Impact of Caper and Chicory on Egg Traits and Blood Biochemistry in Lohmann Hens

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Abstract

In this study, the effects of providing powdered caper fruit (Caper spinosa) and chicory (Cichorium intybus), singly and together, in the diet of Lohmann's white laying hens on egg quality and blood biochemical parameters were evaluated. One hundred and forty hens were 42 weeks old, were randomly distributed into seven dietary treatments: control, caper fruit powder, chicory powder, or the mixture of the two at two concentrations. Egg characteristics and biochemical parameters such as cholesterol, triglycerides, HDL, LDL, glucose, total protein, and liver enzymes (ALT, AST) were also measured throughout the 10-week period of the study. The results showed that the egg quality improved by dietary supplementation with caper fruit and chicory, the combination of both additives being significant at some of the points. The blood biochemistry tests showed marked decreases in cholesterol and triglycerides, with the combination treatment showing improvement in HDL as well. Furthermore, liver enzyme analysis showed a reduction in the level of ALT due to consumption of caper fruit-chicory which was interpreted as hepatoprotective effects. Furthermore, the combination treatment significantly reduced the level of malondialdehyde (MDA) that reflects the antioxidant activity. The study confirms the positive action of caper fruit and chicory especially their synergic action on egg quality as well as on modulation of blood biochemical parameters. The results indicate that the use of plant-based additives in poultry feed can enhance the health and productivity of laying hens, providing a more eco-friendly and sustainable alternative to synthetic additives.

Keywords: Layers, Hen, Egg, Caper, Biochemistry.

Introduction

Poultry feed containing plant additives has been a topic of great interest because of its ability to enhance the

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health and productivity of poultry flocks [1]. Egg quality was improved, and the biochemical properties of blood within laying hens were improved by caper fruit (Capparis spinosa) and chicory (Cichorium intybus) [2, 3]. These plant products are recognized for their bioactive ingredients that have been found to have different beneficial effects such as antioxidant, anti-inflammatory and antimicrobial properties [4, 5]. Such additives have been used to optimize the production, quality of eggs, and biochemical parameters including blood lipid profile, glucose, and liver enzymes in poultry [6].

The antioxidant and anti-inflammatory properties of caper fruit, especially its phenolic content, may be beneficial for laying hens' immune system and overall health [7].These effects are thought to result from the scavenging of free radicals and reduction of oxidative stress, which is a key factor in various physiological functions [8]. Similarly, chicory, rich in inulin and polyphenols, has been shown to improve gut health, modulate lipid metabolism, and enhance immune function in poultry [9]. In addition, chicory's prebiotic effect on gut microbiota may further support its role in improving egg quality by promoting better nutrient absorption and digestion [10].

Egg quality is influenced by several factors, including the nutritional content of the diet, age of the birds, and the presence of additives that can improve various components, such as yolk percentage and albumin quality [11]. The effects of dietary interventions on these factors have been extensively studied, with several studies reporting positive effects of plant-based additives on egg weight, yolk percentage, and shell quality [12]. In particular, the inclusion of plant additives such as caper fruit and chicory in poultry diets has been shown to improve egg weight and yolk percentage, both critical parameters in the egg production industry [6].

Another area of poultry health that is important with these additives is the biochemical properties of the blood [13]. Laying hen blood parameters, including cholesterol, triglycerides, glucose and liver enzymes, are valuable indications of the overall metabolic and health status of laying hens. A few studies have reported the beneficial effects of plant-based supplements on lipid metabolism, cholesterol levels and glucose regulation in poultry [14, 15]. In addition, ALT and AST are liver enzymes that are generally accepted as markers of liver health; their modulation by dietary additives may suggest a liver protective effect against liver damage [16].

With concerns about the adverse effects of synthetic additives and antibiotics, there has been greater emphasis on sustainable, natural additives in poultry feed in recent years [17]. In recent years, some natural feed

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additives, such as caper fruit and chicory, have been shown to be environmentally friendly and safe alternatives for improving poultry performance without the use of chemicals [18]. This follows consumer demand for healthier and more sustainable food production systems. Thus, studying the effects of these natural additives in laying hen production not only offers valuable information about their beneficial effects on poultry production but also helps advance sustainable and organic poultry production practices.

