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Influence of Soybean Oil on Growth Performance, Carcass Properties, Abdominal Fat Deposition and Humoral Immune Response in Male Broiler Chickens

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Abstract: An experiment was conducted to evaluate the effects of different levels of Soybean Oil (SBO) (2, 4 and 6% of diets) on growth performance, carcass properties, abdominal fat deposition and humoral immune response in male broiler chickens. One hundred and fifty, 7-day -old male broiler chicken (Cobb 500) were randomly distributed to 3 treatment with 5 replication. The production parameters including Body Weight Gain (BWG), Feed Intake (FI) and Feed Conversation Ratio (FCR) were monitored weekly and the carcass properties and abdominal fat deposition were measured in different slaughter age (28 and 42 day). All diets were isocaloric and isonitrogenic. BWG, FCR, FI and carcass properties was significantly ($p<0.05$) improved with the increase of soybean oil levels in broiler chicken diets. But, these increases were not significant between 4 and 6 SBO levels. The experiment diet contain 4% SBO had a higher FI in 7-21 and 7-42 days of age. The birds fed with diets contain 2 and 6% SBO had lowest and highest FCR, respectively ($p<0.05$). Also, the birds feed with 6% SBO had a highest carcass, thigh and breast yield percentage than other treatments. Although, with the increasing of SBO levels in broiler diets the abdominal fat deposition increased. But, there was not significant difference between treatments in abdominal fat deposition. Antibody titers production against Infections Bursal Disease Virus (IBDV) was significantly ($p<0.05$) affected by dietary treatments. And with addition of SBO to diets, it's increased ($p<0.05$). The results of this experiment suggests that the increasing of SBO levels in broiler diets improved growth performance, carcass and parts of carcass yield and enhanced humoral immune response.

Key words: SBO, growth performance, carcass properties, abdominal fat deposition, humoral immune response, broiler chickens

INTRODUCTION

Fats are dense sources of energy and have the highest caloric value among all the nutrients. Fats are frequently included in poultry diets to increase the energy density (Pinchasv and Nir, 1992; Sanz *et al*., 1999). Also, fats have been to be a practical and economical means by which to increase energy levels in poultry diets (Latour *et al*., 1994; Peebles *et al*., 1997). The addition of fat to diets, besides supplying energy, improves the absorption of fat-soluble vitamins, diminishes the pulverulence, increases the palatability of the rations and increases the efficiency of the consumed energy (lower caloric increment). Furthermore, it reduces the passage rate of the digesta in the gastrointestinal tract, which allows a better absorption of all nutrients present in the diet. Scaife *et al*. (1994) reported that the birds fed with rations containing different sources of lipids (beef, tallow, soybean oil, marine oil, fish oil or mixture of these oils) and observed that live weight was significantly higher when soybean oil was used. The supplementation of broiler diets with small quantities of fats and oils is longstanding practice for improving the consistency and palatability of mash (Summers and Lesson, 1979) increasing the energy density of broiler meat and stimulating growth and the utilization of food and energy (Rand *et al*., 1958; Dam *et al*., 1959; Carew and Hill., 1964; Vermeersch and Vanschoubroek, 1968). Fats also provide varying quantities of the essential nutrient linoleic acid (Lesson and Summers, 2001). Another important role of fats in diet is its inhibition from *de novo* lipogenesis in broiler chickens (Yeh and Leveille, 1971) that could increase energy efficiency in diets. Soybean oil is rich of poly unsaturated fatty acid of n-6 series. Feeding Conjugated Linoleic Acid (CLA) at a low level produced a rapid, marked decrease in fat accumulation, but increased in protein content without any major effects on food intake. Rats fed 0.5% CLA in a diet had significantly reduced body fat, but increased whole body protein, water and ash. Dietary CLA is also reported to improve feed e fficiency in rats. Deaton *et al*. (1981) and

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Crespo *et al.* (2001) reported that, in males abdominal fat increased with increased fat concentration. But, some researchers did not find any effect of dietary fat concentration when energy to protein ratio remained constant (Fuller and Rendon, 1997; Sizemore and Siegel, 1993).

The objective of this experiment was to evaluate the effects of different levels of soybean oil in isocaloric and isonitrogenic diets on growth performance, carcass properties, abdominal fat deposition and humoral immune response in broiler chickens.

