

EFFECTS OF A HEPATIC TONIC ON HEMATOLOGICAL INDICES, SERUM BIOCHEMICAL PROFILE, LIVER WEIGHT AND HISTOPATHOLOGY IN CCL₄ CHALLENGED BROILER CHICKENS

Veterinary Science

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ABSTRACT

This study evaluated the efficacy of a liver tonic on blood-biochemical parameters, liver weight and histopathology in 240-day-old Vencobb-430Y broiler chicks. Birds were randomly allotted to four treatments (4 replicates/15 birds each): A (Control; basal diet), B (Negative control; CCL₄ liver challenger @ 1ml/kg body weight orally at every 3rd day from 15th to 28th days of trial), C (As B + test liver tonic @ 2 ml/L water), and D (As B + standard liver tonic @ 5, 10 and 20 ml/100 birds at pre-starter, starter and finisher phases, respectively). All birds were floor-reared with ad libitum basal feed (BIS 2007) and routine vaccinations. At the end of the 4th week, administration of CCL₄ (Group B) significantly reduced ($P<0.05$) hemoglobin (Hb) levels and increased relative liver percentage compared to the control group. Furthermore, serum biochemical analysis revealed that CCL₄ exposure in treatment group B significantly elevated ($P<0.05$) SGPT and SGOT activity at both the 4th and 5th weeks relative to treatment group A. Supplementation of test liver tonic (Group C) effectively restored Hb levels and relative liver percentage closer to control group values, demonstrating a response comparable to the standard liver tonic (Group D). Test Liver tonic significantly mitigated CCL₄-induced hepatic injury, keeping SGPT and SGOT levels near to control group levels ($P>0.05$). No significant differences were observed across treatments for differential leukocyte counts (DLC), packed cell volume (PCV), total leukocyte count (TLC), glucose, or albumin levels. The liver histopathological study revealed apparently normal histoarchitecture of hepatocytes in test liver tonic and standard liver tonic supplemented groups similar to control group A at both 28th and 35th day. Overall, the test liver tonic demonstrated significant hepatoprotective activity against CCL₄-induced toxicity, effectively maintaining normal blood-biochemical parameters, liver integrity and histomorphology in broiler chickens.

KEYWORDS

CCL₄, Blood-biochemical, Histopathology

INTRODUCTION

Modern broiler hybrids, such as the Vencobb-430Y, possess high metabolic rates driven by rapid growth and maximal feed conversion efficiency. The liver serves as the central metabolic hub in poultry, executing vital functions including nutrient metabolism, protein synthesis, lipogenesis, detoxification, and immune modulation. However, this intensive metabolic workload renders the avian liver exceptionally vulnerable to chemical toxins, mycotoxins, and metabolic stresses, which can compromise overall health, immune response, and flock performance. Carbon tetrachloride (CCL₄) is a widely recognized chemical hepatotoxin frequently utilized in experimental avian models to induce controlled liver toxicity. Its toxic mechanism involves cytochrome P450-mediated bioactivation into reactive trichloromethyl (CCl₃*) and trichloromethyl peroxy (CCl₃O₂*) free radicals. These free radicals induce severe lipid peroxidation of hepatocyte membrane phospholipids, leading to structural integrity loss, intracellular leakage of transaminase enzymes (SGPT and SGOT), steatosis, and parenchymal cellular degeneration (Aldawood *et al.* 2026; Jogu *et al.* 2026; Baradaran *et al.* 2019). To combat hepatic dysfunction and maintain structural liver integrity, nutritional interventions incorporating targeted lipotropic agents and metabolic supporters are widely deployed in poultry production. Dozliv-Forte P (M/s Carus Laboratories Pvt. Ltd., Karnal, Haryana) is one such commercial liquid hepatic formulation containing L-carnitine, betaine, choline chloride, sorbitol, and magnesium sulphate, could offer a multi-faceted therapeutic approach. L-carnitine facilitates long-chain fatty acid transport into the mitochondria for beta-oxidation, mitigating lipid accumulation in hepatocytes. Betaine and choline chloride serve as crucial methyl donors and essential precursors for phosphatidylcholine synthesis, promoting very-low-density lipoprotein (VLDL) assembly to export excess triglycerides from the liver. Additionally, sorbitol provides osmotic diuretic support and readily available energy, while magnesium sulphate provides indispensable ion cofactor for ATP-dependent enzymes and supports enzymatic pathways critical for biliary excretion and systemic detoxication (Eklund *et al.*, 2005; Rehman *et al.*, 2017; Saeed *et al.*,

2017; Abd El-Ghany and Babazadeh, 2022; Gregg *et al.*, 2022; Toson *et al.*, 2024). Although, these individual constituents have been studied for their protective roles, comprehensive evaluations of multi-component metabolic formulations under acute chemically induced toxic stress remain vital for practical field applications. Therefore, this study was conducted to evaluate the hepatoprotective efficacy of test liver tonic (Dozliv-Forte P) on blood-biochemical parameters, liver weight, and histopathological changes in broiler chickens subjected to CCL₄ challenge.

