



Marigold Petal Meal from Layers

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Effect of Xanthophyll Rich Marigold Petal Meal in the Ration of Commercial Layers on Egg Composition and Quality Characteristics

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ABSTRACT

The study was conducted to determine the effect of xanthophyll rich marigold petal meal (*Tagetes erectus L.*) on egg composition and quality characteristics. One twenty Hyline commercial layers (24wks old) were divided into five groups of four replication each (six birds in each replication) in CRD. The marigold petal meal (MPM) was incorporated (%) in the diet of commercial layers at 0 (T1), 3 (T2), 4 (T3), 5 (T4) and 6 (T5) levels. The CP content of experimental diets ranged from 16.53 to 17.86 per cent and MPM contained 12.49 % CP, 11.43%EE and xanthophylls 2400mg/kg of petal meal. MPM inclusion did not affect egg weight and egg shell thickness between the groups. Even though there was a significant difference in calcium intake between the treatments, Haugh units, yolk index and albumen index were not affected between the treatment groups. Xanthophyll content of egg yolk, yolk colour and crude protein content were higher as the levels of MPM increased in the diet. The inclusion of MPM as a source of carotene and protein in commercial layer diets up to 6 per cent level improved egg quality parameters without any adverse effects on the performance of the layers.

KEYWORDS: Egg composition, Egg yolk, Marigold petal meal, Xanthophyll, Yolk index.

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INTRODUCTION

In poultry industry, maize is used extensively as a source of energy and invariably it is also a source of xanthophyll. However, due to rise in the cost of maize in the recent past, search for alternate feed resources either as source of pigment or any other nutrients is a major thrust area in the field of poultry nutrition. Marigold petal meal is one among several unconventional feed stuffs available locally to the farmers where it contained 11 to 12 per cent CP and 10-11 per cent EE (Sujatha et al., 2015). In addition, it has 100 times more xanthophylls than maize. Several studies were conducted with supplementation of marigold flower extract in the diets of layers but not many on direct feeding of marigold petals in the form of meal as feed additive. Moreover, India produces around 603.18 TMT of marigold flowers and the share of Karnataka alone is around 64025 tons which can be used as a source of xanthophylls and protein in the diets of layers to improve the egg quality (NHB, 2018). However, studies conducted at higher levels of inclusion in

poultry is scarce, therefore, this study was taken up to know the effect of marigold petal meal at higher levels as a component of commercial layer's diet by replacing deoiled rice bran on egg composition and egg quality characteristics.

MATERIAL AND METHODS

One hundred twenty (24 weeks old) White Leghorn pullets of Hyline strain were divided in to five groups of four replications each and six birds in each replication in complete randomized design. The birds were maintained under standard management protocol at Poultry Experimental Unit, Dept. of Livestock Farm Complex, Veterinary College, Shivamogga. The approval of institutional animal ethical committee to conduct the experiment was obtained (IAEC Approval number: No/VCS/IAEC/2019-20/SA-55 Date: 17/02/2020).

Marigold flowers (*Tagetes erectus L.*) were grown at farm section of Dept. of Horticulture, College of Agriculture, KSNUAHS, Shivamogga. The marigold petals were separated from calyx, seeds and shade dried. The dried marigold petals

were incorporated at 0 (T1), 3 (T2), 4 (T3), 5 (T4), 6 % (T5) levels in the standard layer diet (SLD) formulated as per BIS (2007) specification for layers. The SLD contained 17% CP, 2600ME kcal/kg diet, 3.6 % Calcium; 0.74% Phosphorus and 0.36% available Phosphorus. The experiment was started when layers were 24th weeks of age and the laying phase was divided in to three periods of four weeks each from 24th to 35th weeks (Period –I: 24th to 27th, Period-2: 28th to 31st, Period-III: 32nd to 35th week). The experiment was conducted for a period of 120 days. During the experiment, body weight, feed and nutrient intake, intake of marigold petal meal, hen-day egg production, feed conversion ratio (FCR) and economics of inclusion of marigold petal meal were studied. The samples of feed ingredients, maize, marigold petal meal and eggs were collected and subjected for chemical composition (AOAC, 2016) and xanthophyll content of maize, MPM and yolk was analyzed by using spectrophotometer (Visiscan 167) as described by AOAC (2016). The data collected was analyzed by completely randomized design using statistical package for social sciences (SPSS, 15th version, 2017) and the means were compared by Duncan's multiple range test (Duncan and Duncan, 1955) and interpreted accordingly.

