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ระดับที่เหมาะสมของกลีบกระเจี๊ยบแดง (*Hibiscus sabdariffa* Linn.) แห้งในอาหารไก่ไข่

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บทคัดย่อ: การวิจัยในครั้งนี้มีวัตถุประสงค์เพื่อศึกษาการใช้กลีบกระเจี๊ยบแดงแห้งในอาหารไก่ไข่ที่ระดับ 0 2 4 และ 6 เปอร์เซ็นต์ โดยใช้ไก่ไข่อายุ 18 สัปดาห์ จำนวน 576 ตัวแบ่งออกเป็น 4 กลุ่ม (ตามอาหารทดลอง) กลุ่มละ 6 ซ้ำ ๆ ละ 24 ตัว ผลการทดลองพบว่า การเสริมกลีบกระเจี๊ยบแดงแห้งในอาหารไม่มีผลต่อปริมาณอาหารที่กินที่ช่วงอายุ 18-26 สัปดาห์ แต่พบว่า การเสริมกลีบกระเจี๊ยบแดงแห้งในอาหารที่ระดับ 6 เปอร์เซ็นต์ให้ผลผลิตไข่สูงที่สุดที่ช่วงอายุ 19-23 สัปดาห์ และแตกต่างอย่างมีนัยสำคัญทางสถิติ ($P<0.05$) กับกลุ่มควบคุมที่ช่วงอายุ 21-22 สัปดาห์ อย่างไรก็ตาม ในสัปดาห์ที่ 24 พบว่า ไก่ไข่กลุ่มที่ได้รับการเสริมกลีบกระเจี๊ยบแดงแห้งในอาหารที่ระดับ 6 เปอร์เซ็นต์มีปริมาณผลผลิตไข่ต่ำที่สุดเนื่องจากไก่เกิดความเครียด แต่ในสัปดาห์ที่ 26 ผลผลิตไข่ได้คืนกลับมาปกติและสูงกว่ากลุ่มอื่น สำหรับการสุ่มตรวจสอบคุณภาพไข่ที่ 5 และ 50 เปอร์เซ็นต์ของการให้ไข่ พบว่า การเสริมกลีบกระเจี๊ยบแดงแห้งในอาหารไม่มีผลต่อคุณภาพไข่ ($P>0.05$) สรุปได้ว่า การเสริมกลีบกระเจี๊ยบแดงแห้งในอาหารที่ระดับ 6 เปอร์เซ็นต์ ทำให้ผลผลิตไข่เพิ่มขึ้นแต่ไม่มีผลต่อคุณภาพไข่

คำสำคัญ: กระเจี๊ยบแดง ผลผลิตไข่ ไก่ไข่

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The Optimum Level of Roselle (*Hibiscus sabdariffa* Linn.)

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Abstract: An experiment was conducted to examine the benefits of using roselle (*Hibiscus sabdariffa* Linn) dried calyx at varying levels (0, 2, 4 and 6%) in diets for laying hens at 18 weeks. Five hundred and seventy six 18-week old Hisex Brown pullets were randomly allotted into 4 groups of 6 replications, each replication containing 24 birds. Feed intake from 18 to 26 weeks of age was unaffected by the roselle supplement. From 19 to 23 weeks of age the highest egg production was observed in 6% roselle group. Inclusion of roselle at 6 % in the diet was found to increase (P<0.05) egg production at 21 and 22 weeks of age. However, at 24 weeks birds have the physiological stress, thus the lowest egg production was found in 6% roselle. By 26 weeks of age the egg production from birds in this group recovered and was higher than in other groups but this was not significantly different. Egg quality at 5 and 50% lay was not significantly different between the levels of roselle in diet (P>0.05). In conclusion, supplementation of 6% roselle calyx in chicken diets can improve egg production but it does not affect on egg quality.

