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Response of Growing Rabbits to Dietary Fish Oil Supplementation

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ABSTRACT

This experiment was to evaluate the role of dietary inclusion of fish oil (FO) on productiveperformance and some blood parameters of New Zealand White rabbits (NZW). A total of thirty NZW male rabbits, 5 weeks of age , and mean body weight of 850 g were growing used. They were randomly divided into three treatment groups (G1, G2 andG3), 10 rabbits each in fivereplicates, of two rabbits. The fish oil was added to the basal diet at graded levels of 0.0, 0.75% and 1.5% / kg dietfor (control) G1,group 2 and group 3 respectively. At 13 weeks of age, blood samples were collected from three rabbits per each treatment to determine some plasma constituents .group.The results showed that dietary supplementation with FO had insignnificat effect on body weight,body weight gain, feed intake, and feed conversion ratio. However , LBW of rabbits fed the 1.5% FO – supplemental diet had significantly heavier body weight than the other groups .Plasma total lipids ,triglycerides, cholesterol, LDL , and HDL were significantly affeected dietary. Fish oil supplementation significantly increased HDL and decreased LDL levels .The o.75 % level of dietary fish oil significantly increased plasma globulin level and decreased A/G ratio indicative of improved immune responses of rabbits . It is concluded that, dietary FO supplementation had a significant impact in enhancing immunity without negative effects on performance of rabbits .The 0.75 %FO level is recommended for best results.

Keywords: Fish oil, blood parameters, immunity, rabbits.

INTRODUCTION

Fats are the most important source of energy and essential fatty acids needed for animals nutrition . Omega-3 polyunsaturated fatty acids (PUFAs) were reported to have significant physiological effects (Akabas and Deckelbaum,2006). These acids are essential because of they cannot be synthesized by the human body ,since they should be added to the diet (Arterburn *etal.,*2006). The α-linolenic acid (ALA) can be metabolized into eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are present in fish oils (Wallis *etal.*, 2002). Fish oil, has a high level of n−3 polyunsaturated fatty acids,which was known to have immune modulator effect (Xi *et al*., 1998).

Inclusion of fish oil to animals diet has been shown to alleviate the negative impact of of different autoimmune diseases(Philip,2001) and can affect the inflammatory response to a foreign antigens , either in vitro (Billiar *et al*., 1988 andPrescott, 1984) or in vivo (German *etal*. 1987. Addition of fish oil to diets was reported to has benificial effects on suppression of pro-inflammatory eicosanoids (PGE2 and LTB4) (Christophe and Pascaud, 1990; Fritsche *et al*. 1992; Engstrom *et al*. 1996) and cytokines (interleukin (1L)- 1, IL-6,tumour necrosis factor,TNF) production , since protecting animals from cardiovascular, autoimmune and inflammatory diseases (Endres *et al*. 1989; Meydani *et al*. 1991; Caughey *et al*. 1996) .Therefore this experiment was conducted to study the effect of fish oil ongrowth , plasma lipids concentration and immune responses of growing NZW rabbits.

MATERIALS AND METHODS

The present experiment was carried out at the Poultry Physiology Laboratory , Faculty of Agriculture, Ain Sham University. Thirty NZW rabbits were choosen after weaning (at five weeks of age) , kept for one week for adaptation and then divided into three experimental groups, of 10 individuals each,in five replicates of two rabbits each.

The average body weight of rabbits was nearly similar for all groups (850±50g).

Experimental Design:

Rabbits in the 1st group were fed the control diet (G1) ,while those in the 2nd and 3rdgroups were fed the basal diet supplemented with fish oil at levels of 0.75%, and 1.5% per kg diet (G2 and G3, respctively).Feed and water were offered *ad libitum* during the whole fattening period, (6 – 13 weeks of age). Rabbits were housed in one tier-battery cages (50×60 x 40 cm) equipped with suitable feeders and drinkers (nipples).

Rabbits were kept under similar management, hygienic and environmental conditions during the experimental period. The composition and calculated analysis of the basal diet are shown in Table - 1 .

Table 1.Composition and calculated analysis of the basal diet.