RESULTS AND DISCUSSION

The inclusion level of maize (Table 1) in all the treatment diets was kept constant (55%) to know the effect of MPM on changes in body weight, feed and nutrient intake, intake of marigold petal, hen-day egg production, feed conversion ratio (FCR), egg production, egg composition and economics. The MPM was incorporated at different levels in the layers' diet by replacing deoiled rice bran and sunflower meal partially but the level of nutrients kept constant in all the diets according to BIS (2007) specifications so that all the diets should contain 18 per cent crude protein (CP) and 2700 Kcal/kg of metabolic energy (ME). However, the CP content of experimental diets ranged from 16.53 to 17.86 per cent, and crude fibre (CF) ranged from 7.69 to 8.78 per cent, calcium (Ca) ranged from 4.87 to 6.1per cent, and phosphorus (P) ranged from 0.89 to 2.28 per cent (Table 2). However, all the nutrient levels in all treatment groups were well within the recommended level of BIS (2007) specifications. These specifications were similar to the specifications maintained in the diets of commercial layers prepared by the various researchers (Hasin et al., 2006; Moeini et al., 2012; Sujatha et al., 2015).

Table 1. Ingredient composition (% as is basis) of experimental diets of commercial layers

Ingredient	T1	T2	T3	T4	T5
Marigold petal meal (MPM)	0	3	4	5	6
Maize	54.96	54.96	54.96	54.96	54.96
Deoiled rice bran	7	5.5	4	3.5	2.
Sunflower meal	6	3	3	2	2
Soybean meal	21	22	22	22.5	23
Limestone powder	2	2	2	2	2
Shell Grit	7	7	7	7	7
Dicalcium phosphate	1.2	1.2	1.2	1.2	1.2
Salt	0.5	0.5	0.5	0.5	0.5
Vegetable oil	0	0.5	1.0	1.0	1.0
AB ₂ D ₃ K ¹	0.015	0.015	0.015	0.015	0.015
B-complex ²	0.025	0.025	0.025	0.025	0.025
Trace minerals ³	0.1	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1	0.1
Total	100.00	100.00	100.00	100.00	100.00

¹One gram of Vitamin AB₂D₃K supplement contained 82500 IU of Vitamin-A, 50 mg of Vitamin-B₂, 12000 IU of Vitamin-D₃ and 10 mg of Vitamin-K.

²One gram of B-Complex supplement contained 8 mg of Vitamin-B₁, 16 mg of Vitamin-B₆, 80 mcg of Vitamin B₁₂, 80 mg of Vitamin-E, 120 mg of Niacin, 8 mg of Folic acid, 80 mg of Calcium pantothenate, 120 mg of Calcium and 300 mg of Phosphate.

³One gram of Trace Minerals contained 54 mg of manganese, 52 mg of zinc, 20 mg of iron, 2 mg of iodine and 1 mg of cobalt

The CP content of MPM was almost similar to the milling by products like de-oiled rice bran, wheat bran and any gram husk but MPM had higher level of EE (11.43 %). The xanthophyll content of maize grain and MPM used to prepare the experimental diets was 21 and 2400 mg/kg, respectively.

The average feed intake between the treatments was not significant (Table 3). Irrespective of the level of inclusion, the feed intake was similar in both control and treatment groups which indicated that up to 6% inclusion of MPM in the commercial layers diet did not cause adverse effect on the palatability of feed. Similar feed intake was noticed in Hyline laying hens (104-108 grams/ bird/day) in the experiment conducted by Ariana et al. (2011) and Rezaei et al. (2019). On contrary, lower feed intake of around 90 gram/bird/day was observed in desi chickens as reported by Sujatha et al. (2015). Due

to non significance in feed intake the FCR observed in all the experimental groups was also similar, however, the FCR achieved in this study was better than the FCR reported for layers other studies (Hasin et al., 2006; Rowghani et al., 2006; Moeini et al., 2012).

There was a significant difference in hen day egg production between the treatment groups in period I, whereas no significant difference in period II and III. The difference in the period was due to early laying phase of the bird where birds take some time to achieve maximum egg production. The egg production achieved in this experiment due to inclusion of MPM was corroborated with egg production achieved in Shaver 579 laying pullets (71%) (Hasin et al., 2006), in Hyline laying hens (71-76%) (Altunta and Aydin, 2014).