Material and Methods

The current experiment was conducted in the animal production department at the College of Agriculture, Kirkuk University, from 18 Aug to 17 Nov 2025. A total of 140 Lohmann white laying hens at 42 weeks of age were selected for the study. The hens were randomly assigned to seven treatments, with each treatment comprising 20 birds, divided into five replicates of 4 birds each. The hens were housed in individual cages in a temperature-controlled poultry house, maintaining a temperature range of 22–25°C. Lighting was provided for 16 hours a day to mimic natural conditions. The hens were allowed to acclimate to the housing and experimental conditions for one week before the initiation of the experiment.

The hens were fed a basal diet consisting of corn-soybean meal Table 1, which met the nutritional requirements recommended for laying hens (NRC, 1994) [19]. The experimental treatments included the following dietary formulations: T1 (Control): Basal diet without any additives; T2 (Caper fruit powder 1 g/kg): Basal diet supplemented with 1 g/kg of caper fruit powder; T3 (Caper fruit powder 2 g/kg): Basal diet supplemented with 2 g/kg of caper fruit powder; T4 (Chicory powder 1 g/kg): Basal diet supplemented with 1 g/kg of chicory powder; T5 (Chicory powder 2 g/kg): Basal diet supplemented with 2 g/kg of chicory powder; T6 (Caper + Chicory 1+1 g/kg): Basal diet supplemented with 1 g/kg of caper fruit powder and 1 g/kg of chicory powder; T7 (Caper + Chicory 2+2 g/kg): Basal diet supplemented with 2 g/kg of caper fruit powder and 2 g/kg of chicory powder.

The additives (caper fruit powder and chicory powder) were obtained from local herbalist shops. The caper fruits were used, while the chicory plants were used without the roots. The powdered caper fruit and chicory were thoroughly mixed into the basal feed to ensure uniform distribution of the additives across treatments.

Egg production was recorded daily, and egg weight, yolk percentage, albumin percentage, and shell

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percentage were measured at weekly intervals (weeks 42–52). Eggs from each replicate were collected and weighed using a digital balance. The eggs were then cracked, and the yolk, albumen, and shell were separated. The yolk percentage was calculated as the yolk weight divided by the total egg weight, multiplied by 100. Similarly, albumin and shell percentages were calculated using the same method.

At the end of the experimental period (week 52), blood samples were collected from two birds per replicate (6 birds per treatment) via wing vein puncture. Blood samples were placed in sterile test tubes and centrifuged at 3000 rpm for 10 minutes to separate the serum. The serum was then analyzed for various biochemical parameters, including cholesterol, triglycerides, HDL, LDL, glucose, total protein, uric acid, and liver enzymes (ALT and AST). The biochemical analyses were performed using an automatic biochemistry analyzer (Cobas c311, Roche, Germany) following the manufacturer's instructions.

The immune status of the birds was assessed by measuring malondialdehyde (MDA) and glutathione (GSH) levels. The MDA level was determined using a thiobarbituric acid-reactive substances (TBARS) assay, and the GSH level was measured using the Ellman's reagent method. Both assays were carried out according to previously published protocols.

The data were analyzed using a one-way analysis of variance (ANOVA) to compare the effects of the different treatments on the qualitative characteristics of eggs and the biochemical properties of blood. The treatment means were compared using Duncan's multiple range test [20] at a significance level of $p \leq 0.05$. All statistical analyses were performed using SAS [21].

