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EFFECT OF DIETARY HIGH LEVELS OF HEAT TREATED LOCALLY PRODUCED FLAXSEEDS ON BODY WEIGHT GAIN AND IMMUNE RESPONSE OF PRE-LAYER LOCAL CHICKEN

By

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Abstract*:* *The effects of dietary high levels of heat treated locally produced flaxseeds on body weight gain, and immune response were evaluated using local Saudi chicken during the pre-laying period (17-23 wk). Diets were formulated included locally produced heat treated flaxseed roasted at 60˚C for 5 minutes to have 5 dietary levels 0, 10, 20, 30, and 40 % of flaxseed. Each diet was fed to 50 experimental birds randomly assigned in 5 replicates from 17 to 23 wk of age. Dietary treatments had no significant effect on body weight, or delayed hypersensitivity response to bovine serum albumin (BSA). The effect of flaxseeds level on body weight gain at the end of the experimental period was significant ($P<0.05$), especially when effect of the bird sex was concerned. Antibody production against Sheep red blood cells (SRBC) at 3d post injection was significantly ($P\leq 0.05$) affected by 40% level flaxseed diet. Late antibody production at 10d post injection recorded significantly lower antibody titer ($P\leq 0.05$) against SRBC of the birds fed 10% heat treated flaxseed when compared to the control group. Correlation coefficient between body weight and antibody response to SRBC showed a general negative trend of correlation allover experimental period with significant values ($P\leq 0.05$) at some of the experimental measuring points. It is concluded that dietary high levels of heat treated locally produced flaxseeds has a limited pronounced effect on antibody response against SRBC and weight gain on local Saudi chicken at the pre-laying period.*

INTRODUCTION

Recently, there has been an increased interest concerning the use of polyunsaturated fatty acids (PUFA) in poultry rations and its effect on different performance characters. The use of flaxseed as a source of n-3 and n-6 polyunsaturated fatty acids (PUFA) in poultry rations has been reported by (Caston and Lesson, 1990; Aymond and VanElswyk, 1995; Lesson *et al.*, 2000; Wang *et al.*, 2000; Novak and Scheideler, 2001; Bean and Lesson, 2002; Soliman *et al.*, 2003; Ramesh and Gita, 2004; Najib and Al-Yousef, pending for publication). Previous studies have shown that feed consumption was significantly greater for hens fed flaxseed (Caston *et al.*, 1994) however, Ramesh and Gita (2004) reported no differences in feed consumption between control, and hens fed flaxseed, nevertheless, significant lower feed consumption has been noticed with flaxseed-fed hens (Scheideler and Froning, 1996; Novak and Scheideler, 2001). Different researches reported that flaxseed consumption had negative effect on body weight at different ages of birds fed different feeding levels of flax seeds (Scheideler *et al.*, 1998; Lesson *et al.*, 2000; Novak and Scheideler, 2001; Bean and Lesson, 2002; Bean and Lesson, 2003). While, using different dietary ratio of linoleic: linolenic had no effect on body weight of pullets (Puthpongsiriporn and Scheideler, 2005) or growing layer hens (Sijben *et al.*, 2000). Strain showed a significant effect on antibody production but not on body weight of pullets fed different dietary ratio of linoleic: linolenic acid (Puthpongsiriporn and Scheideler, 2005) whereas a significant strain main effect have been reported in pullets fed flaxseeds at some production phases (Novak and Scheideler,2001).

Selected line of chickens for antibody production against Sheep red blood cells (SRBC) showed significant line effect, regardless of dietary ration with PUFA (Parmentier *et al.*, 1997). Many studies have reported that poultry feed containing PUFA can modulate a wide range of immune response (Parmentier *et al.*, 1997; Sijben *et al.*, 2000; Sijben *et al.*, 2001a; Wang *et al.*, 2004; Puthpongsiriporn and Scheideler, 2005). Rich n-3 PUFA diets can increase antibody response and decrease lymphocyte proliferation (Fritsche *et al.*, 1991), increase delayed hypersensitivity (Krover and Klasing, 1997), increase production of the total IgG in blood serum (Wang *et al.*, 2000),and decrease antibody production against Bovine serum albumin (BSA) in broiler chicks (Friedman and Sklan, 1995) .