Table 2. Chemical composition (% on DMB) of commercial layer diets and marigold petal meal (MPM) used in the experiment

Particular	T1 (Control, 0%)	T2 (3%MPM)	T3 (4%MPM)	T4 (5% MPM)	T5 (6% MPM)	MPM	Maize
DM	93.4	93.63	94.29	92.95	92.62	7.76 ^e	89.73
OM	85.33	85.19	84.08	85.78	83.80	92.77	98.75
CP	16.58	16.82	16.94	16.53	17.86	12.49	9.17
EE	2.65	4.33	4.07	3.55	4.42	11.43	3.39
TA	14.67	14.81	15.92	14.22	16.20	7.23	1.25
CF	8.78	8.69	8.34	7.69	8.21	23.22	2.58
NFE	57.32	52.35	53.73	58.01	53.31	45.63	83.65
Ca	4.87	4.91	5.22	6.1	5.25	0.95	1.29
P	0.89	1.44	1.31	1.72	2.28	0.72	0.45
ME [#] , kcal/kg	2555	2546	2561	2547	2539	-	-
Xanthophylls, mg/kg	-	-	-	-	-	2400	21

[#]ME - Metabolized Energy (calculated), MPM- Marigold petal meal .

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Table 3. Effect of dietary inclusion of marigold petal meal on feed intake, FCR and percent hen day egg production.

Treatment	Feed intake (g/day/bird)			FCR #			Hen day egg production (%)		
	Period (weeks)			Period			Period		
	I (24-27)	II (28-31)	III (32-35)	I (24-27)	II (28-31)	III (32-35)	I (24-27)	II (28-31)	III (32-35)
T1	105.17	105.58	104.57	1.54	1.4	1.58	65.48 ^b	71.73	75.45
T2	104.8	105.77	104.40	1.56	1.34	1.54	71.13 ^a	75.30	83.93
T3	104.73	104.34	104.34	1.4	1.35	1.43	66.07 ^b	72.32	83.04
T4	104.04	103.54	103.91	1.44	1.3	1.47	67.86 ^b	69.20	80.80
T5	104.92	103.73	104.15	1.47	1.35	1.43	58.78 ^c	67.86	78.42
SEM	0.21	0.41	0.12	0.03	0.02	0.03	1.82	1.09	1.35
P value	0.423	0.140	0.478	0.121	0.824	0.118	0.02	0.23	0.27
Significance	NS	NS	NS	NS	NS	NS	*	NS	NS

FCR is calculated on dozen egg basis

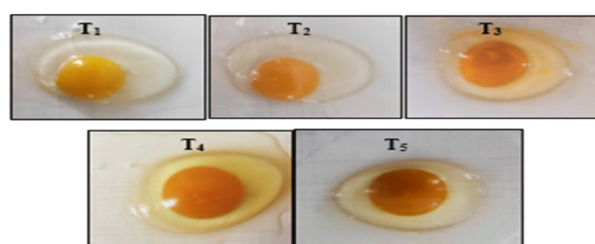
There was no significant effect on shell thickness of the eggs produced by birds fed with different levels of MPM even though there was a variation in the calcium level among the diets (Table 4) which might be due to efficiency of utilization of calcium in formation of egg shell was similar in all groups. Similar shell thickness values (0.33-0.40mm) were reported in several studies in layers of irrespective breeds fed with various levels of either marigold petal powder or extract from marigold flowers (Hasin et al., 2006; Ariana et al., 2011; Sujatha et al., 2015; Rezaei et al., 2018). The mean haugh units recorded in control and treatment groups in this experiment for commercial layers were not differed significantly. MPM inclusion on haugh units was on par with the maize included diet (T1). Whereas the haugh unit recorded in this experiment were higher (85.93 to 88.48) than the values reported by Hasin et al. (2006) in marigold petal powder at 4 per cent level in Shaver

579 laying pullets (80), in hyline W 36 white hens fed with 1.5 per cent marigold powder (72.26) and in hyline (W-36) birds fed with 1 and 3 per cent marigold flower powder (Moeini et al., 2012).

