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Influence of Supplementation of Phytogenic Feed Additives on Egg Quality of Layer Quail

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ABSTRACT

Background: Phytogenic feed additives (PFA) have enormous potential to replace commercial productive performance enhancer in layer quail diet that can be owed to their active principles, easy availability, non-toxic and residue-free nature. The present study was aimed to select an ideal PFA by evaluating the supplemental effect of various phytoadditives on egg quality indices.

Methods: Three hundred sixty quail layers (6 weeks old; same hatch) were randomly distributed into eight groups (n=45), having three replicas of 15 quail layers per group. Basal diet was similar in all groups, except PFA supplementation. Different dietary groups were: Negative control (NC; contains no additive), positive control (PC; herbal growth promoter), whereas T_1, T_2, T_3, T_4, T_5 and T_6 groups were supplemented with 1% dietary additive namely turmeric, garlic, fenugreek, cumin, *aloe vera* and oregano powder, respectively. Eggs were evaluated for external and internal egg quality indices at monthly intervals, but yolk cholesterol was determined at end of trial.

Result: Our investigations revealed that average monthly egg number was significantly increased (P<0.05) in the PC and PFA supplemented groups during the first 3 months of laying. Mean egg weight of the trial was found significantly higher in PC, T_1, T_2, T_4 and lowest in NC, with intermediate egg weights for rest groups. Shell thickness was found highest in PC, T_1, T_3 and lowest in NC, T_5, T_6 whereas rest groups have intermittent values. However, shape index showed higher values in PC, T_1 and lower values in NC and T_3. Average Haugh unit was found significantly higher (P<0.05) in T_1 than rest of the groups, but yolk index showed no significant difference. The cholesterol content of quail egg yolk (mg/g yolk) was highest in NC group followed by PC and lowest in T_2 and T_3. Cost benefit ratio was found highest in T_1, T_3 and T_5 and was lowest in T_6 group. It may be inferred that turmeric supplementation is comparable to commercial herbal additive in terms of egg quality of layer quail.

Key words: Egg quality, Layer quails, Phytoadditives.

INTRODUCTION

Phytogenic feed additives (PFA) encompass a diverse array of plant-derived substances, including essential oils, herbs, spices and other botanical extracts (Gupta *et al*., 2022). These are rich in bioactive compounds and possess beneficial physiological properties *viz*., antimicrobial, antioxidant, anti-inflammatory and digestive stimulation effects (Alagawany *et al*., 2017). But, a wide range of PFA namely turmeric (*Curcuma longa*), garlic (*Allium sativum*), fenugreek (*Trigonella foenum-graecum*), cumin (*Cuminum cyminum*), *aloe vera* (*Aloe barbadensis*) and oregano powder (*Origanum vulgare*) can be exploited as feed additives to enhance production performance and egg quality (Liu *et al*., 2020; Tesissa *et al*., 2023).

Turmeric rhizome possesses various active ingredients *viz*. curcumin, demethoxycurcumin, bisdemethoxycurcumin and tetrahydrocurcumin, that leads to antioxidant, antibacterial, antiviral, antiprotozoal, antifungal, anti-inflamatory, anticarcinogenic, anti-hypertensive and hypo-cholesteremic properties (Chowdhary *et al*., 2021). Garlic bulb contains allicin, alliin, ajoene, diallylsulphide, dithiin and s-allylcysteine which have antimicrobial properties (Batiha *et al*., 2020). Similarly, fenugreek seeds contain neurin, biotin, trimethylamine which stimulates appetite and have hypoglycemic, anthelmintic, antibacterial, antiinflammatory, antipyretic and antimicrobial properties

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(Yatoo *et al*., 2012). Cumin seeds are composed of cuminaldehyde, terpinenes, polyphenols and flavonoids which impart beneficial properties (Alinian *et al*., 2016). *Aloe vera* leaf has more than 75 biologically active ingredients and has anti-oxidant and hypocholesteremic properties (Kichloo *et al*., 2023). Oregano leaves contains different active compounds *i.e.* carvacrol, thymol, rosmarinic acid, borneol, organol, ursolic acid, monoterpene hydrocarbons (terpinene and p-cymene) and monoterpene alcohols which culminates in antimicrobial action (Behnamifar *et al*., 2018).

Earlier researchers also acknowledged that incorporation of above stated PFA have enhanced layer productivity and egg quality (Saleh *et al*., 2019; Liu *et al*., 2020; Tesissa *et al*., 2023). But there is scanty literature regarding its usage in layer quail. With this background, present study was aimed to scrutinize the effect of supplementation of various PFA on egg quality indices of layer quail.

