Effect of dietary *Pistacia atlantica* oil on performance and pathological conditions in chukar partridge

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Abstract Chukar partridge raising is a profitable business. New feed additives of plant origin may be an alternative to antibiotic growth promoters. This study was carried out to determine the effect of different levels of *Pistacia atlantica* oil on performance and pathological conditions in chukar partridge. One-day-old chukar partridge chicks were assigned to three dietary treatments of 40 birds each. Each treatment consisted of four replicates. The control diet (A) was formulated according to the nutrient requirements of chukar partridge chicks. Diets B and C were supplemented with 2.5 and 7 g/kg *Pistacia atlantica* oil, respectively. The birds fed diet supplemented with 7 g/kg *Pistacia atlantica* oil recorded the best value ($p<0.05$). The addition of 7 g/kg *Pistacia atlantica* oil to the diet was improved body weight and feed conversion ratio when compared to the control group. Pathological evaluation did not show any alterations between experimental groups. In conclusion, *Pistacia atlantica* oil could be considered as a natural alternative to antibiotic growth promoter for chukar partridge breeding without causing any pathological effect.

Keywords: antibiotic, growth promoters, partridge, pathology, *Pistacia atlantica*

Received: 23 Aug. 2014, *accepted:* 16 Oct. 2014, *published online:* 12 Nov. 2014

Introduction

The genus of *Pistacia* is classified to the family Anacardiaceae (Cashew family), order Sapindales (Bailey, 1949; Mohannad and Porter, 2012). It contains nine species and five subspecies according to the current study (Mohannad and Porter, 2012). Currently, Iran, United States, Turkey and Syria are the main pistachio producers in the world, contributing over 90% of the world production (FAO, 2010).

Among nine known species of *Pistacia*, only three species grow in Iran, including, *Pistacia vera* L.1753, *Pistacia khinjuk* Stocks 1952 and *Pistacia atlantica* Desf 1800. The *Pistacia atlantica* is the most widely distributed wild species. The *Pistacia atlantica* is further divided into four ecogeographic subspecies: subsp. *Cabulica*; subsp. *mutica*; subsp. *Kurdica*; and subsp. *Atlantica* (Farhoosh et al., 2008). The *Pistacia atlantica* is a valuable plant as the source of gum, fruits and leaves. They have been used as a food and medical purposes.

The fruits of *Pistacia atlantica* (Pistachio nuts) are considered an edible nut. They are an excellent source of oil (Mecherara-Idjeri et al., 2008). *Pistacia atlantica* oil contains different bioactive components and essential oils. The herbal essential oils have been considered as the natural antibiotic alternative growth promoters due to their antimicrobial activities (Solórzano-Santos and Miranda-Novales, 2012). They can affect the animal performance (Rahimi et al., 2011; Amerah et al., 2012; Mathlouthi et al., 2012) and digestive enzymes (Jang et al., 2004; Jang et al., 2007) and improve the digestibility of the feeds (Hernandez et al., 2004; Lee et al., 2004; Rahimi et al., 2011).

The use of antibiotics as growth promoters (AGPs) in poultry production began from several years ago (Castanon, 2007). They were added to diets to stimulate the growth. The usage of AGPs is possibly an important factor that promotes the emergence of antibiotic resistant microorganisms in veterinary and human medicine. The use of AGPs has been banned in some countries (Millet and Maertens, 2011). As a result, non-therapeutic alternatives and new feed additives of plant origin, considered to be as a natural growth promoter (Huyghebaert et al., 2011). Various plant extracts and

herbs have received increasing attention as AGPs replacements (Cross et al., 2007; Sarica et al., 2007; Lević et al., 2008; Huyghebaert et al., 2011).

The aim of this study was to determine the effect of different level of *Pistacia atlantica* oil on chukar partridge performance and pathological conditions of the birds. We believe that this investigation may further help us to use a new natural promoting additive of plant origin for poultry and game birds as an alternative for antibiotic growth promoters.