Keywords: *Hibiscus sabdariffa,* Egg production, Layers

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Introduction

Thailand is one of the world's largest producers of roselle and supplies the product in superior quality. Roselle tea has been found to lower blood pressure and inhibit *Escherichia coli* (McKay *et al*., 2010). Roselle has been used widely as beverage, jam, preservative and medicine uses but not so much in poultry feeding due to the price. A previous study showed that the use of roselle dried calyx at 1 or 2 % in layer diet did not significantly improve egg production or egg quality (Sukkhavanit, 2008). However, there is much evidence on its beneficial use in

humans. Ajiboye *et al.* (2011) reported that roselle calyx extract is a good source of antioxidants due to its anthocyanins. Many studies also suggest that roselle possesses antitumour and inhibitory effects on the growth of several cancer cells (Kamei *et al.*, 1995; Nagase *et al*., 1998; Meiers *et al*., 2001; Tsai *et al*., 2002). Thus, the current study was conducted to examine the optimum level of roselle calyx that can be beneficial to the production in layer diet.

Materials and Methods

Experimental birds and diets

Five hundred and seventy six Hisex Brown pullets at point of lay (18 weeks of age) were used for this study, which a trial period for 2 months. The study investigated the effect of 0, 2, 4 and 6 % levels of roselle in layer diets, at fixed level of metabolisable energy and crude protein. The roselle calyx was oven dried before use. The ME value and nutrient composition of roselle was obtained from Sukkhavanit (2008) for feed formulation. The ingredient and nutrient composition of the experimental diets were as shown in Tables 1. The experiment was conducted in cages, each holding 2 birds. Twelve cages (24 birds) constituted one replicate, with 6 replicates per treatment and there were 4 treatments in total in a completely randomized design. Birds had access to feed and water *ad libitum.* The experiment was conducted at a modern layer house in Thailand. Temperature and ventilation were controlled with an evaporative cooling system. Birds received a total of 17 hours of light per day. Room temperature was controlled at 20-28 °C, and the relative humidity maintained between 60 and 70 %.

Measurements

Body weight was recorded at 18 weeks, and thereafter every week until 25 weeks of age. The total number of eggs, cracked eggs and dead birds were recorded on a daily basis. Feed intake was measured on a weekly basis and converted to daily values. Percent hen-day egg production, egg weight, egg breakage and mortality rate were calculated on a weekly basis. Feed conversion ratio (FCR) was determined as feed intake per egg mass for two periods (during pre-lay and early laying periods). Egg mass was calculated by multiplying percent hen day production by mean egg weight (North and Bell, 1990). Egg quality parameters were measured at 5 and 50 % lay. About 50 % of total eggs per replicate were sampled to measure egg weight, shell thickness, albumen height, Haugh unit and yolk colour. Three pieces of the eggshell were taken for measurement of shell thickness, using a micrometer screw-gauge (Model SM-112, Teclock, Tokyo, Japan),

Table 1 Nutrient composition of diets fed during 18-26 weeks of age

Ingredient (%)	**Dietary Roselle Level (%)**			
	0	**2**	**4**	**6**
Maize	51	49	47	45
Cassava	5	5	5	5
Rice bran oil	2	2	2.2	2.3
Rice bran	2.5	2.5	2.5	2.5
Soybean meal	25	25	24.7	24.6
Meat &bone meal	5	5	5	5
Rosselle	0	2	4	6
DL-Methionine	0.1	0.1	0.2	0.2
Monodicalcium Phosphate	0.12	0.13	0.14	0.16
Calcium carbonate	8.6	8.5	8.4	8.4
Common Salt	0.16	0.16	0.16	0.16
Premix[1]	0.3	0.3	0.3	0.3
Total Batch	100	100	100	100
Nutrient composition (g/kg) by calculation				
ME (MJ/kg)	11.72	11.72	11.72	11.72
Crude Protein	17.8	17.8	17.8	17.8
Fat	4.87	4.95	5.04	5.12
Fiber	3.58	3.77	3.97	4.16
Calcium	3.90	3.90	3.90	3.90
Available P for poultry	0.38	0.38	0.38	0.38
Sodium	0.16	0.16	0.16	0.16
Lysine	0.93	0.92	0.91	0.91
Met+Cys	0.70	0.70	0.70	0.70
Methionine	0.48	0.48	0.48	0.49
Threonine	0.67	0.57	0.66	0.65
Choline	0.10	0.09	0.09	0.09