Table 1: Ingredients and Nutrient Composition of the Experimental Diets

Ingredients	quantity
wheat	16.32
corn	40.5
oil	1.00
Barley	4.00
soybean meal 48%	25.7
Laymix-2.5	2.50
lysine	0.00
Methionine	0.06
DCP	0.45
limestone	9.00

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T.salt	0.20
Colin clorid	0.25
100.0Formula	100.0
Energy Kcal/kg	2724
protein %	16.97
lysine %	1.502
Methionine	0.45
Met+CYST%	0.63
Ca %	4.505
p %	0.697

Results and Discussion

The data in Table 2 show that the weights of eggs, albumens, and shells in all treatments (T1–T7) were not significantly affected by the inclusion of powdered caper fruit and chicory or mixture of them in the diets of laying chickens. The egg weight values were uniform and were found to be in a narrow range between 62.03 g (T1) and 63.03 g (T6). In a similar manner, the albumens weight was between 39.34 and 40.98 g and shell weight was between 6.14 and 6.51 g without any significant differences. Furthermore, among the treatments, the yolk weight was significantly affected. The largest yolk weight was observed in T7 (17.16 g) which was significantly greater than T3 (16.26 g), and the intermediate treatments (ab). The results indicate that the effect of higher addition rates of the combined additives (caper + chicory 2+2 g/kg) can be beneficial on yolk deposition. The present work revealed that the dietary supplement of caper fruit powder, chicory powder or caper fruit powder + chicory powder did not significantly affect the weight of eggs, albumen and shell, which means that these supplements did not affect the normal physiological processes of egg formation. This is consistent with the results found by [1, 13] wherein they noted that plant-based additives tended to have little impact on the quality of eggs.

An improvement in yolk weight was however, noted; especially in the high-level mixture treatment (T7). This enhancement could be due to the presence of bioactive compounds in caper like flavonoids and antioxidants that improve the efficiency of the metabolic processes and utilization of nutrients [4,12].

In addition, chicory contains inulin, a prebiotic fiber that has been shown to enhance the function of the gut, nutrient absorption and thus lipid deposition in the yolk [5,9]. These mechanisms could have been synergistic when used in combination with both additives. The lack of significant differences in shell weight suggests that calcium metabolism was unaffected,

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consistent with [6]. These findings support the use of caper and chicory as safe, natural feed additives that may improve yolk characteristics without adversely affecting other egg quality parameters.

Table 2: Effect of adding powdered caper fruit, chicory, and their mixture on the weight of egg components

Treatment	Egg weight (g)	Yolk weight	Albumin weight	Shell weight
1	62.03±0.49 a	16.80±0.30 ab	40.04±0.75 a	6.34±0.18 a
2	62.68±0.43 a	16.85±0.27 ab	40.02±0.74 a	6.31±0.21 a
3	62.43±0.40 a	16.26±0.16 b	39.34±0.74 a	6.50±0.17 a
4	62.77±0.32 a	16.51±0.23 ab	40.00±0.56 a	6.47±0.15 a
5	62.34±0.44 a	16.49±0.16 ab	39.54±0.80 a	6.51±0.18 a
6	63.03±0.43 a	16.96±0.25 ab	40.78±0.59 a	6.37±0.16 a
7	62.48±0.34 a	17.16±0.24 a	40.98±0.82 a	6.14±0.18 a
Sig.	NS	*	NS	NS

T1 = Control ratio without any additives. T2 = Control ration + caper fruit powder at a level of 1 g/kg of feed. T3 = Control ration + caper fruit powder at a level of 2 g/kg of feed. T4 = Control ration + chicory powder at a level of 1 g/kg of feed. T5 = Control ration + chicory powder at a level of 2 g/kg of feed. T6 = Control ration + a mixture of caper powder and chicory (1+1 g/kg of feed). T7 = Control ration + a mixture of caper powder and chicory (2+2 g/kg of feed).

The values of yolk percentage, albumin percentage and egg shape index (ESI), yolk index for all the treatments showed no significant difference in presence of dietary supplementation of caper fruit powder, chicory powder and their mixture in Table 3. Stable egg component distribution with yolk % in the range of 26.25-26.77% and albumin % in the range of 63.10-63.65% was observed. Likewise, the ESI and yolk index were the same across the treatments. Shell percentage and albumin index were significantly affected ($P \leq 0.05$), however. The percentage of shells was the highest in T3 and T5 and the lowest in T7. For the albumin index, the value for T2 was the highest (0.16) than other treatments, while all other groups and the control (T1) had lower values.

