Research Articles

Effect of dietary fish oil supplement on nutrients digestibility and egg yolk omega-3 fatty acids contents in Japanese Quails

Kunaporn Homyog[1*] Surasak Jittakhot[2] Samatchaya Pengdit[1]

[1]The Center for Veterinary Diagnosis, Faculty of Veterinary Science
[2]Department of Pre-Clinic and Applied Animal Science, Faculty of Veterinary Science,
Mahidol University, Salaya, Nakhon Pathom 73170

[*]Corresponding author, E-mail address: kunaporn.hom@mahidol.ac.th

Abstract

This study were investigated the effects of dietary fish oil supplement on digestibility of nutrients, fatty acid composition of egg yolk and quality of eggs in Japanese quails. Three hundred and twenty, ten weeks old female Japanese quails were randomly divided into 2 treatments, replicated 8 cages with 20 birds per cage. Dietary treatments; control diet and fish oil supplement diet (added 6% fish oil) were fed for 30 days. Samples of diets, feces and egg were daily collected from last 5 days. For proximate analysis of fish oil supplement DM, EE and ash of feed intake were lower than control diet (P<0.01). Moreover, the dietary fish oil supplement on macronutrients digestibility revealed DM, ME (P<0.05) and ash were significantly decrease (P<0.01) and also found negative effect on nitrogen metabolism (P<0.05). Fish oil supplement had significantly negative effect on egg production, egg weight and yolk width (P<0.05). However, detected the increasing of saturated fatty acids, unsaturated fatty acids, omega 3 and omega 9 fatty acids contents of quails fed fish oil supplement diet (P<0.01). On the other hand, fish oil supplement diets were highly significant decrease in omega 6 fatty acids and omega 6 to omega 3 fatty acid ratio (P<0.01). In summary, dietary fish oil supplemented can caused positive effect on content of saturated fatty acids, unsaturated fatty acids, omega 3 and omega 9 fatty acids, but had adverse effect either macro-nutrients intake or their digestibility. Additionally dietary fish oil supplemented lead to lower omega 6 to omega 3 ratios that cloud be beneficial effect on human health.

Keywords: fish oil, nutrient digestibility, fatty acids, omega 3 fatty acids, Japanese quail

ผลของการเสริมน้ำมันปลาในอาหารต่อความสามารถในการย่อยได้ของโภชนะและปริมาณกรดไขมันชนิดโอเมก้า 3 ในไข่แดงของนกกระทาญี่ปุ่น

คุณาภรณ์ หอมยก[1*] สุรศักดิ์ จิตตะโคตร์[2] สมัชญา เพ็งดิษฐ์[1]

[1]ศูนย์ตรวจวินิจฉัยทางการสัตวแพทย์, คณะสัตวแพทยศาสตร์
[2]ภาควิชาปรีคลินิกและสัตวศาสตร์ประยุกต์, คณะสัตวแพทยศาสตร์,
มหาวิทยาลัยมหิดล, ศาลายา, นครปฐม 73170

