Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURE SCIENCES JOURNAL
Volume 5, Issue 2, 2022, Pages 228–239
Available online at www.agricuta.edu.eg
DOI: https://dx.doi.org/10.21608/aasj.2022.153796.1129

Effects of fish oil supplementation on growth performance and blood constituents of Ossimi ram lambs

Abd El-Hakeem S. A.[a*], Abd-Allah M.[a], Taghian Raghda A. S.[b]

[a]*Department of Animal Production, Faculty of Agriculture. Al-Azhar University, Assiut, 71524 Egypt*
[b]*Department of Animal Production, Faculty of Agriculture. Assiut, University, Assiut,71515 Egypt*

Abstract

This study was carried out to determine the influence of fish oil supplementation on growth performance and some biochemical parameters of Ossimi ram lambs. Fifteen Ossimi male lambs were divided randomly into three groups (5 animals/treatment). The first group was fed the basal diet without any addition and served as a control. While the 2nd (T1) and 3rd (T2) groups were fed the basal diet supplemented with fish oil at levels of 1.5 and 3% dry matter (DM), respectively. Data were statistically analyzed using one-way analysis of variance GLM by SAS program. The results revealed that the live body weight (LBW) and daily weight gains (DWG) were significantly ($P \leq 0.05$) increased in the treated lambs compared to the control group. Concentrations of total protein, albumen, aspartate aminotransferase (AST) and alanine transferees (ALT) activities increased significantly ($P \leq 0.05$) by given dietary fish oil than control diet. While, cholesterol was significantly lower ($P \leq 0.05$) in treated ram lambs than in those of the untreated ram lambs. In conclusion, fish oil supplementation at a rate of 1.5 and 3% DM to ram lambs improved growth performance and blood parameters.

Keywords: fish oil, growth rate, biochemical parameters, ram lambs.

*Corresponding author: Abd El-Hakeem S. A.,
E-mail address: saeedabdelsalam2391991@gmail.com

1. Introduction

One of the most important domestic animals that are raised in Egypt is sheep. The sheep population in Egypt increased by 66.7% from 1961 to 2005 (FAO, 2007). Egypt has approximately 5.69 million head of sheep and their meat contributes to 7.4% of all red meat production in Egypt (Elshazly and Youngs, 2019). The main essential omega-3 fatty acids are eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and α-linoleic acid (ALA). Unfortunately, mammals have limited ability to synthesize omega-3 fatty acids, which are necessary for their health benefits (Kris-Etherton *et al*., 2002). Numerous studies have agreed that the nutrition is the major factor influencing the fatty acids profile of ruminants (Chikwanha *et al*., 2018). Lipid in ruminant diets is very important, not only due to its significant energy contribution, but also because it supplies essential fatty acids (EFAs) and fat-soluble vitamins (Woods and Fearon, 2009), affecting both early growth and development (Lin *et al*., 2022). Fish oils are unique fats because they are rich sources of n-3 fatty acids (FAs) and they are polyunsaturated fats that contain many compounds that including omega-3 fatty acids (Harris, 2007). particularly eicosapentanoic acid (EPA) and docosahexaenoic acid (DHA) (García-Márquez *et al*., 2017). preferred fish oil use as a dietary supplement in the diet of farmed animals and aquaculture due to the presence of long chain omega-3 fatty acids, which have been reported to offer major benefits to animal health, including improved immunity against disease (Ashton *et al.*, 1994) and animal performance via increasing the energy density of the diet (Martin *et al*., 2008). In previous studies, dietary supplementation of n-3 polyunsaturated fatty acids (n-3 PUFA) improved the growth and immunity of ruminants (Ebrahimi *et al*., 2014). Moreover, omega-3 has an important role in the maintenance of the structure of cellular membranes, improving the absorption of lip soluble vitamins (A, D, E and K), reducing plasma triglycerides, regulating the cholesterol metabolism, and producing eicosanoids, which regulate various cellular processes vascular and bronchial tone (Ponnampalam *et al*., 2001). This study investigated the effect of fish oil supplementation to Ossimi ram lambs on growth Performance, body dimensions and some biochemical parameters of blood constituents.

2. Materials and methods

The present study was carried out at the experimental farm of Animal Production Department, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt during the period from November 2020 to March 2021.

