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Summary

Experiments were conducted to study the effect of Marigold petal concentrate (MPC) and Capsicum annum fruit concentrate (CFC) on egg yolk pigmentation when added to broken rice and corn -ipil ipil basal diets. 120 Isa Brown layers were divided into 24 pens of five. Each pen received successively 3 replications of 8 treatments of 4 different levels of three pigmentors (MPC, CFC, MPC/CFC combined) in both types of basal diets. Production performances were not affected by the three pigmentors. However, there was marked difference in the levels of inclusion and the colors yielded by the three pigmentors. When applied separately, MPC had to be used in greater concentrations than CFC. Yolk colors depended on the type of basal diet. Addition of either MPC or CFC to the pigmented corn ipil-ipil diet yielded an acceptable yellowish orange color. Addition of MPC to the non-pigmented broken rice diet gave a deep yellow yolk color, while CFC tainted egg yolk to an undesirable pinkish orange. A combination of the two pigmentors in an appropriate ratio (1.2:1, MPC:CFC) lowered the required concentrations of MPC and improved the color effect of CFC.

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Introduction

The color of yolk is one important quality of egg for consumption. Yellowish orange is most preferred. Color of yolk is influenced by sources and levels of xanthophyll in diets, either naturally supplied or purposedly added. Corn and ipil ipil are well known, natured supplied ingredients which are widely used in poultry ration. Having high and efficient lutein contents, corn yields Roche score at 8.2 when used at normal level (Burdick and Fletcher, 1984). The color is lower than that prefer by consumer at 10-12 score. Accroding to Scott (1982) ipil ipil contains 660 mg xanthophyll/kg meal, but is used in a small amount in layer ration, usually not more than 5%. In order to provide the desired color, addition of pigmentors to the diets are generally practice. There are two main sources of additive pigmentors for layers, synthetic pigments and natural pigments. Synthetic pigments include β apo 8' carotenal, β apo 8' acid carotenoic ethyl ester, canthaxanthin and citranaxanthin. It should be noted that using synthetic pigments would incur a higher cost and is prohibited in some countries (Fletcher and Halloran, 1981). Thus, consequently efforts have been made to the find natural sources of pigmentors.

Marigold petal flowers and Capsicum annum fruits are two pigmentors of natural sources. Marigold petal flowers give yellowish color when Capsicum annum fruits give reddish color. Combination of the two yields yellowish-orange color of various shades depending on the ratio of the pigmentors and the exist xanthophyll in basal feed. The two products have long known and used in poultry ration. Marigold petal flowers are used in the form of either finely ground meal, extracts or micro-encapsulated extracts (Fletcher,1985), while Capsicum annum fruits are used in the extracted form (Mackey, 1963). Although the color yields from the two sources are generally

satisfactory, it is believed that better methods of application could be found to obtain higher efficiency.

Marigold petal concentrate (MPC) and Capsicum annum fruits concentrate (CFC) are two products prepared from Marigold flowers and Capsicum annum Fruits. MPC are prepared by combining the extract from marigold flowers with dehydrated marigold petal meal to contain 12 gm xanthophyll per kg product. CFC are prepared by diluted Capsicum annum fruits extract with vegetal meal to contain 10 gm xanthophyll per kg product. The two products were recently introduced for use in broiler and layer industries. The purpose of this experiment is to study the effect of the two products on egg yolk pigmentation when used in two basal diets widely used in local Thai market.

Material and Method

Individually caged 120 Isa Brown layers were placed at random into 24 pens which were allotted to 3 replications to 8 treatments. Three pigmentors were consecutively used in this study : MPC, CFC and MPC/CFC combined. Each pigmentor was used in two standard basal diets (Table 1) : xanthophyll- free broken rice based and corn-ipil ipil based as diet with xanthophyll. Test diets were prepared as in Table 2.

