รายงานวิจัยฉบับสมบูรณ์

โครงการ **ผลของการใช้น้ำมันถั่วเหลืองร่วมกับน้ำมันปาล์มในอาหารไก่ไข่ต่อการให้ผลผลิตและคุณภาพไข่**

โดย **นิวัต เมืองแก้ว**

พฤศจิกายน 2553

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แขนงเทคโนโลยีการผลิตสัตว์
สำนักวิชาเทคโนโลยีการเกษตร
มหาวิทยาลัยวลัยลักษณ์

สนับสนุนโดยสำนักงานกองทุนสนับสนุนการวิจัย

กิตติกรรมประกาศ

โครงการวิจัยเรื่อง ผลของการใช้น้ำมันถั่วเหลืองร่วมกับน้ำมันปาล์มในอาหารไก่ไข่ต่อการให้ผลผลิตและคุณภาพไข่ ได้รับทุนสนับสนุนการวิจัยจากสำนักงานกองทุนสนับสนุนการวิจัย ผู้วิจัยขอขอบพระคุณต่อสำนักงานกองทุนสนับสนุนการวิจัยที่ได้ให้โอกาสต่อผู้วิจัย ขอขอบพระคุณมหาวิทยาลัยเทคโนโลยีราชมงคลศรีวิชัย ที่เอื้อเฟื้อสถานที่และอนุญาตให้ใช้เวลาในการดำเนินการวิจัย ผู้ช่วยศาสตราจารย์ ดร. เสกสม อาตมางกูร ในฐานะที่ปรึกษาและให้คำแนะนำที่ดีโดยตลอดมา และขอขอบคุณคุณปราณี แซ่โค้ว ห้องปฏิบัติการวิทยาศาสตร์ชีวภาพ กรมวิทยาศาสตร์บริการ ที่ดำเนินการวิเคราะห์องค์ประกอบกรดไขมันให้ถึง 2 ครั้ง

ผลของการใช้น้ำมันถั่วเหลืองร่วมกับน้ำมันปาล์มในอาหารไก่ไข่ต่อการให้ผลผลิตและคุณภาพไข่

นิวัต เมืองแก้ว

แขนงเทคโนโลยีการผลิตสัตว์ สำนักวิชาเทคโนโลยีการเกษตร มหาวิทยาลัยวลัยลักษณ์ อำเภอท่าศาลา จังหวัดนครศรีธรรมราช 80161

บทคัดย่อ

ผลของการใช้น้ำมันถั่วเหลืองร่วมกับน้ำมันปาล์มในอาหารไก่ไข่ต่อสมรรถนะการผลิตไข่และองค์ประกอบของกรดไขมันในไข่แดง ทำการทดลองในไก่ไข่พันธุ์ดีคาล์ปอายุ 21 ถึง 40 สัปดาห์ วางแผนการทดลองแบบสุ่มสมบูรณ์ จัดสิ่งทดลองแบบ 4 x 2 แฟคทอเรียลร่วมกับกลุ่มเปรียบเทียบอีก 1 กลุ่ม ผลการศึกษาพบว่าน้ำมันปาล์มโอลีนหรือน้ำมันผสมระหว่างน้ำมันถั่วเหลืองกับน้ำมันปาล์มโอลีนที่ใช้ผสมในสูตรอาหารไก่ไข่ไม่มีผลกระทบต่อการให้ผลผลิตไข่ น้ำหนักไข่ มวลรวมของไข่ ปริมาณอาหารที่กิน ประสิทธิภาพการเปลี่ยนอาหารเป็นไข่ ค่าฮ็อกยูนิต หรือความหนาของเปลือกไข่ อย่างไรก็ดีองค์ประกอบของกรดไขมันในไข่แดงผันแปรไปตามองค์ประกอบของไขมันที่เติมในอาหาร ความผันแปรดังกล่าวสามารถนำมาประยุกต์ใช้ในการผลิตได้คือเมื่อเพิ่มระดับของน้ำมันปาล์มหรือน้ำมันถั่วเหลืองร่วมกับน้ำมันปาล์มในอาหารไก่ไข่ส่งผลให้ไข่ที่ได้มีปริมาณของกรดไขมันอิ่มตัวลดลง ดังสมการ ค่าความเข้มข้นของกรดไขมันชนิดอิ่มตัว = 24.8167 – 0.63ระดับของน้ำมันที่ใช้ในสูตรอาหาร โดยมีค่าสัมประสิทธิ์ตัวกำหนดเท่ากับ 0.66 ไข่ที่ผลิตได้จากแม่ไก่ไข่ที่เลี้ยงด้วยอาหารที่ใช้น้ำมันถั่วเหลืองในสัดส่วนที่สูงส่งผลให้ไข่ที่ได้มีองค์ประกอบของกรดไขมันในไข่แดงในกลุ่มกรดไขมันไม่อิ่มตัวกลุ่มโอเมก้า 6 มีความเข้มข้นสูงขึ้น ในขณะที่ไข่ที่ได้จากแม่ไก่ไข่ที่เลี้ยงด้วยอาหารที่มีน้ำมันปาล์มหรือน้ำมันถั่วเหลือง 75 เปอร์เซ็นต์ ร่วมกับน้ำมันปาล์ม 25 เปอร์เซ็นต์ ในระดับ 1.5 เปอร์เซ็นต์ ในสูตรอาหารส่งผลให้องค์ประกอบของกรดไขมันในกลุ่มกรดไขมันไม่อิ่มตัวในกลุ่มโอเมก้า 3 และ 6 มีความเข้มข้นสูง โดยสรุปการใช้น้ำมันถั่วเหลือง 75 เปอร์เซ็นต์ ร่วมกับน้ำมันปาล์มโอลีน 25 เปอร์เซ็นต์ ในระดับ 1.5 เปอร์เซ็นต์ ในสูตรอาหารไก่ไข่ส่งผลให้ได้ไข่ไก่ที่มีองค์ประกอบของกรดไขมันในกลุ่มโอเมก้า 3 ในระดับดีที่สุด การใช้น้ำมันถั่วเหลืองร่วมกับน้ำมันปาล์มส่งผลให้ความเข้มข้นของกรดไขมันอิ่มตัวในไข่แดงลดลงในขณะที่เพิ่มความเข้มข้นของกรดไขมันไม่อิ่มตัวพันธะเดี่ยว กรดไขมันลิโนลิอิค และกรดไขมันโดโคซาเอ็กซะอิโนอิค (ดีเอชเอ) ไข่ที่ได้จากการศึกษายังไม่สามารถบ่งชี้ได้ว่าเป็นไข่ที่อุดมไปด้วยกรดไขมันไม่อิ่มตัวเนื่องจากความเข้มข้นยังไม่สูงเพียงพอ