2.1 Animals, Diets and Experimental Design

Fifteen Ossimi ram lambs aged 3-4 months with an average live body weight (14.5 kg±1.36) were randomly divided into three groups (5 animals/treatment). The first group was fed the basal diet which consisted as concentrated feed mixture (CFM) and wheat straw (WS) without supplementation and served as the control group. The 2nd (T1) and 3rd (T2) groups were fed the same basal diet supplemented with fish oil at levels of 1.5 and 3% of (DM), respectively. The ration was gradually introduced to the lambs over a period of 2 weeks as adaptation period. The amounts of concentrated feed mixture were adjusted according to the changes in live body weight of ram lambs according to NRC, (1985). The feed was served in roughly two equal meals, at 8 a.m. and 4 p.m. Fresh water was available throughout the day. The ingredients and chemical composition of concentrate feed mixture (CFM) and wheat straw are presented in Table (1). The fatty acid composition of the fish oil was supplemented according to Verma *et al*. (2017) is presented in Table (2).

Table (1): Ingredients and chemical analysis of the concentrate feed mixture (CFM) and wheat straw.

Items	Concentrated feed mixture (CFM)			Wheat Straw
	Co	T1	T2	
Ingredients (%)				
yellow corn	60	60	60	–
Soybean meal	20	20	20	–
Wheat bran	17	17	17	–
Vitamin-minerals (Premix®)	1	1	1	–
Limestone	1.5	1.5	1.5	–
Sodium Chloride	0.5	0.5	0.5	–
Fish oil	0	1.5	3	–
Chemical composition				
Dry matter %	89.7	89.6	89.1	90.63
Organic matter %	89.2	89.3	89.1	88.2
Crude protein %	15.2	14.9	14.6	3
Crude fiber %	5.41	5.28	5.24	39.33
Ether extract %	4.32	4.85	5.89	1.73
Nitrogen free extract %	64.27	64.27	63.37	44.14
Ash %	10.8	10.7	10.9	11.8

Co = basal diet without fish oil. T1, = basal diet supplemented with1.5% fish oil and T2; = basal diet supplemented with 3% fish oil. ® One kilogram of premix contained: vit. A 12000 000 IU, vit. E 1000 mg, vit K3 2000 mg, vit B1 1000 mg, vit. B2 4000 mg, vit. B12 10 mg, pantothenic acid 3.33 g, biotin 33 mg, folic acid 0.83 g, choline chloride 200 g, Mn 5 g, Fe 12.5 g, Cu 0.5 g, I 133.3 mg, Se 16.6 mg and Mg 66.7 g.

Table (2): Fatty acid composition (g/100 g FA) of fish oil supplemented to ram lambs.

Fatty acid	Fish oil
Lauric acid (C12:0)	0.22
Myristic acid (C14:0)	4.69
Myristoleic acid (C14:1)	0.24
Pentadecylic acid (C15:0)	0.80
Palmitic acid (C16:0)	25.26
Palmitoleic acid (C16:1)	12.49
Heptadecanoic acid (C17:0)	0.75
Cis-10-Heptadecanoic acid (C17:1)	1.63
Stearic acid (C18:0)	5.38
Elaidic acid (C18:1 trans-n-9)	2.75
Oleic acid (C18:1 cis-n-9)	9.43
Linoleic acid (C18:3 n-6)	1.93
Gamma- linolenic acid (C18:3 n-6)	0.50
Eicosanoic acid (C20:0)	0.36
á-Linolenic acid (C18:3 n-3)	0.20
Eicosadienoic acid (C20:2 n-6)	0.14
Docosanoic acid (C22:0)	0.19
Eicosatrienoic acid (C20:3 n-3)	0.32
Tricosanoic acid (C23:0)	2.62
Docosadienoic acid (C22:2 n-6)	0.16
Lignoceric acid (C24:0)	0.24
Eicosapentaenoic acid (C20:5 n-3)	16.21
Nervonic acid (C24:1 n-9)	0.49
Docosahexaenoic acid (C22:6 n-3)	10.15

Source: Verma *et al*. (2017)

2.2 Growth parameter

2.2.1 Body weight and daily gain

Weekly live body weight (kg) of ram lambs in all groups was recorded before feeding throughout the experimental period (20 weeks). The total gain was calculated by subtracting the initial body weight from the final corresponding ones. Daily gain was calculated according to the following equation:

$$\text{Lambs daily gain (g)} = \frac{2^{nd}\text{lamb weight} - 1^{st}\text{ lamb weight}}{\text{Period between weights (days)}}$$

2.2.2 Body measurements of lambs

Body measurements were taken to gather with monthly weight measurements. All Body measurements were taken with a measuring tape in centimeter and measured to the nearest 0.5cm. The body measurements taken were body length (the distance between the point of shoulder to the point of leip), chest girth (the circumference of the chest posterior to the fore legs at right angles to the body axis) and wither height (the highest point measured as the vertical distance from the tap of the shoulder to the ground).