Materials and methods

Experimental design and feeding program

One-day-old chukar partridge chicks were randomly divided into 3 dietary treatments A, B and C groups of 40 birds each. Each treatment group was further sub-divided into four replicates of 10 birds per replicate. The presence and the level of *Pistacia atlantica* oil in the diets were the main factor tested. In the control group (group A), the birds were fed a standard diet (table 1) (Woodard, 2002). Two different levels of *Pistacia atlantica* oil were added to the standard diets to generate the other two treatment groups (groups B and C). Diets B and C were supplemented with 2.5 and 7 g/kg of *Pistacia atlantica* oil, respectively. The diets were prepared fresh by each day. Feed and water were available ad-libitum. The ingredients of standard diet are presented in table 1. *Pistacia atlantica* oil was dissolved in vegetable oil and gently mixed with the standard diet. The birds were kept in separate pens. The temperature was controlled and gradually reduced from 35 to 23 ºC on day 56. During the first week of brooding, a photoperiod of 23 hour/day was maintained and then a photoperiod of 20 hour/day was used (Woodard, 2002). The trail was lasted for 8 weeks. All procedures were in accordance with the animal welfare norms.

Table 1. Ingredient and chemical composition of the standard diet (%)

Feeds Ingredients	0-8 week
Corn	46.28
Soybean meal (44% CP)	47.48
Vegetable oil	1.56
Dicalcium Phosphate	2.00
Limestone	1.58
NaCl	0.5
DL-Methionine	0.10
Vitamin Premix *	0.25
Mineral Premix*	0.25
Total	100
Analysis	
Crude protein	25.00
Ca	1.20
P	0.80
ME, kcal/kg	2800

*Vitamin/Mineral Premix (Talavang) supplied per 5 kg: vitamin A, 11000000 IU; cholecalciferol, 5000000 IU; vitamin E, 7 500 IU; K3, 3000 mg; vitamin B1, 3000 mg; vitamin B2, 8000 mg; niacin, 4000 mg; d-pantothenic acid, 15555 mg; vitamin B12, 16 mg; folic acid, 2000 mg; biotin, 150 mg, Mn, 120000 mg; Fe, 40000 mg; Zn, 100000 mg; Cu, 16000 mg; iodine, 125 mg; Se, 300 mg; choline chloride, 900000 mg.

Measurements

The, body weight, body weight gain, feed intake and feed conversion ratio (FCR) were recorded weekly. The mortality was recorded daily.

Pistacia atlantica oil

The oil was used in this study was purchased from Giyahan Shafa Bakhsh Co. Mashhad, Iran. Composition of the Iranian *Pistacia atlantica* nut oil was reported previously (Farhoosh et al., 2008).

Pathological examination

At the end of the experiment, chicks (four chicks per replicate) were sacrificed and complete necropsy was done. Following routine preparation of tissues (kidney, brain, lung, liver and heart) serial sections of paraffin embedded tissues of 5 µm thicknesses were cut using a microtome (Slee-Germany) and stained with hemotoxylin and eosin and studied under light microscope (Stockham and Scott, 2013). The procedure was done in the Department of Pathobiology, Faculty of Veterinary Medicine, Shahid Bahonar University of Kerman, Kerman, Iran.

Statistical analysis

Statistical analysis was performed using SPSS version 18. Data collected were subjected to analysis of variance, and where significant differences were observed, means were further subjected to Tukey's rang test as a post hoc test. The results were considered as significant when p values were less than 0.05.

Results

Performance

The effect of *Pistacia atlantica* oil on the feed intake is presented in table 2. The analysis of data revealed that there was no significant difference between chicks fed on diets were supplemented with 2.5 and 7 g/kg *Pistacia atlantica* oil compared to the control group ($p>0.05$).