Ingredients (%)	Growing diet
Alfalfa hay	30
Wheat bran	32
Soy bean meal (44% CP)	11
Barley	21
Dicalcium phosphate	1.2
Limestone	1.0
Vitamin. & Mineral. Premix*	0.3
Common salt	0.5
Molasses	3.0
	100
Calculated analyses (NRC, 1977):	
Digestible energy; kcal/kg	2623
Crude protein; %	17.7
Ether extract; %	2.59
Crude fiber; %	12.75
Calcium; %	1.16
Non-phytate P; %	0.83
Lysine; %	0.87
Methionine; %	0.21
Meth.+ cyst.;%	0.51

*** Each 3 kg Vitamin. & Mineral. permix contains Vit. A, 10,000,000 IU; Vit. D_3, 1,000,000 IU; Vit. E, 10 g; Vit. K_3, 1.0 g; Vit. B_1, 1.0 g; Vit. B_2, 4.0 g; Vit. B_6, 1.5 g; Nicotinic acid, 20 g; Pantothenic acid, 10 g; Vit. B_{12}, 10 mg; Biotin, 50 mg; Folic acid, 30 g; Choline chloride, 50 g; Fe, 30 g; Mn, 40 g; Cu, 3.0 g, I, 0.45 g; Zn, 45 g and**

Measuremets:

Live body weight (LBW) , body weight gain (BWG) , feed intake (FI) and feed conversion ratio (FCR), were recorded weekly during the whole experiment period (6- 13 weeks of age).

Blood samples:

Blood samples (3 samples / treatment group) were collected at slaughtering time in heparinized tubes, immediately centrifuged (3000rpm/min), plasma decanted

and then stored at -20°C until used latter for determination of plasma total lipids , cholesterol, triglycerides, high density lipoprotein and low density lipoprotein concentrations using commercial kits, according to Fossati and Prencipe (1982),Allain *et al.* (1974) and Myers *et al.* (1994), respectively.

Statistical analysis:

Data were subjected to one way analysis of variance using the procedures of SAS program (SAS., 2003) , and the differences between means were tested by Duncan's multiple range test (Duncan ,1955 .

RESULTS AND DISCUSSION

Growth performance:-

Results in Table 2 show the effect of dietary fish oil on LBW of NZW rabbits during the growing period (6- 13 weeks of age). Live body weight was not significantly different between the control group and those fed fish oil - supplemented diets at both of 0.75 % and 1.5 % levels .

Table 2. Effect of fish oil supplementation on live body weight (g) of NZW rabbits atdifferent ages

Age (week)	G1	G2	G3	SEM	Sig.
6 Wk	861.6	828.0	859.4	51.89	NS
7 Wk	961.4	935.0	985.0	51.85	NS
8 Wk	1165.0	1096.4	1123.8	58.28	NS
9 Wk	1342.0	1276.8	1309.8	70.83	NS
10 Wk	1585.6	1457.4	1493.2	71.92	NS
11 Wk	1769.4	1674.0	1669.0	67.96	NS
12 Wk	1913.0	1839.4	1800.8	59.38	NS
13 Wk	2098.8^{b}	2095.2^{b}	2174.4^{a}	60.46	*

G1= control , G2 = Control +0.75% fish oil , G3 = control + 1.5% fish oil , SEM = standard error. Sig = significance . NS = Not significant at 5% level .

$^{a-b}$: Means within raws with different superscripts are significantly (P≤ 0.05) different.

However,rabbits that fed the basal diet supplied with 1.5% fish oil (G3) achieved significantly the heaviest body weight at 13 wk of age, compared withthe other groups. The mean of final LBW for rabbits from the G3 group was significantly (P≤0.01) higher by 3.60 and 3.78 % than those of the control and G2 groups ,respectively . This could be explained by the fact that fish oil is rich in ,especially n−3 polyunsaturated fatty acids ,especiallyEPA and DHA . These acids were reported to have good effect on growth of animals (Wallis *et al*., 2002) . The present result is in close agreement with that reported by Kowalska and Bielanski (2008) who reported that fish oil in rabbits diet had no significant effect on LBW . Also, omega-3 supplementation to cholesterol fed rabbits had insignificant effect on body weight of different groups (Sugano *et al.* 1997). In contrast, Kowalska (2008) reported highly significant differences in LBW between rabbits fed the control diet and those fed 2% rapeseed oil and 1% fish oil mixure -diet .