MATERIALS AND METHODS

All chicks (coob-5oo) obtained from hatchery fed with standard diet (NRC, 1984) in during of 1st week. On 7 day the chicks were individually weighed, 150 cockerels with same weight randomly reassigned to 15 floor pens (1×1.2 m with 10 cockerel chicks each). This experiment was carried out at the Application Research Farm of the Agricultural Faculty, Uremia University. Three isocaloric and isonitrogenous dietary treatments (2, 4 and 6% SBO) were randomly assigned to the 5 groups of chicks. The composition and calculated nutrient levels for the dietary treatments is shown in Table 1. The diets were formulated to meet the nutrient requirement of the broiler during the starter (7-21 days) and grower (22-42 days) periods according to the National Research Council (NRC, 1984). The chicks had *ad-libitum* access to water and mash form of experimental diets and the birds were supplied with 24 h of light daily. The temperature of the room was maintained at 33°C initially and reduced by 3°C week^{-1} until it reached 21°C, at which temperature the room was maintained for the rest of feeding period. BW, FI, FCR were measured each week. At 28 and 42 day of age, 3 broiler chickens of each floor pens (15 chicks per treatment) were randomly selected; the birds were fasted for 10-12 h prior slaughter. The chicks individually weighed and killed by neck cut. The carcasses were opened and internal organs and abdominal fat pads (adipose tissues surrounding the gizzard, bursa of faberciuse, cloacae and adjacent muscles) were removed and weighed. The percentage of carcasses yield was calculated as a percentage of live weight and the thigh and breast yield and abdominal fat percentage was determined as a percentage of carcass weight. An immunization test was carried out to evaluate the effect of SBO on the immune system of broiler chickens. A live and inactivated IBDV vaccine was applied to the birds in their drinking water on 24 day of the experiment. Seven day after immunization, 3 chickens of each pen were randomly selected and killed by neck cut. Blood samples from 36 chickens were collected and the serum was separated. The tiers of IBDV antibody in serum were measured by ELIZA test as described. Briefly, the IBDV antigen coated plates obtained from IDEXX were allowed to react with the known positive, negative and test serum samples from various treatment groups. After adding the labeled (Horse Radish Peroxidase) goat anti-chicken (H and L chains) against the IBDV antibody and incubating the plates at room temperature for 30 min, the reaction was then stopped by adding Nitric acid (HNO3). With the help of ELISA reader the optical densities of the well of the plates were determined and used to calculate S/P ratio by using following formula.

Table 1: Ingredient (%) and nutrient content of the basal diets

Ingredient	Starter (7-21 day)			Grower (21-42 day)		
Corn	57.6	50.5	44.3	61.43	54.4	48.18
Soybean meal	36.3	35.5	36.32	27.47	26.8	27.5
Wheat bran	-	6.1	7.12	5.54	11.25	12.5
Soybean oil	2	4	6	2	4	6
Sand	-	-	2.34	-	-	2.24
Limestone	1.33	1.29	1.26	1.57	1.57	1.56
Dicalcium phosphate	1.5	1.415	1.42	0.99	0.972	0.974
Vitamin-mineral premix	0.5	0.5	0.5	0.5	0.5	0.5
Salt (NaCl)	0.45	0.42	0.42	0.32	0.31	0.31
DL- methionine	0.27	0.25	0.28	0.18	0.18	0.2
Antioxidant (BHT)	0.0073	0.015	0.022	0.0073	0.015	0.022
Vitamin E	0.005	0.01	0.015	0.005	0.01	0.015
Calculated composition						
Crude protein, %	21	21	21	18.28	18.28	18.28
Crude fiber	3.81	4.27	4.3	3.88	4.31	4.36
Lysine, %	1.13	1.123	1.13	0.933	0.933	0.94
Met+Cys, %	0.94	0.944	0.94	0.78	0.78	0.79
Metabolizable energy, k cal kg^{-1}	2.925	2.925	2.925	2.925	2.925	2.925
Ca, %	0.96	0.914	0.914	0.92	0.92	0.92
Nonphytin P, %	0.434	0.412	0.412	0.32	0.32	0.32

All data were analyzed by using GLM producers of SAS (1999) for completely randomized experimental design. Differences between means were determined by Duncan's multiple range test at significance level of (p<0.05).

RESULTS AND DISCUSSION

This study was carried out to evaluate the effect of different level of Soybean Oil (SBO) on BWG, FI, FCR and humoral immune response. The results presented in Table 2 and 3. The effects of SBO supplementation on BW, FI, FCR, carcass properties and abdominal fat deposition are presented in Table 1. Initially, there was significant difference in the BWG among dietary treatments from 7-21 day of age. But, this significant difference was not followed from 21-42 day. The birds fed with 2, 4 and 6% SBO were heavier, respectively. From 7-42 day there was significant difference among 2% SBO diet with 4 and 6 SBO diets. But this difference was not significant among 4 and 6% SBO diets. In general, BWG was increased with the increase of SBO levels in broiler diet. The chickens fed with 2 and 4% SBO had lowest and highest BWG, respectively.