The effect of *Pistacia atlantica* oil on body weight and FCR are presented in tables 3 and 4, respectively. The analysis of data showed that there were no significant

Table 2. The effect of *Pistacia atlantica* oil on the feed intake of *chukar partridge* (g/bird/day)

		Pistacia atlantica oil (g/kg)		
Weeks	Control	2.5	7	p values
2	12.5±0.62	12.2±0.80	12.6±0.71	NS
3	17.7±1.05	17.2±0.75	18.2±0.76	NS
4	20.4±0.52	20.1±0.26	20.6±0.22	NS
5	22.4±0.75	23.9±0.44	22.5±0.81	NS
6	28.5±1.80	28.5±1.86	29.9±0.32	NS
7	30±1.07	29.2±0.57	30.4±0.72	NS
8	35.5±0.51	34.5±1.06	33.6±0.41	NS
2-8	23.8±2.91	23.6±2.91	23.9±2.86	NS

NS: Non-significant (p>0.05), Values are means ± Std. Error of Mean

differences in the body weight and FCR between experimental groups up to 6 weeks of age, while there was significant differences on weeks 7 and 8 (p<0.05). The best value was observed in the birds of group C, which fed the diet supplemented with 7 g/kg *Pistacia atlantica* oil. The addition of 7 g/kg *Pistacia atlantica* oil to the standard diets improved body weight and FCR compared to the control group. There was no significant difference between chicks fed the diet containing 2.5 mg/kg *Pistacia atlantica* oil and the control group (p>0.05).

Pathology

There were no any gross and microscopic lesions, in the kidney, brain, lung, liver and heart tissues, between the birds fed a standard diet (groups A), and the birds fed the diets supplemented with 2.5 or 7 g/kg of *Pistacia atlantica* oil. Photomicrographs of the partridge tissues treated with *Pistacia atlantica* oil are presented in figures 1 to 10. All tissue samples were normal in the birds.

Discussion

Antibiotics have been used in animal production for decades. Although some are used therapeutically to improve health, most were given to improve growth rate and feed conversion ratio (as AGPs). The use of antibiotics as a growth promoter in animal production has been limited in some countries. (Castanon, 2007; Millet and Maertens, 2011). Most research interest has focused on the various components possess growth promoter properties (Huyghebaert et al., 2011; Millet and Maertens, 2011). Different plant extracts and herbs can

Table 3. The effect of *Pistacia atlantica* oil on the body weight of *chukar partridge* (g/bird)

		Pistacia atlantica oil (g/kg)		
Weeks	Control	2.5	7	P values
2	49.4±0.94	49.57±1.0	49.4±0.94	NS
3	94.8±1.70	94.7±2.02	94.8±2.12	NS
4	143±2.82	143±2.71	143±2.68	NS
5	194±2.20	192±1.04	192±1.72	NS
6	225±1.30	227±2.81	228±2.62	NS
7	283±2.85^{a}	295±2.40^{ab}	301±1.58^{b}	0.009
8	325±1.70^{a}	344±2.37^{ab}	355±2.81^{b}	0.000
2-8	188±7.50^{a}	192±9.96^{ab}	194±4.36^{b}	0.000

NS: Non-significant (p>0.05), Values are means ± Std. Error of Mean, Mean values with different superscripts within a row differ significantly.

Table 4. The effect of *Pistacia atlantica* oil on the feed conversion ratio

		Pistacia atlantica oil (g/kg)		
Weeks	Control	2.5	7	P values
2	2.36±1.22	2.52±0.97	2.43±1.12	NS
3	2.72±1.05	2.32±0.75	2.83±0.76	NS
4	3.05±0.53	2.98±0.76	3.10±0.44	NS
5	2.36±0.75	3.75±0.64	3.33±0.81	NS
6	3.39±1.83	3.02±1.86	3.42±1.32	NS
7	3.61±0.51 ^{a}	3.36±1.06 ^{ab}	2.54±0.41 ^{b}	0.008
8	3.73 ±1.07 ^{a}	3.70±0.57 ^{ab}	2.48±0.72 ^{b}	0.014
2-8	3.03 ±0.21 ^{a}	3.09±0.20 ^{ab}	2.80±0.15 ^{b}	0.010

NS: Non-significant (P>0.05), Values are means ± Std. Error of Mean, Mean values with different superscripts within a row differ significantly.

