Feeding diets with malic acid may increase growth performance without affecting food efficiency of Japanese quails

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Antimicrobial feed additives such as organic acids have made a great contribution to the profitability in the poultry and also provided people with healthy and nutritious poultry products. This study was performed with growing quails to evaluate the effect of malic acid (MA) on performance and some digestive tract traits of Japanese quails (JQ). Malic acid was added to diets and offered to quails freely from 7 to 42 d of age with constant concentration. A total of 320 quails were divided into 4 treatment groups each with 4 replicates containing 20 birds in a randomised design. While one of groups was fed control diet with no additives (0 MA), other groups were fed the diets with MA at 0.4 (0.4 MA), 0.8 (0.8 MA) or 1.2 (1.2 MA) g/kg. Corn and soybean based diet were fed in mash form, and quails had free access to water. Daily weight gains of birds in the 0.8 MA and 1.2 MA groups were higher (P<0.05) than those in the 0 MA group. No differences were observed (P>0.05) among the 0.4 MA, 0.8 MA and 1.2 MA groups for daily weight gain and daily food consumption. The daily food consumption of birds in the 1.2 MA group was higher (P<0.05) than those in the 0 MA group. Addition of the malic acid to the diets did not affect the food efficiency (P>0.05). Birds fed the diets with MA at 0.8 g/kg had a higher (P<0.05) carcass weight compared to other groups. No differences were observed among the 0 MA, 0.4 MA and 1.2 MA groups in terms of the carcass weight (P>0.05). Birds fed the diet with MA at 1.2 g/kg had a higher (P<0.05) digestive tract weight compared to the control diet, but feeding diets with MA did not affect dressing percentage, digestive tract length and inner organs (P>0.05). The results indicated that birds fed the diets with MA can have a higher daily weight gain and food consumption without affecting food efficiency and a significant benefit of feeding diet with MA at 0.8 g/kg compared to the control diet was obtained in terms of carcass weight in the JQ.

Keywords: quail; organic acid; malic acid; performance; digestive tract

Introduction

Recently most of antibacterial performance promoters have been banned, because feeding of antibiotics is risky (Neu, 1992) due to not only cross-resistance but also to multiple resistances. The ban on the use of antibiotics as growth promoters in the European Union and the potential for a ban in the United States has prompted the search for alternative food supplements in animal production. Prebiotics, probiotics and organic acids are three of several approaches that have potential to reduce enteric disease and improve performance in poultry and subsequent contamination of poultry products (Patterson and Burkholder 2003; Ricke, 2003). Antimicrobial food additives such as organic acids, particularly the short-chain fatty acids, acetate, propionate, and butyrate, have made a great contribution to the profitability in the poultry and also provided people with healthy and nutritious poultry products (Patten and Waldroup, 1988; Ricke, 2003; Moharrery and Mahzonieh, 2005).

Malic acid (MA) is formed in metabolic cycles in the cells of plants and animals, including chickens and plays an important role in generating mitochondrial ATP both under aerobic and hypoxic conditions (Moharrery, 2005). Malic acid is not antibiotics but, if used correctly along with nutritional, managerial and biosecurity measures, they can be a powerful tool in maintaining the health of the gastrointestinal tract of poultry, thus improving their zootechnical performances (Moharrery and Mahzonieh, 2005). Although the effects of different levels of MA given in waterer pan on live weight, food consumption and carcass characteristics in the broiler chickens have been studied (Moharrery, 2005; Moharrery and Mahzonieh, 2005), to our knowledge, the effect of exogenous MA supplementation into compound food on growth, and carcass and gastrointestinal tract characteristics of quails has not been reported. Therefore, the present study was conducted to determine the effects of feeding diets with MA on growth performance, carcass and gastrointestinal tract characteristics in Japanese quails (JQ).