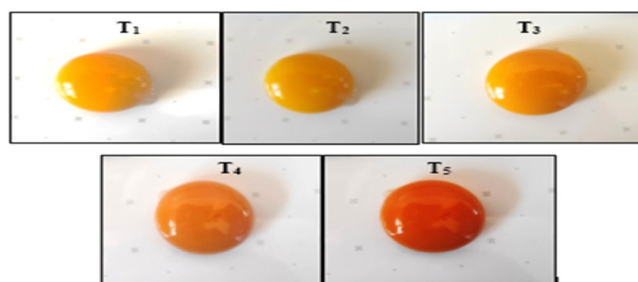
MPM inclusion did not bring any significant change in the yolk index when compared to the maize included group (T1). The values reported in this study (0.46-0.47) were similar to the values (0.45-0.47) reported in desi chicken eggs (Sujatha et al., 2015) whereas lower than the values (40-41) reported for hyline -5 laying hens (Altunta and Aydin, 2014). Not much variation was noticed in albumin index of the eggs between the treatments. In all MPM fed groups, similar values (0.14) were obtained but higher by 1 unit than in T1 group (0.13). Much lower values of albumin index (0.07-0.09) were reported by Altunta and Aydin (2014) and Sujatha et al. (2015).

Table 4. Effect of dietary inclusion of marigold petal meal on egg shell thickness, Haugh unit, yolk index, albumin index, yolk color and xanthophyll content in yolkin commercial layers

Parameter	Period	Treatment					SEM	P value
		T1	T2	T3	T4	T5		
Egg shell thickness, mm	I	0.35	0.35	0.35	0.37	0.33	0.01	0.61
	II	0.34	0.35	0.34	0.34	0.32	0.01	0.53
	III	0.34	0.37	0.35	0.35	0.35	0.01	0.65
Haugh unit	I	81.87	82.62	86.90	86.17	87.37	1.08	0.38
	II	88.13	87.70	85.83	84.88	88.67	0.84	0.60
	III	90.40	87.48	92.73	86.58	87.93	0.91	0.18
Yolk index	I	0.49	0.46	0.48	0.45	0.45	0.01	0.17
	II	0.45	0.47	0.47	0.48	0.48	0.01	0.61
	III	0.43	0.45	0.47	0.45	0.45	0.01	0.38
Albumin index	I	0.12	0.12	0.12	0.14	0.13	0.01	0.67
	II	0.13	0.13	0.15	0.15	0.14	0.01	0.29
	III	0.14	0.16	0.15	0.15	0.14	0.01	0.33
Yolk color	I	8.25 ^b	11.00 ^a	11.50 ^a	11.50 ^a	11.25 ^a	0.3	0.01
	II	9.25 ^d	10.50 ^c	11.50 ^{bc}	12.25 ^b	14.00 ^a	0.39	0.01
	III	9.25 ^b	12.75 ^a	13.50 ^a	13.75 ^a	14.00 ^a	0.48	0.01
Xanthophyll content (mg/100g of yolk)	I	1.07 ^e	3.02 ^d	5.44 ^c	9.34 ^b	12.69 ^a	0.37	0.01
	II	1.16 ^e	3.45 ^d	5.14 ^c	9.04 ^b	12.94 ^a	0.97	0.01
	III	1.24 ^e	3.35 ^d	5.48 ^c	9.03 ^b	12.87 ^a	0.85	0.01



Intensified egg yolk colour in different concentration of marigold petal meal



The yolk color of the egg depends on the carotenoids or any pigments present in the feed ingredients that are used to prepare layers diets. At the beginning of the laying period (Period-I), irrespective of the level of MPM inclusion, birds in all treatment groups imparted same extent of color but significantly higher than control(T1) because birds need some time to stabilize the metabolism of carotenoids in the body. But significantly ($P < 0.01$) higher color in higher level of MPM inclusion was observed (T5) followed by lower levels of inclusion but significantly higher than T1 (control) in period-II. Subsequently, in period-III, the level of color was stabilized among the groups of birds that fed with various level of MPM than control (T1). However, as the level of MPM increased in the diet, the extent of color also increased in yolk. The yolk color obtained in this study was higher than the values reported by Hasin et al. (2006) at 4 per cent level of marigold petal powder (8.2) and orange skin powder (3.3). Rowghwani et al. (2006) also reported lower values in marigold petal powder (8.0 to 9.0), safflower petal meal (5-6) and red pepper meal (9.5-12.5). Moeini et al. (2012) noticed higher yolk color (13.33) in the birds fed with 3% red pepper meal in the diet of layers (Hyline W 36) which matched with 6 per cent level of MPM inclusion in this study.