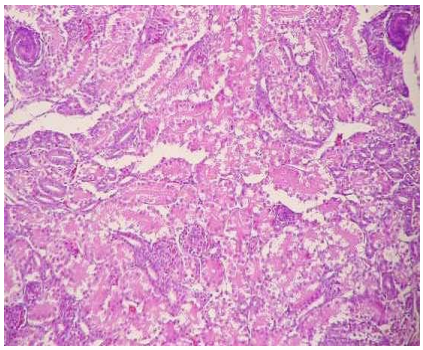

Fig. 1. Photomicrograph of a partridge chick treated with a diet supplemented with 7 g/kg of *Pistacia atlantica* oil. An entire lobe of the normal kidney is seen. ×40 H&E

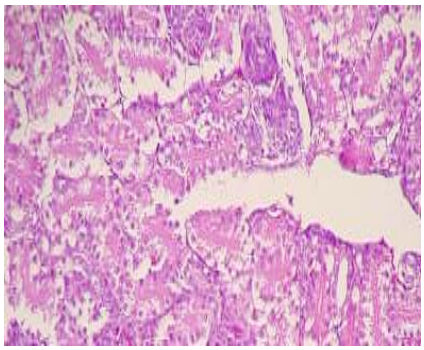

Fig. 2. Photomicrograph of a partridge chick treated with the standard diet. The normal kidney tissue is seen. ×100 H&E

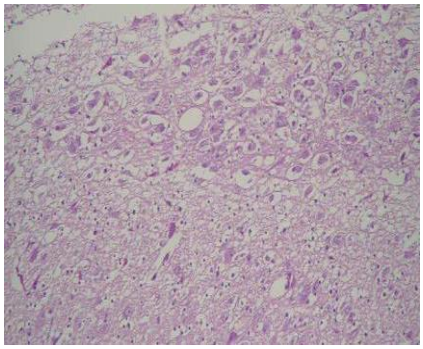

Fig. 3. Photomicrograph of a partridge chick treated with a diet supplemented with 7 g/kg of *Pistacia atlantica* oil. The normal brain tissue is seen. ×100 H&E

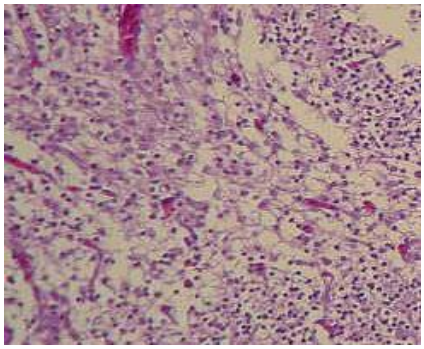

Fig. 4. Photomicrograph of a partridge chick treated with the standard diet. The normal brain tissue is seen. ×400 H&E

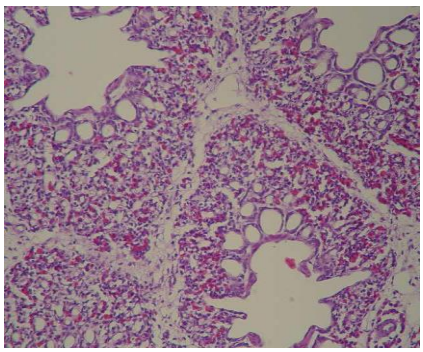

Fig. 5. Photomicrograph of a partridge chick treated with a diet supplemented with 7 g/kg of *Pistacia atlantica* oil. The normal lung tissue is seen. ×100 H&E

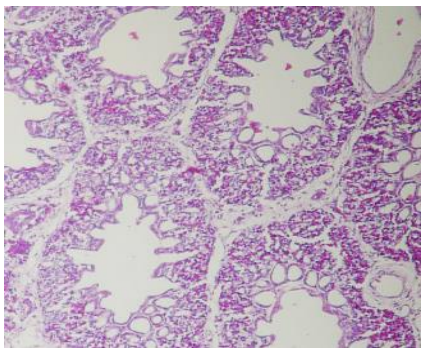

Fig. 6. Photomicrograph of a partridge chick treated with the standard diet. The normal lung tissue is seen. ×100 H&E

