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THE ADDITION EFFECT OF SARDINE OIL IN QUAIL RATION ON OMEGA-3 FATTY ACID COMPOSITION OF EGGS

Zuprizal, Cuk Tri Noviandi, Indratiningsih, Tri Yuwanta, Sri Harimurti[1]

Abstract

This research was undertaken to determine the effect of addition of sardine oil in quail ration on composition of omega-3 fatty acid of eggs. Ninety-six laying quails were randomly placed into 24 battery system cages and each cage consisted of four quails. The six ration treatments were a combination of sardine and palm oil. The six rations were R-0 (control ration, without sardine oil and palm oil), R-1 (0% sardine oil and 8.0% palm oil), R-2 (2.0% sardine oil and 6.0% palm oil), R-3 (4.0% sardine oil and 4.0% palm oil), R-4 (6.0% sardine oil and 2.0% palm oil), and R-5 (8.0% sardine oil and 0% palm oil). All data were analysed with one-way ANOVA and continued with Duncan's New Multiple Range Test using SPSS for Windows Release 7.0 program. The result of this research showed that the utilisation of sardine oil in rations were increased the omega-3 fatty acid (especially EPA and DHA) and didn't decreased the egg cholesterol of the quail. It was also found that the best ratio between omega-3 and omega-6 was the combination of 50% sardine oil and 50% palm oil.

Key words: Sardine and palm oil, Laying quail, Omega-3 and Omega-6

Introduction

Egg is an important food as a source of protein with high nutritional value, but the fat that concentrated in the yolk is relatively poor in omega-3 fatty acids (Noble, 1987). Omega-3 polysaturated fatty acids (PUFAs), such as eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and α-linolenic acid (ALA), are recognized as functional compounds. These fatty acids are now gaining special attention as they are considered to be beneficial in decreasing plasma triacyl glycerol and cholesterol, and lowering the risk of arteriosclerosis (Meydani *et al.*, 1991). Epidemically studies suggest that consumption of fish oil, which is rich in omega-3 PUFAs, may protect against coronary heart diseases (Kobatake *et al.*, 1983; Herold and Kinsella, 1986; Chee *et al.*, 1990; Nardini *et al.*, 1995). Results of some studies indicate that DHA is essential for normal functional development of the retina and brain, particularly in premature infants. Emerging scientific evidences suggest that these fatty acids, especially DHA, may be an essential dietary in growing infants as it is naturally found in human milk. Because omega-3 fatty acids are essential in growth and

[1] Faculty of Animal Science, Gadjah Mada University, Yogyakarta 55281, Indonesia.

development throughout the life cycle, they should be included in the diets of all humans (Simopoulus, 1991). Thus, recent recommendations pertaining to the consumption of dietary fats have emphasized the importance of consuming higher levels of these fatty acids (Simopoulus, 1991; Chee *et al.*, 1990).

Some investigations suggest that increasing dietary levels of mono- and poly-unsaturated fatty acids have large effects on the unsaturated fatty acids of the yolk. Feeding of long chain omega-3 PUFAs increases in their levels in yolk lipid (Caston and Leeson, 1990; Marshall *et al.*, 1994; Oh *et al.*, 1994). Sardine oil, which is abundantly available as a by-product from fishmeal and fish canning industry, is potential as a source of omega-3 PUFAs (Chee *et al.*, 1990). Therefore, it is necessary to develop the utilization of this by-product to enrich non-fish foods with omega-3 PUFAs so as to maximize its potential use.

The research of high omega-3 fatty acid eggs produced by laying hens fed with sardine oil was reported by Umar-Santoso *et al.* (1999), but the research about the addition effect of palm and sardine oil in diet to increase the omega-3 and omega-6 content in quail eggs was not investigated yet. The objective of this research was to determine the effect of feeding the quail with feed contained sardine oil on the composition of omega-3 fatty acids of eggs.

Materials and Methods

Materials

Ninety-six of 42 days old laying quails were used in this experiment. These laying quail were taken from PT Peksi Gunaraharja, Kalasan, Sleman, Yogyakarta. Twenty-four cages with dimension (LxWxH): 230x20x30 cm, which fully equipped with feeder and drinker, was used.

Sardine oil was obtained from fishmeal factory of PT Fishindo, Muncar, Banyuwangi, and palm oil was taken from market. Composition of fatty acid of sardine oil and palm oil are showed in Table 1. Other feed materials (yellow ground corn, soybean meal, rice bran, limestone, meat and bone powder, and diofost were taken from PT Siba Prima Feed Mill, Klaten, and Topmix was produced by PT Medion.

The rations were formulated according to NRC (1994) to meet the requirement for laying quail. The six rations were a combination of sardine and palm oil. The rations were R-0 (control ration, without sardine oil and palm oil), R-1 (0% sardine oil and 8.0% palm oil), R-2 (2.0% sardine oil and 6.0% palm oil), R-3 (4.0% sardine oil and 4.0% palm oil), R-4 (6.0% sardine oil and 2.0% palm oil), and R-5 (8.0% sardine oil and 0% palm oil). The compositions of the rations given to each group are presented in Table 2.