Birds were put on the three consecutive lots of test diets with 14 days on test periods and 14 days interval. All eggs produced were collected for color analysis by Roche Color Fan scale (RCF). Egg production, egg mass and feed intake values were recorded by pen throughout the whole experimental peroid for subsequent analysis of feed intake and feed efficacy. Results of all data were analyzed using analysis of variance and Duncan's multiple range test as described by Steel and Torrie (1960).

Results and Discussion

Effects of adding MPC, CFC and MPC/CFC combined are shown in Table 3, 4 and 5 respectively.

Table 1 Composition of broken rice (BR) and corn-ipil ipil (CI) diet

Ingredients	broken rice	corn-ipil ipil
	kg	
Broken rice	57.8	-
Yellow corn	-	57.3
Rice bran	12.0	12.0
Soybean meal	15.0	12.5
Fish meal	6.0	6.0
Ipil-ipil	-	3.0
Dicalcium phosphate	2.0	2.0
Oster-shell	6.0	6.0
Salt	0.5	0.5
DL-methionine	0.2	0.2
Vitamin-Mineral premix[1]	0.5	0.5
Calculated analysis		
Metabolizable energy, Kcal/kg	2769.75	2778.41
Protein, %	15.97	15.99
Lysine, %	0.94	0.87
Methionine + cystine, %	0.64	0.63
Calcium %	3.25	3.27
Available phosphorus, %	0.66	0.65
Xanthophyll,mg/kg[2]	0.00	30.26

[1]Vitamin-Mineral premix 1 kg provides : Vitamin A 8000 IU, D3 1500 IU, E 8 mg, K 2 mg, B2 3 mg, pantothenic acid 4.5 mg, B12 5 mg, B1 0.5 mg, B6 1 mg, biotin 50 mg, folic acid 0.5 mg. choline 150 mg, nicothenic acid 10 mg, Mn 50 mg, Zn 60 mg, Fe 40 mg, Cu 5 mg, Co 0.5 mg, I 1 mg, Se 0.1 mg and Mo 0.75 mg.

[2]Refer to Scott et al (1982).

Table 2 Dietary treatment of added xanthophyll and total xanthophyll from Marigold petals concentrate (MPC) and Capsicum fruits concentrate (CFC).

Source of Xanthophyll	Type of basal diet	Treatment No.	mg/kg calculated xanthophyll			
			in basal diet	added MPC	added CFC	Total xanthophyll
MPC	BR	T_1	0	0	0	0
		T_2	0	40	0	40
		T_3	0	50	0	50
		T_4	0	60	0	60
	CI	T_5	30.26	0	0	30.26
		T_6	30.26	30	0	60.26
		T_7	30.26	40	0	70.26
		T_8	30.26	50	0	80.26
CFC	BR	T_1	0	0	0	0
		T_2	0	0	5	5
		T_3	0	0	7.5	7.5
		T_4	0	0	10	10
	CI	T_5	30.26	0	0	30.26
		T_6	30.26	0	5	35.26
		T_7	30.26	0	7.5	35.76
		T_8	30.26	0	10	40.26
MPC/CFC combined	BR	T_1	0	0	0	0
		T_2	0	6	5	11
		T_3	0	12	10	22
		T_4	0	18	15	33
	CI	T_5	30.26	0	0	30.26
		T_6	30.26	6	5	41.26
		T_7	30.26	12	10	52.26
		T_8	30.26	18	15	63.26

1. Egg yolk color

1.1 MPC. Addition of MPC to broken rice diet at the xanthophyll levels of 0, 40, 50, and 60 mg/kg feed gave RCF at < 1, 9.5, 10.1 and 11 respectively. The scores were higher than those obtained from adding dried marigold petal meal (MPM) at the xanthophyll levels of 15, 30 and 45 mg/kg given 4, 6 and 8 RCF (Brunlich, 1974) and at the level 33 mg/kg given 7 RCF (Suwanna, 1979). The higher color obtained would probably be due to the preparation process of extraction and dehydration of marigold flower.

