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Effects of dietary synbiotic and cinnamon (*Cinnamomum verum*) supplementation on growth performance and meat quality in Japanese quail

Zohreh Mehdipour [a], Mohsen Afsharmanesh [a,*], Masoud Sami [b]

[a] Animal Science Department, Shahid Bahonar University of Kerman, Kerman, Iran
[b] Food Hygiene and Public Health Department, Shahid Bahonar University of Kerman, Kerman, Iran

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ABSTRACT

The aim of this study was to investigate the effects of dietary supplementation with cinnamon powder, cinnamon oil, and synbiotic as growth promoter agents on growth performance and thigh meat quality in Japanese quail. A total of 420 one-d-old Japanese quail were randomly allocated to seven treatments with four cages per treatment and 15 quail chicks per cage. The dietary treatments consisted of the basal control without any added compounds, 200 mg virginiamycin/kg, 100 or 200 mg cinnamon oil, 1 or 2 g cinnamon powder/kg, and 500 mg synbiotic/kg. Birds were provided feed and water *ad libitum*. Body weight and feed intake of quails were determined at d 0, 21, and 35, and feed conversion ratio was calculated. On d 35, two birds from each cage were slaughtered and the thighs were collected for meat quality measurements. Supplementing 200 mg cinnamon oil/kg and virginiamycin increased body weight gain of quails at d 21–35 ($P=0.003$). Feeding 200 mg cinnamon oil/kg and virginiamycin improved feed conversion ratio compared to control group at d 21–35 and 0–35 ($P<0.05$). Feed intake was not affected by dietary treatments. In this experiment, 2-thiobarbituric acid-reactive substances of Japanese quails fed 200 mg cinnamon oil/kg was lower than the control, virginiamycin, and synbiotic treatments ($P<0.001$). Water holding capacity was increased in quail fed 200 mg cinnamon oil/kg ($P<0.05$). Cooking loss, dripping loss, and pH of the meat were not affected by treatments. In conclusion, 200 mg cinnamon oil/kg can be applied as an alternative to antibiotic for Japanese quail diets to maintain growth performance, and it can also improve meat quality.

1. Introduction

Antibiotic growth promoters (AGP) were used in the livestock and poultry diet to improve their growth, feed consumption, feed utilization, and health for more than half a century (Gollnisch et al., 2001; Kamphues and Hebeler, 1999). The utilization of antibiotics in livestock resulted in main problems such as development of antibiotic resistance (Sorum and Sunde, 2001), drug residues in poultry body (Burgat, 1991), and imbalance of normal microbiota. The use of AGP was banned in the European Union in 2006; therefore, it is important to find alternative AGP (Griggs and Jacob, 2005). There is a large variety of products that can be used to replace AGP, and synbiotics and plant extracts (essential oils) are among the candidates for the replacement (Bedford, 2000). The antimicrobial effects of essential oils have been demonstrated, but the reports on their influence on growth performance of poultry are variable, therefore, it needs more investigation (Brenes and Roura, 2010; Burt, 2004).

* Corresponding author. Tel./fax: +98 341 3221454.
E-mail addresses: mafshar@mail.uk.ac.ir, mafsharmanesh@yahoo.com (M. Afsharmanesh).

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Cinnamon verum J.S. Prsel (syn. Cinnamomum zeylanicum Blume) is a native of Sri Lanka and south India, but bark and leaf are widely used as a spice throughout the world (Petrovic et al., 2010). The essential oil of cinnamon contains cinnamaldehyde and eugenol, which are known as bioactive substances with potential health effects (Chao et al., 2005). It has intense antimicrobial, antifungal, and antioxidant properties (Cocchiara et al., 2005; Goni et al., 2009; Lee et al., 2001, 2007). Cinnamon has already been used for improving the quality and quantity of animal products. Although cinnamon dietary supplementation improves growth performance of broiler chickens in some instances (Al-Kassie, 2010; Garcia et al., 2007; Lee et al., 2004), some studies show no effect of cinnamon on growth characteristics (Hernandez et al., 2004; Khaligh et al., 2011; Koochaksaraie et al., 2011).

Probiotic was known as a live microbial feed supplement that beneficially influences the host animal by improving its microbial intestinal balance (Fuller, 1989). Prebiotics are known as non-digestible feed ingredients that beneficially influence the host by selectively stimulating the growth or activity of one or a limited number of bacteria in the intestine, thus, improving health of the host (Gibson and Roberfroid, 1995). Synbiotic is the combination of both probiotics and prebiotics that can improve the survival of live microbial dietary supplements in the gastrointestinal tract of host and its performance.