[1]Supplying vitamin A, 4.8 million units/kg; vitamin D_3, 0.96 million units/kg; vitamin E, 3; 200 units/kg; vitamin K_3, 0.8 g/kg; vitamin B_1 , 0.4 g/kg; vitamin B_2, 1.6 g/kg; vitamin B_6, 1.2 g/kg; vitamin B_{12}, 0.004 g/kg; Folic acid, 0.2 g/kg; Niacin, 6.0 g/kg; pantothenic acid, 4.0 g/kg; biotin , 0.012 g/kg; manganese, 24.0 g/kg; iron, 16.0 g/kg; zinc, 16.0 g/kg; copper, 2.4 g/kg; iodine, 0.14 g/kg; selenium, 0.028 g/kg anti-caking+antimold+antioxidant , 0.1868 g/kg.

accurate to 0.001 mm. The Haugh unit (HU) values were calculated using the formula:

$$HU = 100 \log (H - 1.7W^{0.37} + 7.6)$$

where HU is Haugh unit, H is observed height of the albumen in millimeters, and W is weight of egg in grams (Doyon *et al*, 1986). Yolk colour was measured using a Hoffmann-La Roche Fan (Hoffmann-La Roche, Inc., Nutley, NJ, USA).

Data analysis and reporting

The data were subjected to regression, using increasing levels of roselle as factor. Analyses were conducted using the Minitab statistical package (Minitab, 1998). All statistics presented in this study were mean values with standard errors, and differences between means were determined by least significant difference (LSD). Differences between mean values were considered to be significant at $P<0.05$.

Results

Feed intake and body weight

Feed intake per day in the pre-lay period (18-21 weeks) was not significantly different between the treatments. At 18-21 weeks of age, feed intake per egg mass was 9.7, 9.4, 9.3 and 7.3 g/g on the 0, 2, 4 and 6 % roselle diets, respectively. During the early laying period, feed intake per egg mass was decrease to about 1.9 g/g in all treatments, while inclusion of roselle did not affect feed intake. The initial weight of birds at 18 weeks was not significantly different between the treatments. However, at 19 weeks 2 % roselle in diet significantly increased ($P<0.05$) body weight to 1708 g (Fig. 1). However, during 20-24 weeks of age the body weight was not significantly different between treatments. At 25 weeks of age inclusion of roselle calyx at the three levels reduced body weight ($P<0.05$), with value at 1892, 1865, 1870 and 1860 g, respectively for the control, 2, 4 and 6 % rosselle groups.

Egg production

Initially, birds on the 6 % roselle diet tended to have a better egg production than those on the other diet but there was no significant difference between the treatments during the early lay period (18-20wks). However, inclusion of 6 % roselle in diet increased egg production by 4.7 and 9.6 %, respectively, at 19 and 20 weeks of age. When hen-day production reached the 50 % mark at 21 weeks of age, the 6 % Roselle diet was approximately 15.8 % more productive than the control diet. A significant increase ($P<0.05$) in hen-day production was also observed at 22 weeks; 56.9 % on 2 % Roselle diet to 74.4 % in the 6 % Roselle diet. Birds were probably stressed during 22 and 23 weeks of age from taking blood samples, thus