This research was conducted to study the effect of feeding different levels of locally produced heat-treated flax seeds during the pre-laying period (17 - 23 weeks of age) on body weight gain and immune response of Saudi local chickens.

MATERIALS AND METHODS

Birds and housing:

Two hundred 17-wk-old local Saudi breed hens and fifty males were raised at King Faisal University Experimental Station. All birds were randomly divided into five dietary treatments including control group, 40 females and 10 males per group. Each treatment was replicated five times. Birds were housed ten per cage (490 cm^2 floor space per bird) in a five levels cage system. Feed and water were provided *ad libitum*. Cages were placed in an open house with ventilation fans. Birds were exposed to the natural out of season daylight during the experimental time. Feed weight backs for each cage were weighed once a weekly to monitor feed consumption.

Diets:

Birds were fed a standard grower diet till 16 wks of age. At 17 wks of age birds were fed the experimental diets, which were formulated to meet the nutrient requirements for poultry of the National research council, 1994 (NRC). Experimental diets were formulated and mixed to contain heat treated locally produced flaxseeds including seed shells in the following levels 0, 10, 20, 30 and 40% (Table 1). Flaxseed was roasted at 60˚C for 5 minutes. This exposure time was enough to allow seed shells to rupture.

Parameters and data collection:

Feed was provided daily *ad libitum* for each cage. Unconsumed feed was collected and weighed at the end of each week per each cage. Total feed consumption was recorded for each cage weekly. All birds were weighed individually to the nearest 10 g on a weekly basis for a period of six weeks. After four weeks of feeding experimental diets, all birds were intramuscularly injected with 1 ml of 15% sheep red blood cells (SRBC) suspended in phosphate buffer saline. Blood samples were obtained from peripheral vein of the wing of each bird at 3, 7, and 10 days after immunization. Serum samples were collected after centrifugation (3000 rpm, 3min) they were stored at -20˚C until the assays were run simultaneously. The SRBC antibodies were assayed using micro heamaglutination (Nelson *et. al.* 1995). The agglutination titer was expressed as the $\log_2$ of the reciprocal of the highest serum dilution giving complete agglutination. Titrations were assessed in 96- well micro plates.

After six weeks of feeding experimental diet all cocks were tested for delayed hypersensitivity to bovine serum albumin (BSA) as an indicator for cell mediated immune response. Delayed hypersensitivity tests were achieved through wattle test (York and Fahey 1990). The delayed hypersensitivity test was calculated as a relative response according to the following formula: Relative response = Thickness of wattle after response (BSA response) / thickness of wattle before injection (control).

Statistical analysis:

The experiment was designed as a completely randomized, using five treatments including control group. Data were analyzed using the general linear model procedure of SAS software version 6 (SAS, 1995). Main effect of diet and sex were tested in a 5×2 factorial design of treatment. Interactions between diet levels and sex were obtained. The correlations between body weight and both feed consumption and antibody titer were considered.

RESULTS AND DISCUSSION

Immune response:

Early antibody titer against SRBC at 3d post injection was significantly ($P \leq 0.05$) affected by high level flaxseed diet group (Table 2). Birds fed diet containing 40% flaxseed showed the highest antibody level against SRBC as compared to all diet groups at 3d post injection. At 7d post injection, dietary groups did not affect antibody titer against SRBC. Late antibody production at 10d post injection recorded significant lower antibody titer ($P \leq 0.05$) against SRBC for birds fed 10% heat-treated flaxseed compared to control group, while no differences were observed between the other diet groups. N-6 fatty acids have been reported to act as an immunological stimulant under some circumstances (Puthpongsiriporn and Scheideler, 2005). Prostaglandin E $(PGE)_1$ and $(PGE)_2$,derived from n-6 fatty acid, have shown to induce Th_2 (T-helper 2) cytokines, which help B cells develop into antibody- producing cells (Phipps *et al.*, 1991). By the early high dose of 40% flaxseed in the current study, an early response expected to be stimulated at 3d after the first exposure to the antigen affected by the increase of n-6 fatty acid level in the body due to dietary consumption of locally produced flaxseeds.