Materials and methods

A total of 320 quails were divided into 4 treatment groups each with 4 replicates containing 20 birds (10 male and 10 female quails). The quail chicks were reared in floor pens with wood-shavings (85×75×75 cm) during the 35 days experimental period. The pens were fitted with feeders and waterers. Lighting was provided for 23 h per day throughout the experimental period by 2 fluorescent bulbs. Mean ambient temperature was reduced by 3°C per week from 30 to 24°C and the relative humidity was maintained within a range of 60-70%. While one of groups was fed control diet with no additives (0 MA), other groups were fed the diets with MA at 0.4 (0.4 MA), 0.8 (0.8 MA) or 1.2 (1.2 MA) g/kg. Malic acid (E 296, Doruk Gida ve Kimya Amb. T. A. S., Istanbul, Turkiye) was added to diets and offered to quails freely from 7 to 42 d of age with constant concentration. The JQ chicks were placed in a room with floor battery brooders and fed a commercial diet (*Table 1*), and they had free access to water. Corn and soybean based diet were fed in mash form.

Table 1. Compositions of the experimental diets

Ingredients	g/kg	Calculated nutrient content per kg experimental diet	
Yellow corn	408.7	Crude protein (g)	239.7
Soybean meal	226.7	Metabolizable energy (MJ)	13.4
Full fat soybean	120	Lysine (g)	18.3
Wheat	100	Methionine (g)	5.1
Sunflower meal	60	Calcium (g)	7.5
Meat and bone meal	30	Available phosphorus (g)	4.8
Fish meal	20		
Vegetable oil	20		
Dicalcium phosphate (DCP)	5.5		
Vitamin and mineral premix [a]	2		
Salt	2.5		
Limestone	2.5		
DL-methionine	1.1		

[a] (per kg diet) vit. A 1,200,000 IU, vit. D_3 160,000 IU, vit. E 1,600 mg, vit. K_3 400 mg, vit.B_1 200 mg, vit. B_2 600 mg, vit. B_6 400 mg, vit. B_{12} 8 mg. vit. C 4,000 mg, Biotin 4 mg, Folic acid 60 mg, Calcium D-pantotenat 800 mg, Choline chloride 80,000 mg, Niacin 2,000 mg, Manganese 8,000 mg. Iron 3,000 mg, Zinc 6,000 mg, Copper 500 mg, Cobalt 50 mg, Iodine 200 mg, Selenium 20 mg.

Body weight and total food consumption data were determined on 14, 28, 35 and 42 d of age. Quails were individually weighed. Food efficiency ratio (g food/g gain) was calculated from body weight and food consumption data. To determine weights of digestive tract and edible inner organs (heart + liver + gizzard) of JQ, on 42 d of age, 4 quails (2 male and 2 female) from each replicate (a total of 16 quails from each treatment) with body weight within 1 standard deviation of the mean treatment weight were slaughtered. Gut was weighed with its content (full gut), while gizzard was

weighed after removing its content digesta. Dressing percentage, gut length and weight and edible inner organ weight were calculated as a percentage of body weight (g/100 g body weight).

The complete randomized model was used to analyze data for weight gain, food consumption, food efficiency and characteristics of carcass and gastrointestinal tract (gut). All data for each variable were subjected to one-way analysis of variance. All percentage data were converted to arcsines prior to analysis and untransformed means are presented. When significant treatment effects were observed, differences among treatment means were tested by the multiple range test of Duncan (SPSS inc., 1999). The level of statistical significance was pre-set at $P < 0.05$.

Results and discussion

Mortality was not occurred in none of groups during the experiment. Body weight gain, food consumption and food efficiency in JQ given the experimental diets are presented in *Table 2*. Daily weight gains of birds in the 0.8 MA and 1.2 MA groups were higher ($P<0.05$) than those in the 0 MA group. No differences were observed ($P>0.05$) among the 0.4 MA, 0.8 MA and 1.2 MA groups for daily weight gain and daily food consumption. The daily food consumption of birds in the 1.2 MA group was higher ($P<0.05$) than those in the 0 MA group. Addition of the MA to the diets did not affect the food efficiency ($P>0.05$).