Xanthophyll content of egg yolk estimated in all the periods was statistically significant ($P < 0.01$) between the treatment groups. In all the periods, xanthophyll content was significantly higher in T5 followed by T4, T3, T2 and T1. As the level of MPM increased in the diet of T2 to T5 groups, the xanthophyll content also increased according to the MPM level in the diet. The xanthophyll content of MPM used in the experiment is 2400 mg/kg of dried MP and intake of xanthophyll through the MPM was also increased according to the level of inclusion. However, the transfer of xanthophyll pigment from the feed to the yolk was significantly higher in groups fed with higher level of MPM (T5) followed by T4, T3, T2 but transfer of xanthophyll pigment to the egg yolk was far higher than control group. When xanthophyll content of yolk was compared to the xanthophyll intake through the feed, the extent of transfer of xanthophyll from the feed to the egg yolk in T1 (maize is the only source of xanthophyll) was 95.04 per cent whereas in T2, T3, T4 and T5 was 37.49, 47.60, 66.84, 79.49 per cent where maize and

marigold petal meal were the sources of xanthophyll. This clearly indicated that transfer of xanthophyll was more efficient in maize included diet fed group than in groups fed MPM as a supplement to maize where the efficiency was not as good as maize. The relationship between xanthophyll intake and yolk color (Figure 1) in commercial layer was positive ($R^2=0.939$) where as the relationship between xanthophylls intake and xanthophyll (Figure 2) content in yolk was also positive ($R^2=0.843$).

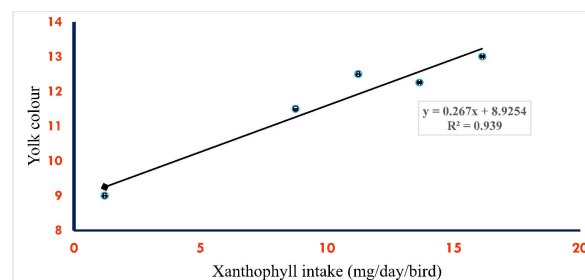


Figure 1: Relationship between xanthophyll intake and yolk color in commercial layers.

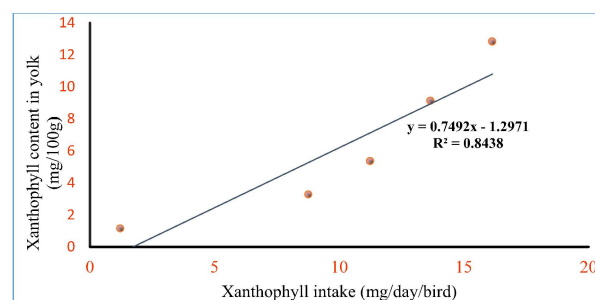


Figure 2: Relationship between xanthophyll intake and xanthophylls content in egg yolk of commercial layers.

The chemical composition of egg without shell and egg yolk of eggs produced during the experiment was analyzed (Table 5). The chemical composition (% as is basis) is given both on 100g, 60g egg weight basis without shell. The CP content of an egg for 100g egg was significantly ($P < 0.01$) higher in T3, T4, T5 groups and lower in T1 and T2 groups. However, the EE, Ca and P contents were also numerically improved in the MPM included groups when compared to the control. The chemical composition expressed on 60g egg also followed the same trend as that of 100g egg because the composition was proportionately converted.

Table 5. Proximate composition (% as is basis) of egg (without shell) of experimental birds.

Particular	Treatment	DM	OM	CP	EE	TA	Ca	P
Egg without shell (100g)	T1	25.34	97.71 ^{ab}	10.47 ^b	7.89	2.30 ^{ab}	0.68	0.32
	T2	25.05	97.12 ^b	11.10 ^{ab}	8.60	2.88 ^a	0.76	0.29
	T3	24.59	98.47 ^a	11.42 ^a	8.67	1.53 ^b	0.83	0.30
	T4	26.54	98.45 ^a	11.84 ^a	9.11	1.55 ^b	0.75	0.33
	T5	26.10	98.23 ^a	11.85 ^a	9.27	1.78 ^b	0.91	0.38
	SEM	0.42	0.16	0.15	0.17	0.16	0.05	0.03
	P value	0.64	0.01	0.01	0.05	0.01	0.61	0.86
Egg yolk (%)	T1	56.38	95.92	14.09 ^b	27.61	4.08	1.43	0.49
	T2	50.62	96.32	15.58 ^a	28.51	3.68	1.52	0.67
	T3	52.50	96.52	15.70 ^a	29.64	3.48	1.38	0.75
	T4	50.76	95.74	16.07 ^a	27.62	4.26	1.43	0.86
	T5	53.84	95.20	15.97 ^a	30.03	4.80	1.64	0.53
	SEM	0.80	0.24	0.23	0.38	0.24	0.14	0.09
	P value	0.12	0.48	0.02	0.12	0.48	0.99	0.69
Egg without shell (60g)	T1	14.70	98.70 ^{ab}	6.36 ^c	4.69	1.30 ^{ab}	0.39	0.19
	T2	15.03	98.34 ^b	6.65 ^{bc}	5.28	1.67 ^a	0.47	0.17
	T3	14.74	99.09 ^a	6.71 ^{abc}	5.09	0.91 ^b	0.48	0.19
	T4	15.92	99.06 ^a	7.22 ^a	5.41	0.94 ^b	0.52	0.22
	T5	15.66	98.74 ^{ab}	7.08 ^{ab}	5.52	1.27 ^{ab}	0.65	0.23
	SEM	0.27	0.09	0.10	0.11	0.09	0.04	0.02
	P value	0.53	0.023	0.021	0.085	0.023	0.18	0.809

