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Effect of Dietary inclusion of Holy Basil (*Ocimum sanctum* Linn) and curry Leaves (*Murraya koenigii* L), either Singly or in Combination on Performance, Egg Quality and Egg Cholesterol in Laying Quails

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ABSTRACT: An experiment was carried out for six weeks using eight weeks old one hundred eighty white feathered laying quails (*Coturnixcoturnix japonica*) to study their production performance, egg quality and egg yolk cholesterol content in ICAR CARI, Izatnagar. The experiment was conducted following 2 x 3 factorial CRD wherein two herbs (holy basil and curry leaves) were fed to laying quails each at three dietary levels (0, 1 and 3%) of holy basil and curry leaves of 0, 2.5 and 5% in combination. All the laying quails were distributed randomly into nine dietary treatment groups (T1 to T9) on the basis of similar egg production and body weight. Each treatment has five replications containing four birds/replication. A standard corn-soya meal based basal diet to meet NRC (1994) standard for laying quails was formulated. From the basal diet as maintained above, nine experimental diets (designated as T1 through T9) were formulated by adding desired levels of Holy basil (HB) leave powder and Curry leaves (CL) powder. No significant effect of holy basil were found on body weight change, feed intake, feed conversion ratio, egg production, egg weight, shape index, specific gravity, shell weight ,shell thickness, yolk index but had significantly (P<0.01) improved haugh unit with the highest value (62.22) and yolk colour (5.67) at 3 % level. Dietary inclusion of curry leaves have shown a significant difference in feed intake, feed conversion ratio, shape index, specific gravity and yolk colour but had no significant effect on body weight, egg production, egg weight, shell weight, shell thickness, albumin index, yolk index and haugh unit eggs. Interaction of holy basil and curry leaves at varying levels showed no significant difference on body weight, feed intake, feed conversion ratio, shell weight, shell thickness, albumen index, yolk index, haugh unit and egg yolk cholesterol but had a highly significant (P<0.01) effect on egg production, egg weight, shape index and yolk colour. Both holy basil and curry leaves addition in diet had a highly significant (P<0.001) effect in lowering egg yolk cholesterol (mg/g yolk) content in Japanese quail eggs. It can be concluded that feeding holy basil and curry leave powder had significant effect on production performance and some of the egg quality traits. Egg yolk cholesterol level was significantly reduced by feeding these two herbs in laying Japanese quails.

Keywords: Holy basil, egg quality, egg yolk cholesterol, Curry leaves, Japanese quail, performance

INTRODUCTION

Cholesterol, a wax like substance found in every living cell in the body. Cholesterol is required for the structure of cell walls, must be available for the body to produce vitamin D, is essential for the production of digestive juices; insulates nerve fibers and is the basic building block for many hormones. Elevated cholesterol is associated with a greater-than normal risk of atherosclerosis, high BP and excessive clotting (Russell, 2005). The normal level of blood cholesterol in human beings is about 150-250 mg/dl but when its level rises to more than 250 mg/dl, it may lead to dangerous consequences like cardiovascular diseases. Increased serum cholesterol levels can be induced when animal fats (saturated fats) and food high in cholesterol, notably eggs, are consumed. Consumer's attitude towards cholesterol has altered the perception of egg as healthy food due to the panic that eggs will raise their serum cholesterol level (Weggemans *et al*., 2001). Thus, any feasible means of reducing Cholesterol content of eggs would be of interest to egg consumers. Since 1972, poultry scientists have been seeking ways to decrease egg cholesterol concentrations, because of recommendations to limit egg consumption by the public to no more than 3 eggs per week, not to exceed cholesterol intake of 300 mg/d (McNamara, 2000). Antimicrobial agents of plant origin such as essential oils, plants extracts and complete plant substances, have gathered significant consciousness as alternatives to the traditional antibacterial feed alternatives. Curry leaf (*Murraya koenigii* L) belongs to the family: Rutaceae and genus Murraya, is distributed in various tropical and subtropical regions, from Sri Lanka, India to southern Ryuku Islands, from China, Malaysia to Australia, and in the Pacific from the Mariana Islands to Vanutau and New Caledonia (Smith, 1985). It is an aromatic, pubescent, deciduous shrub or small tree growing up to 6 min height. In India, it grows up to 1650 m altitude and occurs in wild and cultivated forms (Joseph **&** Peter, 1985). In south India, it is cultivated for its aromatic leaves and is commonly found in home gardens (Joseph **&** Peter, 1985). The leaves are fragrant, strongly aromatic, spicy, bitter, acrid, cooling and weakly acidic in taste. The fresh leaves are a good source of beta carotene (Philip *et al.*, 1981). Tulsi or holy basil (*Ocimum sanctum* Linn) "The Queen

