N18.99

The Effect of Dietary Oils on Growth Performance of Broilers Vaccinated with La Sota Newcastle Vaccine

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Abstract

The objective of this study was to investigate the effects of dietary oils on growth performance of broiler chicks vaccinated with La Sota vaccine against Newcastle disease. One hundred seventy five 1-week old Ross PM3 male broiler chicks were randomly distributed into five dietary groups (35 chicks per group) and fed a commercial starter, grower or finisher diets supplemented with 0.5% sunflower oil (Group A), 0.5% olive oil (Group B), 0.5 % beef tallow (Group C), 0.5% conjugated linoleic acid (CLA, Group D) or 0.5% hazelnut oil (Group E) for 5 weeks. Broiler chicks were vaccinated with La Sota Newcastle vaccine at 22 days of age. Body weights of broiler chicks were measured weekly. At the end of the study, broiler chicks were slaughtered and carcass characteristics and weight of some organ weights were determined. After vaccination, growth rates in the broilers from the Group A, Group C and Group E were negatively influenced compared to the Group D. There was no difference in the proportions of abdominal fat (%) of the chickens among the groups. Also, the relative organ weights of the broilers did not differ significantly among the dietary treatments. This study showed that the broiler chicks fed a diet supplemented with CLA had better performance and carcass weights compared to other groups ($P<0.05$). The present study also indicated that dietary CLA at the level of 0.5% prevented weight loss against vaccination compared to other groups.
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Introduction

Specific fatty acids (such as omega-3 fatty acids and conjugated linoleic acid, CLA) were shown to improve performance and to decrease indices of the inflammatory response in the growing chicks (Cook et al., 1993; Hellerstein et al., 1989; Korver and Klasing, 1997). Omega-3 fatty acids from fish oil was shown to enhance the antibody response of chicks to sheep red blood cells (SRBC), but to suppress rates of lymphocytes proliferation after mitogen stimulation (Fritsche et al., 1991). CLA is a naturally occuring substance in dairy products and meat from ruminant animals as a result of bacterial biohydrogenation in the rumen (Ha et al., 1989) and was reported to exert a variety of biological properties in several animal models, including anticarcinogenic (Belury, 2002), antiatherogenic (Lee et al., 1994) and antidiabetic properties (Houseknecht et al., 1998). Dietary CLA was first shown to be effective in the prevention of growth depression induced by immune stimulation in the chicks and mice (Cook et al., 1993). It was shown that growth suppression induced by the injection of endotoxin was markedly reduced in the mice and chickens fed diets supplemented with CLA (Cook et al., 1993). CLA was also shown to promote immunoglobulin production and modulate the production of various cytokines in rat and mouse splenocytes (Sugano et al., 1998; Yamasaki et al., 2003). It was reported that t-10, c-12 CLA isomer, but not c-9, t-11 CLA was an active isomer to enhance Ig production *in vivo* (Yamasaki et al., 2003). Studies involving fish oil and CLA illustrate possible means of modulating the growth suppressive effects resulting from immune induced alterations in the nutrient metabolism (Cook et al., 1993; Klasing et al., 1987).

The immune system in poultry, like that of humans, has developed several levels of defence strategies to cope with a wide spectrum of pathogens, including parasites, bacteria and viruses (Erf, 2004). Newcastle disease is a highly contagious disease of poultry and other bird species caused by specified viruses of the avian paramyxovirus type I serotype of the genus Avulavirus belonging to the family of Paramyxoviridae (Mayo, 2002) and causes great losses in poultry unless preventive measures are not taken. In the poultry industry, vacccination against Newcastle disease with live vaccines is a common practice and even obligatory in many countries throughout the world. Stimulation of the immune system by a wide variety of immunogens decreases the rate of weight gain, feed intake and the efficiency of feed utilization (Klasing et al., 1987). Vaccination reported to be a potent immune stimulant depresses growth performance in poultry (Chamblee et al., 1992) and to cause a decrease in the rate of protein synthesis in the skeletal muscle and protein accretion (Hentges et al., 1984). It was shown that oral vaccination of chicks for Newcastle disease and infectious bronchitis resulted in decreased protein synthesis and protein accretion in the skeletal muscle (Hentges et al., 1984). It was hypothesized that the growth suppression through vaccination would be prevented by using a dietary supplementation of CLA or different oils. This experiment was carried out to determine the effects of dietary CLA or different vegetable oils on growth performance in male broiler chicks vaccinated with La Sota Newcastle vaccine.