[*]ผู้รับผิดชอบบทความ E-mail address: kunaporn.hom@mahidol.ac.th

บทคัดย่อ

การทดลองนี้มีวัตุประสงค์เพื่อศึกษาผลของการเสริมน้ำมันปลาในอาหารนกกระทาต่อการย่อยได้ของโภชนะ องค์ประกอบของกรดไขมันในไข่แดง และคุณภาพของไข่ในนกระทาญี่ปุ่น โดยใช้นกกระทาญี่ปุ่นเพศเมียอายุประมาณ 10 เดือน จำนวน 320 ตัว ทำการแบ่งกลุ่มนกกระทาแบบสุ่มออกเป็น 2 กลุ่ม กลุ่มละ 8 กรง แต่ละกรงมีนกกระทาญี่ปุ่น 20 ตัว นกกระทาทั้ง 2 กลุ่มทดลองจะได้รับอาหารทดลอง; อาหารกลุ่มควบคุมและอาหารเสริมน้ำมันปลา (น้ำมันปลา 6%) เป็นระยะเวลา 30 วัน ทำการเก็บตัวอย่างอาหาร มูล และไข่ 5 วันสุดท้ายของระยะเวลาการทดลอง จากผลการวิเคราะห์อาหารเสริมน้ำมันปลาพบว่าค่าน้ำหนักแห้ง ไขมันหยาบ และเถ้าในอาหาร ต่ำกว่าอาหารกลุ่มควบคุมอย่างมีนัยสำคัญยิ่ง (P<0.01) นอกจากนี้ยังพบว่าอาหารเสริมน้ำมันปลาส่งผลต่อการย่อยได้ของโภชนะหลักของนกกระทา โดยทำให้ค่าน้ำหนักแห้ง ค่าพลังงานลดลงอย่างมีนัยสำคัญ (P<0.05) และเถ้าลดลงอย่างมีนัยสำคัญยิ่ง (P<0.01) และยังส่งผลลบต่อ เมตาบอลิซึมของไนโตรเจนอย่างมีนัยสำคัญ (P<0.05) นอกจากนี้พบว่าอาหารเสริมน้ำมันปลาส่งผลลบต่อผลผลิตไข่ น้ำหนักไข่ และความกว้างของไข่แดง อย่างมีนัยสำคัญ (P<0.05) อย่างไรก็ตามพบว่าปริมาณกรดไขมันชนิดอิ่มตัวและกรดไขมันไม่อิ่มตัว กรดไขมันโอเมก้า 3 และกรดไขมันโอเมก้า 9 ในไข่แดงของนกกระทากลุ่มที่เสริมน้ำมันปลาในอาหารมีค่าสูงกว่านกกระทากลุ่มควบคุม อย่างมีนัยสำคัญยิ่ง (P<0.01) ในทางกลับกันการเสริมน้ำมันปลาในอาหารพบว่ามีผลทำให้ปริมาณโอเมก้า 6 และอัตราส่วนระหว่างโอเมก้า 6 และโอเมก้า 3 ลดลงอย่างมีนัยสำคัญยิ่ง (P<0.01) จากการทดลองสามารถสรุปได้ว่าการเสริมน้ำมันปลาในอาหารส่งผลบวกต่อปริมาณกรดไขมันในไข่แดงทั้งชนิดอิ่มตัวและไม่อิ่มตัว และส่งผลให้มีปริมาณกรดไขมันชนิดโอเมก้า 3 และ โอเมก้า 9 สูงขึ้น แต่ในขณะเดียวกันยังส่งผลลบต่อปริมาณการกินได้และการย่อยได้ของโภชนะหลักหรือความสามารถในการย่อยได้ของนกกระทา นอกจากนี้การเสริมน้ำมันปลาในอาหารที่ส่งผลให้อัตราส่วนของกรดไขมันชนิดโอเมก้า 3 ต่อ โอเมก้า 6 ลดลงนี้นับว่าเป็นผลดีต่อสุขภาพของผู้บริโภคอีกด้วย

คำสำคัญ : น้ำมันปลา ความสามารถในการย่อยได้ของโภชนะ กรดไขมัน กรดไขมันชนิดโอเมก้า 3 นกกระทาญี่ปุ่น

Introduction

Fatty acids are commonly categorized by the degree of saturation; unsaturated fats (carbon chains with double bonds) and saturated fats (carbon chains with no double bonds). Saturated fats are commonly found in meat, cocoa butter, palm oil, and coconut oil. Monosaturated fatty acids (MUFA) have one double bond and polyunsaturated fatty acids (PUFA) have more than one double bond (Brenner 1981; Stryer 1988). However, based on fatty acids carbon length, number and location of first double bond from the methyl end of the molecule classified fatty acids into three types include omega-3, omega-6, and omega-9 fatty acids (Ackeman 1995).