MATERIALS AND METHODS

Present study was conducted at Division of Animal Nutrition, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Jammu, India in year 2022. Three hundred sixty Japanese quail (*Coturnix coturnix japonica*) layers of same hatch (6 weeks old) were randomly distributed into eight groups (n=45), having three replicas of fifteen quail layers. Maize-soya based basal diet was formulated as per specifications given by ICAR (2013) (Table 1). The eight dietary groups were: Negative control (NC) group contains basal diet, positive control (PC) is supplemented with commercial productive performance enhancer (Reproforte plus™ containing *Adhatoda vasica*- 20%, *Asparagus officinalis*- 15%, *Leptadenia reticulate*- 15%, *Zingiber officinalis*- 10%, *Rubia cordifolia*- 10%, *Tribulus terrestris*- 10%, *Solena amplexicaulis*- 10%, *Punica granatum*- 10% was supplemented @ 500 gm per ton feed, Arvind Herbal Labs, Saharanpur, UP), whereas T_1, T_2, T_3, T_4, T_5 and T_6 groups were supplemented as 1% dietary additive with turmeric, garlic, fenugreek, cumin, *aloe vera* and oregano powder, respectively.

Parameters studied

The eggs were collected and weighed daily by using electronic weighing balance. Evaluation for egg quality indices was done at monthly intervals (February to June, 2022). Three eggs per replica *i.e.* 9 eggs per group were evaluated for quality.

External egg quality

Egg width (mm) and egg length (mm) were estimated by using digital Vernier Caliper, whereas egg shape index (%) was calculated by the formula:

$$\text{Egg shape index (\%)} = \frac{\text{Egg width (mm)}}{\text{Egg length (mm)}} \times 100$$

Egg shell with shell membrane was taken and kept in hot air oven overnight for proper drying. After drying, three different segments of shell were taken and the shell thickness (mm) was estimated with the help of a micrometer screw gauge.

Internal egg quality

Egg content was poured on flat surface to determine albumin height (mm) by using a digital Vernier caliper. Individual Haugh unit (Haugh, 1937) score was estimated using the egg weight and albumin height as follows:

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

Where,
HU= Haugh unit.
H= Observed height of the albumin in mm.
W= Weight of egg in grams.

Yolk diameter (mm) was also estimated by using digital Vernier caliper, whereas yolk height (mm) was measured with the help of spherometer. Yolk index (%) was determined as the ratio of yolk height to yolk width.

$$\text{Yolk index, \%} = \frac{\text{Yolk height}}{\text{Yolk width}} \times 100$$

The egg albumen adhered to the yolk membrane was removed by rolling the intact egg yolk over a filter paper carefully without breaking the yolk membrane. The cholesterol content of egg yolk (mg/g yolk) was estimated as per the method of Aziz *et al.* (2012) with slight modifications.

Statistical analysis

The data pertaining to different parameters were subjected to statistical analysis as per Snedecor and Cochran (1994). The means in different treatments were subjected to Duncan's multiple range test for ranking ($P<0.05$).

RESULTS AND DISCUSSION

The average monthly egg number was significantly increased ($P<0.05$) in PC and all PFA fed groups during the first 3 months of laying in comparison to NC group (Table 2). But no effect was recorded in the last two trial months. Similarly, Abdalla *et al.* (2011) reported increase in egg number in hens on supplementing herbs mixture and attributed it to vitamins and fat soluble unidentified factors (El-Shafei *et al*., 2012). Earlier researchers too reported increased egg production on supplementing turmeric (Azouz, 2020; Zacaria and Ampode, 2021), garlic (Canogullari *et al*., 2010; Omer *et al*., 2019), fenugreek seed powder (Chongtham *et al*., 2015), cumin seeds (Ali *et al*., 2018) and aloe vera (Hasan, 2014). There are different justifications attributed to it: better utilization of the diet, optimum antioxidant activity, stimulation of protein synthesis, stimulation of pancreatic digestive enzymes and reduction in feed transit time in the alimentary tract (Platel and Srinivasan, 2001). But, periodically, least number of

eggs was observed during 1st month of laying cycle, whereas highest egg number was observed during 2nd and 3rd month followed by 4th month and there is decline in 5th month.

External egg quality

Average egg weight was found significantly (P<0.05) higher in PC, T_1, T_2, T_4 in comparison to NC group, whereas, T_3, T_5 and T_6 groups have intermediate egg weights (Table 3). Supporting our results, Yalcin *et al.* (2006), Park *et al.* (2012) and Saleh *et al*. (2019) reported increased egg weight on supplementing turmeric, garlic and cumin, respectively. In contrast, turmeric and garlic powder supplementation did not significantly influence the egg weight in laying birds (Omer *et al*., 2019; Zacaria and Ampode, 2021). The differences in these studies might be either due to different dosages of phytoadditives or different bird species.

Egg shell is the first line of defense against microbial contamination and is essential for proper embryogenesis, besides the keeping quality. Average shell thickness (mm) estimated in this study was found highest in PC, T_1, T_3 and lowest in NC, T_5 and T_6, whereas rest groups have intermediate values (Table 3). Likewise, Liu *et al.* (2020) reported that curcumin supplementation improved egg shell thickness in laying hens and attributed it to the increased release of calcium in the blood for the further participation in eggshell formation. Radwan *et al*. (2008) also stated that egg mass was increased by turmeric addition due to improvement in uterus media (site of calcium deposit) and resulted in enhanced shell weight and thickness. Similar finding has been reported by Park *et al*. (2018) and Tesissa *et al*. (2023) on supplementing fenugreek powder.

Average shape index (%) showed significantly higher values (P<0.05) in PC and T_1 and was lowest in NC and T_3, whereas rest groups (T_2, T_4, T_5 and T_6) showed intermediate egg shape index values (Table 3). But, no difference was seen in monthly egg shape index. Shape index (%) is an important criterion for grading the eggs and it depicts the crushing strength variation and risk of cracked eggs during storage and transportation. Radwan *et al*. (2008) also reported significantly improved egg shape index on turmeric supplementation. On the contrary, no effect on shape index was reported after turmeric powder supplementation by some authors (Liu *et al*., 2020; Zacaria and Ampode, 2021). The differences might be due to the different doses of turmeric powder supplemented in the diet, duration of the experiment period and bird's age. Similarly, Omer *et al*. (2019) reported no change in shape index on supplementing 0.5 and 1% garlic in laying hen. In

Table 1: Ingredient and chemical composition (%) of layer quail basal diet.

Attributes	Ingredient composition (%)
Maize	62.66
Meat bone meal	4.02
Soybean meal	24.65
Salt	0.25
Sodium bicarbonate	0.01
Soybean oil	1.30
DL-Methionine	0.10
L-Lysine hydrochloride	0.12
Limestone powder	6.72
Vitamin supplement	0.05
Trace minerals	0.10
Chemical composition (on DMB, %)	
Organic matter	95.31
Crude protein	18.62
Ether extract	5.51
Crude fibre	4.19
Total ash	4.69
Nitrogen free extract	66.99
ME (Kcal/kg; calculated value)	2850

Table 2: Effect of phytoadditive supplementation on egg number of layer quails.

Treatment	Period					Overall mean ± SEM
	1	2	3	4	5	
			Egg number			
NC	131.00^{AW}±4.58	332.33^{AY}±7.84	326.67^{AY}±8.25	313.67^{XY}±8.09	302.33^{X}±5.78	281.20±20.44
PC	161.33^{BW}±8.82	361.33^{BZ}±7.80	347.00^{ABYZ}±8.19	329.00^{XY}±9.17	314.67^{X}±8.95	302.67±19.62
T_1	166.67^{BW}±7.45	358.00^{BY}±5.13	355.00^{BY}±8.33	336.00^{XY}±9.64	312.33^{X}±9.56	305.60±19.32
T_2	168.67^{BW}±7.31	360.33^{BY}±6.23	354.67^{BY}±8.41	339.00^{XY}±8.96	318.00^{X}±8.66	308.13±19.28
T_3	159.67^{BW}±7.51	361.33^{BY}±6.39	359.33^{BY}±9.24	337.33^{XY}±6.44	316.33^{X}±6.96	306.80±20.34
T_4	167.00^{BW}±7.77	377.67^{BY}±9.21	373.00^{BY}±8.96	339.67^{X}±12.24	326.67^{X}±5.81	316.80±20.96
T_5	158.00^{BW}±6.08	373.67^{BZ}±7.13	372.00^{BZ}±8.72	340.00^{Y}±9.54	315.33^{X}±4.33	311.80±21.53
T_6	158.67^{BW}±7.31	365.67^{BY}±7.84	361.00^{BY}±9.64	330.67^{X}±6.36	318.00^{X}±8.39	306.80±20.59

$^{A, B}$ Observations with different superscripts differ significantly (P<0.05) within the column; $^{W, X, Y}$ and ^{Z} observations with different superscripts differ significantly (P<0.05) within the row. Negative control (NC: Contains no additive); Positive control (PC: Herbal growth promoter-Reproforte plus™ was supplemented @ 500 gm per ton feed), whereas T_1, T_2, T_3, T_4, T_5 and T_6 groups were supplemented with 1% dietary additive namely turmeric, garlic, fenugreek, cumin, *aloe vera* and oregano powder, respectively. Period 1- 0-30 days, Period 2-31-60 days, Period 3- 61-90 days, Period 4- 91-120 days, Period 5- 121-154 days.

accordance with the current results, El-Shafei *et al.* (2012) also found no difference in shape index on feeding fenugreek to layer quails. Supporting our finding, Hasan (2014) also found similar shape index on aloe vera supplementation in drinking water of quails. There is dearth of literature in this regard.

Internal egg quality

Average Haugh unit (HU) observed for whole trail is significantly higher (P<0.05) in T_1 in comparison to the rest of the groups (Table 4). HU is the measure of protein quality based on the albumen height and is a good indicator of freshness of eggs. The present results corroborate with the findings of Saraswati *et al.* (2013) who reported that turmeric powder might have stimulated the growth of epithelial and tubular gland cells in magnum, which resulted in increased albumin synthesis. Similarly, Omer *et al.* (2019) reported no change in Haugh unit on supplementing 0.5 and 1% garlic in laying hen. Also, Canogullari *et al.* (2010) reported similar HU on garlic feeding (1 and 2%) in laying quails. But, Hasan (2014) reported lower HU on *aloe vera* supplementation in drinking water of quails.

Yolk index amongst all the eight groups showed no difference at monthly time intervals and for the entire trial (Table 4). In line with our results, similar yolk index was reported by Asrat *et al*. (2018) on garlic powder supplementation; Saraswati *et al*. (2013) on turmeric supplementation; Omer *et al.* (2019) on garlic feeding; Hasan (2014) on aloe vera supplementation and Gul *et al*. (2019) on oregano supplementation.

The cholesterol content of quail egg yolk (mg/g yolk) was determined on trial completion (Table 5). Highest yolk cholesterol was observed for NC group followed by PC and lowest in T_2 and T_3. Whereas, rest groups showed intermittent results, as T_6 had no difference with PC, T_1, T_4

Table 3: Influence of phytoadditives supplementation on egg weight (g), shell thickness (mm) and egg shape index (%) in layer quail.

Treatments	Period						Overall mean
	1	2	3	4	5	6	± SEM
				Egg weight (g)			
NC	10.59±0.46	11.05±0.31	11.02±0.23	10.90±0.20	11.08±0.39	11.01±0.42	10.94^{a}±0.13
PC	10.79^{X}±0.25	11.76^{Y}±0.08	11.69^{Y}±0.21	11.83^{Y}±0.05	11.54^{Y}±0.13	11.68^{Y}±0.19	11.55^{cd}±0.10
T_1	11.15±0.76	11.49±0.08	11.62±0.15	11.53±0.27	11.65±0.22	11.42±0.09	11.47^{bcd}±0.13
T_2	10.84±0.27	11.32±0.50	12.05±0.17	12.28±0.43	11.85±0.28	11.82±0.20	11.69^{d}±0.16
T_3	11.08±0.44	11.22±0.29	11.38±0.23	11.38±0.32	11.26±0.35	11.28±0.27	11.26^{abc}±0.11
T_4	11.07±0.14	11.63±0.17	11.48±0.36	11.56±0.12	11.47±0.11	11.37±0.27	11.43^{bcd}±0.09
T_5	11.18±0.19	11.04±0.35	11.15±0.39	11.06±0.42	11.11±0.37	11.17±0.22	11.11^{ab}±0.12
T_6	10.95±0.33	11.02±0.37	11.12±0.16	11.12±0.24	11.23±0.37	11.17±0.19	11.10^{ab}±0.10
				Shell thickness (mm)			
NC	0.26±0.01	0.25±0.01	0.25±0.02	0.25±0.01	0.25±0.02	0.25±0.02	0.25^{a}±0.01
PC	0.24±0.01	0.26±0.02	0.28±0.02	0.28±0.01	0.28±0.01	0.28±0.01	0.27^{bc}±0.01
T_1	0.24±0.02	0.26±0.01	0.29±0.01	0.28±0.01	0.29±0.02	0.29±0.02	0.27^{bc}±0.01
T_2	0.26±0.02	0.26±0.02	0.25±.0.01	0.26±0.01	0.26±0.01	0.26±0.02	0.26^{ab}±0.01
T_3	0.25±0.02	0.28±0.01	0.29±0.01	0.28±0.01	0.29±0.01	0.29±0.01	0.28^{c}±0.01
T_4	0.27±0.02	0.23±0.01	0.27±0.02	0.26±0.01	0.26±0.01	0.26±0.01	0.26^{ab}±0.01
T_5	0.24±0.01	0.25±0.02	0.25±0.01	0.25±0.01	0.25±0.02	0.25±0.01	0.25^{a}±0.01
T_6	0.24±0.01	0.24±0.01	0.25±0.01	0.27±0.01	0.26±0.01	0.25±0.01	0.25^{a}±0.01
				Egg shape index (%)			
NC	78.40±1.07	77.31±2.84	75.23±1.45	77.86±1.00	78.83±2.35	79.25±2.77	77.81^{a}±0.78
PC	78.89±0.80	80.46±2.52	81.15±1.10	80.56±0.81	80.57±1.41	80.65±1.39	80.38^{b}±0.53
T_1	78.45±1.37	81.11±2.89	80.16±1.85	80.96±0.98	81.62±0.73	80.89±0.60	80.53^{b}±0.61
T_2	78.88±0.99	78.95±2.09	78.98±2.34	79.31±1.24	79.75±0.67	79.70±0.60	79.26^{ab}±0.52
T_3	77.89±1.52	80.15±0.77	78.27±1.01	77.31±0.53	78.02±0.37	78.72±1.05	78.39^{a}±0.39
T_4	79.01±1.21	78.76±2.02	78.63±2.43	79.71±1.80	80.06±0.17	79.10±1.44	79.22^{ab}±0.59
T_5	79.70±0.60	82.95±1.13	78.20±1.97	79.97±0.90	79.44±0.24	79.72±1.55	79.41^{ab}±0.54
T_6	78.52±1.39	79.09±0.36	78.88±1.62	78.90±0.75	78.31±0.63	79.95±1.33	78.94^{ab}±0.40

^{a,b,c,d} Mean with different superscript differs in a column significantly (P<0.05); $^{X, Y}$Values with different superscript differs in a row significantly (P<0.05);

$^{A, B}$ Values with different superscript differs in a column significantly. NC- Negative control, PC- Positive control, T_1- 1% Turmeric, T_2- 1% Garlic, T_3- 1% Fenugreek, T_4- 1% Cumin, T_5- 1% *Aloe vera*, T_6- 1% Oregano (as dietary additive); Period 1-0 day (45 days old quail), 2-30 days, 3-60 days, 4-90 days, 5-120 days, 6-154 days.

Table 4: Influence of phytoadditives supplementation on Haugh unit and yolk index (%) in layer quail.

Treatments	Period						Overall mean
	1	2	3	4	5	6	± SEM
				Haugh unit			
NC	89.96±1.22	89.83±0.44	89.99±1.97	90.66±1.03	89.53±0.21	89.31±0.52	89.88^{a}±0.39
PC	90.96±0.77	92.42±0.69	91.07±1.72	89.32±0.20	90.14±1.45	88.93±1.59	90.47^{a}±0.50
T_1	90.95±1.26	91.20±2.28	92.15±0.80	92.96±0.46	91.76±1.35	90.47±1.47	92.04^{b}±0.52
T_2	88.79±0.60	90.33±1.14	91.24±1.06	90.56±1.61	91.35±1.47	90.85±1.22	90.52^{a}±0.47
T_3	89.25±0.61	90.13±1.17	90.32±1.07	89.81±1.11	89.77±0.92	89.33±0.82	89.77^{a}±0.34
T_4	89.69±1.54	90.41±1.80	90.20±0.41	89.44±1.65	89.08±0.46	89.78±0.76	89.76^{a}±0.44
T_5	89.32±1.79	91.22±0.91	90.87±0.51	90.91±0.85	89.24±0.63	89.77±1.77	90.22^{a}±0.45
T_6	89.34±0.31	90.73±1.74	90.71±0.96	90.62±1.11	90.14±0.60	89.93±1.88	90.24^{a}±0.44
				Yolk index (%)			
NC	43.38±0.57	42.91±0.65	43.55±1.49	43.88±0.90	45.02±1.02	45.56±0.96	44.05±0.40
PC	44.73±1.33	46.88±4.39	45.23±1.12	43.60±0.46	44.14±1.35	44.45±1.52	44.83±0.77
T_1	43.35±1.30	47.52±1.71	45.50±0.71	45.65±1.05	45.35±1.01	45.05±0.95	45.67±0.75
T_2	44.28±0.71	45.70±1.43	45.93±0.75	46.23±1.27	45.54±2.06	45.26±2.32	45.63±0.67
T_3	43.79±2.20	46.77±l.44	46.83±1.09	45.46±1.13	45.32±1.20	46.93±1.47	45.33±0.68
T_4	43.18±0.60	44.40±2.08	45.99±1.13	47.18±0.48	46.54±1.50	45.99±0.17	45.10±0.56
T_5	44.88±1.55	42.86±1.51	44.74±0.78	45.48±0.71	44.27±1.41	44.96±1.83	44.53±0.51
T_6	44.78±2.16	43.80±1.90	44.83±0.70	44.53±0.45	44.50±0.49	44.78±0.56	44.89±0.82

^{ab}Mean with different superscript differs in the column significantly (P<0.05).

NC- Negative control, PC- Positive control, T_1- 1% Turmeric, T_2- 1% Garlic, T_3- 1% Fenugreek, T_4- 1% Cumin, T_5- 1% *Aloe vera*, T_6-1% Oregano. (as dietary additive. Period 1-0 day (45 days old quail), 2-30 days, 3-60 days, 4-90 days, 5-120 days, 6-154 days.

Table 5: Effect of phytoadditives supplementation on yolk cholesterol (mg/g yolk) in layer quail.

Groups	Yolk cholesterol (mg/g yolk)
NC	18.72^{d}±0.45
PC	17.41^{c}±0.34
T_1	16.50^{abc}±0.48
T_2	15.93^{a} ±0.23
T_3	15.71^{a}±0.23
T_4	16.24^{ab}±0.49
T_5	16.82^{abc}±0.26
T_6	17.19^{bc}±0.11
Overall mean ±SEM	16.81±0.21
P-value	0.00

^{abcd}Mean with different superscript differs in the column significantly (P<0.05).

NC- Negative control, PC- Positive control, T_1- 1% Turmeric, T_2- 1% Garlic, T_3- 1% Fenugreek, T_4- 1% Cumin, T_5- 1% *Aloe vera*, T_6- 1% Oregano (as dietary additive).

and T_5. Also, cholesterol in quail egg yolk of T_4 group had no difference with cholesterol in egg yolk of T_1, T_2, T_3 and T_5 groups. Concurrent with our result, El-Shafei *et al.* (2012) also found lower yolk cholesterol on adding fenugreek in the diet of laying quails. Similarly, Canogullari *et al.* (2010) reported lower (P<0.05) yolk cholesterol on garlic feeding (1, 2 and 4%) in laying quails. In accordance with the current results, Safaa (2007) reported significantly lower (P<0.05) egg yolk cholesterol on adding 2% garlic and 2% fenugreek in Lohmann brown laying hens at 33, 35, 37 and 39 weeks of age. Chowdhury *et al.* (2002) also observed liner reduction in yolk cholesterol on supplementing 2, 4, 6, 8 and 10% garlic paste. Also, as per our finding, Hassan (2000) and El-Kaiaty *et al.* (2002) indicated lowering of yolk cholesterol by 20 and 9% on feeding 2% garlic and 2% fenugreek, respectively. A significant reduction of yolk cholesterol in garlic feeding was also confirmed by Yalcin *et al.* (2006). On turmeric supplementation @ 13.5 mg/ quail/day, Saraswati *et al.* (2013) reported lower cholesterol in first layed egg of quail.

Cost economics

It revealed that total income (Rs.) received by selling eggs and birds was higher in additive supplemented groups (Table 6). The cost benefit ratio was found highest in T_1, T_3 and T_5, but it was lowest in T_6 group. Similar to our findings, Zacaria and Ampode (2021) also got better and a linear increase in both benefit cost ratio and return on investment, with the increase in turmeric inclusion in quail diet. Also, Chauhan *et al.* (2018) revealed that production cost for feed consumed per egg was decreased significantly on turmeric supplementation at 1, 3, 4.5 and 6% levels in the diet of laying hens. Likewise, Bejar (2021) and Kichloo *et al.* (2023) revealed that aloe vera extract supplementation in drinking water at 15 and 25 ml/gallon and 0.6% inclusion in drinking water had showed positive effect on net income and return on investment in layer quails. In line with our study, Abaza *et al.* (2007) reported better returns in groups

Table 6: Effect of phytoadditives supplementation on cost economics of layer quail.

Attributes	NC	PC	T_1	T_2	T_3	T_4	T_5	T_6
No. of layer quails	45	45	45	45	45	45	45	45
Cost of 42 days old quail bird	80	80	80	80	80	80	80	80
Cost of litter (Rs.)	250	250	250	250	250	250	250	250
Feed consumed during trail (kg)	126	125.7	124.95	126.45	124.65	124.8	124.65	124.8
Cost of feed consumed (Rs.)	4432.68	4422.13	4395.74	4448.51	4385.19	4390.46	4385.19	4390.46
Cost of additive (Rs.)	0	315	187.5	289.8	187.5	600	274.23	1475
Total input cost (Rs.)	4762.68	5067.13	4913.24	5068.31	4902.69	5320.46	4989.42	6195.46
Total no. of eggs	4218	4540	4584	4622	4602	4752	4677	4602
Income from quail birds @ Rs. 3/egg (A)	12654	13620	13752	13866	13806	14256	14031	13806
Body weight of birds per group (kg)	3634.59	3686.66	3705.90	3679.54	3651.56	3654.79	3668.25	3636.14
Income from quail birds @ Rs.700/kg live bird (B)	2544.21	2580.66	2594.13	2575.68	2556.09	2558.36	2567.78	2545.30
Total income (A+B)	15198.21	16200.66	16346.13	16441.68	16362.09	16814.36	16598.78	16351.30
Total profit	10435.53	11133.54	11432.89	11373.37	11459.41	11493.89	11609.36	10155.83
Profit/bird	231.90	247.41	254.06	252.74	254.65	255.42	257.99	225.69
Total difference over control (Rs)		698.00	997.36	937.84	1023.87	1058.36	1173.83	-279.70
Difference over control/bird (Rs)		15.51	22.16	20.84	22.75	23.52	26.09	-6.22
Cost benefit ratio	2.19	2.20	2.33	2.24	2.34	2.16	2.33	1.64

NC- Negative control, PC- Positive control, T_1- 1% Turmeric, T_2- 1% Garlic, T_3- 1% Fenugreek, T_4- 1% Cumin, T_5- 1% *Aloe vera*, T_6-1% Oregano (as dietary additive).

supplemented with fenugreek. The increased returns may be due to better feed conversion ratio and improved egg production in fenugreek supplemented group. Lowest cost benefit ratio in oregano supplemented group can be attributed to higher cost of additive in comparison to rest of the groups. Also, Chowdhary *et al.* (2021) got net income increased and better cost benefit ratio on garlic powder supplementation in broilers. In nut shell, it may be stated that phytoadditives has a positive impact on layer quails in terms of cost economics.

CONCLUSION

It may be inferred that turmeric supplementation @1% in layer quail diet was comparable with the commercial herbal additive in terms of egg quality parameters**.** Moreover, Haugh unit was superior in turmeric supplemented group. But in terms of economics, cost benefit ratio is found better in turmeric, fenugreek and aloe vera fed groups. However, it may be concluded that 1% turmeric supplementation in layer quail is beneficial.

Conflict of interest

There is no conflict of interest.

REFERENCES

Abaza, I.M. (2007). Effect of using fenugreek, chamomile and radish as feed additives on productive performance and digestibility coefficients of laying hens. Poultry Science. 27: 199-218.

Abdalla, A.A., Ahmed, M.M., Abaza, I.M., Aly, O.M., Hassan, E.Y. (2011). Effect of using medicinal plants and their mixtures on productive and reproductive performance of gimmizah strain 2-egg production period. Egyptian Poultry Science Journal. 31: 641-654.

Alagawany, M., El-hack, A.B.D., Saeed, M.E., Arain, M., Bhutto, M.A., Fazlani, Z.A., Brohi, S.A., Arif, M. (2017). Effect of some phytogenic additives as dietary supplements on performance, egg quality, serum biochemical parameters and oxidative status in laying hens. Indian Journal of Animal Sciences. 87: 900-905.

Ali, H.A.M., Hussein, A.S., Al-Shamire, J.S.H., Hamodi, S.J. (2018). Effect of interaction between dietary two levels of cumin (*Cuminum cyminum*) and ginger (*Zingiber officinale*) on Japanese quail performance. Euphrates Journal of Agriculture Science. 10(3): 11-19.

Alinian, S., Razmjoo, J., Zeinali, F. (2016). Flavanoids, anthocynuns, phenolics and essential oil produced in cumin (*Cuminum cymium* L.) accessions under different irrigation regimes. Industrial Crops and Products. 81: 49-55.

Asrat, M., Zeryehun, T., Amha, N., Urge, M. (2018). Effects of supplementation of different levels of garlic (*Allium sativum*) on egg production, egg quality and hatchability of white leghorn chicken. Livestock Research for Rural Development. 30(3): 37.

Aziz, Z., Cyriac, S., Beena, V. and Philomina, P.T. (2012). Comparison of cholesterol content in chicken, duck and quail eggs. Journal of Veterinary and Animal Science. 43: 64-66.

Azouz, H.M. (2020). Effects of dietary turmeric and fenugreek powder supplementation on productive performance of local laying hens. Egyptian Poultry Science Journal. 40(1): 243-258.

Batiha, E.S., Beshbishy, M., Wasef, G., Elewa, Y.H.A., Al-Sagan, A.A., Abd-El-Hack, M.E., Taha, M.E., Abd-Elhakim, M., Devkota H.P. (2020). Chemical constituents and pharmacological activities of garlic (*Allium sativa* L.): A review. Nutrients. 12(3): 872. doi: 10.3390/nu12030872.

Behnamifar, A., Rahimi, S., Karimi Torshizi, M.A., Zade, Z.M. (2018). Effect of chamomile, wild mint and oregano herbal extracts on quality and quantity of eggs, hatchability and some other parameters in laying Japanese quails. Journal of Medicinal plants and By-product. 7(2): 173-180.

Bejar, F.R. (2021). Performance of quails with aloe vera extract and acid cheese whey supplementation. EPRA International Journal of Agriculture and Rural Economic Research. 9: 4-7.

Canogullari, S., Baylan, M., Erdogan, Z., Duzguner, V., Kucukgul, A. (2010). The effects of dietary garlic powder on performance, egg yolk and serum cholesterol concentrations in laying quails. Czech Journal of Animal Science. 55(7): 286-293.

Chauhan, S.S., Caeser, D.D., Shakkarpude, J., Shrivastava, K., Khan, M.A., Mishra, A. (2018). Effect of turmeric supplementation on production performance of adult laying birds. International Journal of Current Microbiology and Applied Science. 7(8): 840-844.

Chongtham, S., Tyagi, P.K., Mandal, A.B., Tyagi, P.K., Rokade, J.J., Singh, S. (2015). Effect of dietary inclusion of fenugreek (*Trigonella foenum-graecum* L.) and black cumin (*Nigella sativa* L.) on performance, egg quality traits and egg yolk cholesterol in laying Japanese quails. Indian Journal of Poultry Science. 50(1): 42-47.

Chowdhary, S., Khan, N., Sharma, R.K., Sasan, J.S., Mahajan, V. (2021). Effect of dietary inclusion of turmeric (*Curcuma longa*) and garlic (*Allium sativum*) powders as feed additives on performance of broiler chicken. Indian Journal of Animal Nutrition. 38(1): 92-99.

Chowdhury, S.R., Chowdhury, S.D., Smith, T.K. (2002). Effects of dietary garlic on cholesterol metabolism in laying hens. Poultry Science. 81(12): 1856-1862.

El-Kaiaty, A.M., Soliman, A.Z.M., Hassan, M.S.H., (2002). Combine effect of garlic, fenugreek and black seed on some productive and physiological response of laying hens. Egyptian Poultry Science. 22: 147-174.

El-Shafei, A.A., Hassan, M.S.H., Al-Gamal, M.A., El-Sayed, O.A. (2012). Influence of fenugreek and copper sulfate levels in the diet on physiological and productive performance of laying Japanese quail. Egyptian Poultry Science Journal. 32(4): 909-930.

Gul, M., Yilmaz, E., Yildirim, B.A., Sezmis, G., Kaya, A., Timurkaan, S., Onel, S.E., Tekce, E. (2019). Effects of oregano essential oil (*Origanum syriacum* L.) on performance, egg quality, intestinal morphology and oxidative stress in laying hens. European Poultry Science. 83: 1-15.

Gupta, A., Kichloo, A.A., Khan, N., Mahajan, V., Amrutkar, S. (2022). Amelioration of heat stress in poultry through phytogenic feed additives. Poultry Line. 22(7): 27-30.

Hasan, M. (2014). Effect of aloe vera and vitamin C on productive performance and qualities trails of eggs in Japanese laying quail. Euphrates Journal of Agriculture Science. 6(3): 17-29.

Hassan, M.S.H. (2000). Physiological studies on egg cholesterol and immunity in layers. Ph. D. Thesis, Faculty of Agriculture, Cairo, University, Giza, Egypt.

Haugh, H. (1937). The Haugh Unit for Measuring Egg Quality. The U.S. Egg and Poultry Magazine. 43: 552-555, 572-573.

ICAR, (2013). Nutrient requirement of Animals-Poultry (ICAR-NIANP), Indian Council of Agriculture Research, New Delhi.

Kichloo, A.A., Khan, N., Sharma, R.K., Mahajan, V. (2023). Comparative evaluation of different *Aloe vera* forms over quail performance during summer. Indian Journal of Animal Research. 1, 6. doi: 10.18805/IJAR.B-5140.

Liu, M., Lu, Y., Gao, P., Xie, X., Li, D., Yu, D., Yu, M. (2020). Effect of curcumin on laying performance, egg quality, endocrine hormones and immune activity in heat-stressed hens. Poultry Science. 99(4): 2196-2202

Omer, H.A., Ahmed, S.M., Abdel-Magid, S.S., El-Mallah, G.M., Bakr, A.A., Abdel Fattah, M.M. (2019). Nutritional impact of inclusion of garlic (*Allium sativum*) and/or onion (*Allium cepa* L.) powder in laying hens' diets on their performance, egg quality and some blood constituents. Bulletin of the National Research Centre. 43: 1-9.

Park, S.S., Kim, J.M., Kim, E.J., Kim, H.S., An, B.K., Kang, C.W. (2012). Effects of dietary turmeric powder on laying performance and egg qualities in laying hens. Korean Journal of Poultry Science. 39(1): 27-32.

Park, J.H., Kim, Y.M., Kim, I.H. (2018). Egg production, egg quality, blood profiles, cecal microflora and excreta noxious gas emission in laying hens fed with fenugreek (*Trigonella foenum-graecum* L.) seed extract. Japanese Poultry Science. 55(1): 47-53.

Platel, K. and Srinivasan, K. (2001). Studies on the influence of dietary spices on food transit time in experimental rats. Nutrition Research. 21(9): 1309-1314.

Radwan, N.L., Hassan, E.M.Q., Fayek, H.M. (2008). Effect of natural antioxidant on oxidative stability of eggs and productive and reproductive performance of laying hens. International Journal of Poultry Science. 7(2): 134-150.

Safaa, H.M. (2007). Effect of dietary garlic or fenugreek on cholesterol metabolism in laying hens. Egypt Poultry Science. 27(4): 1207-1221.

Saleh, A.A., Kirrella, A.A., Dawood, M.A.O., Ebeid, T.A. (2019). Effect of dietary inclusion of cumin seed oil on the performance, egg quality, immune response and ovarian development in laying hens under high ambient temperature. Journal of Animal Physiology and Animal Nutrition. 103(6): 1810-1817.

Saraswati, T.R., Manalu, W., Ekastuti, D., Kusumorini, N. (2013). The role of turmeric powder in lipid metabolism and its effect on quality of the first quail's egg. Journal of the Indonesian Tropical Animal Agriculture. 38(2): 123-130.

Snedecor, G.W., Cochran, W.G. (1994). Statistical Methods. 8th Edition, The Iowa State University, Iowa U.S.A.

Tesissa, E., Tamiru, M., Tadese, D.A., Demeke, S., Ababor, S., Asres, A., Beyene, A., Miresa, A. Wamatu, J. Alkhtib, A., Burton, E. (2023). Evaluation of fenugreek (*Trigonella foenum graecum*) seed powder and *Moringa oleifera* leaf meal on production performance and egg quality of laying hens. Preprints. 2023051289. https://doi.org/10.20944/preprints202305.1289.

Yalcın, S., Onbasılar, E.E., Reisli, Z., Yalcın, S. (2006). Effect of garlic powder on the performance, egg traits and blood parameters of laying hens. Journal of the Science of Food and Agriculture. 86(9): 1336-1339.

Yatoo, M.A., Sharma, R.K., Khan, N., Rastogi, A., Pathak, A.K. (2012). Effect of fenugreek and black cumin seeds as feed additives on blood biochemical profile and performance of broilers. Indian Journal of Animal Nutrition. 29(2): 174-178.

Zacaria, A.M. and Ampode, K.M.B. (2021). Turmeric (*Curcuma longa* Linn.) as phytogenic dietary supplements for the production performance and egg quality traits of laying Japanese quail. Journal of Animal Health and Production. 9(3): 285-295.