** P_≤0.01, * P_≤0.05, Means bearing different superscript differ significantly between the rows.

The chemical composition of egg yolk was analyzed separately from the eggs collected during the experiment and there was no significant difference in DM, OM, EE, TA, Ca and P but significantly higher values were observed in MPM added groups when compared to the control group (T1). This indicated that the efficiency of utilization of protein for egg formation was better in MPM fed groups. The CP values of eggs reported in this study were lower than the CP values but higher fat, Ca and P values in the study conducted by Ingrid et al. (2007) in chicken eggs. Rehman et al. (2011) reported almost similar CP values (6.3g) and fat values for chicken eggs of 60g weight. Whereas Ahmad et al. (2017) fed *Moringaolifera* pod meal to Hyline W-36 layers

and recorded higher values of CP, EE for the egg yolk than the values reported in this study.

Feed cost per kg of feed for T1, T2, T3, T4 and T5 was Rs. 21.61, 24.12, 25.31, 26.31 and 27.14, respectively (Table 7). Total feed intake per bird (kg) and egg production per bird during the experiment was 8.83, 8.80, 8.78, 8.72 and 8.80 kg; 60, 65, 62, 61 and 57 nos., in T1, T2, T3, T4 and T5 groups respectively. Feed consumed (g/egg) and total cost (Rs.) of egg production during the experiment were 125.00, 123.33, 115.83, 122.50 and 115.83; 190.8, 212.29, 222.11, 229.47 and 238.85 in corresponding groups, respectively. Cost of production per egg (Rs.) was 2.70, 2.97, 2.93, 3.22 and 3.14. Egg sold price (Rs./egg) was Rs. 4 (control) and Rs. 8 (treatment

groups). Profit by the sale of eggs during the experiment in T1, T2, T3, T4 and T5 groups was Rs. 240.00, 520.00, 496.00, 488.00 and 456.00 Rs, respectively. Benefit Cost Ratio was 1.25, 2.45, 2.23, 2.13 and 1.91 in commercial treatment groups, respectively.

Table 6. Economics of inclusion of marigold petal meal on egg production in commercial layers

Particular	T1	T2	T3	T4	T5
Feed cost (Rs./kg)	21.61	24.12	25.31	26.31	27.14
Total feed intake per bird during the experiment period (kg)	8.83	8.80	8.78	8.72	8.80
Egg production per bird during the experiment (Nos.)	60	65	62	61	57
Feed consumed (g/egg production)	125.00	123.33	115.83	122.50	115.83
Total cost of egg production during the experiment(Rs.)	190.8	212.29	222.11	229.47	238.85
Cost of production per egg (Rs.)	2.70	2.97	2.93	3.22	3.14
Egg sold price (Rs. Per egg)	4.0	8.0	8.0	8.0	8.0
Profit by sale of eggs during the experiment (Rs.)	240	520	496	488	456
Benefit Cost Ratio	1.25	2.45	2.23	2.13	1.91

CONCLUSION

It can be concluded from the above results that higher levels of MPM inclusion in the commercial layer's diets maintained standard egg quality parameters. As the level of MPM increased in the commercial diet, xanthophyll content of the yolk and yolk color increased. Therefore, it can be safely incorporated as unconventional feed resource by replacing some milling by-products without any adverse effect on palatability and egg quality parameters in commercial layers up to 6 per cent.

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