of Herbs" - is the most sacred herb of India and seen throughout India. In traditional systems of medicine, different parts (leaves, stem, flower, root, seeds and even whole plant) of *Ocimum sanctum* Linnhave been recommended for the treatment of bronchitis, bronchial asthma, malaria, diarrhea, dysentery, skin diseases, arthritis, painful eye diseases, chronic fever, insect bite etc. Several indigenous plants including tulsi have been claimed to possess hypolipidaemic, hypocholesteremic and immune stimulating properties that may be beneficial to reduce the risk of cardiovascular diseases. Administration of fresh tulsi leaves, brought about significant changes in the lipid profile of normal albino rats, this resulted in significant lowering in serum total cholesterol, triglycerides, phospholypids, LDL cholesterol level, increase in the HDL cholesterol level and total faecal sterol contents (Aashish, 2007). Therefore, further research is required on different herbs which are having excellent potential on performance, health, as well as a natural growth promoter and its ability to reduce the cholesterol in human, animal as well as birds. Moreover modifying the lipid profile of egg to produce a low cholesterol or designer eggs by supplementing the diet with different health promoting herbs, indeed is a very much in need at present to erase the fear of high cholesterol egg in the mind of every elite health conscious consumers. By viewing the above facts, the present study was conducted to investigate the effects of feeding curry leaves and holi basil on performance, egg quality traits and egg yolk cholesterol content in laying Japanese quails.

MATERIALS AND METHODS

One hundred eighty white feathered laying quails (*Coturnix coturnix japonica*) of 8 weeks of age were used for the experiment. The birds were kept under specially designed laying cages with watering, feeding and egg collection facilities and under uniform and standard managemental conditions. The experiment was conducted following 2 x 3 factorial CRD wherein two herbs (holy basil and curry leaves) were fed to laying quails each at three dietary levels, holy basil at (0, 1 and 3%) and curry leaves at (0, 2.5 and 5.0%) in combination. All the laying quails were distributed randomly into nine dietary treatment groups (T1 to T9) on the basis of similar egg production and body weight. Each treatment has five replications containing four birds/ replication. The feeding trial was conducted for six weeks. The weighted amount of experimental diets differing in levels was offered as mash *ad libitum* to respective groups of birds daily in the morning and fresh and wholesome potable water was always made available to the birds throughout the experimental period.

The basal diet

A standard corn-soya meal based basal diet to meet NRC (1994) standard for laying quails was formulated. From the basal diet as maintained above, nine experimental diets (designated as T1 through T9) were formulated by adding desired levels of holy basil (HB) leaf powder and curry leaves (CL) powder.

T1= 0% holy basil powder and 0% curry leaves powder (Control)
T2= 1% holy basil powder and 0% curry leaves powder
T3= 3% holy basil and 0% curry leaves powder
T4= 0% holy basil powder and 2.5% curry leaves powder
T5= 1% holy basil powder and 2.5% curry leaves powder
T6= 3% holy basil powder and 2.5% curry leaves powder
T7= 0% holy basil powder and 5% curry leaves powder
T8=1% holy basil powder and 5 % curry leaves powder
T9= 3% holy basil powder and 5 % curry leaves powder

During this period, the egg production, performance, egg quality traits and egg cholesterol content of laying quails were investigated at different stages of feeding the experimental diets. All birds were weighted individually for observing any change in body weight at the start and end of experiment. Weekly feed intake, feed conversion ratio and daily egg production and egg weight of individual birds was recorded. Five eggs per dietary treatment were collected on 3rd and 6^{th} week of experiment for various egg quality traits (shape index, specific gravity, shell weight, shell thickness, albumen index, haugh unit, yolk index and yolk colour). Five eggs from each dietary treatment were randomly collected at biweekly interval for analyzing the total yolk cholesterol content (Wybenga and Pileggi, 1970) during six weeks of study period. The data were analyzed by SPSS statistical software package using standard procedures (Snedecor and Cochran, 1989). Tuckey's test was used to determine significant difference among means for different treatments.