คำสำคัญ น้ำมันปาล์มโอลีน น้ำมันถั่วเหลือง ไก่ไข่ องค์ประกอบกรดไขมันในไข่แดง

Effect of feeding soybean and palm blended oil on laying performance and egg quality

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Abstract

The effect of blended dietary oil on the laying hen performance and the fatty acid profiles of eggs produced by 21 to 40 wk old Dekalb Brown laying hens were investigate. The experimental design was a completely randomized design using a 4 x 2 factorial arrangement with one control. The different oil sources did not influence egg production, egg weight, egg mass, feed intake, feed efficiency, Haugh unit or egg shell thickness. However lipid profile of the egg yolk changed as a function of dietary lipid sources. The fatty acid composition of the yolks of eggs produced by the laying hens was analyzed. The fatty acid profile of eggs can be modified by varying the lipid composition of the diet. High inclusion levels of dietary palm olein oil (POO) or blended oil (POO plus soybean oil – SBO) concentrations of total saturated fatty acid (SFA) in eggs yolk were deceased, generated the following : SFA = 24.8167 – 0.63Oil, r^2 = 0.66. Eggs laid by hens fed the diet containing high portion of soybean oil had a large amount of n-6 polyunsaturated fatty acids (PUFA), whereas egg laid by hens fed the diet containing POO or blended oil 25%POO plus 75%SBO at 1.5 % level of inclusion had high percentage of n-3 PUFA and n-9 family. Its was concluded that the quantity of fatty acids present in the egg yolk may be altered according to the source of lipids in the diets; the addition of blended oil 25%POO plus 75%SBO at 1.5 % level of inclusion had high percentage of n-3 eggs. The addition of blended palm olein oil plus soybean oil decreased the concentration of saturated fatty acids while increased the concentrations of monounsaturated fatty acid, α-linolenic and docosahexaenoic acid (DHA). It did not promote the enrichment of the eggs with PUFA

Keywords : Palm olein oil, Soybean oil, laying hen, egg yolk fatty acids.

INTRODUCTION

Birds can synthesize saturated fatty acids *de novo* and to oxidize them to mono- and di-unsaturatedfatty acids up to the ninth carbon inward from the carboxyl end (Δ^9). They lack of the enzymatic capacity to introduce double bonds past the Δ^9. Thus they cannot use stearic acid to synthesize linoleic acid (C18:2 $\Delta^{9,\ 12}$) or α-linolenic acid (C18:3$\Delta^{9,\ 12,\ 15}$). Only plants have the enzymes capable of inserting Δ^{12} or Δ^{15} double bonds into C18 fatty acids and consequently linoleic and linolenic acids are essential fatty acids for birds. Once consumed, these two fatty acids can be further metabolized by enzymes within the endoplasmic reticulum of chicken hepatocytes. Linoleic acid can be desaturated between the sixth and seventh carbons to γ-linolenic acid (C18:3$\Delta^{6,\ 9,\ 12}$), which may be elongated by two carbons and desaturated again to give arachidonic acids (C20:4$\Delta^{5,\ 8,\ 11,\ 14}$). Arachidinic acid may be further metabolized to C22 fatty acids, such as the prostaglandins. Likewise, dietary α-lonolenic acid can be elongated and desaturated by hepatocytes to give eicosapentanoic acid (C20:5$\Delta^{5,\ 8,\ 11,\ 14,\ 17}$) and then further metabolized to other C22 fatty acids (i.e., docosahexaenoic acid - C22:6, n-3) [1]. The C18, C20, and C22 polyunsaturated fatty acids (PUFAs) are stored in phospholipids of cell membranes, when they contribute to the structural integrity and fluidity. They may be released by the action of phospholipases as important events in cellular communication. Released PUFAs serve as precursors for the eicosanoids: prostaglandins, leukotrienes, and thromboxanes. In birds, the eicosanoids regulate almost every physiological system, including oviposition, embryonic development, growth, immunity, bone development, thermoregulation, and behavior [2, 3, 4]. Chicken require linoleic acid at 1% of the diet [5]. This level is also adequate for reproduction [1]. Diets that utilize fat-extracted ingredients (e.g., soybean meal) often require the inclusion of vegetable oil or animal fat to provide essential fatty acids. Substrates used for *de novo* fatty acid synthesis depend on the diet. Chicken use dietary carbohydrate, especially glucose, to synthesize fatty acids. Most dietary energy that is consumed in excess of immediate needs is stored as triglycerides, particularly in adipose tissue. A typical adipose cell is about 90% lipid and the triglycerides are relatively inert. The length of time an average triglyceride molecule residues in the cell without being hydrolyzed by hormone-sensitive lipase is known as the turnover rate. The endogenous fat synthesized by chickens fed a fat free diet is mostly C16:0 and C18:1, with smaller amounts of C16:1 and C18:0. When fat is consumed, the fatty acids may be deposited in stores, diluting endogenously synthesized fatty acids. Three parameters determine the extent to which the types of fatty acids in a bird resemble that of the diet: (i) preferential oxidation or esterification of some types of fatty acids; (ii) modification of dietary fatty acids by elongation and/or desaturation; and (iii) the amount of dietary fatty acids relative to the amount synthesized *de novo* [1]. The increased egg weight was associated with total dietary fat contents of diet rather than the linoleic acid content over 1.0% [6]. Comparing the effects of various dietary energy sources on egg weight, it was suggested that the corn oil significantly increased the egg weight compared to poultry fat [7].