2.3 Blood samples

On the last day of each feeding month, heparinized blood samples were collected from the jugular vein of each ram lambs of experimental groups at 8 am. Plasma samples were obtained by centrifugation of heparinized blood samples at 3000 r.p.m for 15 min and were stored at -20ºC until analysis. Concentrations of plasma protein, albumin, glucose, triglyceride, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined using kits purchased from Spectrum Chemical Company (Cairo, Egypt). While, cholesterol was determined using kits purchased from Vitro company (Cairo, Egypt). Concentrations of plasma globulin were estimated using the difference between total protein and albumin concentrations. A/G ratio was calculated as the ratio albumin to globulin.

2.4 Statistical analysis

Data were statistically analyzed as a completely randomized design using the general Linear model GLM procedure (SAS, 2008). The used model in statistical analysis was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: Yij = The studied trait. μ = The overall mean, Ti = The effect of the ith treatment (i=1, 2, 3,). eij = Represents the experimental error (0, σ2).

The differences among means were tested using Duncan`s Multiple- range test (Duncan, 1955).

3. Results and discussion

3.1 Effect of dietary fish oil supplementation on growth parameter

3.1.1 Body weight of lambs

The effect of fish oil supplementation on body weights of ram lambs are presented in Table (3). There were no significant differences in live body weight between treated and untreated lambs until the 11th weeks later. Treatment with fish oil had a significant (P≤0.05 or P≤0.01) effect on the body weights of Oissmi lambs from the twelve weeks until the end of experiment. At the end of trial, average live body weight of ram lambs fed 1.5% (T1) and 3% (T2) fish oil was heavier by about 24.63% and 28.5% when compared to the control group, respectively. This increase in live body weight in treated lambs may be attributed to the fat or fatty acids contained in fish oil which can increase energy intake and improve body metabolism (Nurlatifah *et al*., 2020) or they work as constituents of many enzymes which involved in the majority of metabolic pathways and are also important for the metabolism of protein (Abu El-Hamd *et al*., 2019).

Table (3): Effect of dietary fish oil supplementation on body weights of ram lambs.

Items	Month	Treatments			P. values
		CO	T1	T2	
Week 0		13.92±1.45	14.50±1.36	15.15±1.71	0.853
Week1	November	15.09±1.54	16.09±2.17	17.23±2.24	0.758
Week 2		16.57±1.73	17.78±2.57	18.26±2.19	0.856
Week 3		17.86±1.77	19.38±2.84	21.08±2.76	0.673
Week 4		19.40±1.81	21.28 ±3.01	22.78±2.76	0.661
Week 5	December	20.69±1.86	22.42±3.05	24.94±2.76	0.393
Week 6		21.17±1.84	24.78±2.82	26.87±2.83	0.313
Week 7		22.59±1.76	27.70±3.33	29.23±2.74	0.231
Week 8		24.57±1.81	29.19±3.01	31.86±3.11	0.130
Week 9	January	26.00±1.92	31.00±3.24	34.80±3.44	0.149
Week 10		27.74±1.78	33.46±3.50	36.48±3.36	0.153
Week 11		28.95±1.64	35.78±3.01	39.08±3.40	0.067
Week 12		29.80±1.75^{b}	37.04±2.61^{a}	40.48±3.25^{a}	0.038
Week 13	February	31.18±1.89^{b}	38.84±3.16^{ab}	42.06±3.27^{a}	0.051
Week 14		32.28±1.89^{b}	39.10±3.22^{ab}	43.22±3.34^{a}	0.055
Week 15		33.32±1.84^{b}	40.40±3.31^{ab}	45.20±3.30^{a}	0.034
Week 16		34.70±1.88^{b}	42.00±3.31^{ab}	47.10±3.45^{a}	0.020
Week 17	March	36.00±2.54^{b}	43.80±3.27^{ab}	48.60±3.66^{a}	0.005
Week 18		37.40±2.73^{b}	45.60± 3.5^{ab}	50.2± 3.97^{a}	0.010
Week 19		39.20±2.74^{b}	48.40± 2.97^{a}	52.0± 3.48^{a}	0.005
Week 20		41.40±3.04^{b}	51.60±2.54^{a}	53.20± 3.2^{a}	0.003

^{a,b} Means at the row with different superscript are significantly (P≤0.05) different. CO = control group. T1 = group treated with1.5% fish oil and T2 = group treated with 3% fish oil.