No study has yet investigated the effect of dietary cinnamon supplementation on meat quality in Japanese quail. The objective of this study was to determine the effects of cinnamon (oil and powder) and synbiotic on quail growth performance and meat characteristics.

Table 1
Ingredients and composition of the basal diet.

Item	Diets	
	Starter diet (d 0–21)	Grower diet (d 21–35)
Ingredient (g/kg)		
Corn	530	589
Soybean meal	366	322
Corn oil	60	50
Dicalcium phosphate	16	16
Calcium carbonate	17	13
DL-Methionine	2.0	1.0
Vitamin premix[a]	25	25
Mineral premix[b]	25	25
Salt	4.0	4.0
Calculated chemical composition		
Metabolizable energy (MJ/kg)	12.98	12.98
Crude protein (g/kg)	227	206
Calcium (g/kg)	10	9.1
Available phosphorous (g/kg)	7.1	6.6
Methionine+cystine	9.0	6.3
Lysine (g/kg)	11.8	10

[a] Provided per kilogram of diet: 15,000 IU of vitamin A (retinol), 3750 IU of vitamin D3 (Cholecalciferol), 37.5 mg of vitamin E (tocopheryl acetate), 2.55 mg of vitamin K3, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B6 (pyridoxine), 24 μg of vitamin B12 (cyanocobalamin), 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin, 13.5 mg of pantothenic acid, 250 mg of choline chloride, and 100 mg of antioxidant.

[b] Provided per kilogram of diet: 37.5 mg of Zn (ZnO, 80.35% Zn), 37.5 mg of Mn ($MnSO_4 \cdot H_2O$, 32.49% Mn), 37.5 mg of Fe ($FeSO_4 \cdot 7H_2O$, 20.09% Fe), 3.75 mg of Cu ($CuSO_4 \cdot 5H_2O$), 0.83 mg of I (KI, 58% I), 62.5 mg of S, and 0.23 mg of Se ($NaSeO_3$, 45.56% Se).

2. Materials and methods

2.1. Birds and experimental diets

The feeding program consisted of a starter diet until d 21 and a finisher diet until d 35. The compositions of the experimental basal diets are shown in Table 1. All diets within a period had the same composition. Diets were formulated to meet or exceed the NRC (1994) requirements for meat Japanese quail. The experiment was conducted in accordance with the animal welfare guidelines at the Veterinary Control and Research Institute of Kerman, Iran.

The dietary treatment consisted of (1) basal control diet without any added compounds (Control); (2) Control+100 mg cinnamon oil/kg diet (CO100); (3) Control+200 mg cinnamon oil/kg diet (CO200); (4) Control+1 g cinnamon powder/kg diet (CP1); (5) Control+2 g cinnamon powder/kg diet (CP2); (6) Control+200 mg virginiamycin (antibiotic)/kg diet (ANT); and (7) Control+500 mg synbiotic (Biomin GmbH, Herzogenburg, Austria)/kg diet (SYN).

Fresh cinnamon inner bark was prepared, sun-shade dried and then was ground to obtain cinnamon powder. Cinnamon barks (50 mesh particle size) were hydrodistilled using Clevenger's apparatus to yield essential oil (Clevenger, 1928). Hydrodistillation is the most common method for volatile oil extraction, and the plant material is boiled in water using a heat source from below the vessel. Chemical compositions of cinnamon oil were obtained by gas chromatography–mass spectrometry (Gurdip et al., 2007). Among the oil constituents, cinnamaldehyde was the main component, accounting for 72%. The amounts of supplements were chosen to provide approximately 72 and 144 ppm cinnamaldehyde for CO100/CP1 and CO200/CP2, respectively.

A total of 420 d-old Japanese quails (*Coturnix japonica*) were randomly assigned to seven treatments with four replicate cages and 15 birds per replicate in a completely randomized design. The birds were reared in cages of identical size (100×100 cm^2 floor area and 80 cm height) for the 35-d experimental period. All groups were subjected to similar management practices (lighting, feeding, and watering) throughout the experiment except the diets offered. Quails were provided 24 h/d fluorescent lighting (20 lx light intensity). Feed and water were provided *ad libitum*. The initial temperature of 37 °C was gradually reduced according to the age of the birds until reaching 25 °C at the end of the experiment. Quails were not vaccinated.

2.2. Performance and biochemical determination

Birds and feeds were weighed at d 1, 21, and 35 on a cage basis. The body weight gain (BWG), feed intake (FI),