Therefore, this experiment was conducted to evaluate the effect of blended dietary lipids (palm olein oil - POO, a mixture of 25%POO plus 75% Soybean oil - SBO, 50%POO plus 50%SBO, and 75%POO plus 25%SBO) on the laying hen performance and the fatty acid profiles of eggs produced by 21 to 40 week old Dekalb Brown laying hens.

MATERIALS AND METHODS

Birds and Diets

Four hundred and thirty-two Dekalb Brown commercial laying hens 21 wk of age, were randomly assigned to 9 dietary treatment. The experimental design was a completely randomized design using a 4 x 2 factorial arrangement with one control. The experiment comprised 4 replicates with 12 birds in each treatment combination. Hens were housed in cages equipped with nipple drinkers and trough feeders, as to place individually in each cage, in an open-sided house with light control (16L:8D). The diets were isocaloric and isonitrogenous (Table 1). Performance characteristics (feed in take, egg production, egg weight, egg mass, and feed conversion) were evaluated every 28 d. Sampling eggs laid from d 26 to 28 of each 28-d period were collected from each experimental unit for Haugh unit, and eggshell thickness determination.

Chemical Analysis

At wk 38 of age, 5 fresh eggs per replicate were determined the profile of the main fatty acids. Yolk fatty acids were extracted as a modified Folch method following the methodologies described by Fletcher et al. [8] and quantified by gas chromatography Shimadzu. [9]

Statistical Analysis

Prior to analyses, Data expressed as a percent of egg production was arc sine and square root transformed. Analysis of variance was performed. Where significant differences among treatments were obtained, comparisons among means were performed by DMRT. Orthogonal polynomial contrasts were used to test the linear or quadratic nature of the response [10; 11].

Table 1 Composition of experimental diets.

Item, %	Control	Palm olein oil (PO)		Blended oil (POO : SBO)	
		1.5%	3.0%	1.5%	3.0%
Ingredients					
Broken Rice	54.10	48.90	44.61	48.90	44.61
Defatted Rice Brand	8.00	12.00	15.00	12.00	12.00
Soy bean oil meal 42%CP	19.60	19.30	19.12	19.30	19.12
Fish meal 58%CP	5.00	5.00	5.00	5.00	5.00
Palm olein oil	0.00	1.50	3.00	0.00	0.00
Blended oil (POO : SBO)	0.00	0.00	0.00	1.50	3.00
Oyster shell	8.00	8.00	8.00	8.00	8.00
Dicalcium Phosphate 18%P	0.70	0.70	0.67	0.70	0.70
Common Salt	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.10	0.10	0.10	0.10	0.10
Vitamin-Mineral Premix[1/]	0.25	0.25	0.25	0.25	0.25
Calculation composition					
Crude Protein	17.50	17.50	17.50	17.50	17.50
AME (kcal/kg)	2,710	2,720	2,740	2,720	2,750
Crude Fiber	2.90	3.32	3.63	3.32	3.63
Calcium	3.53	3.53	3.57	3.53	3.53
Available phosphorus	0.36	0.36	0.36	0.36	0.36
Lysine	1.05	1.05	1.05	1.05	1.05
Methionine	0.49	0.49	0.48	0.49	0.48
Methionine+Cystine	0.76	0.76	0.76	0.76	0.76
Threonine	0.78	0.78	0.77	0.77	0.77
Tryptophan	0.24	0.24	0.24	0.24	0.24

[1/] Supplied per kilogram of diets : vitamin A, 19,200 IU; vitamin D_3, 3,840 IU; vitamin E, 8 IU; vitamin K_3, 3.2 mg; thiamin, 2.4 mg; riboflavin, 6.4 mg; vitamin B_{12}, 0.0024 mg; nicotinic acid, 2.4 mg; folic acid, 0.8 mg; biotin, 0.16 mg; pantothenic acid, 16 mg; manganese, 96 mg; zinc 160 mg; iron, 128 mg; copper, 9.6 mg; selenium, 0.24 mg.

Results

The lipid profiles of the oil and blended oil were determined by gas chromatography Shimadzu (Table 2), Palm olein oil was detected the highest in palmitic acid (41.80%) but was not detect linolenic acid, whereas soybean oil was detected the highest in linoleic acid (57.30%) and it was detected linolenic acid (11.10%). Blend oil (POO : SBO) were detected fatty acids profile depending on ratio of inclusion. However, arachinodic acid was unclear.

Table 2 Fatty acids profile of palm olein oil, soybean oil and blended oil..

Fatty acid	Palm olein oil (POO)	Soybean oil (SBO)	Blended oil 25%POO + 75%SBO	50%POO + 50%SBO	75%POO + 25%SBO
Lauric acid (C 12)	0.40	ND	0.20	0.20	0.30
Myristic acid (C 14)	0.70	ND	0.30	0.40	0.70
Palmitic acid (C 16)	41.80	9.00	17.90	24.80	33.90
Stearic acid (C 18)	2.70	2.90	3.90	3.40	3.60
Oleic acid (C 18:1)	40.10	19.30	25.90	29.10	35.20
Linoleic acid (C 18:2)	14.30	57.30	43.20	35.50	22.80
Linolenic acid (C 18:3)	ND	11.10	7.30	6.30	3.50
Arachidonic acid	ND	0.40	1.30	0.30	ND

Performance parameters are presented in Table 3 and 4; they are grouped according to the percentage of replacement of POO with SBO (0, 25, 50, or 75% replacement). There were no statistically significant differences among treatments. Egg productions (% hen day) average 80% were recorded in first period and more than 90% in second to fifth period.