Omega-3 fatty acids are an essential fatty acids for human which contain α-linolenic acid (18:3) as the parent compound and can be converted to eicosapentaenoic (20:5) and docosahexaenoic (20:6) acids (Farell 1998; Mayer et al., 2003). Dietary sources of omega-3 fatty acids may derive from linseed, canola and soybean oils. Furthermore, freshwater and especially marine fish such as salmon, trout, tuna, and mackerel are rich sources of omega-3 fatty acids (Harris 2004). Omega-3 fatty acids play an important role on human health; first as a supplement to improve structure and function of nervous system (Garmin et al., 1992; Anderson 1994). Second as a reducer of cholesterol or VLDL which accumulate in vascular in order to prevent atherosclerosis (Atakisi et al., 2009). Hammershoj (1995) reported dietary supplement of fish oil which contains high omega-3 fatty acids was obviously reduced cholesterol levels while omega-3 fatty was increased in egg yolk. This finding was similar to those observed by Atakisi et al. (2009) who performed the effect of omega-3 in fish oil on cholesterol level in egg yolk was significantly different among control group and fish oil supplement group. Third, eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids also in the group of omega-3 fatty acids which can be exhibit an important role in the prevention and treatment of heart disease and inhibit the growth of prostate cancer and breast cancer (Lewis 2000). Moreover, omega-3 fatty acids can be decreased the incidence of Alzheimerís disease (Harris 2004), Rheumatoid arthritis (Volker et al., 2000), Systemic lupus erythematosus (Walton 1991) and Ulcerative colitis (Stenson 1992).

There were studied reported that dietary fish oil supplement in feed significantly reduced feed intake, egg weight and egg production (Saleh 2013). Moreover, the positive effects of fish oil supplement on egg production include shell thickness, yolk height and yolk color were reported (Shang 2004). The studied particular in Japanese quails were conducted by Atakisi et al. (2009) suggested that adding omega-3 fatty acids and cholesterol level in yolk and plasma tapered down as bird and yolk weight found no effect. Therefore, the aims of present study were to evaluate the effects of dietary fish oil supplement on digestibility of nutrients, fatty acid composition of egg yolk and quality of eggs in Japanese quails.

Materials and Methods

Experimental animals

Japanese quails *(Coturnix coturnix japonica)* purchased from a local hatchery 140-150 g of weight, healthy and randomly allocated of each treatment. During egg production period the layers were reared in quail community batteries, under similar management, hygienic and environmental condition. Feed and water were providing ad libitum, continuous light provided along experiment. Twenty month old of 320 female Japanese quails were randomly divided into 2 treatments,

replicated 8 cages with 20 birds per cage (50x100x30 cm). One stack or battery cages consists of 4 cages height per treatment.

Experimental diets, feeding and design

Layers of the different treatments consumed the experimental diet. Feeds were offered twice a day (9.00 am and 3.00 pm) in trough feeders. Dietary included the control diets and treatment diets (fish oil 6 % added) were formulated in term of iso-proteinous and iso-caloric fashion to meet the requirements of Japanese quail (NRC 1994). The ingredients and chemical composition of the control diet and fish oil supplement diets were shown in Table 1. Both experimental diets were fed for 30 days and according to the independent T-test.

Samples collecting

Table 1 Ingredients and chemical compositions of experimental diets

Items	Experimental diets	
	Control	**Fish oil supplement**
Ingredients (%)		
Corn grain meal	38.00	38.00
Rice bran	20.60	20.60
Soy bean meal	21.70	21.70
Fish meal	2.00	2.00
Shell meal	5.30	5.30
Dicalcium phosphate	1.20	1.20
NaCl	0.30	0.30
Cu-Met[1]	0.20	0.20
Soy bean oil	6.00	0.00
Methionine	0.50	0.50
Premix	0.30	0.30
Spirulina	4.00	4.00
Fish oil	0.00	6.00
Total	**100**	**100**
Chemical compositions analyzed		
Macronutrients (%)		
Dry matter, DM	94.44	96.55
Nitrogen- free extract, NFE	47.43	52.36
Crude protein, CP	25.80	24.54
Ether extract, EE	6.7	6.51
Ash	11.50	9.85
Crude fiber, CF	3.01	3.29
MEn (kcal/kg diet)[2]	**3103**	**3235**