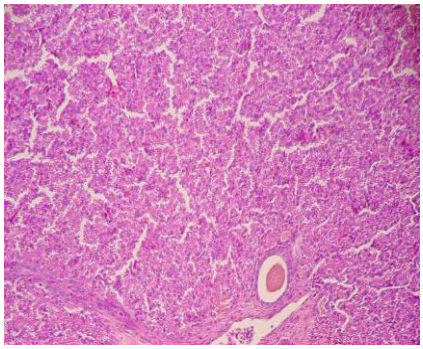

Fig. 7. Photomicrograph of a partridge chick treated with a diet supplemented with 7 g/kg of *Pistacia atlantica* oil. The normal liver tissue is seen. ×100 H&E

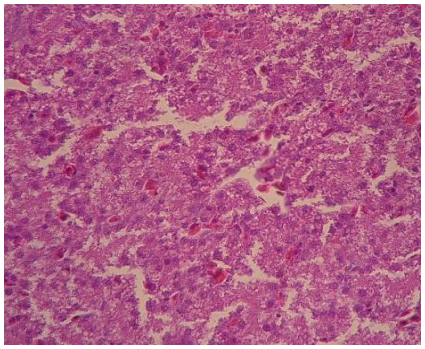

Fig. 8. Photomicrograph of a partridge chick treated with the standard diet. The normal liver tissue is seen. ×200 H&E

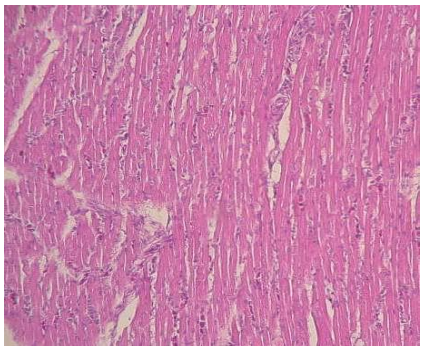

Fig. 9. Photomicrograph of a partridge chick treated with a diet supplemented with 7 g/kg of *Pistacia atlantica* oil. The normal histological features of the cardiac myocytes are seen. ×100 H&E

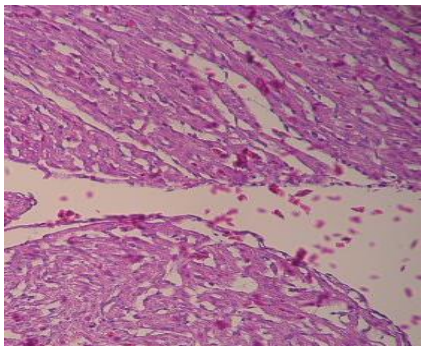

Fig. 10. Photomicrograph of a partridge chick treated with the standard diet. The normal histological features of the cardiac myocytes are seen. ×200 H&E

be used as AGPs replacements. These plants and their components are perceived as natural and safe by consumers. The objective of the present study was to investigate the effect of different level of *Pistacia atlantica* oil on performance and pathological conditions in chukar partridge.

The addition of *Pistacia atlantica* oil to the diets affected body weight of chukar partridge chicks. The highest body weight value was shown in chukar partridge group, which fed standard diet supplemented with 7 g/kg *Pistacia atlantica* oil.

The analysis of data revealed that *Pistacia atlantica* oil supplementation in the chukar partridge diet has a significant effect on FCR. Birds fed on diet with 7 g/kg *Pistacia atlantica* oil showed the best value compared to the control group.

In the current study, the better body weight and FCR in birds fed diet supplemented with *Pistacia atlantica* oil could be due to the active ingredients content and chemicals in this oil such as essential oil, antioxidant effects, antimicrobial activity, etc. This subject needs to further investigations.