RESULTS AND DISCUSSION

A. The effect of dietary addition of holy basil and curry leaves powder on production performance in laying quails

The effect of dietary addition of holy basil and curry leaves powder on production performance in laying quails is given on table 1 to table. In the present study, initial body weight, final body, means body weight change was not affected by 2.5 and 5% curry leaves. This was disagreed by Moorthy *et al.* (2009) who reported that mean body weight (g/bird) of broilers at 6 weeks of age fed with different inclusion levels of dried ginger, pepper and curry leaf powder differ significantly ($P<0.05$) among treatment groups at six weeks of age in the broiler diet. Also, Xie *et al.* (2006) found that the body weight was reduced after the curry leave extract treatment in diabetic *ob/ob* mice model. Previous report have shown that by feeding a diet containing various doses of curry leaf (5-15%), the diabetic *ob/ob* mice continued to lose weight while vehicle-treated animals had gradual weight increase (Yadav *et al.*, 2002). Dineshkumar *et al.* (2010) also reported that rat fed with curry leave supplementation loss weight which may be associated with lipid lowering activity of mahanimbine or due to its influence on various lipid regulation systems. Dietary inclusion of 2.5 and 5% curry leaves showed a highly significant change ($P<0.01$) at III week and significant difference ($P<0.05$) at VI week in feed intake. Curry leaves at 5% showed significant decrease in feed intake of 32.33 g/day/bird at III week and 31.75 g/day/bird at VI week. Disagreeing to the present finding which showed a significant effect on feed consumption (g/bird/day) in laying quails, Moorthy *et al*. (2009) working on broiler chicken found no significant change between treatment groups from first to sixth week which might be due to isocaloric and isonitrogenous diet fed throughout the experiment with inclusion of varying levels of ginger, pepper and curry leaves. Analysis of data on mean on feed conversion ratio revealed highly

significant difference at II, IV and V week with highest FCR of 3.73, 4.01 and 4.14 at 5% dietary level of curry leaves was in agreement with the findings of Moorthy *et al*. (2009) who found that feed conversion ratio was significantly (P<0.01) superior in ginger-curry leaf and pepper-curry leaf powder fed groups compared to control in broiler chicken.

Table 1: Effect of dietary addition of holy basil and curry leaves powder on body weight in laying Quails.

Interaction / Treatment	Dietary treatment HB (%)	CL (%)	Initial bwt(g)	Final bwt(g)	Bwt change (g)
T1	0	0	238.50	239.05	0.55
T2	1	0	235.00	241.50	6.50
T3	3	0	240.50	244.25	3.75
T4	0	2.5	236.50	242.00	5.50
T5	1	2.5	239.25	248.00	8.75
T6	3	2.5	240.25	244.25	4.00
T7	0	5	242.00	245.75	3.75
T8	1	5	241.25	249.50	8.25
T9	3	5	241.00	243.25	2.25
Effect of holy basil					
HB1	0		239.00	242.27	3.27
HB2	1		238.50	246.33	7.83
HB3	3		240.58	243.92	3.33
Effect of curry leaves					
CL1	0		238.00	241.60	3.60
CL2	2.5		238.67	244.75	6.08
CL3	5		241.42	246.17	4.75
Pooled SEM			1.19	1.30	0.81
Statistical significance					
Treatments			NS	NS	NS
Holy basil			NS	NS	NS
Curry leaves			NS	NS	NS

NS= Non significant

Table 2: Effect of dietary addition of holy basil and curry leaves powder on daily feed intake of laying quails (I to VI wk).

