reported.

RESULTS AND DISCUSSION

The chemical composition of artichoke leaves is shown in Table 2. The contents of total phenol, flavonoid and antioxidant in artichoke were 2.387, 1.614 and 6.92% respectively. The effects of dietary treatments on broiler performance are shown in Table 3.

Table 2 Chemical compositions of artichoke leaves on air r dry

Item	Percentage
Moisture	7.70
Dry matter	92.30
Crude protein	11.69
Crude oil	4.49
Crude fiber	23.87
Ash	9.60
Growth energy (kcal/kg)	3712.61
Ca	0.45
Na	0.22
P	0.33

Table 3 Effect of dietary treatments on growth performance of broiler chickens (0 to 42 d)

Treatment	BW	FI	FCR
Control	2024.80±36.70^{a}	3599.60±49.01^{b}	1.78±0.03^{b}
1.5% artichoke	1879.40±41.09^{ab}	3714.91±57.71^{a}	1.97±0.04^{a}
3% artichoke	1853.26±56.39^{b}	3622.21±64.58^{ab}	1.96±0.04^{ab}
300 mg vitamin E	1953.90±56.44^{ab}	3603.33±40.74^{ab}	1.85±0.03^{ab}

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
BW: body weight gain (g); FI: feed intake (g) and FCR: feed conversion ratio (g of feed/g of BW gain).

There were significant (P<0.05) differences among the treatments for body weight (BW), feed intake (FI) and feed conversion ratio (FCR). Artichoke supplemented group (3%) showed significantly (P<0.05) lower BW than the control group. A significantly higher (P<0.05) feed intake (FI) was observed in 1.5% artichoke supplemented birds than control. The value of FCR was higher with diet supplemented with 1.5% artichoke compared to control (P<0.05).

Data of this study are in agreement with those of Dora *et al.* (2008) reporting that supplementation with Echinacea cob, that have similar ingredients including caffeic acid derivatives (Tierra, 2007), resulted in a significant lower BW. Data reported by Hassan *et al.* (2004) showed an improvement in FCR under dietary treatment with herbal additives. Herbs have evolved a wide range of secondary metabolites, in particularly, isoprene derivatives and flavonoides with antioxidant properties which have positive effect on gastrointestinal tract function (Shin *et al.* 1995). Findings of the current study are contrary to the data of Abu-Dieyeh and Abu-Drawish (2008) in which an addition of 1 and 1.5 percent seed powder of *Nigella sativa* to the broiler diet increased BW gain and also improved the FCR. These differences could be partly due to different methodology, experimental design and condition. Meanwhile, different medical plants differ in its phytogenic compounds (Lee *et al.* 2003). Galib *et al.* (2011) observed no difference in FI in broiler fed black pepper. However, results of the current study are contrary to those reported by Lee *et al.* (2004) in which dietary additions of cinnamon to broiler diet improved growth performance. Results of this study are in agreement with some previous research that indicated herbs, plant extracts, essential oil and / or the main components of essential oil did not affect BW, FI or feed efficiency in broilers (Cross *et al.* 2002; Cross *et al.* 2007; Hernandez *et al.* 2004; Bampidis *et al.* 2005). The effect of dietary treatments on blood parameters is shown in (Table 4).

The blood plasma concentration of total protein and globulin was significantly different between treatments on the 21st day of trial. In this regard, the plasma total protein and globulin concentrations were lower (P<0.05) in 1.5 percent artichoke treated group and higher (P<0.05) in control group. The blood plasma albumin concentration remained non significant throughout the experiment. However, the blood plasma total protein, albumin and globulin concentrations remained non significant between experimental groups on the 42nd day of trial. This result was consistent with the results of El-Sayaad *et al.* (1995) who reported that incorporation of artichoke bracts (AB) in New Zealand White rabbit's diets up to 20% for 9 weeks had no significant effect on some blood components. In addition, these finding are in agreement with the results of Abdo *et al.* (2007) who reported that the supplementation broiler diet with artichoke had no significant difference on total protein, albumin and globulin. The effects of dietary treatments on heterophil, lymphocytes and H:L ratio are shown in Table 5. Results showed significant differences in heterophil and lymphocytes percentage and H:L ratio between treatments at 28 days of age. On 28th day of experiment, the birds fed a diet supplemented with artichoke had higher heterophil but lower lymphocytes percentage. Consequently, artichoke supplemented birds showed a higher H:L ratio than control.

On 42nd day of experiment, dietary treatments differed only for lymphocytes percentage, showing lower lymphocytes percentage in vitamin E dietary treatment compared with others. Results of the current study are in agreement with those of Galib *et al.* (2011) who showed that treatment group fed black pepper with similar phytogenic compounds to artichoke had significantly lower H:L ratio as compared with the control group. Lavinia *et al.* (2009) reported that using aromatic plants (*Satureja hortenis*, *Mentha piperita and Hippophae rhamnoides*) did not show significant differences in the leucocytes profile.

Mansoub (2011) showed that the effect of black pepper on H:L ratio was higher in the group supplemented with 2% black pepper. In contrast to our results on the 42nd day of trial, Fallah *et al.* (2013) showed that the higher percentage of heterophil and also the highest H:L ratio was observed by 1.5% artichoke +200 mg Mentha in the broiler chickens. It seems that Mentha acts as stressor on chickens. In this context, Mahdavi *et al.* (2013) and Nobakht *et al.* (2011) reported a higher H:L ratio in broiler diet supplemented with *Mentha pulegium*. It has been demonstrated that the secondary metabolites and essential oils of medicinal plants improve the function of immune system in poultry (Lavinia *et al.* 2009).