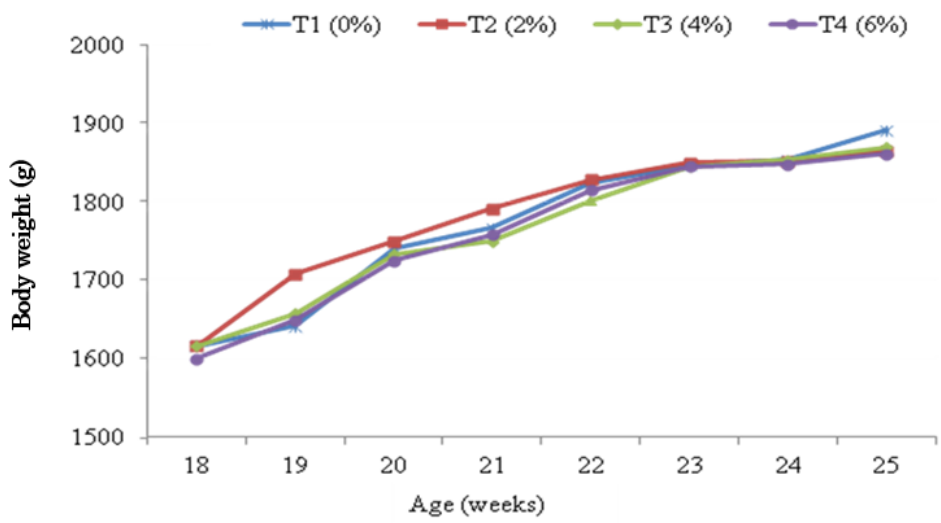

Fig. 1 Effect of roselle at different levels on body weight (g) on 18-25 weeks of age

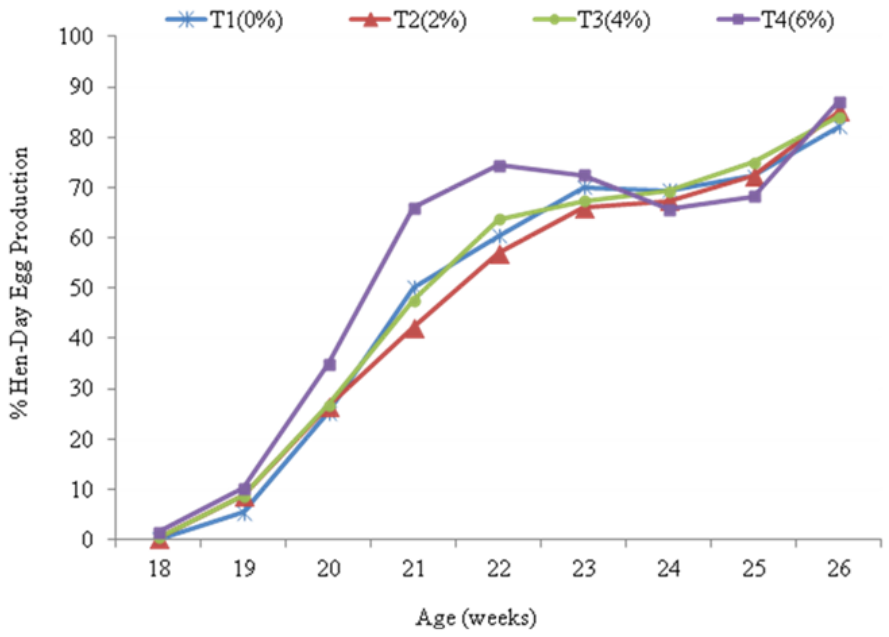

Fig. 2 Hen-day egg production (%) over the entire period (18-26 weeks)

egg production was decreased, particularly at 6 % roselle but there was no significant difference between the treatments. However, these were tending to recovered by 26 weeks of age as shown in Figure 2.

Egg Quality

Egg quality values from 20 and 24 weeks of age are shown in Table 2. Egg weight did not differ significantly with diet at any age. At 20 weeks the average egg weight was between 55.4 and 55.9 g and 61.6-62.8 g at 24 weeks. Inclusion of roselle at any level in

Table 2 Egg quality of hens on diets containing different levels of dried roselle calyx at 20 and 24 weeks of age