In corn-ipil ipil diet, xantohphyll level was calculated using Scott value (Scott, 1982) to contain 30.26 mg/kg. Addition of MPC at the xanthophyll level of 30 mg/kg make up the total level 60.26 mg/kg. RCF scored at 10.22 the same score as given by broken rice diet when adding 50 mg/kg xanthophyll, and lower than score 11 given by broken rice with 60 mg/kg. The lower score obtained from corn-ipil ipil basal diet would have been the result of the overestimation of xanthophyll level in corn and ipil ipil. However, if the corn-ipil ipil diet did give the xanthophyll level of 60.26 mg/kg, the equivalent score obtained from broken rice diet with 50 mg/kg xanthophyll reflected the efficacy of the pigmentor added.

1.2 CFC. Addition CFC of at xanthophyll level of 10 mg/kg in broken rice diet and at xanthophyll level of 5, 7.5 and 10 mg/kg in corn-ipil ipil diet yielded RCF at 10.77, 10.9, 12.11 and 12.92 with no statistical difference. In 1983, Fletcher and Halloran obtained agreeable RCF of 12 and 12.7 from the addition of paprika oleoresin at the levels of 3 and 6 mg xanthophyll/kg of corn-alfalfa diet which contained 16.5 mg/kg. Chandra (1977) obtained RCF 14.5 by adding paprika oleoresin to a non-pigmented basal diet at the xanthophyll level of 53.5 mg/kg feed. However, it should be noted that the addition of solely CFC to the non-pigmented

Table 3 Effect of MPC on production performance and egg yolk color in 14 days peroid[1].

Treatments	Egg Production (%)	Egg mass (kg)	Feed intake* (kg)	FCR[2]	Egg yolk**[3] color
T_1 (Broken rice)	60.95 ± 18.34	2.25 ± .70	7.50 ± .45^{abc}	2.70 ± 0.98	1.00 ± 0.00^{a}
T_2 (T_1 + Xantho 40 mg/kg)	72.86 ± 6.23	2.78 ± .27	7.84 ± .09^{a}	1.87 ± 0.17	9.5 ± 0.31^{cdefgh}
T_3 (T_1 + Xantho 50 mg/kg)	69.53 ± 3.43	2.56 ± .13	7.91 ± .09^{a}	1.96 ± 0.12	10.10 ± 0.23^{defgh}
T_4 (T_1 + Xantho 60 mg/kg)	76.67 ± 11.26	2.83 ± .41	7.77 ± .41^{ab}	1.83 ± 0.32	11.00 ± 0.19^{fgh}
T_5 (Corn-ipil ipil)	55.24 ± 21.53	1.98 ± .78	6.95 ± .21^{ab}	3.09 ± 1.30	7.25 ± 0.16^{bcde}
T_6 (T_5 + Xantho 30 mg/kg)	69.05 ± 2.65	2.61 ± .10	7.18 ± .28^{abc}	1.79 ± 0.11	10.22 ± 0.22^{efgh}
T_7 (T_5 + Xantho 40 mg.kg)	69.52 ± 8.01	2.60 ± .28	6.89 ± .13^{c}	1.74 ± 0.20	11.33 ± 0.17^{h}
T_8 (T_5 + Xantho 50 mg/kg)	58.10 ± 16.17	2.16 ± .68	6.85 ± .07^{c}	2.46 ± 0.81	11.09 ± 0.21^{gh}
Mean	66.49 ± 4.05	2.47 ± .15	7.36 ± .12	2.18 ± 0.22	8.94 ± 1.22

*(P < .05), **(P < .01)

a, b, c, d, e, f, g, h. Mean within each color value with different superscripts are significantly different.

[1] Mean ± SE

[2] Feed/dozen eggs

[3] Roche Yolk color fan

Table 4 Effect of CFC on production performance and egg yolk color in 14 days peroid[1].