[1]Copper-methionate chelate content analytically was 172,745 ppm

[2]Calculated by MEn (Nitrogen-corrected metabolizable energy), kcal/kg diet = 31.02 x %CP + 77.03 x %EE + 37.67 x %NFE (Janssen, 1989)

Daily recorded the number of eggs and mortality birds meanwhile the last 5 days of the experiment, 160 birds from each dietary treatment (20 per replicate) were placed in individual battery cages for collection of egg production, feed consumption and excrement to measure the nutrient digestibility of macronutrient (dry matter (DM), ether extract (EE), crude fiber (CF), nitrogen-free extract (NFE), ash, and net nitrogen utilization) and fatty acid compositions.

Egg quality measurements (internal and external quality assessments) were executed using all eggs collected in the last day of the experiment from all treatments. The eggs were rinsed with water and all eggs of each replication were prepared as egg yolk. Egg yolk samples were thoroughly homogenized with a blender at low speed and packed in sealed plastic bags before frozen at -20°C until analysis for fatty acid compositions. Total excreta were collected quantitatively, weighted and frozen at -20°C before an analysis of nutrient compositions.

Egg quality measurements

After collecting eggs, immediately start measuring process. Six parameters were used to assess exterior and interior quality of eggs by measured each egg sample. Egg weight was measured using a balance (recorded in grams) and egg yolk color was determined by using Roche Yolk Color Fan. Yolk and albumen height were measured with a micrometer and expressed in mm. Shell thickness measured by a 25M-micrometer gauge, a mean value of measurement at three locations on the egg (air cell, equator, and sharp end) by using a dial, pipe gauge. The specific gravity of eggs was determined by using the saline flotation method of Hempe et al. (1988). Salt solutions were made in incremental concentrations of 0.004 in the range 1.060 to 1.100.

Samples analysis

Feeds and excreta samples were dried at 80°C for two days weighed and pooled per cage. Macronutrients and protein were determined by Kjeldahl method in Kjeltec, FOSS. Total fat was determined by acid digestion prior to continuous extraction by petroleum ether in Soxtec system. Moisture content was determined by drying the sample in hot air oven 105°C for 5 hrs. Crude fiber was determined by heat of neutralization of a weak acid and a weak base in Fibertec, FOSS. Ash was determined by ashing in muffle furnace at 525°C (AOAC 2003). Feeds and egg yolks used for fatty acid compositions analysis which analyze by using fatty acid methyl ester synthesis (O'fallon 2007).

Statistical analysis

Prior to statistical data analysis, all parameters observed were checked for normal distribution by Shapiro-Wilk test. Data were statistically analyzed according to the independent T-test. All statistic calculations were performed using the SPSS statistics program version 21.0. The difference between treatments was determined by independent T-test. Overall differences between treatment means were considered significant when P-value ≤ 0.05.

Results

Macronutrient analysis

Data in Table 2 shown the dietary fish oil supplement on nutrients and excreta tends to decrease in ME of feed intake ($P<0.05$), whereas DM, EE and ash of feed intake were significantly decreased in fish oil supplemental diet ($P<0.01$) when compared with control diet. The studies of dietary fish oil supplement on

macronutrients digestibility revealed a significantly decreased in DM, ME (P<0.05) and highly significant difference in ash (P<0.01) when compared with control diet (Table 3). The dietary fish oil supplement on nitrogen metabolism (Table 4) detected net nitrogen utilization of fish oil supplemental diet was significantly decreased (P<0.05). In addition, nitrogen intake and apparent nitrogen retention were also significantly decreased when compared with control diet (P<0.01).