Table 3 Egg production, egg weight and egg mass of birds fed diet containing palm olein oil or blended oil.

Item	21-24 wks	25-28Wks	29-32Wks	33-36Wks	37-40Wks	Over all
Egg production (% Hen Day)						
Blended oil (POO + SBO)						
0 (Control)	78.52	92.32	92.27	91.82	91.46	89.94
25%POO + 75%SBO	81.84	93.80	92.14	92.55	91.63	90.32
50%POO + 50%SBO	80.08	94.94	93.01	92.50	90.23	90.15
75%POO + 25%SBO	82.40	94.15	93.59	93.09	91.53	90.95
100%POO	79.63	94.38	92.69	92.58	90.79	90.01
Level of inclusion in the diet						
1.50 %	81.84	94.41	92.32	92.27	91.27	90.42
3.00 %	80.14	94.23	93.39	93.09	90.82	90.29
Pooled SEM	4.03	2.60	2.97	2.99	2.69	2.24
C.V. (%)	6.29	3.42	3.98	4.02	3.69	2.48
Egg weight (g)						
Blended oil (POO + SBO)						
0 (Control)	54.60	57.29	57.75	59.50	60.87	57.81
25%POO + 75%SBO	55.97	57.23	58.96	60.19	62.15	58.90
50%POO + 50%SBO	57.07	57.84	59.25	60.29	61.86	59.24
75%POO + 25%SBO	55.07	56.55	58.02	59.24	60.39	57.91
100%POO	55.45	57.65	59.17	59.59	61.53	58.43
Level of inclusion in the diet						
1.50 %	55.64	56.98	58.34	59.60	61.13	58.34
3.00 %	56.14	57.66	59.36	60.05	61.83	58.90
Pooled SEM	1.19	1.22	1.28	1.05	1.41	1.03
C.V (%)	2.13	2.12	2.18	1.77	2.30	1.76
Egg mass (g/day)						
Blended oil (POO + SBO)						
0 (Control)	42.84	52.88	53.28	54.63	55.66	52.04
25%POO + 75%SBO	45.78	53.67	54.32	55.70	56.94	53.24
50%POO + 50%SBO	45.72	54.91	55.11	55.77	55.82	53.45
75%POO + 25%SBO	45.38	53.25	54.31	55.16	55.27	53.73
100%POO	44.18	54.41	54.84	55.17	55.85	52.68
Level of inclusion in the diet						
1.50 %	45.52	53.80	53.86	54.99	55.80	52.80
3.00 %	45.03	54.33	55.43	55.90	56.14	53.37
Pooled SEM	3.38	1.71	1.9	1.86	1.88	1.69
C. V. (%)	7.52	3.17	3.51	3.37	3.35	3.19

Table 4 Feed intake and feed efficiency of birds fed diet containing palm olein oil or blended oil.

Item	21-24 wks	25-28Wks	29-32Wks	33-36Wks	37-40Wks	Over all
Feed intake (g)						
Blended oil (POO + SBO)						
0 (Control)	98.37	104.71	106.19	115.05	113.28	107.05
25%POO + 75%SBO	98.50	107.25	106.58	114.57	114.38	108.13
50%POO + 50%SBO	97.69	106.27	107.70	114.35	113.90	107.98
75%POO + 25%SBO	97.86	104.98	108.70	113.66	114.54	107.95
100%POO	98.61	105.38	107.77	115.22	113.00	107.91
Level of inclusion in the diet						
1.50 %	98.12	104.79	106.52	114.08	113.89	107.48
3.00 %	98.21	107.15	108.92	114.81	114.01	108.51
Pooled SEM	1.12	1.96	2.52	1.13	2.26	1.26
C.V. (%)	1.14	1.85	2.35	0.99	1.99	1.17
Feed intake / Egg mass						
Blended oil (POO + SBO)						
0 (Control)	2.30	1.86	1.85	1.80	1.85	2.07
25%POO + 75%SBO	2.16	1.83	1.82	1.77	1.82	2.03
50%POO + 50%SBO	2.15	1.78	1.77	1.75	1.77	2.02
75%POO + 25%SBO	2.17	1.84	1.81	1.78	1.81	2.05
100%POO	2.24	1.81	1.80	1.79	1.80	2.05
Level of inclusion in the diet						
1.50 %	2.16	1.83	1.82	1.79	1.76	2.037
3.00 %	2.20	1.81	1.77	1.76	1.75	2.040
Pooled SEM	0.16	0.06	0.07	0.06	0.06	0.05
C.V. (%)	7.49	3.09	3.66	3.45	3.49	2.61

Table 5 Haugh unit and egg shell thickness of bords fed diet containing palm olein oil or blended oil.

Item	Haugh unit	Egg shell thickness (mm)
Blended oil (POO + SBO)		
0 (Control)	84.50	0.3725
25%POO + 75%SBO	79.05	0.3856
50%POO + 50%SBO	81.00	0.3732
75%POO + 25%SBO	82.37	0.3788
100%POO	83.02	0.3807
Level of inclusion in the diet		
1.50 %	81.41	0.3788
3.00 %	81.19	0.3804
Pooled SEM	6.51	0.0205
C.V. (%)	7.97	5.40

The fatty acid profiles of egg yolk extraction were determined by gas chromatography Shimadzu (Table 6). The concentration of total saturated fatty acid (SFA) was linearly decreased (P<0.05) only by level of inclusion (Table 7), generated the following : SFA = 24.8167 – 0.63Oil, r^2 = 0.66. Higher concentration of palmitoleic acid (P<0.05) was observed in eggs laid by hens fed the diet containing palm olein oil (100%POO), followed be hens fed the control diet. In contrast, Concentration of pamitoleic acid was decreased in egg yolk from hens fed the diet containing blended oils with 25%POO up to 75%POO.