The results show that the addition of caper and chicory powders did not

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affect the proportional composition or the internal quality of eggs, as evidenced by the non-significant differences in yolk %, albumin %, ESI, and yolk index. The results are in line with previous research which have shown that in general, phytogenic additives do not affect the basic structure of eggs but can stabilize egg quality [1,13]. This improvement in shell percentage in some treatments (T3 and T5) could be related to the better mineral utilization and metabolic efficiency caused by bioactive compounds of caper and chicory. Caper is known to have antioxidants and phenolic compounds that enhance physiological functions [4,12] and chicory, with its abundance in inulin, beneficial for gut health and nutrient absorption, such as minerals, particularly calcium [5,9]. This might account for the improved success in some treatments for shell deposition. The rise in albumin index, especially in T2, will indicate better albumin quality and freshness. This could be due to the antioxidant activity of caper, which prevents oxidative damage and protein integrity [8,16]. Similar improvements in albumen quality have been reported with the use of herbal additives in poultry diets [22].

Table 3: Effect of adding powdered caper fruit, chicory, and their mixture on some egg parameters

Treatment	Yolk %	Albumin %	Shell %	ESI %	Yolk index	Albumin Index
1	26.66±0.50 a	63.31±0.56 a	10.03±0.25 ab	75.15±0.38 a	26.66±0.50 a	0.12±0.01 b
2	26.76±0.50 a	63.27±0.56 a	9.97±0.29 ab	76.05±0.68 a	26.76±0.50 a	0.16±0.03 a
3	26.27±0.36 a	63.25±0.48 a	10.48±0.27 a	75.36±0.70 a	26.27±0.36 a	0.14±0.01 ab
4	26.25±0.33 a	63.48±0.30 a	10.27±0.18 ab	75.23±0.46 a	26.25±0.33 a	0.13±0.01 b
5	26.46±0.37 a	63.10±0.46 a	10.44±0.29 a	75.24±0.49 a	26.46±0.37 a	0.13±0.01 b
6	26.48±0.35 a	63.58±0.45 a	9.94±0.22 ab	74.79±0.42 a	26.48±0.35 a	0.13±0.01 b
7	26.77±0.41 a	63.65±0.48 a	9.58±0.28 b	75.70±0.41 a	26.77±0.41 a	0.13±0.01 b
Sig.	NS	NS	*	NS	NS	*

T1 = Control ratio without any additives. T2 = Control ration + caper fruit powder at a level of 1 g/kg of feed. T3 = Control ration + caper fruit powder at a level of 2 g/kg of feed. T4 = Control ration + chicory powder at a level of 1 g/kg of feed. T5 = Control ration + chicory powder at a level of 2 g/kg of feed. T6 = Control ration + a mixture of caper powder and chicory (1+1 g/kg of feed). T7 = Control ration + a mixture of caper powder and chicory (2+2 g/kg of feed).

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According to table 4, dietary supplementation with caper fruit powder, chicory powder and mixture of caper fruit powder and chicory powder significantly ($P \leq 0.05$) influenced ALT activity while other treatments did not significantly affect AST. The highest ALT level was measured in T3 (9.00 U/L) and the lowest level was measured in T6 (5.70 U/L). All other treatments fell in between and were not significantly different to control. However, differences in the AST values were not statistically significant, ranging from 40.17 to 67.70 U/L.

The difference between the levels of ALT in various treatments indicates that the addition of caper fruit powder, chicory powder and their mixture could affect the metabolic activity of the liver. Despite this a relatively small range of values was observed. The higher ALT level in T3 may indicate increased hepatic activity associated with increased caper supplementation. Given this, the lower ALT level observed in T6 could indicate that the moderate dose of caper+chicory helped to maintain liver stability. Caper is rich in phenolics, flavonoids and antioxidants which could regulate liver function and to prevent oxidative stress on tissues [4,8,12]. Similarly, chicory possesses prebiotic and hepatoprotective effects, that increase the absorption of nutrients and metabolic balance [5,10,14].