Table 2 Effect of dietary fish oil supplement on macronutrients intake and excretion

Parameters	Experimental diets		P-value
	Control	Fish oil supplement	
Macronutrients intake (g/day)			
DM	22.06 ± 1.60	19.76 ± 1.54	0.01
NFE	11.08 ± 0.80	10.72 ± 0.84	0.39
EE	1.57 ± 0.11	1.33 ± 0.10	0.00
Ash	2.69 ± 0.20	2.02 ± 0.16	0.00
CF	0.70 ± 0.05	0.67 ± 0.05	0.29
ME intake (kcal/day)	72.48 ± 5.26	66.21 ± 5.17	0.03
Macronutrients excreta (g/day)			
DM	2.86 ± 1.37	3.41 ± 0.58	0.33
NFE	0.68 ± 0.36	0.85 ± 0.19	0.27
EE	0.04 ± 0.03	0.03 ± 0.02	0.40
Ash	0.59 ± 0.28	0.70 ± 0.13	0.34
CF	0.29 ± 0.13	0.36 ± 0.09	0.24
ME excreta (kcal/day)	9.24 ± 4.41	11.43 ± 1.98	0.23

Table 3 Effect of dietary fish oil supplement on macronutrients digestibility

Parameters	Experimental diets		P-value
	Control	Fish oil supplement	
Macronutrients digestibility (%)			
DM	87.31 ± 5.47	82.01 ± 1.26	0.03
NFE	93.99 ± 2.88	92.09 ± 1.60	0.13
EE	97.51 ± 1.48	97.64 ± 1.77	0.88
Ash	78.52 ± 9.21	65.49 ± 5.33	0.00
CF	59.29 ± 15.98	50.77 ± 3.66	0.18
ME (%)	**87.54 ± 5.36**	**82.75 ± 2.52**	**0.05**

Table 4 Effect of dietary fish oil supplement on nitrogen metabolism

Parameters	Experimental diets		P-value
	Control	Fish oil supplement	
Nitrogen intake (g/day) (%)	0.97 ±0.07	0.80 ±0.07	0.00
Nitrogen output (g/day)	0.20 ±0.10	0.23 ±0.04	0.40
Apparent nitrogen retention (g/day)	0.76 ±0.05	0.57 ±0.05	0.00
Net nitrogen utilization (%)	79.59 ±8.63	70.74 ±4.22	0.03

Egg quality measurement

There were no significant different observed in egg quality parameters such as color number, albumin width, albumin height, and yolk height of Japanese quail layers fed with control and fish oil supplemental diet (Table 5). However, fish oil supplemental diet had significantly negative effect on egg production, egg weight, and yolk width (P<0.05).

Table 5 Effect of dietary fish oil supplement on egg quality

Parameters	Experimental diets		P-value
	Control	Fish oil supplement	
Egg production (%)	84.14 ±0.31	75.86 ±0.46	0.05
Egg weight	10.75 ±0.25	10.36 ±0.41	0.04
Color number[1]	9.11 ±0.31	9.20 ±0.46	0.67
Width range (cm)			
Albumin	3.86 ±0.46	3.75 ±0.09	0.51
Yolk	2.26 ±0.12	2.12 ±0.06	0.01
Height range (mm)			
Albumin	2.70 ±0.66	2.90 ±0.21	0.40
Yolk	9.77 ±0.57	9.91 ±0.32	0.56
Egg shell thickness	0.18 ±0.01	0.19 ±0.01	0.08
Egg specific gravity	1.07 ±0.00	1.07 ±0.00	0.03

[1]Measured by The Yolk Color Fan scale (Roche)

Fatty acid compositions analysis

Fatty acid compositions detected in yolk (Table 6) were highly significant reduction of some fatty acids included C18:2n6t, C18:2n6c, C18:3-3, C18:3n6, C20:2 and C20:4n6 in Japanese quails fed with fish oil supplemental diets (P<0.01) compared with control diet. Whereas the other fatty acids contents in yolk of quails fed with fish oil supplemental diets were highly significant increased (P<0.01).