Table 6 Fatty acid composition of egg yolk (%w/w) as influenced by hen diets containing palm olein oil or blended oil.

Fatty acids	Control	Palm olein oil (POO)		POO 25% + SBO 75%		POO 50% + SBO 50%		POO 75% +SBO 25%	
		1.5%	3.0%	1.5%	3.0%	1.5 %	3.0%	1.5%	3.0%
Lauric acid (C 12)					0.01			0.02	
Myristic acid (C 14)	0.25	0.26	0.30	0.30	0.29	0.35	0.19	0.36	0.32
Palmitic acid (C 16)	20.13	19.59	19.55	19.23	18.63	20.68	18.78	19.09	18.42
Stearic acid (C 18)	4.11	3.43	3.11	4.58	4.02	3.82	4.13	4.46	3.63
Saturated fatty acid (SFA)	24.49	24.11	22.95	24.85	23.10	23.90	22.37	23.28	22.96
Palmitoleic acid (C 16:1)	7.04	9.34	8.10	6.31	4.70	5.94	5.61	5.76	5.59
Oleic acid (C 18:1)	48.34	44.74	48.69	40.81	39.81	44.72	42.39	44.34	43.98
Linoeic acid (C 18:2) n-6	16.36	15.34	15.36	17.39	28.23	20.54	19.95	21.13	20.55
Linolenic acid (C 18:3) n-3	0.11	1.61	1.06	2.23	0.92	0.35	1.87	0.25	1.01
Docosahexaenoic (C 22:6) n-3	0.22	0.66	0.51	0.27	0.48	0.20	0.42	0.56	1.05
Polyunsaturated fatty acid (PUFA)	16.69	17.61	16.93	19.89	29.63	21.09	22.24	21.94	22.61
n-3	0.33	2.27	1.57	2.50	1.40	0.55	2.29	0.81	2.06
Unsaturated fatty acid (UFA)	72.07	67.01	74.14	71.75	70.24	72.04	71.18	71.69	73.72
Others	3.44	5.03	3.32	8.88	2.91	3.40	6.66	4.04	5.45
UFA/SFA	2.94	2.78	3.23	2.89	3.04	3.01	3.18	3.08	3.21

Table 7 Response of fatty acid composition of eggs yolk (%w/w) as influenced by hen diets containing palm olein oil or blended oil.

Item	Saturated fatty acid	Palmitoleic acid C16:1	Linoleic acid C18:2	Linolenic acid C18:3	Docosahexaenoic acid C22:6	Polyunsaturated fatty acid	Total n-3
Blended oil POO : SBO							
0 (Control)	24.49	7.04 [ab]	16.36	0.11	0.22	16.69	0.33
25%POO + 75%SBO	23.98	5.51 [b]	22.81	1.58	0.38	24.76	1.95
50%POO + 50%SBO	23.14	5.78 [b]	20.25	1.11	0.31	21.67	1.42
75%POO + 25%SBO	23.12	5.68 [b]	20.84	0.63	0.81	22.28	1.44
100%POO	23.53	8.27 [a]	15.35	1.34	0.59	17.27	1.92
SEM	0.925	0.730	3.483	0.783	0.211	3.844	0.887
P-value	0.699	0.045	0.432	0.584	0.239	0.325	0.641
Level of inclusion in the diet							
0.00 %	24.49 [a]	7.04	16.36	0.11	0.22	16.69	0.33
1.50 %	24.04 [ab]	6.84	18.60	1.11	0.43	20.13	1.53
3.00 %	22.85 [b]	6.00	21.03	1.22	0.62	22.85	1.83
SEM	0.512	1.577	4.236	0.753	0.259	3.916	0.762
P-value	0.025	0.718	0.568	0.459	0.381	0.377	0.287

[a-b] Means within a column with no common superscript differ significantly (<0.05)

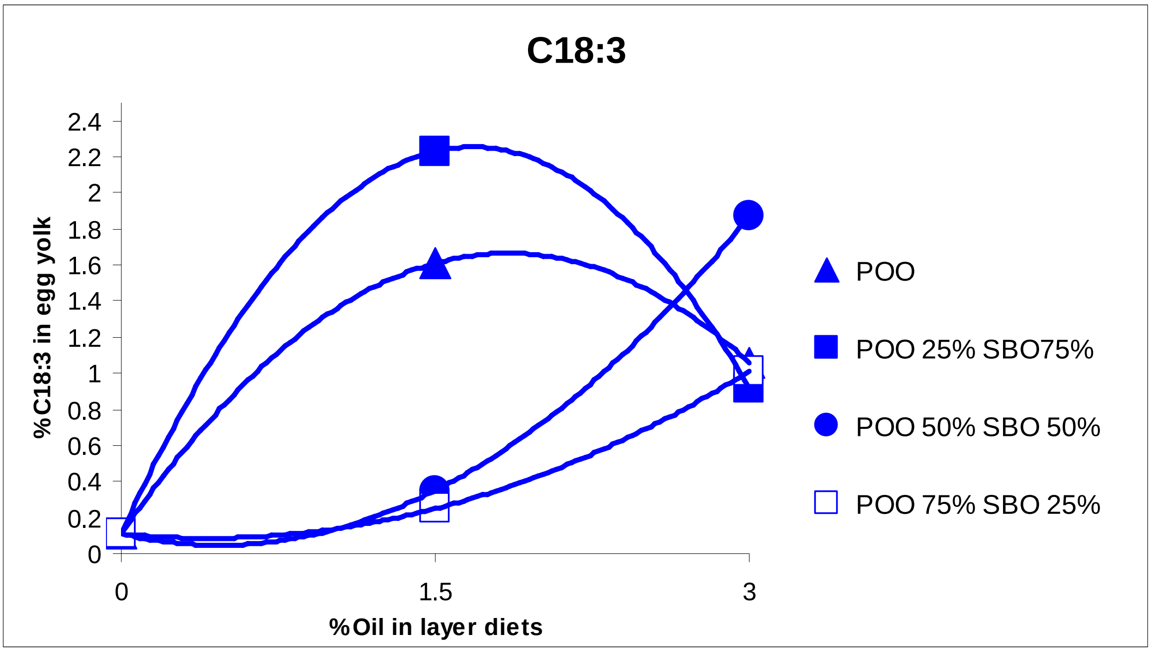

Figure 1 Response of Linolenic acid (LNA - C18:3) of the yolk of eggs produced by the laying fed the diet containing palm olein oil or blended oil.