Feed intake of birds fed diet supplemented with 4 and 6% of soybean oil were significantly higher than birds fed the diet contain 2% SBO. The lowest feed intake was found in the birds that consumed 2% SBO while the highest was from the birds receiving 4% SBO (except from 7-21 day) of age. The Feed Conversation Ratio (FCR) improved significantly (p<0.05) with the increase of soybean oil levels in broiler diets. But, this improvement was not significant between the birds of fed diet supplemented with 4 and 6% of SBO. Carcass yield, thigh yield and breast yield with the increase of soybean oil in bird diets was significantly (p<0.05) improved but, in generally, this improvement was not significant between 4 and 6% of SBO diets. At 28 and 42 day of slaughter age, the abdominal fat with the increase of soybean oil values in broiler diets was increased (p>0.05).

There was a linear increase (p<0.05) in BWG with the addition of soybean oil in broiler diets. Vieira *et al.* (2002) evaluated broiler rations containing 0, 4 and 8% of soybean oil and acidulated soybean oil soapstock and observed similar weight gain between the different lipidic sources and improved feed conversion in birds fed with soybean oil in comparison to the birds fed with acidulated soybean oil soapstock. They also observed a reduction in feed intake of birds fed with acidulated soybean oil soapstock when the inclusion level was increased from 4-8%, whereas no reduction in feed intake was observed in birds fed with soybean oil.

Table 2: Effects of different level of SBO on growth performance in broiler chickens

Parameters	2% oil	4% oil	6% oil	SEM
Body weight gain				
7-21	564.5[c]	586[b]	595[a]	0.95
21-42	1530[a]	1566[a]	1549[a]	4.2
7-42	2094[b]	2187[a]	2203[a]	2.7
Feed intake				
7-21	875[b]	898[a]	903[a]	1.49
21-42	3006[b]	3051[a]	3015[b]	2.89
7-42	3882[b]	3960[a]	3940[a]	2.4
FCR				
7-21	1.56[a]	1.53[b]	1.52[b]	0.0017
21-42	1.97[a]	1.95[a]	1.94[a]	0.0053
7-42	1.85[a]	1.81[ab]	1.78[b]	0.005

Means[abc] within a row with no common superscript differ significantly (p<0.05)

Table 3: Effects of different levels of SBO on carcass properties, abdominal fat deposition and anti body tier production against IBDV

Parameters		2% oil	4% oil	6% oil	SEM
Carcass yield	28-d	74[b]	76.33[a]	76.17[a]	0.18
	42-d	76.83[b]	78.5[ab]	79[ab]	0.28
Thigh yield	28-d	25[c]	27.67[bc]	29.67[a]	0.13
	42-d	25.67[d]	29[ab]	30.33[a]	0.25
Breast yield	28-d	26.33[d]	28.67[ab]	29.33[a]	0.13
	42-d	24.33[d]	27.1[bc]	29.33[a]	0.14
Abdominal fat %	28-d	2.71[ab]	2.83[ab]	3.15[a]	0.047
	42-d	3.38[a]	3.5[a]	3.73[a]	0.081
Antibody titer	28-d	1234[c]	1487[b]	1834[a]	69.5

Means[abc] within a row with no common superscript differ significantly (p<0.05)

Soybean oil stimulated growth rate of chicks when included in certain types of poultry diets (Carew *et al.*, 1961). Unsaturated vegetable fat or oils are more energetic than saturated animal fat.

The addition of fats or oils to diets causes to increase the animal tendencies for diet consumption and subsequently, energy consumption volume and other nutrients was increased and at least cause to increase the BWG in bird (Ensminger *et al.*, 1990; Manillan *et al.*, 1999). The increase in BWG is mostly due to higher ME consumption in same unit of diets by chickens. On the other hand, addition of fats to diets reduces the digesta passage rate in the gastrointestinal tract (Mateos *et al.*, 1982; Ketels *et al.*, 1986) which allows a better absorption of all nutrients present in the diet. Because the passage rate of digesta can be influence on energy production of diet. Fat or oil with decreasing the dust state of diet and, with improving the apparent of diets causes to increase the tendency of bird for consumption. Because, the physical composition of diets can be effective on food consumption. For example plating increased the feed intake.

The addition of oil in broiler diet was significantly improved the FCR in broiler chickens. Improvements in FCR could be due to better energy utilization of diets contain fat. In generally, parts of body yield include thigh and breast have highly correlation with carcass yield. The addition of high oil levels to diets results that; the birds can not regulate the feed intake content on requirement energy. Consequently, is consumed more feed by bird.