These results in agreement with those reported by Robinson *et al*. (1999) who found that the fish oil increased the growth rate of early weaned lambs and the inclusion of fish meal at level of 3.25 g/kg of body weight increased (LBW) by about 32%. However, Nguyen (2018) concluded that oils inclusion in finishing diets did not influence lamb growth has no detrimental effects on lamb growth. In contrast, Cooper *et al*. (2006) found that no effect of oil supplements on growth performance of cows.

3.1.2 Average daily gain

Total gain and average daily gain (ADG) were improved significantly (P≤0.01) as a function of fish oil level, Average daily weight gain of ram lambs fed 1.5% (T1) and 3% (T2) fish oil was heavier by about 35% and 38.46% when compared to the control group, respectively. In the same way average daily gain of ram lambs between different periods during the experiment is clear from the results that the lambs treated with fish oil had higher daily growth rates than the control group (Table 4). The significant increase in average daily gain could be due to improving the ability to use nutrients from food and convert them into muscle protein and hence improving daily weight gain (Okukpe *et al*., 2011).

Table (4): Effect of dietary fish oil supplementation on average daily weight gain and total gain of ram lambs.

Items	Treatments			P. values
	CO	T1	T2	
DG1, g	182.60±13.23^{b}	226.0±62.78^{ab}	254.40±38.43^{a}	0.516
DG2, g	129.80±13.64^{b}	225.66±10.94^{ab}	230.60±24.54^{a}	0.000
DG3, g	126.66±13.30^{a}	201.33±16.90^{ab}	189.33±7.14^{ab}	0.003
DG4, g	117.33±32.16^{b}	105.33±33.44^{ab}	168.00±16.47^{a}	0.051
DG5, g	180.0±60.83^{ab}	260.66±34.31^{a}	153.33±38.15^{b}	0.071
ADG, g	196.28 ±22.74^{b}	265.65±10.63^{a}	271.50±14.39^{a}	0.001
Total gain, kg	27.48±3.18^{b}	37.1±1.489^{ab}	38.05±2.01^{a}	0.001

$^{a\ b}$ Means at the row with different superscript are significantly (P≤0.05) different. CO = control group. T1 = group treated with1.5% fish oil and T2 = group treated with 3% fish oil. DG1, g = daily weight during 1st Month, DG2, g = daily weight during 2nd Month, DG3, g = daily weight during3rdMonth, DG4, g = daily weight during 4rd Month and DG5, g = daily weight during 5th Month.

The present results are in agreement with Nurlatifah *et al*. (2020) who found a significant increase (P≤0.05) in average daily gain by feeding oils to sheep diets. Furthermore, fish oil increased the average daily weight gain of lambs and the estimated optimal level obtained from fish oil levels for daily weight gain was 11.2 g/kg (Hernández-García *et al*., 2017). In contrast, fish oil at concentrations of 20-30 g/kg (Annett *et al*., 2011) and 4.5% (Roy *et al*., 2013) had no significant effect on the daily weight gain of lambs.

3.1.3. Body measurements

The effects of dietary supplementation of fish oil on the body dimensions of ram lambs are shown in (Table 5). No significant differences in wither height, chest girth and body length were observed between the treated ram lambs and control groups.

Table (5): Effect of dietary fish oil supplementation on body measurements of ram lambs.

Items	Period	Treatments			P. values
		CO	T1	T2	
Wither height (cm)	1st Month	50.40±1.53	51.40±.92	50.00±0.77	0.674
	3rdMonth	69.20±2.33	72.20±2.03	75.20±1.46	0.142
	5th Month	70.20±2.31	73.80±2.37	77.00±1.22	0.102
Chest girth (cm)	1st Month	56.60±2.87	61.20±3.82	57.20±3.96	0.627
	3rdMonth	77.80±2.70	85.80±3.15	88.60±3.90	0.094
	5th Month	78.20±2.59	86.40±2.94	89.00±3.98	0.085
Body length (cm)	1st Month	38.20±1.31	39.60±1.20	39.00±2.30	0.842
	3rdMonth	55.00±2.21	58.20±2.22	60.80±1.93	0.197
	5th Month	56.80±2.33	60.00±2.16	63.20±1.62	0.132

CO = control group. T1 = group treated with1.5% fish oil and T2 = group treated with 3% fish oil.

In general, there was a clear increase in body dimensions of the treated ram lambs compared to the control group. Table (5). Previous results that are in agreement with our results were reported by Nurlatifah *et al*. (2020) in sheep and Nguyen (2018) reported that the inclusion of different levels of oils in lamb' diets did not cause any significant differences in body conformation or body condition scores (BCS). Additionally, oils had no significant effect (P > 0.05) on body measurements at the beginning and end of the experiment (Gallo *et al*., 2019).