Interaction / Treatment	Dietary treatment HB (%)	CL(%)	Feed intake(g/b/d) I wk	II wk	III wk	IV wk	V wk	VI wk
T1	0	0	33.43	32.07	33.18	31.96	32.43	32.54
T2	1	0	33.36	32.36	34.14	33.79	33.39	32.71
T3	3	0	34.11	32.96	34.32	33.61	33.82	33.26
T4	0	2.5	32.25	33.00	32.75	33.36	32.50	32.32
T5	1	2.5	33.07	32.71	32.68	32.79	31.89	32.32
T6	3	2.5	32.39	33.04	33.07	33.57	33.25	32.46
T7	0	5	31.82	31.50	32.43	33.75	32.75	31.96
T8	1	5	32.57	32.68	32.21	33.25	33.00	31.64
T9	3	5	33.39	31.96	32.36	33.75	33.71	31.64
Effect of holy basil								
HB1	0		32.50	32.19	32.79	33.02	32.56	32.27
HB2	1		33.00	32.58	33.01	33.27	32.76	32.23
HB3	3		33.30	32.65	33.25	33.64	33.60	32.45
Effect of curry leaves								
CL1	0		33.63	32.46	33.88^{y}	33.12	33.21	32.84^{y}
CL2	2.5		32.57	32.92	32.83^{xy}	33.24	32.55	32.37^{xy}
CL3	5		32.60	32.05	32.33^{x}	33.58	33.15	31.75^{x}
Pooled SEM			0.21	0.19	0.20	0.17	0.18	0.17
Statistical significance								
Treatments			NS	NS	NS	NS	NS	NS
Holy basil			NS	NS	NS	NS	NS	NS
Curry leaves			NS	NS	P<0.01	NS	NS	P<0.05

NS= Non significant. Mean values sharing any one common superscript in a column do not differ significantly

Table 3: Effect of dietary addition of holy basil and curry leaves powder on feed conversion ratio of laying quails (I to VI wk).

Interaction / Treatment	Dietary treatment HB (%)	CL (%)	Feed conversion ratio I wk	II wk	III wk	IV wk	V wk	VI wk
T1	0	0	3.78	3.51	3.69	3.63	3.85	3.91
T2	1	0	3.64	3.56	3.84	3.72	3.62	3.58
T3	3	0	3.64	3.46	3.60	3.54	3.72	3.63
T4	0	2.5	3.41	3.74	3.81	3.77	3.69	3.95
T5	1	2.5	3.48	3.65	3.70	3.83	3.89	3.97
T6	3	2.5	3.54	3.81	3.86	3.94	4.07	3.73
T7	0	5	3.38	3.71	3.88	4.07	4.01	3.91
T8	1	5	3.42	3.74	3.78	3.97	4.16	3.89
T9	3	5	3.64	3.75	3.87	3.99	4.23	3.81
Effect of holy basil								
HB1	0		3.53	3.65	3.79	3.82	3.85	3.92
HB2	1		3.51	3.65	3.77	3.84	3.89	3.82
HB3	3		3.61	3.67	3.78	3.82	4.01	3.72
Effect of curry leaves								
CL1	0		3.69	3.51^{x}	3.71	3.63^{x}	3.73^{x}	3.71
CL2	2.5		3.48	3.73^{y}	3.79	3.85^{y}	3.89^{x}	3.88
CL3	5		3.48	3.73^{y}	3.84	4.01^{y}	4.14^{y}	3.87
Pooled SEM			0.042	0.037	0.036	0.038	0.044	0.037
Statistical significance								
Treatments			NS	NS	NS	NS	NS	NS
Holy basil			NS	NS	NS	NS	NS	NS
Curry leaves			NS	P<0.05	NS	P<0.001	P<0.001	NS

NS= Non significant. Mean values sharing any one common superscript in a column do not differ significantly

Table 4: Effect of dietary addition of holy basil and curry leaves powder on egg production of laying quails (I to VI wk).

Interaction / Treatment	Dietary treatment HB(%)	CL (%)	Egg production (%) I wk	II wk	III wk	IV wk	V wk	VI wk
T1	0	0	80.00	84.28	83.57	82.86	84.28	83.57^{m}
T2	1	0	82.14	82.85	84.28	85.00	85.00	84.29^{mn}
T3	3	0	82.14	86.43	84.28	85.71	85.00	84.28^{mn}
T4	0	2.5	82.86	82.14	85.00	83.57	85.71	87.86^{n}
T5	1	2.5	83.57	83.57	84.28	84.28	83.57	83.57^{m}
T6	3	2.5	80.00	82.14	83.57	84.28	84.28	83.57^{m}
T7	0	5	82.14	82.14	85.00	84.28	82.85	82.85^{m}
T8	1	5	82.14	85.00	84.28	83.57	82.85	84.28^{mn}
T9	3	5	82.14	84.28	84.28	83.57	84.28	85.00^{mn}
Effect of holy basil								
HB1	0		81.67	82.86	84.52	83.57	84.28	84.76
HB2	1		82.62	83.81	84.28	84.28	83.81	84.05
HB3	3		81.43	84.28	84.04	84.52	84.52	84.28
Effect of curry leaves								
CL1	0		81.43	84.52	84.05	84.52	84.76	84.05
CL2	2.5		82.14	82.62	84.28	84.05	84.52	85.00
CL3	5		82.14	83.81	84.52	83.81	83.33	84.04
Pooled SEM			0.37	0.38	0.29	0.27	0.27	0.33
Statistical significance								
Treatments			NS	NS	NS	NS	NS	P<0.01
Holy basil			NS	NS	NS	NS	NS	NS
Curry leaves			NS	NS	NS	NS	NS	NS