Treatments	Egg Production (%)	Egg mass (kg)	Feed intake (kg)	FCR[2]	Egg yolk color**[3]
T_1 (Broken rice)	73.33 ± 12.81	3.00 ± .49	7.85 ± .18	1.96 ± .35	1.00 ± 0.00^{a}
T_2 (T_1 + Xantho 5 mg/kg)	82.86 ± 8.37	3.45 ± .29	8.11 ± .30	1.70 ± .11	8.00 ± 0.21^{bcde}
T_3 (T_1 + Xamtho 7.5 mg/kg)	76.67 ± 3.43	3.08 ± .07	7.65 ± .07	1.72 ± .09	9.25 ± 0.18^{cdef}
T_4 (T_1 + Xantho 10 mg/kg)	60.95 ± 2.90	2.48 ± .15	7.28 ± .29	2.06 ± .14	10.77 ± 0.36^{defg}
T_5 (Corn-ipil ipil)	66.19 ± 5.97	2.70 ± .21	7.46 ± .06	1.97 ± .21	7.10 ± 0.10^{bc}
T_6 (T_5 + Xantho 5 mg/kg)	66.19 ± 14.58	2.51 ± .55	7.24 ± .25	2.10 ± .52	10.09 ± 0.18^{efg}
T_7 (T_5 + Xantho 7.5 mg/kg)	70.95 ± 5.04	2.86 ± .27	7.24 ± .33	1.77 ± .14	12.11 ± 0.11^{fg}
T_8 (T_5 + Xantho 10 mg/kg)	74.76 ± 5.79	3.02 ± .29	7.52 ± .14	1.75 ± .16	12.92 ± 0.08^{g}
Mean	71.49 ± 2.82	2.89 ± .12	7.54 ± .09	1.86 ± .08	8.52 ± 0.43

**($P < .01$)

a, b, c, d, e, f, g. Mean within each color value with different superscripts are significantly different.

[1]Mean ± SE

[2]Feed/dozen eggs

[3]Roche yolk color fan

Table 5 Effect of MPC/CFC combined at the xanthophyll ratio 1.2 : 1 on production performance and egg yolk color in 14 days period[1].

Treatments	Egg Production* (%)	Egg mass** (kg)	Feed intake** (kg)	FCR*2	Egg yolk**3 color
T_1 (Broken rice)	75.24 ± 1.72^{ab}	$2.82 \pm .08^{ab}$	$7.25 \pm .05^{a}$	$1.65 \pm .04^{a}$	1.00 ± 0.00^{a}
T_2 (T_1 + Xantho 11 mg/kg)	84.76 ± 3.12^{bc}	$3.18 \pm .10^{bcd}$	$7.28 \pm .07^{a}$	$1.48 \pm .05^{abc}$	10.54 ± 0.28^{bcdef}
T_3 (T_1 + Xantho 22 mg/kg)	89.52 ± 1.26^{c}	$3.32 \pm .09^{cd}$	$7.26 \pm .02^{a}$	$1.39 \pm .02^{bc}$	12.54 ± 0.22^{defg}
T_4 (T_1 + Xantho 33 mg/kg)	89.05 ± 5.49^{c}	$3.43 \pm .15^{d}$	$7.06 \pm .07^{b}$	$1.37 \pm .09^{bc}$	13.85 ± 0.10^{g}
T_5 (Corn-ipil ipil)	82.38 ± 2.38^{bc}	$3.11 \pm .07^{bcd}$	$6.47 \pm .09^{c}$	$1.35 \pm .03^{bc}$	7.67 ± 0.22^{b}
T_6 (T_5 + Xantho 11 mg/kg)	88.10 ± 1.72^{c}	$3.31 \pm .06^{cd}$	$6.47 \pm .07^{c}$	$1.26 \pm .04^{c}$	11.43 ± 0.17^{cdefg}
T_7 (T_5 + Xantho 22 mg/kg)	78.10 ± 7.01^{abc}	$2.98 \pm .27^{abc}$	$6.43 \pm .03^{c}$	$1.44 \pm .15^{abc}$	12.90 ± 0.28^{efg}
T_8 (T_5 + Xantho 33 mg/kg)	69.52 ± 4.15^{a}	$2.57 \pm .12^{a}$	$6.43 \pm .03^{c}$	$1.60 \pm .09^{abc}$	13.60 ± 0.16^{fg}
Mean	82.08 ± 1.82	$3.09 \pm .07$	$6.83 \pm .08$	$1.44 \pm .03$	10.71 ± 0.40

*(P < .05), **(P < .01)

a, b, c, d, e, f, g. Mean within each color with different superscripts are significantly different.

