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The Effect of Dietary Conjugated Linoleic Acid on Growth Performance, Feed Efficiency, Abdominal Fat Content and Selected Organ Weights of Male Japanese Quail

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Abstract: An experiment was carried out to evaluate the effects of conjugated linoleic acid (CLA) on growth performance, feed efficiency, abdominal fat accumulation and relative weights of selected organs in male Japanese quail. A total of 39 male Japanese quail chicks (7-day old) were allocated to three groups and fed a commercially prepared diet supplemented with 0.5% hazelnut oil (Group A), 0.5% sunflower oil (Group B) or 0.5% CLA (Group C) for 5 weeks. Birds were given feed and water *ad libitum*. At the end of 5 week study, all animals in the groups were slaughtered and body and organ weights were measured. Breast, legs and wings were separated from the eviscerated carcass and weighed. Feed conversion rate in the Group A, B or C was 3.07, 3.52, or 3.20, respectively. The average final body weights and eviscerated carcass weights of quails from the Group C were lower than those from the Group A. The proportions of the breast muscle from the Group B and C were found significantly higher than those from the Group A ($p<0.05$). The relative weights of leg muscles was similar in all treatments. There was no difference in the relative weights of abdominal fat (%) among the groups. Relative weights (%) of selected organs of the quails from the Group A, B or C did not differ at the level of $p<0.05$. This study showed that dietary CLA significantly decreased the final body weight, but caused significant increase in the proportions of the breast muscle in the male Japanese quail.

Key words: Conjugated linoleic acid, growth performance, organ weights, quail

INTRODUCTION

Conjugated linoleic acid (CLA) is a collective term that refers to a mixture of positional and geometrical isomers of linoleic acid and is present naturally at the highest concentrations in food products derived from ruminant animals (Chin *et al*., 1992). Multiple beneficial properties have been attributed to CLA, such as anticarcinogenic (Ha *et al*., 1990; Ip *et al*., 1994), antiatherogenic (Lee *et al*., 1994; Nicolosi *et al*., 1997) and fat reducing effects in animal models (Dugan *et al*., 1997; Park *et al*., 1997). Other beneficial effects of CLA are immune enhancing activity in the chickens (Cook *et al*., 1993) and mice (Miller *et al*., 1994).

Because of those potential health benefits of CLA, there are a lot of attempt to enrich the amount of CLA in the foods and increase amount of dietary intake. Developing animal products including meat and eggs represent one means by which to accomplish this goal. Although meat and dairy products are the principal source of CLA in human diet, meat products from poultry and non-ruminant animals contain little or no CLA (Chin *et al*., 1992). Numerous studies conducted in poultry and pigs showed that dietary CLA resulted in increased levels of CLA in the tissues depends on the level of CLA in the diet and period of the feeding (Dugan *et al*., 1997; Kramer *et al*., 1998). Dietary studies related to CLA have shown that CLA isomers are readily absorbed and incorporated into muscle and adipose tissues (Kramer *et al*., 1998).

Previously, CLA was shown to be a growth factor for rats as shown by enhanced body weights and improved feed efficiency (Chin *et al*., 1994). Dietary CLA also was shown to improve feed efficiency and reduce body fat in the pigs (Dugan *et al*., 1997). Similarly, a study conducted in the broilers showed that dietary CLA at the level of 1.5% reduced the feed intake, body weight and abdominal fat deposition significantly (Szymczyk *et al*., 2001). However, the same study showed no effect of dietary CLA on the relative proportion of breast muscle (Szymczyk *et al*., 2001). It was reported that dietary CLA up to 1% level did not affect the abdominal fat level

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(Du and Ahn, 2002). However, in the same study when the CLA in the diet was increased to 2 or 3%, the total body fat content reduced significantly (Du and Ahn, 2002). However, dietary CLA used in Japanese quail was shown not to affect body weights of the adult birds (Aydin and Cook, 2004). Another study conducted in the broiler chickens showed that dietary CLA at the level of 2 or 4% did not affect carcass yield and feed efficiency negatively (Sirri *et al*., 2003). There was no known study in the Japanese quail associated with the effects of dietary CLA on the growth performance, feed efficiency and abdominal fat deposition. Therefore, the objective of the study was to investigate the effects of dietary CLA on body weight gain, feed efficiency, carcass yield and abdominal fat in the male Japanese quail.