Results in Table 3 show that fish oil supplementation to diets of NZW rabbits has no significant effect on BWG during the periods from6 - 7and 8 -9week of age. However, BWG of rabbits of G1 treatment has significantly higher weight gain than those fed the fish oil – supplemented diets during the period from 7 -8 weeks and 9 -10 weeksof age . This may be due to the palatability of diets, as fish oil was sprayed on diets , since its oder and taste might be undesirable for rabbits at the beginning of the experiment. This results in lower BWG of rabbits . Of interest , this case was reversed at the next growing periods ,where rabbits fed the 0.75 % FO – diet had significantly higher BWG than those of the control and 1.5% FO diets at 10 -11 and 11 - 12weeks of age . In addition ,the BWG of rabbits fed diet supplementedwith 1.5% FOper kg diet(G3) was significantly higher (P<0.01) by 101.08% and 45.71 % than those fed the control and o.75 % FO diets ,respectively . However , during the whole period (6 – 13wk) , BWG was significantly higher for rabbits fed the 0.75% FO and control diets comared with those fed the 1.5 % FO diet .

Table 3. Effect of fish oil supplementation on average BWG (g)of NZW rabbits at different ages.

Period(week)	G1	G2	G3	SEM	Sig.
6 -7 wk	99.80	107.00	125.60	15.70	NS
7 - 8 wk	203.60^{a}	161.40^{b}	138.80^{b}	17.11	*
8 - 9 wk	177.00	180.40	186.00	25.3	NS
9 - 10 wk	243.60^{a}	180.60^{b}	183.40^{b}	15.88	*
10-11 wk	183.80^{b}	216.60^{a}	175.60^{b}	14.55	*
11-12 wk	143.60^{b}	165.40^{ab}	131.80^{b}	15.46	*
12-13 wk	185.80^{c}	256.40^{b}	373.60^{a}	13.66	**
6-13 wk	1237.20^{a}	1267.20^{a}	1215.40^{b}	32.78	*

G1= control , G2 = Control +0.75% fish oil , G3 = control + 1.5% fish oil , SE = standard error. Sig = signfician . NS = Not significian at 5% level .

The effect of FO supplementation to rabbits diet on weekly FI isshown in Table 4. Feed intake was not significantly affected by dietary FO from 6-9 weeks of age. But, from 9 to 10 weeks of age and the subsequent periods FI was significantly decreased in the fish oil – fed groups compared to the control one . The lowest FI value was for rabbits fed the 0.75 % FO diet compared by other treatments during all periods .In general, our results cleared that supplementation of rabbits diet with o.75 or 1.5 % FO decreased FI during the whole experimental period .

Table 4. Effect of fish oil supplmentationon weekly FI(g)of NZW rabbits atdifferent ages .

Period(week)	G1	G2	G3	SEM	Sig.
6 - 7 wk	433.40	360.20	443.20	38.09	NS
7 - 8 wk	571.20	506.20	560.60	30.29	NS
8 - 9 wk	620.20	551.40	624.60	35.42	NS
9 - 10 wk	775.00^{a}	659.00^{b}	670.20^{b}	25.62	*
10-11 wk	866.20^{a}	741.00^{b}	724.80^{b}	26.69	**
11-12 wk	915.00^{a}	792.40^{b}	811.20^{b}	22.80	**
12-13 wk	973.00^{a}	859.40^{b}	882.40^{b}	26.66	**
6 -13 wk	5153.80^{a}	4469.40^{b}	4716.80^{ab}	144.27	*

G1= control , G2 = Control +0.75% fish oil , G3 = control + 1.5% fish oil , SEM = standard error. Sig = signfician . NS = Not significant at 5% level .

$^{a-b}$: Means in the same raw with different superscripts differ significantly (P≤ 0.05).

Results showed also that FCR did not differ significantly among all treatments during the period from 6 -7;7 --8 ; 8- 9 and12-13 weeks of age (Table 5).In general, the best FCR was recorded for rabbits fed the control basal diet which was significantly better than that of rabbits of the G3 and G2 during the 9th to 10th week of age , however the first and thesecond and groups of rabbits achieved better means of FCR for the whole period as compared to the third experimental groups.