[1] Mean + SE

[2] Feed/dozen eggs

[3] Roche yolk color fan

broken rice diet yielded undesirable pinkish orange color while corn-ipil ipil basal diet yielded a more favourable yellowish orange color. Accordingly, Fletcher and Halloran (1981) suggested that paprika should be used in combination with a yellow pigmentor, either as an additive or as a natural supplied source. Mackay (1963) gave the same comment on the use of paprika extract in layer ration.

1.3 MPC/CFC combined. MPC, as the source of yellow pigment (Y) and CFC, as the source of red pigment (R), were combined at the ratio of xanthophyll Y:R = 1.2:1. Addition of the combined products in broken rice diet at the xanthophyll level of 22 and 33 mg/kg yielded RCF of 12.54 and 13.85. In corn-ipil ipil diet, addition of the combined pigmentors at the xanthophyll levels of 11, 22 and 33 mg/kg resulted in total xanthophyll level of 41.26, 52.26 and 63.26 mg/kg yields the same range of RCF of 11.43, 12.90 and 13.60 respectively. There were no significant difference in the color scores obtained though total of levels xanthophyll in corn-ipil ipil doubled the levels in borken rice diet. Moreover, lutein in corn also added up the yellow color, making Y:R ratio wider than the initial combined MPC/CFC, thus altered the efficiency of the pigmentors. Fletcher and Halloran (1981) conducted a similar experiment by preparing a mixture of marigold concentrate and paprika oleoresin at the xanthophyll levels of 48 and 2.4 mg/kg given total xanthophyll of 50.4 mg/kg and Y:R ratio of gained 20:1. They Roche score of 11.3, the same color range as obtained in corn-ipil ipil diet in this study. Increase red pigmentor to reach Y:R ratio of 5:1 and 3.3:1 at total xanthophyll levels of 72 and 78 mg/kg Fletcher and Halloran were able to increase the color of egg yolk to 14.3 and 15.0 respectively. The relatively low scores obtained from higher xanthophyll levels in both corn-ipil ipil diet and

from Fletcher and Halloran work (1981) comparing to those in broken rice diet suggested the influence of the ratio of xanthophyll Y:R on coloration of egg yolk. This is supported by the report of Mc Naughton (1971) that Y:R ratio of 1:1 to 1.5:1 yield most efficient utilization of pigment than other ratio.

2. Production performances

Addition of MPC or CFC in broken rice and corn-ipil ipil basal diets had no effect on egg production, egg mass and feed conversion (feed/ dozen eggs). Significant differences were found in the experiment with MPC in feed intake ($P < .05$) and MPC/CFC in combined feed intake ($P < .01$), egg production ($P < .05$), egg mass ($P < .01$) and feed conversion ($P < .05$). Difference in feed intake in both experiments were found between types of basal diets ($P < .01$). Layers fed on broken rice ate more than those fed on corn-ipil ipil diet. Levels of pigmentors added did not effect feed intake neither in broken rice nor corn-ipil ipil diet.

In the experiment with MPC/ CFC combined two birds out of five in T_8 did not lay throughout the experimental peroid resulting in lowest egg mass and feed conversion. Production performances were not effected by the levels of pigmentors added neither in broken rice diet nor corn-ipil ipil diet.

It was shown in the three experiments that MPC and CFC could be separately used or use in combination as pigmentors in layers without effecting the production performances. Coloration properties differed in levels of inclusion and effects of colors given. Rate of pigment deposition were similar in the three experiments.