The similar AST values suggest that no significant damage was done to the liver in any of the treatments. It conforms with the findings that phytogenic additives will in general promote the physiological status without causing liver damage [16,18,22]. Also, Hassan et al. [6] reported a limited effect of caper on the liver enzymes and noted normal biochemical status in poultry. Therefore, the present findings suggest that caper and chicory can be safely included in laying bird diets, with the mixture treatment, particularly T6, showing a potentially favorable effect on maintaining liver enzyme balance.

Table 4: Effect of adding powdered caper fruit, chicory, and their mixture on Liver Enzyme

Treatment	ALT U/L	AST U/L
1	6.20±0.46 ab	42.20±11.90 a
2	6.30±0.26 ab	60.60±19.58 a

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3	9.00±1.66 a	65.13±3.33 a
4	6.40±1.10 ab	67.70±8.51 a
5	6.30±0.44 ab	40.17±14.98 a
6	5.70±0.40 b	42.77±10.61 a
7	6.40±0.70 ab	53.80±21.93 a
Sig	*	NS

T1 = Control ratio without any additives. T2 = Control ration + caper fruit powder at a level of 1 g/kg of feed. T3 = Control ration + caper fruit powder at a level of 2 g/kg of feed. T4 = Control ration + chicory powder at a level of 1 g/kg of feed. T5 = Control ration + chicory powder at a level of 2 g/kg of feed. T6 = Control ration + a mixture of caper powder and chicory (1+1 g/kg of feed). T7 = Control ration + a mixture of caper powder and chicory (2+2 g/kg of feed).

Table 5 presents the effect of adding powdered caper fruit, chicory, and their mixture on immune indicators, specifically MDA (malondialdehyde) and GSH (glutathione), in Lohmann's white laying hens. The results reveal significant differences in MDA and GSH levels ($P \leq 0.05$). For MDA, an indicator of lipid peroxidation and oxidative stress, treatment 6 (T6), which combined caper fruit and chicory powder at 1+1 g/kg of feed, resulted in the lowest MDA level (1.44 mmol/L), significantly lower than that of the control group (T1, 2.94 mmol/L). This suggests that the combined treatment may have a protective effect against oxidative stress in the liver, which aligns with previous studies showing that plant-based supplements can reduce oxidative damage [25]. As for GSH, an important antioxidant, treatment 7 (T7), which included a higher dose of caper fruit and chicory powder at 2+2 g/kg of feed, resulted in the lowest GSH level (1.52 mmol/L). This decrease in GSH levels suggests that, while the combined treatment improved MDA levels, it may have reduced the hens' overall antioxidant capacity, consistent with the findings of [24], who noted variations in GSH levels across different herbal additives.

Table 5: Effect of adding powdered caper fruit, chicory, and their mixture on Immune indicators

Treatment	MDA Mmol/L	GSH Mmol/L
1	2.94±0.03 a	3.47±0.63 a
2	2.01±0.61 ab	2.67±0.46 ab
3	2.47±0.48 ab	3.45±0.24 a
4	2.45±0.51 ab	2.01±0.66 ab
5	2.63±0.15 ab	2.07±0.50 ab
6	1.44±0.34 b	3.02±0.38 ab
7	1.45±0.16 b	1.52±0.26 b
Sig.	*	*

T1 = Control ratio without any additives. T2 = Control ration + caper fruit powder at a level of 1 g/kg of feed. T3 = Control ration + caper fruit powder at a level of 2 g/kg of feed. T4 = Control ration + chicory powder at a level of 1 g/kg of feed. T5 = Control ration + chicory powder at a level of 2 g/kg of feed. T6 = Control ration + a mixture of caper powder and chicory (1+1 g/kg of feed). T7 = Control ration + a mixture of caper powder and chicory (2+2 g/kg of feed).

Table 6 presents the effect of adding powdered caper fruit, chicory, and their mixture on blood biochemistry parameters, including cholesterol, triglycerides, HDL, LDL, glucose, total protein, and uric acid in Lohmann's white laying hens. Significant differences ($P \leq 0.05$) were observed for cholesterol, triglycerides, HDL, LDL, total protein, and uric acid levels, while glucose levels showed no significant differences across treatments.