NS= Non significant. Mean values sharing any one common superscript in a column do not differ significantly

No significant change was also found in the present findings on body weight, feed intake, feed conversion ratio and egg production of laying quail by dietary inclusion of 1 and 3% holy basil leaves powder in layer quail diet. Tulsi having no effect on body weight gain and FCR in the present study was agreed by the finding of Vara Prasad *et al.* (2014) who reported that dietary supplementation of *O. sanctum*, selenium and their combinations on mean body weight of broilers and FCR at weekly intervals did not vary significantly among the groups. Similar observations were also recorded with supplementation of E-Care-Se-Herbal preparation (vitamin E, selenium and *Ocimum* extracts) in broilers as reported earlier by Nageshwara *et al*. (2003).

Elangovan *et al*. (2011) also found no significant effect on body weight gain, feed intake, feed conversion ration and hen day egg production by feeding 2% garlic powder, tulsi oil (0.25%), fenugreek seeds (2%) and statin (2 mg/kg) in diet in laying Japanese quails. On the contrary other authors Khatun *et al.* (2013) studied the efficacy of tulsi and neem extract in broiler production and found that in control group (Group A) initial live wt. 168±8.54 gm, final live weight was. 1561±12.10 gm and weight gain 1393±11.07 gm and feed conversion ratio (FCR) was 2.25. In all treatment groups supplementation of herbal extracts 1-3 ml/litre drinking water resulted in significant (P<0.05) increase in mean live weight. Similarly, Nath *et al*. (2012), reported an increased in body weight and feed efficiency in broiler chicken fed with tulsi, black pepper and cloves extract as growth promoter. Sanjyal & Sapcota (2011) found significantly highest body weight (1.440 kg) in sixth week old broiler birds fed diet supplemented with amala and tulsi, and the lowest body weight (1.317 kg) was seen in antibiotics fed birds and during the entire experimental period, feed intake was found higher in birds fed diet fortified with tulsi and amala. Tirupathi Reddy *et al.* (2012) found a significant (P < 0.05) increase in body weight gain in broilers by dietary supplementation of tulsi at 0.25 and 0.5% level. The egg production and feed efficiency were significantly improved by inclusion of herbal feed supplements in layers diet (Narahari *et al.*, 2009). Rai *et al.* (1997) also reported that supplementation of tulsi powder significantly decreased the food intake and weight gain in normal rats given 1% tulsi powder diet. On the contrary, Thamolwan *et al.* (2009) found that body weight gain and food consumption rapidly increased in rats fed with supplementation of tulsi during the first four weeks and then increased more slowly.

B. Effect of curry leaves and holy basil leaves powder on egg quality

The results on effect of curry leaves and holy basil leaves powder on egg quality traits are shown in table 5 to table 8. Interaction of holy basil and curry leaves showed a highly significant (P<0.01) differences on egg weight with the highest egg weight of 11.23 g in both T3 receiving 3% holy basil and T4 groups (2.5% curry leaves) and highest yolk colour (7.00) in T8 (1% holy basil + 5% curry leaves) and T9 (3% holy basil + 5% curry leaves) groups. Significant differences were also observed on holy basil and curry leaves interaction in shape index at II weeks with the highest shape index (78.56%) in T9 group. Curry leaves had a significant (P<0.05) effect on shape index (77.44) and specific gravity (1.029) in II weeks feeding at 5% level but had no significant effect on haugh unit of eggs. Holy basil had no significant effect on shape index and specific gravity of Japanese quail eggs. Both holy basil and curry leaves had no significant effect on egg weight, shell weight, shell thickness, albumen index and yolk index. Holy basil had significantly (P<0.01) influenced haugh unit with the highest value (62.22) at 3% level in VI weeks feeding. No work has been carried out previously studying the effect of curry leaves on egg quality in laying birds. Elangovan *et al*. (2011) also found no significant change on egg quality parameters viz. shape index, shell weight, shell thickness, albumen index, yolk index and internal quality unit which remained similar in all the dietary treatments when fed with feeding 2 % garlic powder, tulsi oil (0.25%), fenugreek seeds (2%) and statin (2 mg/kg) in diet in laying Japanese quails. Narahari *et al.* (2009) reported no significant change on the egg weight, internal egg qualities except yolk colour by feeding herbal feed supplements containing *O. sanctum* (holy basil /tulsi) in layer diets. Similar conclusions were drawn by Narahari *et al*. (2004) and Narahari (2005). The carotenoid pigments in holy basil at 1 and 3% level at VI weeks and curry leaves at 2.5 and 5% level at II weeks treatments had significantly (P<0.01) improved the yolk colour and the carotinoid pigment levels in the yolk. This was in agreement with the earlier findings of Narahari *et al*. (2004) and Narahari *et al.* (2009). No literature could be traced on effect of curry leaves on egg quality traits on laying birds.