3.2. Effect of dietary fish oil supplementation on Blood constituents

The results illustrated in Table (6) showed that fish oil supplementation significantly increased the concentrations of plasma protein, albumin (g/dL) and liver enzymes, (AST and ALT) (U/L). No significant (P≤0.05) differences were found among treatments for concentrations of plasma globulin, A/G ratio, glucose and triglycerides (P≤0.05). However, the concentrations of plasma cholesterol (mg/dL) were significantly lower (P≤0.05) in treated ram lambs than in untreated ram lambs. Cholesterol levels of ram lambs were the highest level (P≤0.05) in control (70 mg/dL) followed by T1 (69.17 mg/dL) and T2 (68.11 mg/dL). The increases in concentrations of plasma protein and albumin due to fish oil is in agreement with previous results reported by Teama and El-Tarabany (2016) who found that total protein levels are significantly increased as a result of supplementation of omega-3 plus in the diet of goats. No differences were detected for total globulin, which was in accordance with the report of (Kholif *et al*., 2016) and A/G ratio, with (Abu El-Hamd *et al*., 2015). The increase in AST and ALT activity in the treated ram lambs is in agreement with Yonjalli *et al*. (2019) in sheep and Bianchi *et al*. (2014) also reported that when oils were supplemented to a diet of sheep at 6% of dietary DM, the activity of AST and ALT increased considerably. In contrast, no differences were detected for total proteins, albumin, AST and ALT (Kholif *et al*., 2016). The increased concentration of plasma protein caused by fish oil supplementation is possibly due to the fact that fatty acids act as reservoirs for potent biologically active molecules, that they regulate the environment of membrane-bound proteins are involved in improving protein (Calder, 2012). The lower cholesterol concentration in the treated ram lambs is in agreement with Verma *et al*. (2017) and Ponnampalam *et al*. (2001). They observed that feeding 1.5% (FO) decreased plasma concentrations of cholesterol in lambs. However, these results are in contrast with Nurlatifah, *et al*. (2020) who didn't find any significant effect of fish oil supplementation on cholesterol in sheep. The lower cholesterol concentration in the treated ram lambs may be attributed to the up regulation of low-density lipoprotein (LDL) receptors and/or the cholesterol redistribution between tissue pools and plasma (Parvar *et al*., 2017). Glucose concentration in plasma was not affected by fish oil supplementation in our study, which was in accordance with the report of Fair *et al*. (2014) in sheep. However, many studies have found that oil supplementation reduces plasma glucose concentrations (Lee *et al*., 2008). The unaffected plasma triglyceride in this study was consistent with the report of Li *et al*. (2012) in goats. In contrast, oil supplementation caused an increase in the concentration triglyceride in goats (Teama and El-Tarabany, 2016).

Table (6): Effect of dietary fish oil supplementation on blood constituents of ram lambs.

Items	Treatments			P. values
	CO	T1	T2	
Total Protein (g/ dL)	5.81±0.03[b]	6.22±0.14[a]	6.32±0.19[a]	0.0329
Albumin (g/ dL)	3.38±0.07[b]	3.48±0.04[ab]	3.61±0.04[a]	0.0279
Globulin (g/ dL)	2.43±0.09	2.74±0.14	2.71±0.20	0.3038
A/G ratio	1.44±0.10	1.33±0.08	1.45±0.12	0.6752
Cholesterol (mg/dL)	70.00±0.11[a]	69.17±0.55[ab]	68.11±0.53[b]	0.0210
Triglyceride (mg/ dL)	53.33±2.22	56.67 ±2.72	58.33±2.77	0.3922
Glucose (mg/ dL)	66.15±0.38	65.35±0.40	64.81±0.42	0.0782
AST (U/L)	122.20±0.18[b]	122.8±0.21[ab]	123.00±0.16[a]	0.0359
ALT (U/L)	24.61±0.39[b]	25.25±0.48[ab]	26.40±0.17[a]	0.0168

[a,b] Means at the row with different superscript are significantly (P≤0.05) different. CO = control group. T1 = group treated with1.5% fish oil and T2 = group treated with 3% fish oil.

4. Conclusion

Based on the above results it can be concluded that the obvious improvements in body weight, daily gain and body measurement of ram lambs could reflect the importance of supplying ruminants with omega-3 fatty acids by treating lambs with fish oil at rate of 1.5 and 3%. The difference in the proportions of blood components by treating lambs with fish oil is an indication of some physiological changes that may be useful in producing lamb meat that possess specific properties.

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