Sex effect on antibody responses against SRBC were obvious, female antibody responses were significantly superior ($P \leq 0.01$) over male response to all dietary groups including control group (Table 3). In the current study the late response to SRBC at 10d post injection may be affected by n-3 × n-6 interaction which has immunomodulating effect (Sijben *et al.*, 2001b). The locally produced flaxseed containing 2.4:1 Lenolenic: Lenoleic acid which may not be the optimum ratio between those two fatty acids. The optimum ratio between n-3:n-6 fatty acids have not been established for chicken (Puthpongsiriporn and Scheideler, 2005). The difference due to sex seems to be not related to the dietary treatments. The experimental group is a random part of a local breed flock exposed previously to some mating procedures that may affect the heritable of the immune response capacity in male due to unintentionally high selection intensity within male birds because of low number of male within the flock.

Diet levels have no impact on delayed hypersensitivity test against BSA (Table 2). Dietary linolenic acid has been reported to induce $(PGE)_1$ and $(PGE)_2$ production which inhibits synthesis of Th_1 (T-helper 1) cytokines for cytotoxic T-lymphocyte activity (Harbige and Fisher, 1997). The ratio between PUFA seems to be not at the optimum level to support delayed hypersensitivity at this experimental condition due to the high n6 PUFA in the experimental Locally produced flaxseed. Average delayed hypersensitivity have been previously reported to be low in birds fed diets high in n-6 but low in n-3 or diets high in Lenolenic acid and Lenoleic acid (Sijben *et al.*, 2001b).

Body weight and weight gain:

The effect of feeding different levels of flax seeds during the growing period (17 – 23 wks) was not significant (P>0.05) pertaining to the body weight of the birds. However there was a numerical decrease in body weight with higher level of flax in the diet (Table 4). This result was better shown when body weight was calculated as weight gain during that period (Table 4). The differences were statistically significant (p<0.05), in addition to a significant effect of interaction between flax level in the diet and sex effect of the bird on body weight gain (Table 5 and Fig 1). Lowest gain was observed in females fed 40 % flax seeds. Surprisingly, birds with lowest body weight consumed the highest amount of feed and consequently higher amount of flax. Caston *et al.*, (1994) reported that with an increased level of flaxseeds, there was often an increase in feed intake and a concomitant reduction in body weight. Whether this high level of flax was toxic to the birds is open for speculation. Flax seeds is known to contain anti-nutritional factors such as trypsin inhibitors, phytic acid, mucilage, and cyanogenic glycosides (Madhusudhan *et al.*, 1986; Bhatty, 1993; Rodrigues *et al.*, 2001).

Flax seeds in this experiment were heat treated for 5 minutes at 60 °C in an attempt to eliminate the anti-nutritional factors. Obviously, roasting time and temperature were not enough to completely remove the anti nutritional factors. Bean and Leeson (2002) extruded the flaxseeds at 149 °C for 15 – 20 s. Research conducted in this institute provided evidence that level of flax at 15 % dropped egg production rate in leghorn layers (Najib abd Al-Yousif, pending for publication). Birds used in this experiment were of local origin and have never been subjected to any genetic improvement program. They usually mature late and start laying, when they are 25 weeks of age. This means that treatments were applied as the birds approaching their maturity with many physiological changes occurring at the ovary site preparing for production. At this time the birds need fully balanced ration. Ortiz *et al.*, (2001) concluded that deleterious factors in flaxseeds interact with other dietary ingredients in flax-based diets, resulting in a decrease in diet AME_n. This could lead to a lower body weight.