Table 5. Effect of fish oil supplementationon weekly FCR (feed: gain) of NZW rabbits at different ages

Period(week)	G1	G2	G3	SEM	Sig.
6 - 7 wk	4.343	3.366	3.546	0.553	NS
7 - 8 wk	2.806	3.136	4.039	0.523	NS
8 - 9 wk	3.504	3.057	3.358	0.527	NS
9 - 10 wk	3.181^{c}	3.649^{b}	3.564^{b}	0.353	*
10-11 wk	4.713^{a}	3.421^{b}	4.123^{a}	0.371	*
11-12 wk	6.372^{a}	4.788^{b}	6.155^{a}	0.547	*
12-13 wk	5.237	5.516	5.083	0.528	NS
6 -13 wk	3.841^{ab}	3.328^{c}	4.229^{a}	0.126	*

B:- Blood parameters:

Concerning plasma total lipids concentration , the obtained results showed that the higher level of FO supplementation to rabbits diets had a significant (P<0.01) effect on plasma total as compared to the other groups (Table 6). Blood plasma concentrations of Total lipids was significantly increasd by 6.19% in rabbits that fed 1.5% FO than the control treatment group . Concerning to the effect of FO on plasma cholesterol level . Our results clearly revealed that FO (1.5%) significantly increased its level compard to the other. Similarly, triglycerides level was higher for the 1.5% FO treatment group (G3) followed by those of (G2) with the lowest value being recorded for control treatment groups , respectively . Moreover, HDL level was significantly higher for both FO fed rabbit groups compared by the control group.

Results showed alsothat plasma LDL level was significantly decresed by FO supplementation to diet . This trend was supported by many studies that indicate that FO has a beneficial and healthy impacts due to its effect on increasing HDL and reducing LDL the hozoraous lipoprotein fraction .

In this concern Harris (1996) reported that PUFAintake reduce the plasma LDL level, although some other studies reported anunaltered or even an increase in plasma LDL level. In human studies , the metabolism of omega-3 fatty acids results in 1-3% increase of plasma HDL cholesterol level (Harris, 1989, 1996 and 1997).This was the same as the present result showed significant increases in HDL level especially in G3 rabbits. The increase in HDL cholesterol level was a result from the reducuction of free fatty acids in plasma (Rustan etal. 1992 and 1993).

Table 6. Effect of fish oiladministrationon plasma total lipids, cholesterol, triglycerides, HDL and LDL of NWZ rabbits.

Variable \ Treatment	G1	G2	G3	SEM	Sig.
Total lipids (mg/d1)	268.34^{b}	265.88^{b}	284.92^{a}	18.26	**
Triglycerides(mg/d1)	69.65^{b}	72.48^{b}	81.56^{a}	10.68	*
Cholesterol(mg/d1)	88.54^{ab}	85.72^{b}	95.60^{a}	11.95	*
HDL(mg/d1)	19.36^{c}	23.58^{b}	27.45^{a}	1.52	*
LDL(mg/d1)	55.24^{a}	44.63^{b}	42.14^{b}	2.37	*

G1= control , G2 = Control +0.75% fish oil , G3 = control + 1.5% fish oil , SE = standard error. Sig = signfician . NS = Not significian at 5% level .

[a-b-c]: Means in the same raw with different superscripts differ significantly (P≤ 0.05).

The results in table (7) clearly Show that FO supplmentation to NZW rabbits deit had insiguificant effecton plasma total protein and albumin with numerical increase of plasma total protein level being recorded for those fed the 0.75% FO deit (G2).At the same time, Plasma albumin supplementation to rabbits diets had insignificant effecton plasma total protein concentratin was also higher for the sma group of rabbits .

However,plasma globulin level washigher (P≤ 0.05) for rabbit fed the 0.75% FO diet followed by those fed 1.5% FO diet while the lowest value being recorded for control groups , respectively . It is important to mention that , A/G ratio was significantly lower for rabbits that fed both FO (0.075%, 1.5%) ascompard to the control group . This result is a consequence of the higher diets plasma globulin level of FO fed rabbits indicative of better immune responses of rabbits associated to fish oil supplementation.