Table 5: Effect of dietary addition of holy basil and curry leaves powder on egg weight of laying quails (I to VI wk).

Interaction	**Dietary treatment**		**Egg weight (g)**					
Treatment	**HB(%)**	**CL (%)**	**I wk**	**II wk**	**III wk**	**IV wk**	**V wk**	**VI wk**
T1	0	0	10.98	10.89	10.81	10.88	10.93	10.77^{m}
T2	1	0	10.92	10.85	10.91	10.80	10.83	11.18^{mn}
T3	3	0	10.82	11.07	10.98	10.90	11.00	10.80^{mn}
T4	0	2.5	10.95	10.96	10.97	10.88	10.86	10.95^{mn}
T5	1	2.5	10.99	11.04	10.88	10.81	10.75	10.96^{mn}
T6	3	2.5	10.97	11.05	10.91	10.96	10.91	11.23^{n}
T7	0	5	11.00	10.92	10.94	11.05	11.01	11.23^{n}
T8	1	5	10.94	10.95	11.06	10.98	10.79	11.07^{mn}
T9	3	5	10.89	10.97	10.94	11.08	10.63	10.79^{mn}
Effect of holy basil								
HB1	0		10.97	10.92	10.91	10.94	10.93	10.98
HB2	1		10.95	10.95	10.95	10.86	10.79	11.07
HB3	3		10.89	11.03	10.94	10.98	10.85	10.94
Effect of curry leaves								
CL1	0		10.91	10.94	10.90	10.86	10.92	10.91
CL2	2.5		10.97	11.02	10.92	10.88	10.84	11.05
CL3	5		10.94	10.94	10.98	11.04	10.81	11.03
Pooled SEM			0.03	0.04	0.03	0.03	0.04	0.04
Statistical significance								
	Treatments		NS	NS	NS	NS	NS	P<0.01
	Holy basil		NS	NS	NS	NS	NS	NS
	Curry leaves		NS	NS	NS	NS	NS	NS

NS= Non significant. Mean values sharing any one common superscript in a column do not differ significantly

Table 6: Effect of dietary addition of holy basil and curry leaves powder on shape index and specific gravity of laying quails.

Interaction	Dietary treatment		Shape index			Specific gravity		
Treatment	HB(%)	CL (%)	II wk		VI wk	II wk		VI wk
T1	0	0	76.62^{mn}		76.14	1.024		1.03
T2	1	0	76.80^{mn}		76.21	1.024		1.027
T3	3	0	76.31^{m}		77.59	1.026		1.029
T4	0	2.5	77.71^{mn}		76.44	1.027		1.028
T5	1	2.5	76.62^{mn}		75.93	1.027		1.029
T6	3	2.5	77.36^{mn}		76.21	1.032		1.031
T7	0	5	76.43^{m}		76.80	1.028		1.026
T8	1	5	77.34^{mn}		75.91	1.028		1.025
T9	3	5	78.56^{n}		76.39	1.03		1.029
Effect of holy basil								
HB1	0		76.92		76.46	1.026		1.028
HB2	1		76.92		76.02	1.026		1.027
HB3	3		77.41		76.73	1.029		1.030
Effect of curry leaves								
CL1	0		76.58^{x}		76.64	1.025^{x}		1.029
CL2	2.5		77.23^{xy}		76.19	1.029^{y}		1.029
CL3	5		77.44^{y}		76.36	1.029^{y}		1.027
Pooled SEM			0.17		0.13	0.0007		0.0008
Statistical significance								
Treatments			P<0.05		NS	NS		NS
Holy basil			NS		NS	NS		NS
Curry leaves			P<0.05		NS	P<0.05		NS

NS= Non significant. Mean values sharing any one common superscript in a column do not differ significantly

Table 7: Effect of dietary addition of holy basil and curry leaves powder on shell weight and shell thickness of laying quails.