Response of linolenic acid of the egg yolk produced by the laying fed the diet containing 1.5 % POO deposited higher than control and those fed diet containing 3.0 %POO. Linolenic acid of the egg yolk produced by the laying fed the diet containing 1.5% blend oil (25%POO+75%SBO) deposited highest (2.23%). Increase of level, tended to decreased the deposition of linolenic acid when inclusion at the level 3.0% in the diet (figure 1).

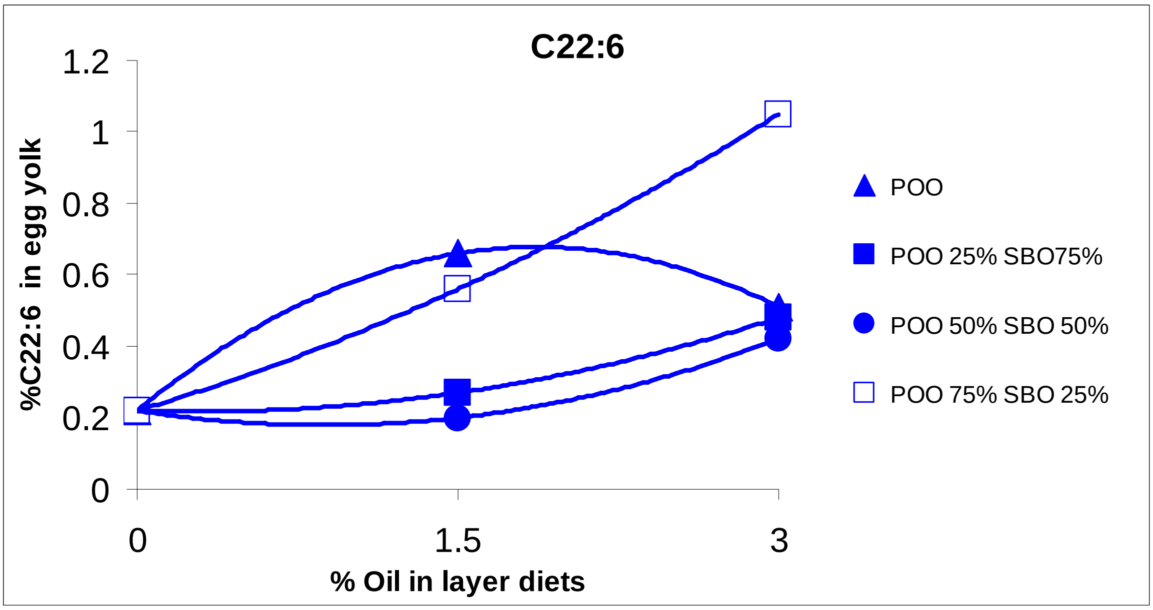

Figure 2 Response of docosahexaenoic acid (DHA - C22:6) of the yolk of eggs produced by the laying fed the diet containing palm olein oil or blended oil.

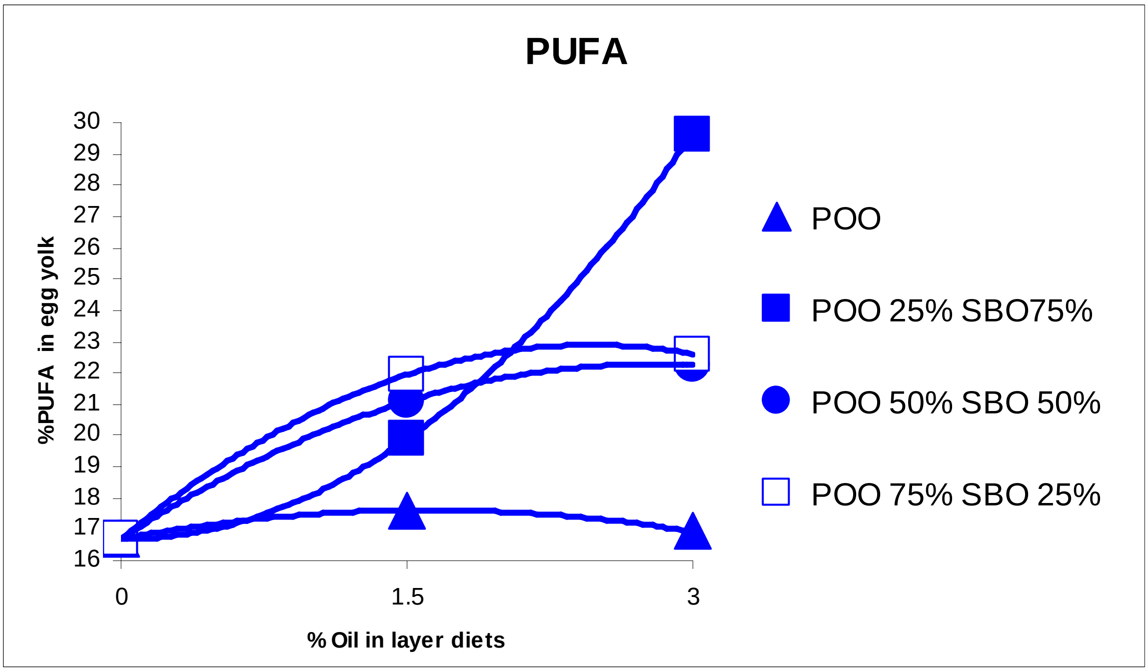

Figure 3 Response of polyunsaturated fatty acid (PUFA) of the yolk of eggs produced by the laying fed the diet containing palm olein oil or blended oil.