Roselle (%)	Egg wt. (g)	Albumen height	Yolk colour score	yolk wt. (g)	Shell wt. (g)	Shell thickness (mm)	Albumen wt. (g)	Haugh units
20 weeks								
0	55.4	6.7	8.6	12.8	5.6	0.49	37.0	82.1
2	55.7	6.5	8.6	12.6	5.7	0.49	37.4	81.1
4	55.9	6.4	8.4	12.9	5.6	0.49	37.4	80.5
6	55.4	6.5	8.6	12.9	5.5	0.48	36.6	80.8
SEM	1.64	0.37	0.34	0.52	0.28	0.02	1.26	2.80
24 weeks								
0	62.8	7.3	8.2	14.9	6.4	0.50	41.5	83.8
2	61.6	7.4	8.1	14.4	6.6	0.51	40.7	84.9
4	62.3	7.4	8.2	14.5	6.3	0.50	41.4	84.6
6	61.6	7.4	8.4	14.1	6.5	0.50	40.9	84.8
SEM	2.00	0.57	0.51	0.58	0.18	2.61	1.55	3.55

diet has no significant effect on yolk color score, with the value on the control diet approximately 8 at both 20 and 24 weeks of age. Shell weight at 20 and 24 weeks ranged between 5.5 and 5.7 g and 6.3 and 6.6 g, respectively; however, these were not significantly affected by Roselle level. At 20 weeks, shell thickness ranged between 480 and 490 µm, while at 24 weeks the thickest shells were from the 2 % Roselle group (510 µm). There were no apparent effects of roselle level on albumen and yolk weight. At 24 weeks, albumen weight ranged between 40.7 and 41.5 g. A similar trend was evident in the Haugh unit score; however, the highest Haugh unit score at 24 weeks, 84.9, was observed on the 2 % Roselle diet, while the lowest was 83.8 on the 0 % Roselle diet.

Discussion

The current results demonstrated that feed intake and feed conversion ratio (FCR) were not affected by at any level of roselle in the diet. However, between 18 and 21 weeks of age, FCR, was marginally improved at all level of roselle in diets. The improved FCR may be due to the acidifying property of the supplement and ability to increase

trypsin activity and fat digestibility. Aphirakchatsakun *et al.* (2008) also suggested that roselle in powder form in post-weaning pig diet acted as an acidifier and antioxidant. At 25 weeks of age inclusion of roselle calyx found to significantly lower body weight. The contrast was reported by Aphirakchatsakun *et al.* (2008) that using Roselle at 4 and 8% in post-weaning pig diet had no effect on body weight. However, roselle seed meal at less than 20% significantly decreased body weight gain of broiler chickens (Salih and Abdel, 1999). This could be due to the high dietary fiber content which affect nutrient digestibility (Mgbenka and Lovell, 1987; Shiau, 1989). However, no clear trend was observed in body weight change at other stage of this study. The data from the current trial showed that using 2 and 4% roselle in diet did not significantly affect hen-day production. This is similar to the observations of Sukkhavanit *et al.* (2011) who reported that roselle calyx extract and powder at 1, 2 and 2, 4 % diet supplied phenolic compounds of up to 1,113 mg/kg diet but had no effect on egg production and egg quality. However, the current study showed that birds at higher level of roselle (6 %) in diet tended to have a better egg production than those on any other diet. A significant increase in hen-day production was also observed at 22 weeks of age. Moreover, after the induction of physiological stress at 23 weeks, egg production dropped but recovered and marginally improved at 26 week of age. This can be due to the beneficial effects of phenolic compounds in roselle calyx including quercetin and protocatechuic acid as well as ascorbic acid. Phenolic compounds act as an antioxidant by reducing agents, hydrogen donators and singlet oxygen quenchers (Kruawan and Kangsadalampai, 2006). However roselle calyx seems not to have any beneficial effect on egg quality, which is similar to the study from Sukkhavanit *et al.* (2011). Even though, roselle calyx seems to be rich in natural red pigments (anthocyanins). However, in this study there still no trend of improvement in yolk color score. This could be explain by Klassing (1998) that the pigment deposition in specific tissues depends on many factors such as the appropriate quantity in the diet, the deposition rate in the growing tissue and the capacity of the bird to digest, absorb and metabolize. Moreover, the use of pigment can be limited due to hydrolytic action by specific intestinal esterase of low digestion, when the pigment is esterified with long chain fatty acids (Klassing, 1998).

Conclusion

Dried roselle calyx at 6 % in diet improved egg production. However, it had no

beneficial effect on egg quality. Further studies should be done at the higher levels particularly toward improvement in yolk color score.

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