Interaction	Dietary treatment		Shell weight (%)		Shell thickness (mm)	
Treatment	HB(%)	CL (%)	II wk	VI wk	II wk	VI wk
T1	0	0	8.38	9.01	0.208	0.220
T2	1	0	8.19	8.49	0.212	0.220
T3	3	0	8.42	9.06	0.208	0.228
T4	0	2.5	8.69	8.52	0.212	0.222
T5	1	2.5	8.37	8.45	0.214	0.220
T6	3	2.5	8.20	8.58	0.210	0.216
T7	0	5	8.33	8.18	0.206	0.212
T8	1	5	8.65	8.83	0.210	0.222
T9	3	5	8.87	8.79	0.214	0.222
Effect of holy basil						
HB1	0		8.47	8.57	0.209	0.218
HB2	1		8.40	8.59	0.212	0.221
HB3	3		8.50	8.81	0.211	0.222
Effect of curry leaves						
CL1	0		8.33	8.86	0.209	0.223
CL2	2.5		8.42	8.51	0.212	0.219
CL3	5		8.61	8.60	0.210	0.219
Pooled SEM			0.058	0.074	0.0019	0.0016
Statistical significance						
Treatments			NS	NS	NS	NS
Holy basil			NS	NS	NS	NS
Curry leaves			NS	NS	NS	NS

NS= Non significant

Table 8: Effect of dietary addition of holy basil and curry leaves powder on albumen index, haugh unit, yolk index and yolk colour of laying quails.

Interaction	Dietary treatment		Albumen index		Haugh unit		Yolk index		Yolk colour	
Treatment	HB(%)	CL (%)	II wk	VI wk	II wk	VI wk	II wk	VI wk	II wk	VI wk
T1	0	0	11.76	11.00	58.79	60.06	41.52	41.52	5.00	5.00^{m}
T2	1	0	11.29	11.04	60.08	60.54	40.84	41.37	5.00	5.00^{m}
T3	3	0	11.95	11.17	60.30	62.33	41.07	41.15	5.40	5.00^{m}
T4	0	2.5	11.74	11.09	60.08	60.74	41.18	41.42	5.80	5.00^{m}
T5	1	2.5	11.39	11.06	59.77	61.26	40.86	41.32	5.80	5.00^{m}
T6	3	2.5	11.20	11.84	60.32	61.85	41.29	41.29	5.80	5.00m
T7	0	5	11.79	11.43	60.40	60.53	41.26	41.62	7.40	5.80^{mn}
T8	1	5	11.49	11.14	61.00	60.99	41.21	41.51	7.80	7.00^{o}
T9	3	5	11.66	11.30	62.80	62.47	41.41	41.26	7.80	7.00^{o}
Effect of holy basil										
HB1	0		11.76	11.17	59.76	60.44^{a}	41.32	41.52	6.07	5.27^{a}
HB2	1		11.39	11.08	60.28	60.93^{a}	40.97	41.40	6.20	5.67^{b}
HB3	3		11.60	11.44	61.14	62.22^{b}	41.25	41.24	6.33	5.67^{b}
Effect of curry leaves										
CL1	0		11.67	11.07	59.72	60.98	41.14	41.35	5.13^{x}	5.00
CL2	2.5		11.44	11.33	60.06	61.28	41.11	41.34	5.80^{y}	5.00
CL3	5		11.65	11.29	61.40	61.33	41.29	41.46	7.67^{z}	6.60
Pooled SEM			0.074	0.083	0.304	0.201	0.078	0.099	0.205	0.133
Statistical significance										
Treatments			NS	NS	NS	NS	NS	NS	NS	P<0.01
Holy basil			NS	NS	NS	P<0.01	NS	NS	NS	P<0.01
Curry leaves			NS	NS	NS	NS	NS	NS	P<0.01	NS

NS= Non significant. Mean values sharing any one common superscript in a column do not differ significantly

C. Effect of dietary addition of holy basil and curry leaves powder on egg yolk cholesterol of laying quails

The effect of feeding holy basil and curry leaves either singly or in combination on egg yolk cholesterol is given in table 9. Both holy basil and curry leaves addition in diet had a highly significant (P<0.001) effect in lowering egg yolk cholesterol (mg/g yolk) content in Japanese quail eggs. Diet having 3% holy basil had highest egg yolk cholesterol reduction of 15.60 mg/g, 15.27 mg/g and 14.97 mg/g at II, IV and VI weeks feeding. Curry leaves (5%) level showed highest egg yolk cholesterol reduction of 15.86, 15.47 and 15.14 mg/g of yolk at II, IV and VI weeks feeding.