Humoral immune response: Anti body titer production against IBDV in birds supplemented with dietary experiments was significantly ($p<0.05$) differed. And, with increasing of SBO levels in broiler diets, the anti body titer production against IBDV increased ($p<0.05$). In animals since nutrients are selection for rapid growth has compromised immunity in animal since nutrients are allocated for growth (Cook, 2000). Therefore, manipulation of specific nutrients to enhance immunity is of great interest. Fat composition of diets, along with protein, has a significantly role in health through its content of fatty acids, cholesterol and fat-soluble vitamins. Vegetable oils especially, SBO is rich in $18_{2n\text{-}6}$ PUFA (linoleic acid), oleic acid and low in n-3 PUFA and Saturated Fatty Acids (SFA). The essential fatty acid for poultry is linoleic acid. Also, linolenic acid may be required, but the minimal requirement for linolenic acid is unknown. In birds, a deficiency in linoleic acid (18:2), α-linolenic acid (18:3) and arachidonic acid (20:4) reduced the production of eicosanoides and hampers normal growth and health (Watkins, 1991). Both n-6 and n-3 PUFA are precursors for eicosanoides. Eicosanoides are biologically active hormones with a short half-life and included Prostaglandins (PGs), Leukotrienes(LTs), lipoxins and tramboxsans. Eicosanoides are precursors for PGs and LTs (Samuelsson, 1983). Prostaglandin (PG) and Leukotrienes (LT) have potent immunomodulatory roles. In general, PGs and LTs from the n-3 fatty acids have less potent biological effects than their n-6 counter parts (Calder, 1997). Therefore, higher levels of n-3 metabolites may be required to have the same physiological effects as n-6 metabolites. Prostaglandin E2 modulates the production of interleukin (IL)-1 and Tumor Necrosis Factor (TNF) (Kinsella *et al.*, 1990). Leukotriene B4 augments T and B cell proliferation, natural killer cell activity and cytokine release from monocytes and T cells and acts as a potent chemoattractant (Rola-Pleszczynski, 1989). The principal precursor of eisosanoids in mammals (Horrobin, 1983) and poultry (Watkins, 1991) is arachidonic acid (AA, C20:4n-6). Betz reported that PGE_2 enhances humoral immunity while suppressing cellular immunity. Interestingly, at low concentration, PGE_2 boosts cell-mediated immunity while suppressing at high concentration (Merin and Mertin; Clissold). Eicosanoids govern the production of pro-inflammatory cytokins such as IL-1, TNF and IL-6 (Endress, 1996). PGE_2 and LTB_4 drived from the n-6 arechidonic acid regulate cytokine production and shift the balance favoring T-helper-2 from T helper cell cytokine profiles. Parmentire *et al.* (1997) reported that the n-6 linoleic acid enhanced antibody response to SRBC while the n-3 α-linolenic acids decreased antibody response to bovines serum albumin in chickens genetically selected for humoral immunity. Weng (2002) reported that dietary SBO enhanced T- and B- cell proliferation by CONA and LPS, respectively. And the birds fed with SBO significantly had higher antibody titer production against Sheep Red Blood Cell (SRBC). Antibody response was found in broilers fed low levels of linoleic acid. Increasing dietary linoleic acid increased arachidonic acid in macrophages and PGE_2 synthesis (Johnston, 1988; Kinsella *et al.*, 1990). Adeficiency of linoleic acid, on the contary, reduced AA and eicosanoid production by macrophages and reduced *in vitro* lymphocyte proliferation, Il-2 production and leucocyte chemotaxis (Kinsella *et al.*, 1990; Lefkowith, 1990). However, high n-6 dietary PUFA intake and high *in vitro* dosages depressed immune responses *in vitro*: lymphocyte proliferation (Calder *et al.*, 1992; Soyland *et al.*, 1993), Il-1 and Il-2 production (Yaqoob and Calder, 1993) and *in vivo* hypersensitivity and Ab production (Friend *et al.*, 1980). The consumption of SBO (rich in n-6 PUFAs) resulted increase of PGE_2 synthesis and PGE_2 is a key lipid mediator secreted by macrophages, fibroblasts and epithelial cells and is a pro-inflammatory factor inducing inflammatory response (Calder *et al.*, 2002). It seems that the enhancement of immunity by consumption of SBO in birds may be due to the high concentration of Conjugated Linoleic Acid (CLA). The immunity effect of CLA is reported by much work (Hayek *et al.*, 1999).

CONCLUSION

Addition of SBO in broiler chicken diets improved the growth performance, carcass properties and enhanced humoral immune response. Increasing of SBO in poultry diets increased the n-6 PUFA concentration in diets, which can increase the eicosanoides generation of arachidonic acid (archidonic acid synthesized of linoleic acid). Eicosanoides are precursors for prostaglandins and leukotriens. Prostaglandin (PG) and Leukotrienes (LT) have potent immunomodulatory roles. On the other hand, linoleic acid especially (CLA) has potential health benefit such as anticarcinogenic, antiatherogenic, antidiabetic and antiadipogenic effects. And, improved the growth performance, feed efficiency, decreased abdominal fat deposition and enhanced immune response.

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