Correlation coefficient between body weight and antibody response to SRBC showed a general negative trend of correlation all over experimental period with a significant values ($P \leq 0.05$) at some of the experimental measuring points (Table 6).

This study indicates that dietary locally produced heat treated flaxseed at high levels for local Saudi pre-layer chicken slightly affect antibody response to SRBC, and body weight gain in specific measuring points but not delayed hypersensitivity reaction. However, heat-treated locally produced flaxseeds at high levels were not able to induce a high significant immunomodulation, or body weight gain change under the current experimental conditions. The chicken breed, nature of the challenging antigen, the ratio of polyunsaturated fatty acid (PUFA) of the experimental seeds, and the period of growth explained much of the variation between results of such studies. Further studies of feeding PUFA are needed to determine the appropriate ratio of different PUFA ratio for modulate immune response, and changes in body weight gain of the local breed at the pre-layer period.

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Table (1): The feed ingredients and calculated composition of the experimental diets

Feed Ingredients	Flax level in the ration, %				
	0	10	20	30	40
YELLOW CORN	68.34	60.32	52.11	44.00	35.78
SOYBEAN MEAL 48%	20.3	16.85	13.45	10.00	6.60
WHEAT BRAN	8.00	8.00	8.00	8.00	8.00
L.STONE	1.40	1.40	1.40	1.40	1.40
PREMIX	0.25	0.25	0.25	0.25	0.25
DIC.PHO	1.21	1.21	1.21	1.21	1.21
SALT	0.40	0.40	0.40	0.40	0.40
ANTIOXIDANT	0.10	0.10	0.10	0.10	0.10
FLAXSEED	0.00	10.00	20.00	30.00	40.00
sand	0.0	1.47	3.08	4.64	6.26
total	**100**	100	100	100	100
Calculated omposition					
Crude protein	16	16	16	16	16
ME, Kcal/Kg	2850	2850	2850	2850	2850
Calcium	0.95	0.91	0.92	0.94	0.95
Av. Phosphorus	0.35	0.35	0.35	0.35	0.35
Riboflavin	1.77	2.0	2.24	2.48	2.72
Niacin	37.19	38.24	39.29	40.34	41.38
Pantothenic Acid	8.46	7.99	7.52	7.04	6.57
Choline	1090	1263	1437	1611	1785
Methionine	0.27	0.26	0.26	0.26	0.26
Meth + Cyst	0.55	0.50	0.53	0.52	0.51
Lysine	0.83	0.78	0.73	0.68	0.63
Tryptophan	0.22	0.22	0.22	0.23	0.23
Threonine	0.59	1.02	1.46	1.90	2.34

[1] [1]The multi vitamin-minerals premix provide the following per kilogram of diet: 7000000 IU, vit A; 1500000 ICU, vit D3; 30000 IU, vit E; 50000 mg, vit C; 2300 mg, vit K; 1400 mg, vit B1; 5520 mg, vit B2; 2300 mg, vit B6; 12 mg, vit B12; 27600, mg Niacin; 920 mg, Folic acid; 6900 mg, PA; 92 mg, Biotin; 50000 mg, Antioxidant (BHT); 220 mg, Cobalt; 4400 mg, copper; 800 mg, Iodine; 26400 mg, Iron; 44000 mg, Manganese; 180 mg, Selenium; 44000 mg, Zinc.

Table (2): Immune response against SRBC and BSA for different experimental diet groups

	Antibody titer against SRBC			BSA response
Treatment (diet)	**3d post injection**	**7d post injection**	**10d post injection**	
Control	1.85[b**]	3.28	3.15[a]	2.47±0.34
Diet 1*	2.06[b]	3.34	2.61[b]	2.03±0.34
Diet 2	2.02[b]	3.42	3.02[ab]	2.19±0.33
Diet 3	2.02[b]	3.21	2.73[ab]	2.63±0.34
Diet 4	2.4[a]	3.42	2.67[ab]	2.13±0.33