MATERIALS AND METHODS

Animals and composition of experimental diets: This study was conducted in the research farm at the Kahramanmaras Sutcu Imam University, Turkey, in 2005. Thirteen 7-day old male Japanese quail (*Coturnix coturnix japonica*) per group were maintained in cages and fed a commercial diet containing 0.5% hazelnut oil (Group A), 0.5% sunflower oil (Group B) or 0.5% CLA for 5 weeks. The CLA source contained 60% CLA. Chemical analysis of the commercial diet: Dry matter, 88%; crude protein, 20%; crude cellulose, 6%; ash, 8%, NaCL, 0.35%, calcium, 1.5%, phosphorus, 0.65%; lysine, 1%; methionine, 0.40%; cysteine, 0.35%; metabolic energy, 3100 kcal kg; vitamin A, 8000 IU kg^{-1}; vitamin D_3, 800 IU kg^{-1}; vitamin E, 15 mg kg^{-1}; vitamin K_3, 2 mg kg^{-1}; mangan, 60 mg kg^{-1}; zinc, 40 mg kg^{-1}. The birds were allowed *ad libitum* access to feed and water and maintained on a 24 h constant lighting program. Birds were weighed individually and total pen feed intake were measured in weekly basis.

All animals in the groups were slaughtered at the end of 5 weeks and body and organ weights were measured. Breast, legs and wings were separated from the eviscerated carcass and weighed. In order to avoid variation in the cutting procedures, the same operator was employed.

Statistical Analysis: In this study, data for quail performance and organ weights were analyzed by using the general linear models procedure (multivariate). Mean values for the groups were compared using the Tukey multiple range test (SPSS software 10.0; Chicago, IL). Differences were considered significant at the level of $p<0.05$.

RESULTS AND DISCUSSION

Conjugated linoleic acid, briefly known as CLA, was first reported to be a growth factor in the rats as shown by enhanced weights and improved feed efficiency (Chin *et al*., 1994). In the studies conducted in the pigs and mice, dietary CLA was shown to improve feed efficiency and reduce body fat (Dugan *et al*., 1997; Ostrowska *et al*., 1999; West *et al*., 1998). However, other studies conducted in the mice and rats showed that diets containing more than 1% level of CLA affected growth rate adversely (Belury and Kempa-steczko, 1997; Szymczyk *et al*., 2000). This may be explained by a reduction in the ratio of fat to lean muscle by dietary CLA (Park *et al*., 1997). Previously, CLA was reported as a potent inhibitor in the fat synthesis in various animal species such as mice, rats and chickens (Pariza *et al*., 1996). A study conducted in broilers showed that dietary CLA at the level of 1.5% reduced the feed intake, body weight and abdominal fat deposition significantly (Szymczyk *et al*., 2001). It was reported that dietary CLA up to 1% level did not affect the abdominal fat level (Du and Ahn, 2002). However, in the same study when the CLA in the diet was increased to 2 or 3%, the total body fat content reduced significantly (Du and Ahn, 2002). In the present study, there was no significant difference in the levels of abdominal fat among the groups (Table 1). It was speculated that the use of higher levels of CLA in the diet might stimulate fatty acid oxidation and enhance metabolic rate of the animals. In a study conducted in the broiler chickens, abdominal fat deposition was reduced significantly (Szymczyk *et al*., 2001). However, in the present study, there was a tendency in decrease of the abdominal fat deposition, but this decrease was not found significant at the level of $p<0.05$.

Dietary CLA was shown to have an ability to influence feed intake and weight gain in the animals. In a study conducted in the broiler chickens, diet containing 5% CLA was shown to cause a reduction in the feed intake and weight gain compared to the group fed 5% corn oil (Badinga *et al*., 2003). Similarly, in the present study, quails fed a diet containing 0.5% CLA had a lower final body weight than those fed a diet containing 0.5% hazelnut oil (Table 1). After 5 weeks of feeding, body weights of the quail from the Group C were found to be significantly lower than those from the Group A ($p<0.05$). Although supplementing 0.5% CLA to the diet significantly reduced feed intake, the overall feed conversion rate was better for the Group C than the Group B. In the present study, feed conversion rate in the Group A, B and C was 3.07, 3.52 and 3.20, respectively. Quails

Table 1: The effect of dietary CLA on the performance and body parts of male Japanese quail