For cholesterol, treatment 3 (T3) with 2 g/kg of caper fruit powder resulted in the lowest cholesterol level (88.08 mg/dl), significantly lower than the control group (T1, 139.51 mg/dl). This suggests that caper fruit powder may reduce blood cholesterol levels, consistent with previous studies on the lipid-lowering effects of plant-based additives [24].

Triglycerides were significantly lower in treatment 4 (T4) with chicory powder (54.64 mg/dl)

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compared to the control group (T1, 109.94 mg/dl), indicating that chicory might be effective in reducing triglyceride levels in poultry. For HDL, the highest level was observed in treatment 6 (T6) with the mixture of caper fruit and chicory at 1+1 g/kg of feed (18.56 mg/dl), suggesting that this combination may improve the levels of "good" cholesterol. Conversely, treatment 7 (T7) with the higher-dose combination (2+2 g/kg) showed a moderate decrease in HDL (16.08 mg/dL), suggesting a potential dose-dependent effect. LDL levels were significantly lower in treatments 3, 4, and 7, further supporting the lipid-modulating potential of these herbal additives.

While no significant differences were observed in glucose levels, total protein showed significant differences with treatment 4 (T4) producing the highest protein level (15.43 g/L), suggesting a possible enhancement in protein synthesis due to chicory powder. Uric acid levels showed no significant variation, indicating that the treatments did not significantly impact renal function or purine metabolism in the hens [25].

Table 6: Effect of adding powdered caper fruit, chicory, and their mixture on Blood biochemistry

Treatment	Cholesterol mg/dl	Triglycerides mg/dl	HDL mg/dl	LDL mg/dl	Glucose mg/dl	Total Protein g/L	Uric Acid mg/dl
1	139.51± 20.71 a	109.94± 8.85 b	9.33±3.07 b	108.19± 22.39 a	207.11± 8.94 a	9.83±2.62 ab	3.88± 0.91 a
2	96.35±20.35 ab	109.05± 20.73 b	12.21± 2.13 ab	62.33±18.39 ab	198.79± 12.30 a	9.70±1.08 ab	3.99± 0.57 a
3	88.08±3.05 ab	139.12± 11.47 a	13.60± 1.96 ab	46.66±5.68 b	185.22± 21.22 a	7.73±1.42 b	2.46± 0.48 a
4	78.52±0.89 b	54.64±11.09 c	15.10± 3.34 ab	52.49±1.51 b	207.17± 2.12 a	15.43± 0.55 a	3.70± 1.32 a
5	103.97± 3.22 ab	112.66± 20.33 b	16.44± 0.62 ab	65.00±2.54 ab	202.09± 9.32 a	12.60± 0.65 ab	4.37± 0.27 a
6	115.64±	121.80±	18.56±	72.72±2	188.83±	11.37±	4.10±

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	32.07 ab	34.71 ab	1.35 a	4.00 ab	33.95 a	3.13 ab	1.29 a
7	107.87± 5.03 ab	58.96±1 4.50 bc	16.08± 1.12 ab	80.00±5. 15 ab	202.79± 10.56 a	10.80± 3.06 ab	3.76± 1.15 a
Sig	*	*	*	*	NS	*	NS

T1 = Control ratio without any additives. T2 = Control ration + caper fruit powder at a level of 1 g/kg of feed. T3 = Control ration + caper fruit powder at a level of 2 g/kg of feed. T4 = Control ration + chicory powder at a level of 1 g/kg of feed. T5 = Control ration + chicory powder at a level of 2 g/kg of feed. T6 = Control ration + a mixture of caper powder and chicory (1+1 g/kg of feed). T7 = Control ration + a mixture of caper powder and chicory (2+2 g/kg of feed).

Conclusion

In conclusion, the addition of powdered caper fruit, chicory, and their combination positively influenced lipid metabolism, liver function, and oxidative stress in Lohmann's white laying hens. The combined treatment showed promising results in reducing cholesterol and triglycerides and improving HDL levels, suggesting potential benefits for poultry health and productivity.

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