* Diets 1, 2, 3, and 4 are 10, 20, 30 and 40% flaxseeds' levels respectively.
**Values with different superscript within each day postinjection are significantly differ ($P\leq 0.05$)
SRBC: sheep red blood cells
BSA: bovine serum albumin

Table (3): Effect of sex within each experimental diet on immune response against SRBC at 3, 7, and 10 days post injection

			Treatment (diet)				
		Sex	**Control**	**Diet 1***	**Diet 2**	**Diet 3**	**Diet 4**
Antibody titer against SRBC	**3d post injection**	M	1.10	1.70	1.80	1.66	2.80**
		F	2.05**	2.15**	2.08**	2.10**	2.36
	7d post injection	M	3.20	2.10	3.00	2.55	2.90
		F	3.30**	3.66 **	3.54**	3.39**	3.55**
	10d post injection	M	2.55	2.00	2.22	2.28	2.40
		F	3.24**	2.76**	3.22**	2.80**	2.81**

* Diets 1, 2, 3, and 4 are 10, 20, 30 and 40% flaxseeds' levels respectively.
**Values superscript (**) within each diet and day of injection are significantly differ ($P\leq 0.01$)
SRBC: sheep red blood cells

Table (4): The interaction between flaxseed level in the diet and sex of the bird on body weight and body weight gain

Diet × Sex	BW0	BW1	BW2	BW3	BW4	BW5	BW6	BW6-BW0
	NS	NS	NS	NS	NS	NS	NS	*
C M	1014.0±132.5	1141.0±134.5	1319.0±174.6	1374.0±201.1	1422.0±187.2	1446.0±207.8	1471.0±204.0	457.0±117.3
D1 M	1122.0±161.0	1131.0±182.0	1242.0±189.0	1279.0±185.5	1305.0±186.8	1366.0±200.0	1399.0±180.7	277.0±76.4
D2 M	1128.0±120.1	1112.0±122.7	1287.0±144.4	1353.0±156.1	1375.0±158.3	1431.0±168.4	1461.0±149.6	333.0±102.3
D3 M	1107.0±144.1	1096.0±157.9	1229.0±182.5	1299.0±204.1	1369.0±217.6	1430.0±229.0	1449.0±234.1	342.0±121.0
D4 M	1118.0±157.4	1171.0±159.9	1217.0±129.4	1291.0±214.4	1299.0±131.6	1411.0±160.0	1410.0±182.3	292.0±118.5
C F	761.8±92.9	796.5±209.5	867.0±168.7	915.8±98.8	922.5±180.2	901.0±276.0	923.2±326.9	235.5±109.1
D1 F	765.8±126.3	832.5±123.6	871.8±136.2	910.0±142.5	933.8±146.8	945.0±223.3	998.2±172.4	232.5±82.9
D2 F	827.0±115.2	884.5±114.2	917.5±124.6	952.2±114.5	954.2±191.1	937.0±293.8	924.0±375.7	201.0±107.1
D3 F	798.8±125.0	841.2±126.1	863.8±192.1	900.8±192.2	934.2±196.2	954.0±254.2	992.5±266.6	222.8±94.6
D4 F	778.2±100.2	796.8±165.2	850.8±118.8	888.0±124.8	882.5±238.2	919.8±252.0	889.5±333.4	184.0±116.1
P	0.4611	0.2787	0.7489	0.8285	0.7553	0.9077	0.8226	0.0191

C, D1, D2, D3 and D4 = level of flax in the diet; 0, 10, 20, 30, and 40 %. M = Male, F = Female; BW0 = Body weight **at** the beginning of the study,
BW1… BW6 – Body weight of the birds from week 1 to week 6. BW6; BW6 – BW0 = Weight Gain ; NS = Not significant, P>0.05, * = Significant , P<0.05

Table (5): The effect of feeding different levels of flax seeds during growing period (17-23 wk) on body weight and weight gain