Table 1. Composition of sardine and palm oil fatty acid

Fatty acid	Total percentage of detected fatty acid	
	Sardine oil	Palm oil
C 14:0	14.58	1.11
C 16:0	20.71	40.41
C 16:1	15.83	-
C 18:0	4.14	3.12
C 18:1	13.59	40.68
C 18:2n-6	2.81	14.31
C 18:3n-3	0.89	0.11
C 20:0	0.33	0.21
C 20:1	3.98	0.06
C 20:4n-6	1.96	-
C 20:5n-3	11.98	-
C 22:6n-3	9.21	-
Total n-6	4.77	14.31
Total n-3	22.08	0.11
Energy Bruto (kcal GE/kg)	9562.85	9652.82

Table 2. Composition of rations

Feed material	R-0	R-1	R-2	R-3	R-4	R-5
Yellow corn	64.10	34.00	34.00	34.00	34.00	34.00
Rice bran	-	14.00	14.00	14.00	14.00	14.00
Sardine oil	-	0.00	2.00	4.00	6.00	8.00
Palm oil	-	8.00	6.00	4.00	2.00	0.00
Soybean meal	18.47	32.17	32.17	32.17	32.17	32.17
Meat powder	10.00	1.00	1.00	1.00	1.00	1.00
DL-methionin synthetic	0.48	0.48	0.48	0.48	0.48	0.48
L-lysin HCl	0.50	0.60	0.60	0.60	0.60	0.60
Lime stone	6.00	8.00	8.00	8.00	8.00	8.00
Dcp/diophost	-	1.00	1.00	1.00	1.00	1.00
Salt (NaCl)	0.20	0.25	0.25	0.25	0.25	0.25
Topmix	0.25	0.50	0.50	0.50	0.50	0.50
Total amount	100.00	100.00	100.00	100.00	100.00	100.00
Nutrient content:	R-0	R-1	R-2	R-3	R-4	R-5
Energy Bruto (cal/gram)						
EM (kcal/kg)	2814.90	3033.20	3033.30	3033.40	3033.50	3033.60
Protein (%)	19.87	20.82	20.82	20.82	20.82	20.82
Fat (%)	3.63	11.37	11.37	11.37	11.37	11.37
Crude Fiber (%)	2.74	1.38	1.38	1.38	1.38	1.38
Ca (%)	3.66	3.71	3.71	3.71	3.71	3.71
P (%)	0.64	0.61	0.61	0.61	0.61	0.61
Water (%)	11.72	10.42	10.42	10.42	10.42	10.42
Ash (%)	12.24	11.99	11.99	11.99	11.99	11.99

Methods

The experiment method used was completely randomized design. The laying quails were randomly divided into six groups; each group consisted of 16 laying quails. The birds were randomly placed into 24 battery-cages with four birds in each cage. Every 4 cages was a replication for 1 ration treatment. Laying quails were fed *ad libitum* and maintained in the cages for 12 weeks. In the end of 4th, 8th, and 12th week, cholesterol and fatty acid analysis was done.

All data collected were analysed with one-way ANOVA and continued with Duncan's New Multiple Range Test using SPSS for Windows Release 7 (1993) programme.

Results and Discussions

Fatty Acid Content and Composition of Egg

The effect of treatment on fatty acid content (SAFA, MUFA, PUFA, saturated and unsaturated fatty acid, EPA, DHA, and ratio of omega-3 and omega-6) of quail eggs are showed in Table 3.

The result showed that the addition of sardine oil in the ration increased omega-3 fatty acid content, and the best ratio of omega-3 and omega-6 was shown by the ration that contain 50% of sardine oil and 50% of palm oil (R-3). Sulistiawati (2000) reported that the optimal ratio of omega-3 and omega-6 was 1:5, and in this research the ratio which nearly to optimal ratio was 1:7.55 (R-3).

Crude Fat and Cholesterol Content of Egg

The results indicate that the crude fat content of eggs were similar. The addition of oil didn't give any differences, but there was a significantly differences on cholesterol of eggs ($P<0.05$). The results of the crude fat and cholesterol content of quail egg are showed in Table 4.

The range of cholesterol content in eggs was 48.58-67.65 mg/egg or 491.21-667.91 mg/100 g egg. This result was higher than the result of another research using 5% sardine oil, i.e. 131.4 mg/100 g egg (Saerang, 1997). Jiang and Sim (1991) reported that the factors that determine the cholesterol content in egg were the weight of yolk. Smaller yolk contains lower cholesterol than the bigger ones. In addition, low fatty acids intakes also decrease the cholesterol content in egg.