The chemical compositions of essential oil of *Pistacia atlantica* were determined (Flamini et al., 2004; Barrero et al., 2005; Farhoosh et al., 2008; Gourinea et al., 2011). Some studies show that, essential oils enhance the performance of birds, increase digestion of protein, cellulose and fat, improve digestibility of the nutrient, and increase the activity of liver and pancreatic enzymes such as lipase and amylase (Hernandez et al., 2004; Lee et al., 2004; Jang et al., 2007; Rahimi et al., 2011; Amerah et al., 2012; Mathlouthi et al., 2012). On the other hands, some oils affected pathogenic microorganisms in the digestive system and showed an increasing effect on live weight gain and FCR (Elgayyar et al., 2001; Jang et al., 2007; Miguel, 2010). Several studies evaluated the antibacterial activity of *Pistacia atlantica* oil (Benhammou et al., 2008; Ghalem and Mohamed, 2009; Tohidi et al., 2011; Bahmani and Eftekhari, 2012). So, it can affect the pathogenic content of the digestive system.

The results of our study are in agreement with the results of studies in which different essential oils were added to poultry diets. These studies showed that oils derived from different herbal plants have improved body weight and FCR (Hernandez et al., 2004; Bampidis et al., 2005;

Cross et al., 2007; Ocak et al., 2008; Mukhtar, 2011). Reports on the effect of dietary *Pistacia atlantica* oil on partridge performance and pathological conditions are very limited. Our study shows that supplementation of 7 g/kg *Pistacia atlantica* oil in the diet significantly improves the performance of the chukar partridge over a growing period of 8 weeks. Furthermore, there were not any pathological alterations following the addition of 7 g/kg *Pistacia atlantica* oil to the diets.

Acknowledgment

The authors wish to thank Mr. S. Hasanzadeh for his kind cooperation in slide preparation.

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Communicating editor: *Mohamad Salarmoini*

اثر تغذیه ای روغن پستاشیا آتلانتیکا بر پرفرمنس و شرایط پاتولوژیکی در کبک چوکار

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چکیده پرورش کبک چوکار یک شـغل پرمنفعت محسـوب می گردد. افزودنی های خوراکی جدید با منشـأ گیاهی به عنوان جایگزینی برای آنتی بیوتیک های محرک رشـد مطرح می باشند. مطالعه حاضر به منظور بررسی اثر سطوح مختلف روغن پسـتاشـیا آتلانتیکا بر پرفرمنس و شرایط پاتولوژیکی در کبک چوکار انجام پذیرفت. جوجه های کبک چوکار یک روزه به سـه گروه تغذیه ای ۴۰ قطعه ای تقسـیم شـدند. برای هر گروه چهار تکرار در نظر گرفته شـد. جیره غذای گروه کنترل (گروه الف) بر اسـاس احتیاجات تغذیه ای کبک چوکار در نظر گرفته شد. جیره های غذایی گروه های ب و ج به ترتیب شامل ۲/۵ و ۷ گرم/کیلوگرم روغن پستاشیا آتلانتیکا بود. پرندگانی که با جیره غذایی دارای ۷ گرم/کیلوگرم روغن پسـتاشـیا آتلانتیکا تغذیه شـده بودند بهترین نتیجه را نشـان دادند ($P<0.05$). افزودن ۷ گرم/کیلوگرم روغن پسـتاشـیا آتلانتیکا به جیره غذایی، وزن بدن و ضـریب تبدیل غذایی را در مقایسه با گروه کنترل بهبود بخشید. ارزیابی پاتولوژیکی هیچگونه عارضـه ای را در گروه های آزمایش نشان نداد. به عنوان نتیجه گیری کلی می توان بیان نمود که روغن پستاشیا آتلانتیکا می تواند به عنوان یک جایگزین طبیعی برای آنتی بیوتیک های محرک رشد در پرورش کبک چوکار بدون ایجاد هیچگونه آثار پاتولوژیک مطرح باشد.