Table 9: Effect of dietary addition of holy basil and curry leaves powder on egg yolk cholesterol of laying quails.

Interaction	Dietary treatment		Egg yolk cholesterol (mg/g yolk)		
Treatment	HB(%)	CL (%)	II wk	IV wk	VI wk
T1	0	0	18.19	18.10	18.01
T2	1	0	16.91	16.79	16.26
T3	3	0	16.13	15.84	15.64
T4	0	2.5	17.20	17.14	16.91
T5	1	2.5	16.33	15.85	15.67
T6	3	2.5	15.68	15.55	15.32
T7	0	5	17.17	16.96	16.80
T8	1	5	15.42	15.03	14.66
T9	3	5	14.98	14.43	13.95
Effect of holy basil					
HB1	0		17.52c	17.40c	17.24c
HB2	1		16.22b	15.89b	15.53b
HB3	3		15.60a	15.27a	14.97a
Effect of curry leaves					
CL1	0		17.08^{z}	16.91^{z}	16.64^{z}
CL2	2.5		16.41^{y}	16.18^{y}	15.97^{y}
CL3	5		15.86^{x}	15.47^{x}	15.14^{x}
Pooled SEM			0.16	0.18	0.19
Statistical significance					
Treatments			NS	NS	NS
Holy basil			P<0.001	P<0.001	P<0.001
Curry leaves			P<0.001	P<0.001	P<0.001

NS=Non significant. Mean values sharing any one common superscript in a column do not differ significantly

There is no significant difference on egg yolk cholesterol reduction by combination of holy basil and curry leave in all test groups (T1 to T9). No literature could be traced on the effect of curry leaves on egg yolk cholesterol reduction in laying birds. Also no work has been carried out in studying the cholesterol lowering effect by feeding a combination of these two herbs. This agrees with the findings those reported by Narahari *et al*. (2009) who found significant (P<0.01) reduction in yolk cholesterol levels in laying hens by dietary inclusion of *O. sanctum* (holy basil/ tulsi) @ 3g/kg (OS) and *O. album* (White Basil) @ 3g/kg (OA) treatments; followed by *Eclypta alba* (Bhringaraj) @1g/kg (EA) and *Phyllanthus neruri* (Bhuiamla) @ 1g/kg (PN) treatments. The active principles in these herbs might be responsible for lowering the yolk cholesterol levels. Similarly, Kirubakaran (2003), Michealraj (2004) and Narahari *et al*. (2004) reported cholesterol lowering properties of herbs like basil leaves, garlic, fenugreek seeds. The present finding is also in accordance with the study of Mahajan *et al*. (2010) who had shown a significant hypocholesteremic effect (P<0.05) by feeding of polyherbal preparation containing *Emblica officinalis* (Amla), *O. sanctum* (tulsi), *Withania somnifera* (Ashwagandha) and *Tinospora cordifolia* (Giloy) in Kadaknath, White dwarf broiler and Coloured dwarf breed lines and concluded that these herbs can be used effectively for reducing lipid contents in egg yolk for better human consumption and reducing the risk of Cardiovascular diseases. On the contrary, no significant effect of tulsi oil incorporation in laying Japanese quails diet on egg cholesterol, serum cholesterol and serum triglycerides as compared to control (Elangovan *et al*., 2011). The results of the present study revealed that feeding curry leaves and holy basil had not much
Significant effect on production performance and some of the egg quality traits. However, the egg yolk cholesterol level was significantly reduced by feeding these two herbs in laying Japanese quails. Therefore, further investigation or series of biological trials can be conducted wherein; multiple effects of feeding certain herbs, either singly or in combination can be tested and efforts can be made to develop enriched quail eggs by using these herbs with flaxseed, linseed oil, sardine oil etc.

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