Materials and Methods

Four hundred 1-day-old Ross PM3 broiler chicks were obtained from a commercial hatchery and were housed in room with a 24 hour constant fluorescent lighting. At the end of one week of feeding, sexes of the broiler chicks were determined. One hundred seventy five 1-week old Ross PM3 male chicks were randomly distributed into five dietary groups (35 chicks per group) and fed a diet supplemented with 0.5% sunflower oil (Group A), 0.5% olive oil (Group B), 0.5 % beef tallow (Group C), 0.5% CLA (Group D) or 0.5% hazelnut oil (Group E) for 5 weeks. Chemical analysis of the commercial starter diet: Dry matter, 88%; crude protein, 23%; crude cellulose, 6%; ash, 8%, NaCL, 0.35%, calcium, 1-1.5%, phosphorus, 0.7%; lysine, 1.2%; methionine, 0.50%; cysteine, 0.40%; metabolic energy, 3100 kcal/kg; vitamin A, 8000 IU/kg; vitamin D_3, 800 IU/kg; vitamin E, 15 mg/kg; vitamin K_3, 2 mg/kg; mangan, 60 mg/kg; zinc, 40 mg/kg. Chemical analysis of the commercial grower diet: Dry matter, 88%; crude protein, 22%; crude cellulose, 6%; ash, 8%, NaCL, 0.35%, calcium, 1-1.5%, phosphorus, 0.7%; lysine, 1.1%; methionine, 0.50%; cysteine, 0.40%; metabolic energy, 3100 kcal/kg; vitamin A, 8000 IU/kg; vitamin D_3, 800 IU/kg; vitamin E, 15 mg/kg; vitamin K_3, 2 mg/kg; mangan, 60 mg/kg; zinc, 40 mg/kg; vitamin B-2, 4mg/kg; vitamin B-12, 10mg/kg. Chemical analysis of the commercial finisher diet: Dry matter, 88%; crude protein, 20%; crude cellulose, 6%; ash, 8%, NaCL, 0.35%, calcium, 0.9-1.5%, phosphorus, 0.65%; lysine, 1%; methionine, 0.40%; cysteine, 0.30%; metabolic energy, 3100 kcal/kg; vitamin A, 8000 IU/kg; vitamin D_3, 800 IU/kg; vitamin E, 15 mg/kg; vitamin K_3, 2 mg/kg; mangan, 60 mg/kg; zinc, 40 mg/kg; vitamin B-2, 4mg/kg; vitamin B-12, 10mg/kg.

The birds were allowed *ad libitum* access to feed and water and maintained on a 24-hour constant lighting program. At the 22^{nd} days of age, water was withdrawn for 4 hours before vaccination. Broiler chicks were vaccinated with La Sota vaccine mixed in unchlorinated water. Body weights of broiler chicks were measured weekly. Mortality in the groups were recorded daily. At the end of the study, broiler chicks were slaughtered and carcass weight and weight of some organ weights were determined.

Statistical Analysis: In this study, data for broiler performance and organ weights were analyzed by using the general linear models procedure and differences were considered significant at the level of P<0.05.

Results

Table 1 represents the effects of dietary oils on the performance of the broiler chickens vaccinated against Newcastle disease. There is no significant difference among the body weights in the groups until vaccination. However, after vaccination on the 22 days of age, the body weight performances were significantly influenced in all groups, except the Group D. Diet supplemented with 0.5% CLA (Group D) significantly prevented vaccine induced decrease in the body performance (P<0.05).

Table 1: The effects of [1]dietary treatments on the body performance on weekly basis in male broiler chickens

	Dietary Treatments				
Weeks	**Group A**	**Group B**	**Group C**	**Group D**	**Group E**
1	191.5	186.5	195.4	192.9	189.9
2	500.6	507.5	513.3	516.2	499.1
3	1025.2	1066.5	1051.3	1072.2	1028.2
4	1520.5[b]	1575.2[ab]	1566.2[ab]	1608.9[a]	1516.6[b]
5	2068.2[b]	2128.1[ab]	2073.2[b]	2163.3[a]	2037.8[b]

[1]Dietary treatments: Commercial diets supplemented with 0.5% sunflower oil (Group A), 0.5% olive oil (Group B), 0.5% beef tallow (Group C), 0.5% CLA (Group D) or 0.5% hazelnut oil.