In the current studied, the contents of saturated fatty acids, unsaturated fatty acids, omega 3 and omega 9 fatty acids in eggs yolk of quails fed with fish oil supplemental diets were higher than those observed in control diet (P<0.01) (Table 7). On the other hand, fish oil supplemental diets had negatively effect on omega 6 fatty acids and omega 6/omega 3 fatty acids (P<0.01) which lower in fish oil supplement group (2.99) than control group (11.60).

Table 6 Effect of dietary fish oil supplement on fatty acid compositions in yolk

Parameters	Experimental diets		P-value
	Control	Fish oil supplement	
Yolk fatty acid contents (% of total fatty acids)			
C14:0	0.59 ±0.03	0.94 ±0.04	0.00
C16:0	23.42 ±0.23	24.81 ±0.16	0.00
C18:0	11.00 ±0.26	11.52 ±0.30	0.00
C18:1,n9c	33.56 ±0.56	35.02 ±0.82	0.00
C18:2,n6t	0.19 ±0.01	0.10 ±0.01	0.00
C18:2,n6c	22.65 ±0.57	15.18 ±0.36	0.00
C18:3,n3	0.85 ±0.05	0.62 ±0.05	0.00
C18:3,n6	0.10 ±0.01	0.00 ±0.00	0.00
C20:2	0.08 ±0.01	0.06 ±0.04	0.07
C20:4,n6 (ARA)	3.02 ±0.08	1.75 ±0.07	0.00
C20:5,n3 (EPA)	0.02 ±0.02	0.83 ±0.21	0.00
C22:6,n3 (DHA)	1.39 ±0.05	4.39 ±0.34	0.00

Table 7 Summary of Yolk fatty acid contents (% of total fatty acids)

Parameters	Experimental diets		P-value
	Control	Fish oil supplement	
Yolk fatty acid contents (% of total fatty acids)			
Saturated fatty acids	35.26 ±0.31	37.84 ±0.36	0.00
Unsaturated fatty acids	2.76 ±0.33	3.97 ±0.29	0.00
Omega 3 fatty acids	2.26 ±0.04	5.83 ±0.54	0.00
Omega 6 fatty acids	26.14 ±0.57	17.32 ±0.37	0.00
Omega 9 fatty acids	33.56 ±0.56	35.02 ±0.82	0.00
Omega 6/omega 3	11.60 ±0.26	2.99 ±0.27	0.00

Saturated fatty acids = C14:0+C16:0+C17:0+C18:0

Unsaturated fatty acids = C14:1+C16:1+C20:2

Omega 3 fatty acids = C18:3n3+C20:5n3+C22:6n3

Omega 6 fatty acids = C18:2n6t+C18:2n6c+C18:3n6+C20:3n6+C20:4n6

Discussion

From the results, metabolizable energy (kcal/kg diet) of the control diets was similar to fish oil supplement diets. The difference in metabolizable energy between those diets was taken into account that both diets would contain iso-energetic amounts of added energy. Nevertheless, high energy derived from fish oil make metabolizable energy higher in fish oil supplement diets than control diets. As a result, dry matter intake (%) decreased in the fish oil supplement diets group (Table 2), since the fact that dry matter intake changed inversely with metabolizable energy (AFRC 1998). Lowering of dry matter intake (g/day) in fish oil supplement group led to significantly decline of ether extract intake (g/day), ash intake (g/day) and metabolizable energy intake (kcal/day), consequently. This finding was similar to those observed by Jones (1989) who deduced 3% fish oil supplement in hamsters and found dry matter intake and metabolizable energy intake tended to decline. Furthermore, dry matter intake decreasing had significantly negative effect on dry matter digestibility (%), ash digestibility (%) and metabolizable digestibility (%) which shown in Table 3. Nitrogen intake, apparent nitrogen retention and net nitrogen utilization also reduced that was probably due to the crude protein composition in fish oil supplement diets was lower than control diets as in Table 1. Amino acids which are building blocks of protein play an important role in egg development involving with yolk and albumen contents (Johnson 1986). Hence, it is possible that the decreasing of egg production, egg weight and yolk width as performed in Table 5 due to the negative effect on nitrogen metabolism of fish oil supplement diets. Horrocks (2011) also reported that addition of flaxseed and fish oil may negatively affect egg quality and Saleh (2013) demonstrated that feeding fish oil decreased feed intake, egg weight and egg production as well as Elswyk et al. (1994) who concluded that diets supplement with 3 % fish oil tapered down yolk weight and total egg weight when compared with vegetable oil. Although the results from this study did not agree with the studied of Hazim et al. (2010) that the dietary fish oil at the inclusion level of 3 % was the best results ($P<0.05$) in regard to egg weight, egg production, fertility, and hatchability of eggs.