Table 7. Effect different treatment on Plasma proteins level of NZW rabbits:

Variable \ Treatment	G1	G2	G3	SEM	Sig.
Total protein (g/d1)	5.48	6.44	5.66	0.58	NS
Albumin (g/d1)	3.17	3.26	2.98	0.31	NS
Globulin (g/d1)	2.32^{c}	3.15^{a}	2.69^{b}	0.14	*
A/G ratio	1.35^{a}	1.02^{b}	1.12^{b}	0.05	*

G1= control , G2 = Control +0.75% fish oil , G3 = control + 1.5% fish oil , SEM = standard error. Sig = signficiant . NS = Not significiant at 5% level .

[a-b-c]: Means in the same raw with different superscripts differ significantly (P≤ 0.05).

CONCLUSION

It is concluded that dietary fish oil supplementation to rabbit rations at 0.75% or 1.5% level could be used for improving the growth performance and immunity of growing NZW rabbits.

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إستجابة الأرانب النامية لإضافة زيت السمك فى العليقة

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أجريت هذه التجربة في قسم إنتاج الدواجن بكلية الزراعة جامعة عين شمس وذلك بهدف دراسة تأثير إضافة زيت السمك بمستوى ٠.٧٥% أو ١.٥% إلى عليقة الأرانب النامية على الأداء الإنتاجي وبعض قياسات الدم ,ولتحقيق هذا الهدف تم استخدام عدد ٣٠ أرنب نيوزلاندي عمر ٥ أسابيع متوسط وزن ٨٥٠ جرام عند بداية التجربة (٦ أسابيع) حيث قسمت عشوائياً إلثلاث مجموعات : الأولى المقارنة غذيت على العليقة الأساسية أما المجموعتان الثانية والثالثة فغذيت على نفس العليقة مع زيت السمك إليها بمعدل ٠.٧٥% ، ١.٥% مل على التوالي(بالرش فوق العليقة قبل تقديمها للأرانب) وخلال فترة النمو تم قياس وزن الجسم و الزيادة الوزنية , إستهلاك العلف ومعدل التحويل الغذائي إسبوعياً ثم في نهاية التجربة تم ذبح ثلاثة أرانب من كل مجموعة لأخذ عينات من الدم لتقدير محتواها من الدهون الكليةو الجلسريدات الثلاثية والكوليسترول الكليو الكوليسترول ذو الكثافة المرتفعة و المنخفضة(HDL وLDL) مع قياس بروتينات الدم الكلية ، الألبيومين والجلوبيولين . وتوضح نتائج البحث ما يلي:-١- لم يتأثر وزن الجسم معنوياً في المعاملات المختلفة طول فترة التجربة ولكن في الأسبوع الثالث عشر تفوقت الأرانب في المجموعة الثالثة (١.٥% زيت سمك) معنوياً في وزن الجسم عن باقي المعاملات .٢- كان للمعاملات تأثير معنوي على الزيادة الوزنية للأرانب وذلك خلال فترة التجربة فيما عدا الفترة بين ٦-٧ و ٨-٩ أسابيع .٣- هناك زيادة معنوية في كمية الغذاء المأكول للأرانب التي غذيت على العليقة الأساسية بينما انخفض استهلاك الغذاء في المجموعات الأخرى.٤- تحسنت كفاءة التحويل الغذاء بإضافة ٠.٧٥% زيت سمك للعليقة مقارنة بالمجموعات الأخرى.٥- يوجد تأثير معنوي للمعاملات على الدهون الكلية والجلسريدات الثلاثية والكوليسترول الكلي و الكوليسترول المرتفع الكثافة مع نقص في الكوليسترول المنخفض الكثافة عند التغذية على عليقة تحتوى على زيت سمك ١.٥%.٦- لم يتأثر معنوياً مستوى البروتين الكلي والألبيومين في بلازما الدم نتيجة المعاملات ولكن مستوى الجلوبيولين في الدم تحسن معنوياً نتيجة إضافة ٠.٧٥% زيت سمك أو ١.٥% على التوالي كما انخفضت النسبة بين الألبومين والجلوبيولين نتيجة المعاملات وهذا دليل على تحسن مناعة الأرانب لهذه المعاملات . وقد خلصت الدراسة إلى أن إضافة زيت السمك إلعلائق الأرانب تؤدي إلى تحسن الأداء الإنتاجي بصفة عامة وكذلك مستوى الكوليسترول العالي الكثافة و جلوبيولين الدم وعليه توصى الدراسة بإضافة زيت السمك بمعدل من ٠.٧٥% أو ١.٥% لعليقة الأرانب .