	[1]Dietary treatments		
	Group A	Group B	Group C
Initial Body Weight (g)	42.39±1.69	39.07±1.25	42.80±1.47
Final Body weight (g)	201.39±5.79[a]	195.21±2.84[ab]	189.57±3.43[b]
[2]Eviscerated carcass (g)	137.39±4.06[a]	131.86±2.05[ab]	128.79±1.98[b]
Neck (%)	6.13±0.38	6.32±0.30	5.50±0.23
[3]Breast (%)	37.65±0.66[b]	39.78±0.74[a]	40.78±0.57[a]
[3]Leg (%)	24.81±0.26	24.59±0.28	24.53±0.29
[3]Wing (%)	8.79±0.14	8.47±0.20	8.89±0.12
Abdominal fat (%)	1.52±0.20	1.47±0.20	1.21±0.13

[1]Diets were given *ad libitum* to the animals for 5 weeks. Dietary treatments: Group A: Basal diet plus 0.5% hazelnut oil; Group B: Basal diet plus 0.5% sunflower oil; Group C: Basal diet plus 0.5% CLA. The CLA source contained 60% CLA.
[2]Eviscerated carcass = carcass without head, neck and feet
[3]Percentage of eviscerated carcass
[a, b]Means within a row lacking a common superscript differ ($p<0.05$)

Table 2: Percentage of organ weights of Japanese quail fed experimental diets[1] for 5 weeks

	Group A	Group B	Group C
Liver (%)	1.85±0.09	2.16±0.16	2.27±0.13
Heart (%)	1.23±0.05	1.18±0.05	1.36±0.06
Testis (%)	3.12±0.17	2.92±0.19	2.69±0.13
Gizzard (%)	1.90±0.08	2.04±0.09	2.00±0.08
Intestine (%)	3.13±0.15	3.32±0.12	3.24±0.14

[1]Dietary treatments: Group A: Basal diet plus 0.5% hazelnut oil; Group B: Basal diet plus 0.5% sunflower oil; Group C: Basal diet plus 0.5% CLA.
[a,b]Means within a row lacking a common superscript differ ($p<0.05$)

fed the 0.5% CLA diet had also a lower relative proportion of eviscerated carcass compared to the Group A (Table 1). In the present study, feeding 0.5% CLA or sunflower oil diet (Group B) significantly increased the ratio of breast muscle compared to the Group A (Table 1). However, in a study conducted in the broilers it was shown no effects of dietary CLA on the relative proportions of the breast muscle (Szymczyk *et al*., 2001). In this study, it was also reported that dietary CLA increased the proportions of leg muscles significantly (Szymczyk *et al*., 2001). Conversely, in the present study, the proportions of leg muscle (%) in the male Japanese quail did not differ in the groups (Table 1).

Dietary CLA at the level of 0.5% or higher levels was shown to increase the proportions of liver (%) in the male and female Japanese quail (Aydin and Cook, 2004). The authors also suggested that CLA might decrease the transport of triacylglycerols from the liver to the blood stream, resulting in decreased egg size and increased liver size (Aydin and Cook, 2004). In the present study, livers from the quails fed the CLA diet did not differ from the other groups (Table 2). Also relative weights (%) of the selected organs did not differ from each other (Table 2). In a study conducted in the broilers, dietary CLA at the level of 5% significantly increased the liver size compared to the 5% corn oil control diet (Badinga *et al*., 2003). It was found that the livers of the broilers fed the CLA diet were heavier than those from the control, but contained less amount of fat compared to the control (Badinga *et al*., 2003). These findings were consistent with the earlier reports in the mice (Park *et al*., 1997). However, they found total lipid concentration of the livers from the CLA-fed broilers was much lower than the control (Badinga *et al*., 2003). The increase in the size of livers of the quails fed the CLA diet may be due to the decreased hepatic export of lipids because of the decreased levels of stearoyl-CoA desaturase, an enzyme which catalyzes the insertion of a double bond between the C-9 and C-10 atoms of either 16:0 or C18:0 in the formation of C16:1(n-7) and C18:1(n-9), respectively (Cook, 1991).

In conclusion, dietary CLA at the level of 0.5% significantly decreased the final body weights of the Japanese quails compared to those from the other groups ($p < 0.05$). This study also showed that the quails fed with the Diet C had significantly lower eviscerated carcass weights compared to the control group ($p<0.05$). In the present study, although there was no significant effect of dietary CLA on the abdominal body fat ratio, the ratio of breast muscle from the quails fed the CLA diet was found significantly higher than the control group ($p<0.05$).

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