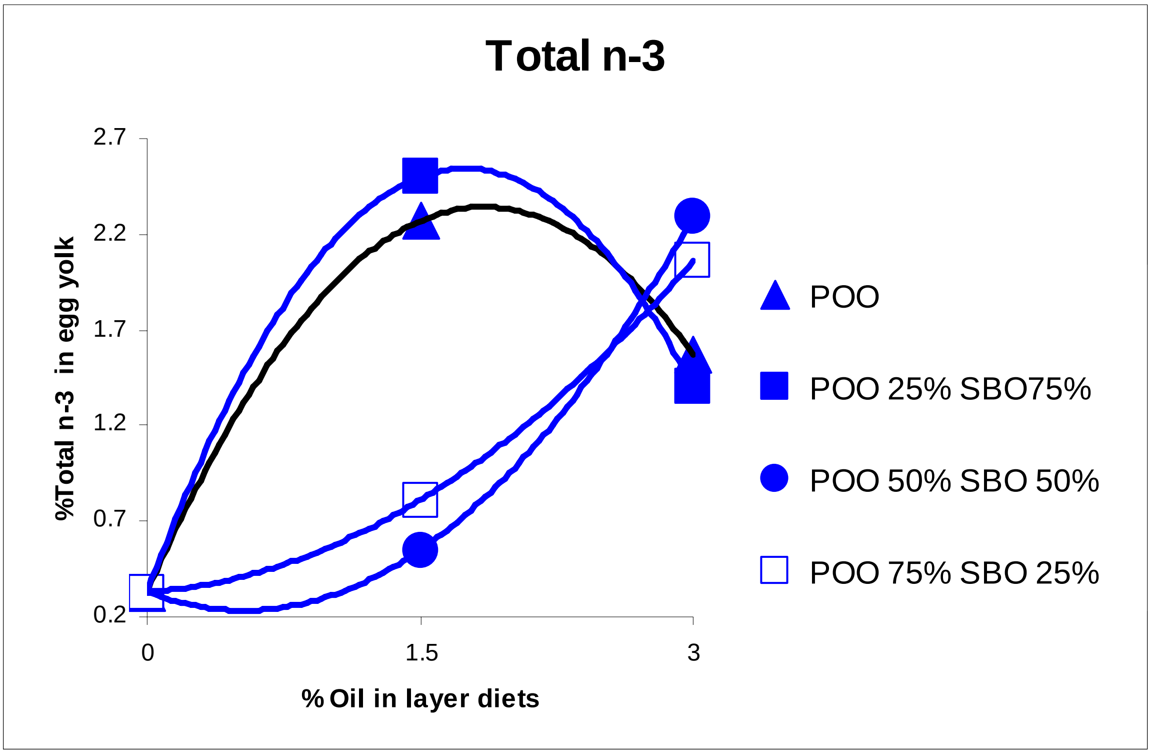

Figure 4 Response of total n-3 (C18:3 and C22:6) of the yolk of eggs produced by the laying fed the diet containing palm olein oil or blended oil.

Birds that consumed 3.0% blended oil between POO 75% and SBO 25% deposited higher amounts of docosahexaenoic acid (figure 2), and total n-3 fatty acids into their eggs, whereas hens fed diet 3.0% POO decreased deposited DHA less than hens fed diet 1.5% POO. The DHA content of the total fatty acids in the egg yolk of laying hens was 0.22 % for control diet, yolk eggs from hen fed diet containing POO at level 1.5% was 0.66% DHA. The highest deposited of DHA (1.05%) was taken eggs yolk from hen fed diet containing 3.0 % blended oil at combination from 75%POO plus 25%SBO.

The highest polyunsaturated fatty acid content was done from eggs yolk of hen fed diet containing 3.0% blend oil (25%POO plus 75%SBO - figure 3). Total n-3 in egg yolk from laying hens showed the same trend as C18:3, the eggs yolk from hen fed diet containing 1.5% blend oil (25%POO plus 75%SBO) was the highest value and then there was decreased when inclusion up to 3.0% (figure4).

Discussion

In the past, fish meal, fish oil , linseed, flaxseed, and algae products have been utilized to increase the amount of the n-3 PUFA in chicken eggs and meat. However, fish odour is a regular concern with increasing amount of dietary fish oil [12]. Increasing the α-linolenic acid content of chicken diets may result in a meat source high in n-3 PUFA that may reduce pressure on diminishing marine stocks [4]. The fatty acids composition of palm olein oil was agree with report by Aida et al. [13], soy bean oil was agree with reports by Grobas et al. [6] and Mazalli et al. [14]. Value obtained are in the range indicated by AOAS [15].

The performance parameters were analyzed according to the level of POO and blend oil inclusion, there were no statistically significant differences in the studied parameters among treatment. These results are in accordance with the Linoleic acid requirements determined by the NRC [5].

The lipid composition of yolk was influenced by fatty acid sources [16]. From this result fatty acid sources (table 3) were not detected DHA, but eggs yolk from laying hen fed any diets were found moderate amount of DHA. Leskanich and Noble [17] and Meluzzi et al [18] conclude that it must be recalled that DHA is obtained in yolk from a double path; the direct deposit of DHA from the diet and a final result of the *de novo* synthesis from its precursors (Linolenic acid, eicosapentanoic acid, and docosapentaenoic acid) given in the diet.