The data in Table 6 showed that there were significant differences (P≤0.05) between dietary treatments for carcass, breast, thigh and pancreas weights.

Artichoke supplemented birds showed significantly (P<0.05) lower breast and thigh weight compared to others. The weight of heart, abdominal fat, gizzard and proventriculus were non significant between dietary treatments.Pancreases weight was higher and lower in 1.5% artichoke and 300 mg vitamin E treated groups, respectively. In contrast to our results, Alcicek *et al.* (2003) observed an improvement in the carcass yield of broilers when supplemented with an essential oil in broiler diet. The bioactive components in natural medicines are quite complex and their mode of action is unclear, though they may serve to provide animals with nutrients and bioactive components such as anti-microbial activity, immune enhancement and stress reduction (Wang *et al.* 1998). Debersac *et al.* (2001) indicated that a plant extract from rosemary enhanced hepatic metabolism and hence, increased relative liver weights in rats. Javandel *et al.* (2008) showed no significant differences in carcass traits among birds fed garlic powder in the range of 0-2%. Ocak *et al.* (2008) found no differences in carcass and organs weight of broiler fed a diet containing 2% thyme powder. Similar results were observed by Hernandez *et al.* (2004) who found no difference in weight of organs of broiler chickens fed diets containing an extract from thyme and oregano. Mansoub (2011) said that the present of antioxidants and phenolic substance in herbal plant may be the main cause of improvement percent of broiler carcass.

Table 4 Effect of dietary treatments on blood parameters of broilers at 21 and 42 days of ages

Treatment	21 d			42 d		
	Total protein	Albumin	Globulin	Total protein	Albumin	Globulin
Control	3.64±0.31^{a}	1.64±0.11	2.00±0.30^{a}	5.27±0.57	2.78±0.28	2.48±0.49
1.5% artichoke	2.62±0.18^{b}	1.86±0.10	1.03±0.18^{b}	5.38±0.35	2.24±0.26	3.14±0.37
3% artichoke	2.88±0.24^{ab}	1.90±0.23	1.37±0.11^{ab}	4.66±0.31	2.05±0.43	2.61±0.37
300 mg vitamin E	2.89±0.36^{ab}	2.08±0.26	1.32±0.33^{ab}	4.91±0.37	2.34±0.25	2.57±0.36

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

Table 5 Effect of dietary treatments on heterophil, lymphocytes and H:L ratio at 28 and 42 days of age

Treatment	28 d			42 d		
	Heterophil	Lymphocyte	H:L	Heterophil	Lymphocytes	H:L
Control	15.10±0.644^{c}	77.60±0.60^{a}	0.195±0.009^{b}	17.2±0.489	75.50±0.341^{a}	0.228±0.007
1.5% artichoke	15.80±0.661^{bc}	76.10±0.66^{ab}	0.208±0.01^{ab}	16.8±0.416	75.00±0.365^{ab}	0.224±0.006
3% artichoke	17.60±0.541^{a}	75.50±0.582^{b}	0.233±0.008^{a}	17.2±0.416	74.50±0.166^{ab}	0.230±0.005
300 mg vitamin E	17.30±0.422^{ab}	75.40±0.371^{b}	0.229±0.005^{a}	17.8±0.489	74.20±0.442^{b}	0.240±0.007

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

Table 6 Effect of dietary treatments on carcass traits at 42 days of age

Carcass traits	Treatments			
	Control	1.5% artichoke	3% artichoke	300 mg vitamin E
Carcass	1265.34±27.33^{a}	1211.14±34.65^{ab}	1111.99±42.07^{b}	1202.78±38.38^{ab}
Breast	466.97±10.53^{a}	438.06±12.72^{ab}	393.31±18.36^{b}	449.79±9.83^{a}
Thigh	375.32±8.25^{a}	365.33±11.57^{ab}	332.89±9.23^{b}	371.46±7.14^{a}
Heart	14.20±2.57	13.90±2.04	13.83±2.47	13.96±1.58
Abdominal fat	29.76±4.83	28.16±4.17	27.86±3.98	24.99±5.27
Gizzard	46.59±5.03	46.12±11.63	48.51±7.86	46.50±6.92
Pancreas	5.39±0.67^{ab}	5.59±1.05^{a}	5.39±1.19^{ab}	4.57±0.90^{b}
Proventriculus	8.62±1.12	8.93±0.96	8.76±1.30	8.46±1.31
Liver wt.	55.22±6.53	55.35±7.41	55.13±6.86	58.22±8.85

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

Cardoso *et al.* (2012) found that orally administered piperine did not interfere on weight gain or liver relative weight of broiler chickens. Hernandez *et al.* (2004) found no change in the weight of liver, stomach and digestive tract of broiler chicks fed a diet supplemented with cinnamon extract. A reduction of fat percentage at 1% (Al-Sultan, 2003) and 1.25 (Samarasinghe *et al.* 2003) over body weights were reported by inclusion of turmeric powder in broiler ration. Significant decrease in abdominal fat (57%) was observed by Emadi and Kermanshahi (2006) by inclusion of turmeric rhizome powder (0.75%) in broiler rations.

CONCLUSION

The results of present study revealed that BW was similar for birds fed diet supplemented with 1.5 percent artichoke and 300 mg vitamin E. FCR for birds fed 3 percent artichoke and 300 mg vitamin E was similar to control group. H:L ratio was higher for birds treated with 3 percent artichoke powder and 300 mg vitamin E compare to control. Therefore, artichoke powder as natural antioxidant can be used in poultry diet instead of vitamin E, in particularly, due to its lack side effects, but its best level needs more investigation.

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