Table 2 shows the effects of dietary oils on body performance and carcass characteristics in male broiler chickens. Final body weights of broilers from the Group A, Group C and Group E were significantly lower than those from the CLA-fed broilers ($P<0.05$). Dietary CLA at the level of 0.5% significantly reduced body weight losses in the broiler chicks ($P<0.05$). Also eviscerated carcass weights in the Group D were significantly higher than the other groups ($P<0.05$). The proportions of body parts and abdominal adipose tissue did not differ among the groups.

Table 2: The effect of [1]dietary treatments on the performance and body parts of male broilers

	Dietary Treatments				
	Group A	Group B	Group C	Group D	Group E
Initial B.W., g	192.1	187.8	194.8	192.1	190.3
Final BW, g	2068.2[b]	2128.1[ab]	2073.2[b]	2163.3[a]	2037.8[b]
[2]Eviscerated carcass, g	1548.6[b]	1574.1[b]	1531.5[b]	1648.2[a]	1509.3[b]
Neck (%)	4.68	4.65	5.17	5.04	5.05
[3]Breast (%)	32.41	33.75	32.43	33.24	33.26
[3]Leg (%)	28.97	27.99	29.15	28.55	28.19
[3]Wing (%)	10.71	10.49	10.76	10.26	10.76
Back	23.24	23.11	22.49	22.92	22.75
Abdominal fat (%)	1.36	1.53	1.46	1.42	1.56

[1]Diets were given *ad libitum* to the animals for 5 weeks. Commercial diets supplemented with 0.5% sunflower oil (Group A), 0.5% olive oil (Group B), 0.5% beef tallow (Group C), 0.5% CLA (Group D) or 0.5% hazelnut oil. The CLA source contained 60% CLA.
[2]Eviscerated carcass= carcass without head, internal organs, abdominal fat and feet
[3]Percentage of eviscerated carcass [a, b]Means within a row lacking a common superscript differ ($P<0.05$)

The effects of dietary treatments on the percentage of organ weights of male broilers were observed in the Table 3. There were no significant difference in the proportions of liver, heart and intestine of male broilers from Group A, Group B, Group C, Group D or Group E. However, the proportion of the gizzard from Group C was found significantly higher than other groups ($P<0.05$).

Table 3: Percentage of organ weights of male broilers fed [1]diets supplemented with different oils for 5 weeks.

	Dietary Treatments				
	Group A	**Group B**	**Group C**	**Group D**	**Group E**
Liver (%)	2.70	2.55	2.60	2.52	2.57
Heart (%)	0.81	0.79	0.83	0.79	0.79
Gizzard (%)	1.87^{b}	1.84^{b}	2.17^{a}	1.82^{b}	1.87^{b}
Intestine (%)	5.81	5.56	5.61	5.48	5.50

[1]Commercial diets supplemented with 0.5% sunflower oil (Group A), 0.5% olive oil (Group B), 0.5% beef tallow (Group C), 0.5% CLA (Group D) or 0.5% hazelnut oil.
[a,b]Means within a row lacking a common superscript differ ($P<0.05$)