Fish oil provides a good source of omega-3 fatty acids which compose of α-linolenic acid as the parent compound and can be converted to EPA and DHA (Farell 1998; Mayer et al., 2003). As would be expected on the basis of concentration of α-linolenic, EPA and DHA in the fish oil supplement diets, the relative concentration of those fatty acids in yolk of quails fed with fish oil supplement was higher than that in quail fed with control diet as shown in Table 6 except α-linolenic acids which can be determined that it has the ability to synthesize EPA and DHA from α-linolenic acids if received enough α-linolenic acid through their diets (Kralik 2008). These results corresponded to previous studied that EPA and DHA levels in yolks increased with the increasing fish oil levels in the ration (Balevi 2000). DHA levels in yolks taken from hens consuming the ration which supplemented with 0, 1, 2, and 3 % of fish oil was found to be 0.51, 0.53, 0.53 and 0.75 % at week 1 and 0.75, 2.72, 4.21 and 3.83 % at week 4, respectively. Similarly observations have been reported by Kralik (2008) that the content of EPA was higher ($P<0.05$) in egg yolks of group E1 (1.50% linseed oil +3.5% fish oil) than group E2 (2.50% linseed oil+2.5% fish oil) and E3 (3.50% linseed oil+1.5% fish oil). For fatty acids in yolk; myristic, palmitic, palmitoleic, margaric, stearic and oleic increased highly significant while linolelaidic, linoleic, γ-linolenic and arachidonic acid

decreased highly significant in quail fed with fish oil supplement. The current study has demonstrated that fish oil supplement had significantly positive effect on saturated, unsaturated, omega 3, and omega 9 fatty acids. In contrast to omega 6 that significantly decreased when compare with control diets (Table 7) corresponding to the results of Balevi (2000) revealed that egg yolks which has been fed 3 % fish oil increased in omega 3 fatty acid and omega 6 fatty acids decreased compared to egg yolk fed without fish oil. Similarly, Dalton (2000) found that supplement 5% fish oil in diets also i ncreased in omega 3 fatty acids in liver, heart, yolk and polyunsaturated fatty acids. It is known that omega 3 fatty acids inhibit the synthesis of arachidonic acid and compete with arachidonic acid for incorporation into the position of glycerol-phospholipids as a substrate for the cyclooxygenase, lipoxygenase and epoxygenase enzymes which could be decrease omega 6 fatty acids as described by various studied (Fritsche et al., 1991; Turek et al., 1998; Kemp 1998; Baguma-Nibasheka et al., 1999). Additionally, this study indicates a lower omega 6/omega 3 ratio in fish oil supplement group which can be prevent cardiovascular disease, lower risk of breast cancer, suppress inflammation in patients with rheumatoid arthritis and had beneficial effect on patients with asthma (Simopoulos 2002).

Conclusion

Dietary fish oil supplement were positive effect on saturated fatty acids, unsaturated fatty acids, omega 3 and omega 9 fatty acids contents which could be served as functional egg. Additionally the dietary fish oil supplemented on omega 6 to omega 3 ratio was decreases that beneficial effect on human health. However, additionally dietary fish oil supplemented had negative effect on feed intake (DM, EE, ME and ash), macronutrients digestibility (DM, ME and ash), net nitrogen utilization, egg production, egg weight and yolk width. Therefore, it should be supplemente d fish oil in bird diet only at appropriate level that necessary clarify for further study.

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