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บทย่อ

ผลของการใช้กลีบดอกดาวเรืองแห้งเข้มข้น และพริกชี้ฟ้าแห้งเข้มข้น เป็นสารให้สีในอาหารไก่ไข่

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วรรณี เมืองเจริญ

เวชชสารสัตวแพทย์ *18(4);2531:305-317*

การศึกษาการใช้กลีบดอกดาวเรืองแห้งเข้มข้น (Marigold petal concentrate) และพริกชี้ฟ้าแห้งเข้มข้น (Capsicum annum fruits concentrate) เป็นสารให้สีเหลืองและสีแดงในอาหารไก่ไข่ที่นิยมใช้กันมาก 2 ชนิด คือ อาหารที่ไม่มีแหล่งสีประกอบด้วยปลายข้าวเป็นหลัก และอาหารที่มีข้าวโพดและใบกระถินเป็นแหล่งให้สี ใช้ไก่ไข่พันธุ์อีซ่าบราวน์จำนวน 120 ตัว แบ่งเป็น 8 กลุ่ม ๆ ละ 5 ตัว จำนวน 3 ซ้ำ ทำการทดลอง 3 ครั้งต่อเนื่องกันโดยมีระยะห่างระหว่างการทดลองเท่ากับ 14 วัน การทดลองที่ 1 ใช้กลีบดอกดาวเรืองแห้งเข้มข้นเป็นแหล่งให้สีในระดับ แซนโทฟิล 0, 40,50 และ 60 มิลลิกรัม/กิโลกรัม ของอาหารที่ไม่มีแหล่งสี และ 0,30,40 และ 50 มิลลิกรัม/กิโลกรัม ของอาหารที่มีแหล่งสี การทดลองที่ 2 ใช้พริกชี้ฟ้าแห้งเข้มข้นเป็นแหล่งให้สีในระดับ แซนโทฟิล 0,5, 7.5 และ 10 มิลลิกรัม/กิโลกรัม ของอาหารทั้ง 2 ชนิด และการทดลองที่ 3 ใช้กลีบดอกดาวเรืองแห้งร่วมกับพริกชี้ฟ้าแห้งในอัตราส่วนของแซนโทฟิล จากแต่ละแหล่งเท่ากับ 1.2:1 ใช้ส่วนผสมนี้ในระดับ แซนโทฟิล 0,11,22 และ 33 มิลลิกรัม/กิโลกรัมของอาหารทั้ง 2 ชนิด พบว่าการใช้กลีบดอกดาวเรืองแห้งเข้มข้นเป็นแหล่งสีต้องใช้ในระดับสูง ในขณะที่การใช้พริกชี้ฟ้าแห้งเข้มข้นเป็นแหล่งสีจะใช้ในระดับต่ำกว่าเพื่อให้ได้พัดสีในระดับใกล้เคียงกัน สำหรับการให้สีแก่ไข่แดง จะขึ้นกับอาหารพื้นฐานที่ใช้ ถ้าเป็นอาหารที่มีข้าวโพด ใบกระถินเป็นแหล่งสีอยู่เดิม เมื่อเติมสารสีชนิดใดชนิดหนึ่งจะทำให้สีของไข่แดงเข้มขึ้นและไข่แดงจะมีสีเหลืองอมส้มซึ่งเป็นที่นิยมของผู้บริโภค ในอาหารที่ไม่มีแหล่งสีเดิมอยู่เลยเช่น อาหารปลายข้าว การเติมกลีบดอกดาวเรืองแห้งเข้มข้นจะทำให้ไข่แดงออกสีเหลืองเข้ม ซึ่งเป็นสีที่ใกล้เคียงกับเหลืองอมส้ม ในขณะที่การเติมพริกชี้ฟ้าแห้งเข้มข้นจะทำให้ไข่แดงมีสีส้มอมชมพู ซึ่งไม่เป็นที่ยอมรับของผู้บริโภค เมื่อนำสารสีทั้งสองมาใช้ร่วมกันในอัตราส่วนข้างต้น จะลดปริมาณการใช้สารสีลงและทำให้ไข่แดงมีสีเหลืองอมส้ม ในอาหารทั้ง 2 ชนิด

ภาควิชาสัตวบาล คณะสัตวแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย