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Examining the Effects of Adding Cosmos Sulphureus Flower Powder to the Diet of Mewari Laying Hens on Their Growth, Egg Quality, and Blood Components

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A B S T R A C T

A 60 days' experiment was carried out to examine the effects of adding Cosmos sulphureus flower powder to the diet of Mewari laying hens on their growth, egg quality, and blood components. One hundred dual purpose Mewari laying hens at the age of 45 weeks with an average initial weight of 1488 ± 2.00 g were used for the experiment. Birds in treatment 1 (control) received basal diet without Cosmos sulphureus flower powder while those in treatment 2, 3, 4 and 5 were fed basal diet supplemented with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively. Result on the carotenoid content of Cosmos sulphureus flower powder showed that it contained □-carotene (45.12 µg/g) and □-cryptoxanthin (20.88 µg/g). Quantification of phyto-compounds in Cosmos sulphureus powder showed that flavonoids had the highest concentration of 16.88 % while glycosides was lowest (0.11 %). Other compounds found in the sample were, phenols (12.06 %), tannins (9.51 %), alkaloids (3.95 %), steroids (2.70 %) and saponins (0.68 %). Dietary supplementation of Cosmos sulphureus flower powder enhanced ($p<0.05$) the average final weight, Average weight gain, feed conversion ratio, hen day egg production, hen housed egg production except average feed consumption and creatinine level ($p>0.05$). Cosmos sulphureus flower powder dietary supplementation increased ($p<0.05$) egg weight, egg shape, egg length, albumen height, yolk colour and haugh unit. The levels of haematocrit, haemoglobin, red blood cell, total protein, serum levels of alanine transaminase and aspartate aminotransferase and decreased ($p<0.05$) cholesterol level. In conclusion, dietary supplementation of Cosmos sulphureus flower powder up to 20 g/kg diet of hens had no detrimental effect on their growth performance and health status

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INTRODUCTION

Cosmos sulphureus is native to Mexico, America and Asia and it belongs to the family Asteraceae. The plant is an ornamental plant that has a long standing role in traditional medicine that is now been validated by modern science (Jadav and Gowda, 2017; Alagbe et al., 2023). The plant is rich in phytochemicals such as, tannins, flavonoids, alkaloids, saponins, phenols, steroids amongst others that do more than nourish but possess therapeutic properties: antimicrobial, anti-inflammatory, antioxidant, immuno-stimulatory, hepato-protective, antiviral, antifungal, antibacterial, cytotoxic, anti-helminthic, antidiabetic and anti-diarrhoeal (Kaur et al., 2006, Alagbe, 2023). The leaves and flowers of Cosmos sulphureus are loaded with polyphenols that protects cells from oxidative damage and neutralize the activities of free radicals in the cells, thus preventing infections in the body (Wangkiri et al., 2021).

In pre-clinical studies, extracts from Cosmos sulphureus have shown anti-inflammatory and antitumor activities by reducing cancer cells proliferation (Saleem et al., 2019). The leaves hold different kinds of medicine that supports detoxification at the cellular level (Megnigueu et al., 2020) and also to restore vitality and strengthens the blood after illness (Jadav and Gowda, 2017), lowers low density lipoprotein and support the heart by improving lipid metabolism (Shimokoriyama and Hattori, 1953; Alagbe, 2022). Aqueous and ethanolic root extract from Cosmos sulphureus have shown strong antimicrobial activities of pathogenic organisms in the gut (Kamboj et al., 2015). It has also been utilized to treat cough, wounds, gastro-intestinal disorder, snake bite, malaria, pyrexia, anorexia, sexually transmitted infections, tooth ache, diabetes, amongst others (Amamiya and Iwashina, 2016). The plant acts as a stabilizer and nourisher where their bioactive compounds form a single therapeutic system saddled to sustain cellular energy and shields the body against infection (Malaka et al., 2015; Alagbe et al., 2023).

Previous studies by Saleh et al. (2021) have shown that the dietary supplementation of sunflower meal in laying hens at 100 g/kg feed had no influence live weight gain, feed intake, feed conversion ratio, egg mass and cholesterol content ($p>0.05$) except for yolk color and yolk height ($p<0.05$). Ah-Shami et al (2011) also reported that dietary inclusion of Alfalfa leaf meal had a positive effect on growth performance and egg quality of laying hens. Moeini et al. (2019) investigated the effect of red pepper (Capsicum annuum) and Marigold flower (Tagetes erectus) powder on the egg quality and blood constituents of laying hens, he observed that there were no significant differences among treatments for egg quality traits but the yolk color changed in treated group compared with controls ($P<0.01$). Similarly, leucocyte count, uric acid, glucose, total cholesterol, triglycerides, calcium, phosphorus, high density lipoprotein, low density lipoprotein and serum enzymes were not affected by the treatment ($p<0.05$) except eosinophils count ($p>0.05$).

However, there is little or no information on the effect of dietary supplementation of Cosmos sulphureus flower powder on the growth performance, egg quality and blood constituents of Mewari laying hens. This research is timely because there is increasing awareness on the use of natural

products in poultry production because of their safety and efficacy. This will further help to boost the production of birds and promote its sustainability.

LITERATURE REVIEW

Description of Experimental Location

The research was carried out at the Poultry Section, Gandhi College of Agriculture, Rajasthan located in the North-Western part of India which lies between longitude 23o 03′ to 30o 12′ North and latitude 69o 30′ and 78o 17′ East. The experiment was carried out according to the research ethics and guidelines of Animal Nutrition and Biochemistry, Gandhi College of Agriculture, India.

Collection, Authentication and Processing of Cosmos Sulphureus Flower

Yellow flowers of Cosmos sulphureus were collected from the premises of Gandhi College of Agriculture, Rajasthan in India. After collection, samples were taken to the Department of Taxonomy of the same institution where it was authenticated and assigned a voucher specimen number – TG/08C/2025. The flowers were shade dried for 11 days and grounded into powder with an electric blender and stored in plastic containers prior to analysis.

Analysis of Phyto-Compounds in Cosmos Sulphureus Flower Powder

Phyto-compounds in Cosmos sulphureus powder were analyzed using Elmerd GC (Model 2300 C, Hamburg, Germany). The kit was maintained at a temperature: 50 oC, with 2 minutes' initial hold, and then to 230 oC at 15 oC/min, with final hold time of 15 minutes; helium was used as carrier gas at a flow rate of 1 mL/min. Quantification of each compounds was recorded at different optical densities, tannins at 506nm, flavonoids (450nm), alkaloids (603nm), saponins (250 nm), steroids (320 nm), phenols (460 nm) and glycosides (250 nm) as presented in Table 1.

Analysis of Carotenoid Content in Cosmos Sulphureus Powder

Analysis of □-carotene and □-cryptoxanthin in Cosmos sulphureus was carried out using Kepra High-Performance Liquid Chromatography [HPLC, Model 28009C, China] and Ultra violet–vis detector and quantified at an optical density of 450 nm. For proper precision, kit was set at a column temperature and pressure of 40o C and 75 % respectively. Values obtained were expressed in µg/g as presented in Table 2.

Animal Management, Diet and Experimental Design

One hundred dual purpose Mewari laying hens at the age of 45 weeks with an average initial weight of 1488 ± 2.00 g were used for the experiment. Birds were weighed before the commencement of the study with digital automatic scale, stratified based on their weights and equally divided into five dietary treatments with five replications consisting of 20 birds each. Hens were housed in battery cages measuring 1.50 × 0.50 × 0. 80m equipped with nipple drinker with a chute –type feeder and space for egg collection. Birds were placed on two weeks' acclimatization period and dewormed with Albendazole® (Jutra Pharmaceuticals, Punjab India) which was administered based on instructions stated on the package insert. The experiment lasted for 90 days excluding the quarantine period and a completely experimental design was adopted. The average temperature and relative humidity of the pen was maintained at 27℃

and 80 % respectively. A 19 hours lighting period was adopted (12 hours of natural light and 7 hours with fluorescent light). Basal diet was compounded according to the nutrient requirement for laying birds according to NRC (1994) [Table 3]. Hen in treatment 1 received basal diet without Cosmos sulphureus flower powder as contol while those in treatment 2, 3, 4 and 5 were fed basal diet supplemented with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively. A completely randomized experimental design was adopted and fresh water was made available at all times. Biosecurity measures were also taken into cognizance throughout the study period. Feed intake was calculated as the amount of feed consumed per bird was determined as the difference between the feed offered and refused. Feed offered and refused was estimated daily while feed conversion ratio was determined as a unit egg weight per unit feed consumed.

Proximate analysis of basal diet was carried out KPM Analytics NIR Spectroscopy Analyzers (Model 3800F, China). 100 g of feed sample was poured into the rotary reflecting dish and set at a spectral range of 1400 – 2500 nm for optimal measurement

Egg Production Parameters

Eggs were collected thrice daily from each pen at 0800, 1200 and 1700 hours. The summation of the three collections along with the number of birds alive on each day was recorded and summarized at the end of the period. Hen day egg production and Hen house egg production was determined using the formula below:

% Hen Day Egg Production = total number of eggs produced/total number of hens present on the day of recording ×100

% Hen House Egg Production = total number of eggs produced/number of hens initially housed × 100

Evaluation of Characteristics Related to Egg Quality

Ten eggs were chosen at random from each replication at the conclusion of the experiment in order to assess the quality of the eggs. By breaking eggs on a flat glass and separating each component—such as shell weight, shell thickness, yolk color, yolk weight, yolk length, yolk height, yolk index, albumen weight, albumen height, and Haugh unit—the internal egg quality criteria were evaluated. An electronic digital scale was used to determine the egg's weight.

Using a delicate balance with a precision of 0.01 g, the shell, albumen, and yolk were meticulously separated and weighed separately. The interior membrane was removed to determine the weight and thickness of the shell. A digital micrometer screw gauge was used to measure the thickness of the shell. A tripod micrometer was used to measure the height of the albumen and yolk. The color of the appropriately combined yolk sample was compared to the color strips of the Roche color fan measurement, which has a color range of 1 to 15. The Haugh unit (HU) was calculated using the Keener et al. (2006) approach. The formula used to compute it was HU = 100 log10 (h + 7.57 − 1.7w 0.37), where h is the observed albumen height and w is the egg weight.

Blood Sample Collection and Analysis

On the final day of the experiment, six randomly chosen birds per replication had 10 mL of blood drawn in the morning from their wing veins for

haematological and serum biochemical analysis. Five milliliters of blood were transferred to anticoagulant-containing bottles for haematology, and the remaining five milliliters were placed in clean, dry sample vials devoid of anticoagulants. After collection, samples were placed in an already prepared ice pack. Using Medrex Auto-Haemo Analyzer (Model 3800 HC, China) and strictly adhering to manufacturer's instructions, samples for haematology were analyzed for haematocrit, red blood cell, haemoglobin and white blood cells. Commercial kit, Mutlab-Biochemical Analyzer (4000FC, Germany) was used to determine the concentrations of albumin, globulin, creatinine, cholesterol and serum enzymes [(aspartate transaminase (AST), alanine transaminase (ALT)].

METHODOLOGY

Statistical Analysis

Data collected were analyzed by using the general linear model (GLM) procedures of SAS, by employing one-way analysis of variance (ANOVA). Significant differences between treatment's means were separated by Duncan's multiple range test (Duncan, 1955). The following statistical model was used: Yij= μ+ Ti+ eij Where: Yij= the observation of ij; μ = overall mean; Ti = effects of treatments, (i = 1, 2, 3, 4 and 5) and eij = experimental random error.

RESULTS AND DISCUSSION

Quantification of phyto-compounds in Cosmos sulphureus powder is presented in Table 1. The most prominent compound in the sample is flavonoids which contains 16.88 % while glycosides had the lowest concentration of 0.11 %. Other present compounds were; phenols (12.06 %), tannins (9.51 %), alkaloids (3.95 %), steroids (2.70 %) and saponins (0.68 %). Result obtained showed that the true power of Cosmos sulphureus powder lies in its chemistry and unique phyto-compounds making it one of the most versatile medicinal plant (Alagbe, 2025). Outcome recorded in this study aligns with the findings of Dyah et al. (2019); Sugiharti et al. (2018) and Zeng et al. (2008). Edoega et al. (2008) reported that leaves and flowers from Cleome rutidosperma, Emilia coccinea, Euphrobia heterophylla, Physcalis bransilensis, Scorparia dulcis, Richardia bransilensis, Sida acuta, Spigelia anthelmia, Stachytarpheta cayennensis and Tridxa procumbens contains flavonoids, tannins, anthraquinones, terpenoids, saponins, glycosides amongst others.

The higher concentration of flavonoids in Cosmos sulphureus powder suggests that has the capability to fight oxidative stress (Hernandez and Alagbe, 2025a; John, 2024a), support cardiovascular system and immune health (Hernandez and Alagbe, 2025b; John, 2024b). Phenolic compounds are natural antioxidants also reported to be found in most fruits is capable of scavenging free radicals, reducing lipid peroxidation and suppressing inflammatory enzymes (Muritala et al., 2022; John, 2024c). They are also capable of restoring antioxidant enzymes like catalase, superoxide dismutase and glutathione peroxidase confirming its hepato-protective properties (John, 2024d; Musa et al., 2020).

Tannins and alkaloids have antimicrobial properties and are equally show cytotoxic effect against cancer cells without harming healthy tissues (Adewale et al., 2021; Singh et al, 2021). Saponins are known to promote protein synthesis, enhances blood sugar regulation and tissue repair (Ojediran et al., 2024; Shittu and Alagbe, 2020). Glycosides and steroids are powerful agents for pains, kidney support, cellular repair, reproductive and metabolic health (Alagbe et al., 2025). They offer incredible healing but together unlock a deeper level of synergy (John, 2024d; Daniel et al., 2023). The result in this study indicates that the compounds in Cosmos sulphureus powder collectively serve as molecular body guard, forms an antioxidant shield that protects the cell from oxidative stress, inflammation and radiation induced damage (Singh et al., 2022).

Table 2 reveals the carotenoid content in Cosmos sulphureus powder. The sample contains □-carotene (45.12 µg/g) and □-cryptoxanthin at 20.88 (µg/g). □-carotene and □-cryptoxanthin are pro-vitamins A and their dietary supplementation can prevent the risk of heart disease, promote good eye sight and the absorption of calcium, thus enhancing the formation of bones (Ozaki et al., 2015). According to (Niizu and Rodriguez, 2007), β-carotene in Cosmos sulphureus flower contributes to its vibrant pink/ orange colours and also helps during the process of photosynthesis (Mlcek and Rop, 2011). Values obtained in this study was comparable to 46.0 (µg/g) □-carotene reported for fresh Primula flower but higher than 10.00 (µg/g) and 8.00 (µg/g) □-carotene in Cosmos yellow and Diana elegance pink flower reported by Sasicha et al. (2019).

Performance of Mewari hens fed diet supplemented with Cosmos sulphureus flower powder is presented in Table 4. Average final body weight was lower in treatment 1[T1] (1698.1 g) than T2 (1880.6 g), T3 (1881.3 g), T4 (1883.4 g) and T5 (1883.9 g) ($p<0.05$). Birds fed diet supplemented with Cosmos sulphureus flower powder show better improvement in weight compared to the control. Although average weight gains of birds which received T2 and T3 were comparable to those in T4 and T5 ($p>0.05$). This result suggests that Cosmos sulphureus flower powder has the capability to stimulate digestive enzymes release, improve nutrient absorption and inhibits the activities of pathogens in the gastro-intestinal tract translating to better body weight gain and feed conversion ratio. This outcome is in line with a recent study by Roge´rio et al. (2024) who reported that the inclusion of moringa leaf meal at 6 % enhanced the final body weight of hens.

Odunsi et al. (2002) also recorded a positive outcome on the weight of birds when fed diet supplemented with Gliricida sepium leaf meal. Average feed consumption values which varied from 124.5 – 125.2 g/b were not influenced by the treatment ($p>0.05$). This result suggests that Cosmos sulphureus flower powder did not influence the flavor of the diet. This is contrary to the reports of Alagawany et al. (2015) and Saleh et al. (2021) who recorded a significant increase in feed consumption of laying hens fed diet supplemented with Sunflower meal. Variation in result can be attributed to differences in level of supplementation, variety, geographical location, chemical compounds as well as duration of study (John, 2024d; Alagbe et al., 2025).

Egg production of Mewari hens fed diet supplemented with Cosmos sulphureus flower powder is presented in Table 5. Hen housed egg production and hen day egg production values varied from 49.22 – 63.55 % and 56.73 – 69.06 % were significantly ($p<0.05$) affected by the treatments. Results revealed that dietary supplementation of Cosmos sulphureus flower powder improved hen day egg production and hen housed egg production suggesting that it possess both nutritional and medicinal properties (Alagbe, 2022; Nguyen et al., 2005). According to Alagbe (2025), amino acids especially methionine and lysine could enhance egg quality and quantity of eggs. Hammershoj et al. (2005) recorded a hen day egg production values which ranged from 50.00 – 70.00 % in laying hens fed diet supplemented with Lupinus angustifolius. However, result obtained in this study is in agreement with the reports of Laudadio et al. (2014).

Egg quality of Mewari hens fed diet supplemented with Cosmos sulphureus flower powder is presented in Table 6. Egg weight (46.77 – 58.92 g) were influenced by the treatment ($p<0.05$). Hens fed Cosmos sulphureus flower powder supplemented diet also had an increase egg shape index, egg width and egg length compared to the control. This outcome confirms the earlier result of Ebenebe et al. (2013); Anigbogu (2013) when Moringa oleifera leaf meal was included in the diet of laying hens. This result suggests that basal diet was rich in necessary nutrients needed by birds for production. Shell weight was higher in T2 (8.11 g), T3 (8.32 g), T4 (8.32 g) and T5 (8.55 g) than T1 (5.71 g). This is a clear indication that Cosmos sulphureus flower powder is rich in minerals especially calcium which gives strength to egg shell and further translates to improved albumen height and haugh unit (Chantiratikul et al., 2008). Weight, colour, length and height of the yolk were higher among birds fed Cosmos sulphureus flower powder relative to the control. This could be due to the presence of □-carotene and □-cryptoxanthin capable of influencing yolk colour of eggs, thus increasing consumers acceptability of product (Alagbe, 2025)

Haematological components of Mewari hens fed diet supplemented with Cosmos sulphureus flower powder is presented in Table 7. Haematocrit values was lower in T1 (28.17 %) than T2 (32.16 %), T3 (32.69 %), T4 (32.71 %) and T5 (32.75 %) ($p<0.05$) whereas haemoglobin level was higher in T3 (13.09 g/dL), T4 (13.11 g/dL) and T5 (13.27 g/dL), intermediate in T2 (11.40 g/dL) and lower in T1 (9.07 g/dL) ($p<0.05$). Haematocrit values recorded in this study was within 27.50 – 36.00 % reported by Kakore et al. (2021a). Haemoglobin concentration was within 8.00 – 16.00 g/dL cited by Graczyk et al. (2003). Red blood cell values which ranged from 1.92 – 3.28 (×1012/L) was within normal range 1.50 – 5.00 (×1012/L) reported by Ali et al. (2019). The result suggests that dietary supplementation of Cosmos sulphureus flower powder did not negatively affect iron production in the blood (Muritala et al., 2022). White blood cell promotes the production of antibodies to fight infection in the body (Omokore and Alagbe, 2019). White blood cell value was lower in T1 [(3.04 (x109/L)] than T2 [(5.09 (x109/L)], T3 [(5.16 (x109/L)], T4 [(5.26 (x109/L)] and T5 [(5.28 (x109/L)] ($p<0.05$). White blood cell values obtained in this experiment was within the normal range 2.60 – 7.00 (x109/L) cited by Straková et al. (2010). Result indicates that Cosmos sulphureus flower powder has immuno-modulatory compounds

that help to balance immune activities stimulating it when defenses are low and calming it when its overactive (Hernandez and Alagbe, 2025b). This dual action helps the body to responds to defense against infections.

Table 8 revealed the serum biochemical constituents of Mewari hens fed diet supplemented with Cosmos sulphureus flower powder. Total protein value was higher in T3 (6.33 g/dL), T4 (6.38 g/dL) and T5 (6.42 g/dL), intermediate in T2 (6.18 g/dL) and lower in T1 (4.39 g/dL). Total protein, albumin and globulin values were within the reference range 3.00 – 7.50 g/dL, 1.88 – 3.50 g/dL and 1.95 – 4.00 g/dL cited by Kokore et al. (2021b); Harr (2006). This result suggests that the dietary protein was enough to support the growth of birds (Musa et al., 2020). Cholesterol values (64.14 – 94.33 mg/dL) was significantly influenced by the treatment except for creatinine level (0.35 – 0.44 mg/dL) ($p>0.05$). The result suggests that Cosmos sulphureus flower powder has hypolipidemic properties, thus reducing the risk against cardiovascular diseases (Adewale et al., 2021). Creatinine level was within the normal range 0.20 – 1.00 mg/dL reported by Hochleithner (2013); Hrubec et al. (2002). Alanine transaminase (59.08 – 58.77 U/L) and Aspartate transaminase (27.07 – 28.91 U/L) were not influenced ($p>0.05$) by the treatment. Alanine transaminase and Aspartate transaminase recorded in this study was within the reference range 30.00 – 65.00 U/L and 18.0 – 35.00 U/L cited by Swenson (2004). This result indicates that Cosmos sulphureus flower powder has the potential to defend liver tissues from toxins (Musa et al., 2020).

Table 1. Quantification of Phyto-Compounds in Cosmos Sulphureus Powder

Compounds	Composition (%)
Tannins	9.51
Saponins	0.68
Flavonoids	16.88
Phenols	12.06
Alkaloids	3.95
Steroids	2.70
Glycosides	0.11

Table 2. Carotenoid Content in Cosmos Sulphureus Powder

Constituents	Composition (µg/g)
β-carotene	45.12
β-cryptoxanthin	20.88

Table 3. Gross Composition of Basal Diet (Expressed in % DM)

Ingredients	Inclusion level (%)
Maize	51.25
Wheat bran	15.0
Soybean meal	22.0
Bone meal	3.50
Oyster shell	7.00
L-Lysine	0.20

DL-Methionine	0.25
Premix (Min & Vit)	0.25
Toxin binder	0.20
Salt	0.35
Total	100.00
Determined analysis (% DM)	
Crude protein (CP)	16.85
Crude fibre (CF)	7.59
Ether extract (EE)	4.81
Ash	9.48
Energy (Kcal/kg)	2800.6

Mineral and vitamin mixture contained (per kg): Vitamin A: 10,000 IU, D3: 6000 IU, 49.8 g Di calcium phosphate, 25 g Magnesium sulfate, 9.15 g Ferrous sulfate, 0.3 g Potassium iodide, 0.753 g Copper sulfate, 0.248 g Cobalt sulfate, 0.373 g Zinc sulfate, and 0.022 g

Table 4. Performance of Mewari Hens Fed Diet Supplemented with Cosmos Sulphureus Flower Powder

Parameters	T1	T2	T3	T4	T5	SEM
Average initial body weight (g/hen)	1488.0	1488.2	1487.7	1487.3	1486.5	0.02
Average final body weight (g/hen)	1698.1^{b}	1880.6^{a}	1881.3^{a}	1883.4^{a}	1883.9^{a}	16.75
Average weight gain (g/hen)	120.1^{b}	392.4^{a}	393.6^{a}	396.1^{a}	397.4^{a}	2.51
Average feed consumption (g/hen)	124.5	124.9	125.0	125.1	125.2	0.94
Feed conversion ratio	5.11^{a}	4.63^{b}	4.61^{b}	4.61^{b}	4.60^{b}	0.01

a,b: Means within a row with different superscripts are significantly different ($p<0.05$); Treatment 1: basal diet without Cosmos sulphureus flower powder; Treatment 2, 3, 4 and 5 received basal diet with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively; SEM: Standard error of mean

Table 5. Egg Production of Mewari Hens Fed Diet Supplemented with Cosmos Sulphureus Flower Powder

Components	T1	T2	T3	T4	T5	SEM
Hen Housed Egg Production (in %)	49.22^{b}	60.61^{a}	61.80^{a}	63.25^{a}	63.55^{a}	0.83
Hen Day Egg Production (%)	56.73^{b}	66.93^{a}	68.11^{a}	69.02^{a}	69.06^{a}	0.46

a,b: Means within a row with different superscripts are significantly different ($p<0.05$); Treatment 1: basal diet without Cosmos sulphureus flower powder; Treatment 2, 3, 4 and 5 received basal diet with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively; SEM: Standard error of mean

Table 6. Egg Quality of Mewari Hens Fed Diet Supplemented with Cosmos Sulphureus Flower Powder

Components	T1	T2	T3	T4	T5	SEM
Egg weight (in grams)	46.77[b]	57.11[a]	58.09[a]	58.55[a]	58.92[a]	0.37
Egg shape index	70.92b	86.25a	87.31a	87.49a	88.01a	0.21
Egg width (mm)	32.08b	40.92a	41.73a	41.97a	42.06a	0.11
Egg length (mm)	41.73b	50.88a	51.61a	52.01a	52.09a	0.15
Shell weight (g)	5.71b	8.08a	8.11a	8.32a	8.55a	0.01
Albumen height (mm)	4.05b	7.03a	7.74a	7.84a	7.91a	0.02
Yolk weight (g)	16.72b	20.03a	20.11a	21.19a	21.25a	0.04
Yolk length (mm)	30.51b	45.61a	45.88a	46.07a	46.11a	0.18
Yolk colour	9.96b	11.41a	11.75a	11.86a	11.95a	0.02
Haugh unit	69.11b	79.10a	80.30a	80.85a	81.22a	0.06
Yolk index	0.22c	0.32b	0.40a	0.45a	0.47a	0.01

a,b,c: Means within a row with different superscripts are significantly different ($p<0.05$); Treatment 1: basal diet without Cosmos sulphureus flower powder; Treatment 2, 3, 4 and 5 received basal diet with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively; SEM: Standard error of mean

Table 7. Haematological Components of Mewari Hens Fed Diet Supplemented with Cosmos Sulphureus Flower Powder

Parameters	T1	T2	T3	T4	T5	SEM
Haematocrit (%)	28.17b	32.16a	32.69a	32.71a	32.75a	0.16
Haemoglobin (g/dL)	9.07c	11.40b	13.09a	13.11a	13.27a	0.03
Red blood cell ($x10^{12}$/L)	1.92b	3.09a	3.16a	3.26a	3.28a	0.01
White blood cell ($x10^{9}$/L)	3.04c	5.09b	5.16a	5.26a	5.28a	0.01

a,b,c: Means within a row with different superscripts are significantly different ($p<0.05$); Treatment 1: basal diet without Cosmos sulphureus flower powder; Treatment 2, 3, 4 and 5 received basal diet with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively; SEM: Standard error of mean

Table 8. Serum Biochemical Constituents of Mewari Hens Fed Diet Supplemented with Cosmos Sulphureus Flower Powder

Parameters	T1	T2	T3	T4	T5	SEM
Total protein (g/dL)	4.39c	6.18b	6.33a	6.38a	6.42a	0.02
Albumin (g/dL)	2.29c	2.59a	2.63a	2.65a	2.68a	0.01
Globulin (g/dL)	2.10c	3.59b	3.70a	3.73a	3.74a	0.02
Creatinine (mg/dL)	0.35	0.38	0.41	0.40	0.44	0.11
Cholesterol (mg/dL)	94.33a	71.09b	68.55b	68.29b	68.14b	0.92
Alanine transaminase (U/L)	59.08	58.64	58.77	58.51	58.43	0.15
Aspartate transaminase (U/L)	28.91	27.38	27.18	27.07	27.16	0.05

a,b,c: Means within a row with different superscripts are significantly different ($p<0.05$); Treatment 1: basal diet without Cosmos sulphureus flower powder;

Treatment 2, 3, 4 and 5 received basal diet with Cosmos sulphureus flower powder at 5 g, 10 g, 15 g and 20 g/kg diet respectively; SEM: Standard error of mean

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, Cosmos sulphureus flower powder is rich in phyto-components which have broad spectrum antimicrobial properties, support cardio-health and immune balance. These compounds are non-toxic and could be supplemented in the diet of laying hens up to 20 g/kg diet without compromising the performance of birds. At 20 g Cosmos sulphureus flower powder /kg diet, quality of eggs were also improved thereby increasing their shelf life and consumers preference.

FURTHER STUDY

This research still has limitations, so it is necessary to conduct further research related to the topic of Examining the Effects of Adding Cosmos Sulphureus Flower Powder to the Diet of Mewari Laying Hens on Their Growth, Egg Quality, and Blood Components in order to perfect this research and increase insight for readers.

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