Diets	BW0	BW1	BW2	BW3	BW4	BW5	BW6	WG (6-0)
	*	NS	NS	NS	NS	NS	NS	**
Control	812.2[b]	865.4[a]	957.4[a]	1007.4[a]	1022.4[a]	1010.0[a]	1032.8[a]	279.8[a]
Diet 1	837.0[ab]	892.2[a]	945.8[a]	983.8[a]	1008.0[a]	1029.2[a]	1078.4[a]	241.4[ab]
Diet 2	887.2[a]	930.0[a]	991.4[a]	1032[a]	1038.4[a]	1035.8[a]	1031.4[a]	227.4[b]
Diet 3	860.4[ab]	892.2[a]	936.8[a]	980.4[a]	1021.2[a]	1049.2[a]	1083.8[a]	246.6[ab]
Diet 4	846.2[ab]	871.6[a]	924.0[a]	968.6[a]	965.8[a]	1018.0[a]	993.60[a]	205.6[b]
P	0.0468	0.9328	0.3111	0.2799	0.3953	0.9797	0.9017	0.0005
Male	1097.8[a]	1130.2[a]	1258.8[a]	1319.2a	1354.0[a]	1416.8[a]	1438.0[a]	340.2[a]
Female	786.3[b]	830.3[b]	874.15[b]	913.4b	925.4[b]	931.4[b]	945.5[b]	215.2[b]
p	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

BW0… BW6 = Body weight of the birds from week 1 to week 6. WG = Weight Gain ; NS = Not significant,
P>0.05, * = Significant , P<0.05

Table (6): Correlation coefficient between weekly body weight and antibody response to SRBC at 3, 7, and 10 d post injection

Treatment	Antibody response	Weekly body weight					
		wk 1	wk 2	wk 3	wk 4	wk 5	wk 6
Control	3d	-0.26 (0.07)	-0.31 (0.03)	-0.35 (0.01)	-0.34 (0.01)	-0.34 (0.02)	-0.33 (0.02)
	7d	-0.06 (0.67)	-0.05 (0.7)	-0.07 (0.6)	-0.08 (0.5)	-0.09 (0.51)	-0.12 (0.41)
	10d	-0.09 (0.52)	-0.18 (0.2)	-0.28 (0.05)	-0.30 (0.04)	-0.26 (0.07)	-0.59 (0.001)
Diet 1*	3d	0.007 (0.96)	0.003(0.98)	0.005 (0.97)	0.02 (0.85)	0.04 (0.77)	0.06 (0.66)
	7d	-0.19 (0.18)	-0.20 (0.14)	-0.22 (0.12)	-0.20 (0.16)	-0.14 (0.33)	-0.13 (0.36)
	10d	-0.08 (0.54)	-0.06 (0.66)	-0.04 (0.77)	-0.03 (0.83)	-0.01 (0.89)	0.01 (0.90)
Diet 2	3d	-0.01 (0.91)	-0.04 (0.75)	-0.05 (0.72)	-0.07 (0.61)	-0.09 (0.52)	-0.08 (0.56)
	7d	-0.15 (0.29)	-0.13 (0.35)	-0.19 (0.18)	-0.22 (0.12)	-0.19 (0.19)	-0.18 (0.22)
	10d	-0.26 (0.08)	-0.19 (0.18)	-0.29 (0.05)	-0.30 (0.04)	-0.31 (0.03)	-0.62 (0.001)
Diet 3	3d	-0.03 (0.80)	-0.07 (0.60)	-0.08 (0.57)	-0.08 (0.55)	-0.05 (0.69)	-0.03 (0.82)
	7d	-0.21 (0.15)	-0.24 (0.09)	-0.28 (0.05)	-0.29 (0.04)	-0.57 (0.001)	-0.58 (0.001)
	10d	-0.11 (0.46)	-0.15 (0.32)	-0.20 (0.18)	-0.19 (0.22)	-0.17 (0.27)	-0.16 (0.30)
Diet 4	3d	0.17 (0.22)	0.20 (0.16)	0.21 (0.13)	0.22 (0.12)	0.18 (0.22)	0.13 (0.38)
	7d	-0.38 (0.009)	-0.37 (0.01)	-0.30 (0.03)	-0.33 (0.02)	-0.35 (0.01)	-0.36 (0.01)
	10d	-0.15 (0.38)	-0.10 (0.56)	0.04 (0.79)	0.05 (0.77)	0.03 (0.86)	-0.69 (0.001)