Discussion

The possibilities of immune stimulants in growing poultry are numerous and could induce antigen exposure from cuts, management procedure (toe and beak trimming) and stimulants in the air, water and feed (Cook et al., 1993). One of the immune stimulants was reported to be vaccination procedure against disease outbreaks (Chamblee et al., 1992). As the vaccination against deadly Newcastle virus prevents mortality, weight losses in chickens are being neglected in poultry industry. Actually, vaccination of chicks was reported to cause a decrease in the rate of protein synthesis in the skeletal muscle and protein accretion (Hentges et al., 1984). It was reported that stimulation of the immune system by a wide variety of immunogens decreases feed intake, feed conversion rate and weight gain in growing chicks (Klasing et al., 1987). In the present study, broilers fed a diet containing 0.5% CLA significantly prevented vaccine-induced reductions in the body weights. Following immune stimulation, cytokines of interleukin-1 (IL-1) and tumor necrosis factor (TNF-α) released by macrophages induce degradation of skeletal muscle and decrease muscle synthesis (Klasing et al., 1987). It was reported that IL-1 stimulated the production of muscle prostaglandin E_2 (PGE_2) (Hellerstein et al., 1989) which is an elongated desaturated product of linoleic acid. IL-1 is a cytokine produced by macrophages following immune stimulation and is capable of decreasing rate of gain and feed intake (Klasing et al., 1987). In a study conducted in the rats, it was shown that rats fed a diet containing fish oil did not exhibit a characteristic depression in feed intake when injected with IL-1 (Hellerstein et al., 1989). Application of PGE_2 directly into muscle also caused a wasting process (Rodemann and Goldberg, 1982). Two eicosanoids important in the inflammatory response are PGE series and leukotrienes of the B series (Korver and Klasing, 1997). After feeding diets containing 0 (control), 0.5 or 1% CLA for 3 weeks, there was a trend toward a reduction in the release of leukotriene B4 (LTB4) from the exudates cells in response to the dietary CLA levels (Sugano et al., 1998).

Studies involving fish oil and CLA illustrated possible means of modulating the growth suppressive effects resulting from immune induced alterations in the nutrient metabolism. Omega-3 fatty acids are generally known to decrease the levels of pro-inflammatory cytokines (IL-1, IL-6 and TNF-α), etc.) and increase anti-inflammatory cytokines (e.g. interleukin-2, IL-2) (Chandrasekar and Fernandes, 1994). In a study conducted in mice, it was reported that CLA supplementation resulted in increased T-cell proliferation and enhanced IL-2 by splenocytes (Hayek et al., 1999). Previously, dietary CLA was reported to decrease production of prostaglandins in a number of tissues (Whigham et al., 1998; Cunningham et al., 1997). Another study conducted in early weaning pigs suggested that dietary CLA enhances cellular immunity by modulating phenotype and effector functions of $CD8^+$ cells involved in both adaptive and innate immunity (Bassaganya-Riera et al., 2001). It was reported that t-10, c-12 CLA, bout not c-9, t-11 CLA, was an active isomer of CLA to enhance Ig production *in vivo* (Yamasaki et al., 2003). In a study conducted in rats, it was shown that splenic levels of immunoglobulins A (IgA), IgG, and IgM increased while those of IgE decreased significantly in animals fed 1% CLA diet (Sugano et al., 1998).

Previously, the ability of CLA to prevent immune induced decreases in growth was investigated (Cook et al., 1993). It was shown that growth suppression induced by the injection of endotoxin was markedly reduced in mice and chickens fed diets supplemented with CLA (Cook et al., 1993). CLA which is a group of positional and geometrical isomers of linoleic acid (18:2, n-6) was found to be more effective to alleviate the effects of endotoxin injection on the growth rate compared to the fish oil. In that study, it was shown that mice fed a basal diet or diet with 0.5% fish oil lost twice as much as body weight after endotoxin injection than mice fed CLA (Miller et al., 1994). It was hypothesized that dietary CLA protected against cytokine-induced muscle wasting by altering the eicosanoid metabolism pathway (Cook et al., 1993). In the present study, dietary oils except CLA did not prevent vaccine-induced losses in the body weights. Broiler chickens fed a diet supplemented at the level of 0.5% significantly had greater body weight gain than the other groups ($P<0.05$). This may be due to prevention of the catabolic activity of immune stimulation by feeding CLA in the broilers (Cook et al., 1993). In the present study, feeding 0.5% hazelnut oil (high in 18:3, n-3) was not effective to prevent vaccine-induced body weight loss.

In conclusion, after vaccination, growth rate in the broilers from the Group A and Group E was negatively influenced compared to the other groups. The relative organ weights of the broilers did not differ significantly among the dietary treatments. This study showed that the broiler chicks fed a diet supplemented with CLA had better performance and carcass weights ($P<0.05$). The present study also indicated that dietary CLA at the level of 0.5% protected weight loss against vaccination.

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