Aida et al [13] report that dietary palm olein at level of 3% altered the fatty acid composition of egg yolk and total lipid in Lohmann Brown laying hens as C16:0, C16:1, C18:0, C18:1, and C18:2n-6 were 19.96, 8.40, 8.30, 29.10 and 10.61%, respectively. The different levels of dietary palm olein oil (POO 0-4.5%) did not affect the saturated fatty acid content of egg yolk. The oleic acid (major fatty acid in the omega-9 family) was not increased as level of POO increased in the diet. The SFA and SFA/PUFA ratio did not change with the level of dietary palm olein oil [Hosseini-Vashan *et al*, 19]. The type of supplemental fats (4% of crude palm oil, 1% to 4% palm stearin oil, 4% palm olein oil, 4% soya oil, 4% tallow, and 4% tuna oil) did not affect egg production, egg weight, feed intake, feed intake per dozen egg produced, egg quality, egg composition and cholesterol content in serum and egg yolk. There were significant difference in feed intake per kg egg produced and egg mass. The supplementation of palm olein and tuna oil at 4% in the diet provided higher feed cost per kg egg weight when compared to the control. It was found that the unsaturated fatty acid affected the change of fatty acid composition in egg yolk [Akarapunyavit, 20]. The yolk and blood cholesterol content were increased in 3.0% palm olein oil and the different among level of palm olein oil level and control were statistical significantly [Hosseini-Vashan and Afzali, 21]. Eggs laid by hens fed the diet containing high portion of soybean oil at 3.0% had a large amount of n-6 polyunsaturated fatty acids (PUFA), whereas egg from hens fed the diet containing palm olein oil (POO) or high proportion of POO had high percentage of n-3 PUFA. Suggest that egg yolk lipid modifications by blended oil, soybean oil 75% plus palm olein oil 25% at level 3.0% of inclusion had more amount of n-6 PUFA or soybean oil 25% plus palm olein oil 75% at same level had more amount of n-3 PUFA, whereas egg yolk from hens fed the diet containing palm olein oil at 3.0 % of inclusion decreased both n-3 and n-6 PUFA when compare with 1.5% of inclusion in the diet. Inclusion of 3% palm olein oil in the feed for Lohman Brown laying hens also resulted in the lowest content of saturated fatty acids - palmitic and stearic acids, as well as linoleic acid from the group of n-6 PUFA [16] Report of Filardi et al. [15] showed that fat sources influenced the fatty acid profiles, except for the concentrations of the PUFA C20:3n-3 and C20:3n-6. Thus, an excess of linoleic acid will prevent the transformation of α-LNA into its derivates EPA and DHA, and the opposite is also true.

The fatty acids composition of total yolk lipids reflected that of laying hen diets. The fact that both linoleic acid and linolenic acid are substrates of Δ^6 desaturase, allowing linolenic acid to establish a competitive inhibition of the linoleic desaturation [2, 22]. Aymond and Van-Elswyk [23], who observed that high amounts of n-6 fatty acids reduced the activity of Δ^6 desaturase enzyme in the conversion of linolenic acid to DPA and DHA, causing a reduction of these acids in egg yolks. The regulation of DHA levels in tissues remains in enigma. The fact that DHA can be formed from linolenic acid, albeit at a very low rate, but cannot be increased by increased dietary linolenic acid, suggests that DHA concentrations, at least in circulating phospholipid pools, are regulated to satisfy a relatively low metabolic demand that can be satisfied by the relatively low levels observed in vegans with no dietary DHA intake [24].

Conclusions

Blended oil had no effect on the efficiency of production, egg weight, egg mass output, feed conversion, Haugh unit and egg shell thickness. Results obtained in the present study indicate that the fatty acid profile of eggs can be modified by varying the lipid composition of the diet. Eggs laid by hens fed the diet containing high portion of soybean oil at 3.0% had a large amount of n-6 polyunsaturated fatty acids (PUFA), whereas egg laid by hens fed the diet containing palm olein oil (POO) or blended oil 25%POO plus 75%SBO at 1.5 % level of inclusion had high percentage of n-3 PUFA. and n-9 family. The addition of blended palm olein oil plus soybean oil decreased the concentration of saturated fatty acids, increased the concentrations of monounsaturated fatty acid, α-linolenic and DHA, and with moderate amount of linolenic acid, is used as substrate. In addition of blended oil did not promote the enrichment of the eggs with PUFA.

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Output จากโครงการวิจัยที่ได้รับทุนจาก สกว.

1. ผลงานตีพิมพ์ในวารสารวิชาการนานาชาติ
   ส่งตีพิมพ์ Walailak J. Sci. Tech.

2. การนำผลงานวิจัยไปใช้ประโยชน์
   - เชิงพาณิชย์ แนะนำให้ใช้น้ำมันปาล์มโอลีนร่วมกับน้ำมันถั่วเหลืองแทนการใช้น้ำมันปาล์มโอลีน หรือน้ำมันปาล์มดิบเนื่องจากองค์ประกอบของกรดไขมันให้ผลดีต่อสุขภาพของผู้บริโภคมากกว่า (ค่า DHA เป้าหมายที่ผู้ผลิตตั้งเป้าไว้คือ 2.20 เปอร์เซ็นต์ ผลจากการศึกษาสูงสุดที่ 1.05 เปอร์เซ็นต์ เมื่อใช้น้ำมันถั่วเหลือง 25 เปอร์เซ็นต์ ร่วมกับน้ำมันปาล์มโอลีน 75 เปอร์เซ็นต์ ผสมในสูตรอาหารไก่ไข่ในอัตรา 3.0 เปอร์เซ็นต์
   - เชิงนโยบาย -
   - เชิงสาธารณะ -
   - เชิงวิชาการ ใช้เป็นตัวอย่างสำหรับการเรียนการสอนสรีรวิทยาการผลิตสัตว์ และโภชนะศาสตร์สัตว์
3. อื่นๆ -