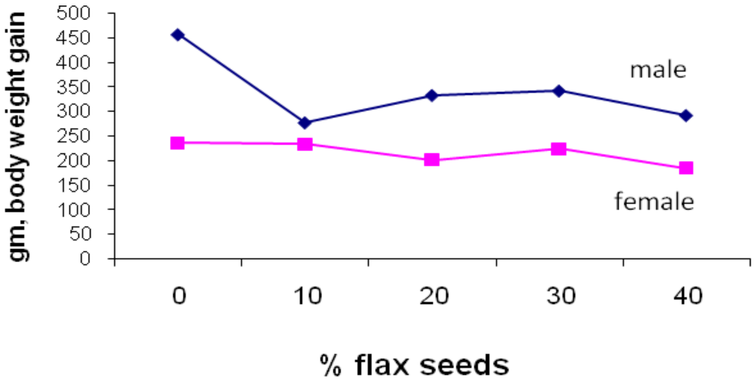

Fig (1): The effect of interaction between flaxseed levels and sex of the bird on body weight gain

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الملخص العربى

تأثير التغذية علي مستويات مرتفعة من بذور الكتان المحلية المعاملة حرارياً علي الزيادة الوزنية والإستجابة المناعية لبداري انتاج البيض السعودي

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تم تصميم التجربة لدراسة تاثير التغذية على مستويات مرتفعة مختلفة من بذور الكتان المعاملة حراريا والمنتجة محليا على الزيادة فى وزن الجسم والاستجابة المناعية للدجاج السعودى المحلى فى فترة ما قبل الانتاج. تم تكوين علائق التجربة بحيث تحتوى على مستويات صفرو ١٠و ٢٠ و ٣٠و ٤٠% من بذور الكتان التى تم تعريضها لحرارة ٦٠ درجة مئوية لمدة ٥ دقائق. صممت التجربة باستخدام ٥ مكررات لكل معاملة كل مكرر يحتوى على ٥٠ طائر من عمر ١٧ الى ٢٣ اسبوع . من خلال النتائج لوحظ ان المعاملات المختلفة لم تؤثر معنويا على وزن الجسم او اختبار فرط الحساسية المتاخر لالبيومين سيرم دم الابقار . لوحظ تاثير معنوى للمعاملات على الزيادة فى وزن الجسم بنهاية التجربة ولاسيما حينما اخذ فى الاعتبار تاثير الجنس . مستوى الاجسام المضادة المتكون ضد انتجين كرات الدم الحمراء للاغنام اظهر تاثيرا معنويا بعد ٣ ايام من الحقن فى ظل استخدام ٤٠% من بذور الكتان بالعليقة. هذا بالاضافة الى ان مستوى الاستجابة المناعية ضد نفس الانتجين كان منخفضا معنويا بعد ١٠ ايام من الحقن للمعاملة التى تم تغذيتها على عليقة تحتوى ١٠% بذور كتان بالمقارنة بالكنترول. كان هناك اتجاة عام لمعامل ارتباط سلبى بين وزن الجسم ومستوى الاجسام المناعية ضد انتجين كرات الدم الحمراء للاغنام وقد اظهر الارتباط معنويه فى العديد من اوقات القياس على مدار التجربة. من خلال نتائج التجربة يتضح ان التغذية على مستويات مرتفعة من بذور الكتان المحلى المعامل حراريا ادت الى تاثير محدود على الاستجابة المناعية ضد انتجين كرات الدم الحمراء للاغنام وزيادة وزن الجسم فى الدجاج المحلى السعودى خلال فترة ما قبل الانتاج.