Table 2. Body weight gain, food consumption and food efficiency in Japanese quails given the experimental diets

Measures	0 MA	0.4 MA	0.8 MA	0.12 MA	SEM
Initial body weight, g	25.8	25.7	25.8	25.7	0.07
Body weight gain, g/day/bird	4.0 a	4.2 ab	4.4 b	4.3 b	0.03
Food consumption, g/day/bird	17.1 a	17.5 ab	17.8 ab	18.0 b	0.16
Food:gain, g:g	4.09	4.10	4.12	4.18	0.02

a,b: Values in the same row not sharing a common superscript differ significantly ($P<0.05$).
SEM: standard error of the mean.

Means for carcass weight, dressing percentage, the relative weight and length of gut and the relative weight of edible inner organs at 42 d of age are shown in *Table 3*. Birds fed the diets with MA at 0.8 g/kg had a higher ($P<0.05$) carcass weight compared to other groups. No differences were observed among the 0 MA, 0.4 MA and 1.2 MA groups in terms of the carcass weight ($P>0.05$). Birds fed the diet with MA at 1.2 g/kg had a higher ($P<0.05$) gut weight compared to the control diet, but feeding diets with MA did not affect dressing percentage, gut length and inner organs weight ($P>0.05$).

Table 3. Carcass weight, dressing percentage, gut length and weight and edible inner organ weight in Japanese quails given the experimental diets

Measures	0 MA	0.4 MA	0.8 MA	1.2 MA	SEM
Carcass weight, g	116.2 a	117.2 a	121.2 b	118.9 a	0.68
Dressing percentage, g/100 g BW	70.09	67.86	67.41	67.48	0.41
Full gut length, cm/100 g BW	12.87	12.17	12.09	11.97	0.27
Full gut weight, g/100 g BW	49.73 a	50.63 ab	52.18 ab	53.68 b	0.23
Edible inner organs, g/100 g BW	2.33	2.36	2.27	2.24	0.04

a,b: Values in the same row not sharing a common superscript differ significantly ($P< 0.05$).
SEM: standard error of the mean.

The results reported here for body weight gain, food consumption and carcass weight disagree with the previous observations in broiler (Moharrery, 2005; Moharrery and Mahzonieh, 2005). These researchers showed that the MA given in the waterer pan did not affect body weight gain, food efficiency and dressing percentage, but that food consumption tended to be lower in boilers on treatment with 0.15% MA concentration to compare with control (0% MA), This discrepancies may be attributed to differences in the inclusion level (0.12% vs. 0.15%) and where (diet vs. water) of MA and bird species (quail vs. broiler) used in the present and previous studies. Ozturk et al. (2004) reported that organic acid (Genex) supplementation into diet had no the beneficial effect on performance and intestinal flora of broiler chicks.

Antimicrobial agents may have more impact when the diet used is less digestible, and the diet contained highly digestible ingredients so that bacterial growth in the intestine probably may be limited (Lee et al., 2003). However, the digestibility of the basal diet used in the current study was not probably as high as that in the study of Moharrery (2005) and Moharrery and Mahzonieh (2005). In fact, it has been show that dietary antibiotics appear to stimulate the activities of amylase and chymotrypsin in pancreatic tissue from broilers fed on wheat-soybean meal based diet (Enberg et al., 2000). A difference in full gut weight does not support the idea that the digestibility of the basal diet used in the current study was low.

It was expected that supplementing the antimicrobial principles would stimulate growth performance in poultry (Lee et al., 2003). The result of the present study indicated that feeding diets with MA at 0.8 and 1.2 g/kg might increase growth performance and food consumption without affecting food efficiency and a significant benefit of feeding diet with MA at 0.8 g/kg compared to the control diet was obtained in terms of carcass weight in the JQ. This results support the idea that malate has carbohydrate effects (Dunaev et al., 1988; Abraham and Flechas, 1992) and MA is active against some bacteria and yeasts (Dhawale, 2005; Moharrery and Mahzonieh, 2005), although the carbohydrate or antimicrobial effects MA was not determined in the present study.

In conclusion, feeding diets with MA may increase growth performance and food consumption without affecting food efficiency. Further research is need for better understanding the role of the dietary MA on poultry performances and on toxins, colonisation and proliferation of microorganisms in the poultry gastrointestinal tract.

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