Table 3. The effect of ration on fatty acids content of quail egg

Parameter		R-0	R-1	R-2	R-3	R-4	R-5	Sign.
SAFA :	C4:0	0.24	0.09	0.10	0.11	0.03	0.08	
	C6:0	0.07	0.03	0.03	0.05	0.01	0.02	
	C8:0	0.07	0.04	0.03	0.05	0.03	0.02	
	C10:0	0.07	0.05	0.04	0.03	0.01	0.01	
	C12:0	0.94	0.80	0.84	1.44	1.26	1.10	
	C14:0	0.06	0.03	0.03	-	0.02	0.09	
	C16:0	40.63	31.34	32.50	35.59	34.90	33.04	
	C18:0	0.01	0.29	0.40	0.56	0.02	0.57	
	C22:0	0.02	0.50	0.05	-	0.39	-	
Total SAFA		**42.10**	**33.16**	**33.97**	**37.81**	**36.45**	**34.91**	NS
MUFA :	C14:1	0.11	0.09	0.14	0.30	0.18	0.15	
	C16:1	-	-	-	-	-	-	
	C18:1	0.03	0.26	0.43	0.16	0.04	0.49	
	C20:1	-	0.01	0.05	0.10	0.05	0.09	
Total MUFA		**0.14**	**0.35**	**0.61**	**0.56**	**0.26**	**0.72**	NS
PUFA :	C18:2	57.08	64.57	61.18	53.33	60.20	60.82	
	C18:3	-	-	5.28	5.80	-	-	
	C20:4	-	0.01	0.06	-	0.01	-	
	C20:5	0.21	0.59	0.23	0.65	0.79	0.67	
	C22:3	0.21	0.81	0.95	1.23	1.56	2.17	
	C22:6	0.28	0.54	0.42	0.63	0.77	0.76	
Total PUFA		**57.77**	**66.51**	**65.44**	**61.62**	**63.31**	**64.41**	NS
Polyunsaturated fatty acid		57.91	66.86	66.05	62.19	63.45	65.09	NS
Polysaturated fatty acid		42.09	33.14	33.95	37.81	36.55	34.91	NS
Total		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	
Omega-3 :	C18:3	-	-	5.28	5.80	-	-	
	C20:5	0.21	0.59	0.23	0.65	0.79	0.67	
	C22:6	0.28	0.54	0.42	0.63	0.77	0.76	
Total Omega-3		**0.49^{a}**	**1.13^{a}**	**5.93^{ab}**	**7.07^{b}**	**1.55^{a}**	**1.42^{a}**	*
Omega-6 :	C18:2	57.08	64.57	61.18	53.33	60.20	60.82	
	C20:4	-	0.01	0.06	-	0.01	-	
Total Omega-6		**57.08**	**64.58**	**61.24**	**53.33**	**60.21**	**60.82**	NS
Omega-9 :	C18:1	0.03	0.26	0.42	0.16	0.04	0.49	
	C20:1	-	0.01	0.05	0.10	0.05	0.09	
Total Omega-9		**0.03**	**0.27**	**0.47**	**0.26**	**0.09**	**0.58**	NS
EPA (C20:5)		0.21^{a}	0.60^{ab}	0.23^{a}	0.65^{ab}	0.79^{b}	0.67^{ab}	*
DHA (C22:6)		0.28	0.54	0.42	0.63	0.77	0.76	NS
Ratio Omega 3:6		**1:117.68**	**1:57.40**	**1:10.34**	**1:7.55**	**1:38.84**	**1:42.83**	

^{a,b} Different superscript in the same row showed a significant differences (P<0.05)

Table 4. The effect of ration on crude fat and cholesterol content of quail's egg

Parameter	R-0	R-1	R-2	R-3	R-4	R-5
Crude fat (%) ^{ns}	29.92	31.18	30.07	30.33	32.30	29.22
Cholesterol of egg (mg/100g)	491.21^{a}	486.84^{a}	495.62^{a}	485.15^{a}	571.00^{b}	667.91^{c}
Cholesterol of egg (mg/egg)	48.58^{a}	50.94^{a}	52.25^{a}	48.90^{a}	56.26^{b}	67.65^{c}

$^{a, b, c}$ Different superscript in the same row showed a significant differences ($P<0.05$)

In this research, the rations that contain sardine and palm oil had higher cholesterol content (mg/egg) than the ration that didn't contain any oil (R-0). The raising of using of sardine oil can increase the HDL cholesterol content and decrease the LDL cholesterol content, whereas HDL cholesterol is needed by the body. The using of sardine and palm oil in ideal ratio (R-3, 50% sardine oil and 50% palm oil) can decrease the cholesterol content because there is a synergism between saturated and unsaturated fatty acid absorption, thus it will suppress the synthesis of egg's cholesterol.

Conclusions

The results presented here indicate that:

1. The addition of sardine oil in the ration can increase the omega-3 content in quail egg, especially EPA and DHA.
2. The addition of sardine oil in the ration, in general, cannot decrease the cholesterol content of quail egg.
3. The best ratio between omega-3 and omega-6 was the combination of 50% sardine oil and 50% palm oil.

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