MATERIAL AND METHODS

Ethical Approval

The animal experiment was conducted in accordance with guidelines approved by the Institutional Animal Ethics Committee (CPCSEA), Dated 17.10.2021, with Res. no. IAEC 89/21 in the Department of Poultry Science, College of veterinary and animal sciences, MAFSU, Parbhani, Maharashtra

Experimental Design

This trial was conducted on 240, day old Vencobb-430 broiler birds for 5 weeks at broiler unit (deep litter system) of Department of Poultry Science, College of Veterinary & Animal Sciences, MAFSU, Parbhani, Maharashtra to assess the effect of a hepatic product Dozliv-Forte P (procured from M/s. Carus Laboratories Pvt. Ltd., Sector 3, HSIIDC, Karnal, Haryana, India) on the hemato-serological parameters, relative liver weight & histopathological examination of liver. The birds were randomly allotted to four treatments (4 replicates/15 birds each): A (Control; basal diet), B (Negative control; CCL₄ liver challenger @ 1ml/kg body weight orally at every 3rd day from 15th to 28th days of trial), C (As B + test liver tonic @ 2 ml/L water), and D (As B + standard liver tonic @ 5, 10 and 20 ml/100 birds at pre-starter, starter and finisher phases, respectively). All the birds were provided with standard and uniform managerial conditions throughout the experimental period. All the birds were vaccinated as per routine vaccination schedule. The ingredients and their composition for the basal diet which was formulated as per Bureau of Indian Standards (BIS 2007) are presented in Table 1.

Table 1: Ingredient and Nutrient Composition of Pre-starter, Starter, and Finisher Feed

Sr.No.	Ingredients (%)	Pre-starter	Starter	Finisher
1	Maize	53.000	54.000	58.220
2	Soybean meal	40.200	37.800	32.600
3	Vegetable oil	2.770	4.150	5.100
4	Dicalcium phosphate (DCP)	1.800	1.800	1.900
5	Limestone powder (LSP)	1.200	1.200	1.200
6	Salt (NaCl)	0.250	0.250	0.250
7	Trace mineral premix*	0.100	0.100	0.100
8	Vitamin premix**	0.050	0.050	0.050
9	DL-Methionine	0.160	0.190	0.150
10	L-Lysine	0.070	0.060	0.030
11	Choline chloride 60%	0.100	0.100	0.100
12	Toxin binder	0.100	0.100	0.100
13	Coccidiostat	0.050	0.050	0.050
14	Sodium bicarbonate	0.150	0.150	0.150
Total		100.00	100.00	100.00

Nutrient Composition (Calculated basis)

1	ME (kcal/kg)	3000.33	3101.54	3200.44
2	Crude Protein (%)	23.019	22.04	20.03
3	Ether Extract (%)	5.18	6.57	7.64
4	Crude Fiber (%)	4.20	4.08	3.87
5	Calcium (%)	1.01	1.00	1.01
6	Total Phosphorus (%)	0.70	0.69	0.68
7	Available Phosphorus (%)	0.42	0.42	0.43
8	Total Lysine (%)	1.30	1.23	1.08
9	Total Methionine (%)	0.50	0.52	0.45

* **Trace Mineral Mixture:** Each 1 kg contains: Copper – 15 g, Iron – 80 g, Manganese – 100 g, Zinc – 80 g, Iodine – 2 g, Cobalt – 0.5 g, Selenium – 0.5 g, Chromium – 10 mg, and Molybdenum – 50 mg.

Vitamin Premix: Each 500 g contains: Vit. A – 12.50 MIU, Vit. D3 – 2.50 MIU, Vit. E – 12 g, Vit. K – 1.50 g, Thiamine (B1) – 1.50 g, Riboflavin (B2) – 5 g, Pyridoxine (B6) – 2 g, Cyanocobalamin (B12) – 0.015 g, Niacin – 15 g, Cal D Pantothenate – 10 g, and Folic acid – 0.50 g.

At the end of the 4th and 5th weeks, two birds were randomly selected from each replicate (8 birds per treatment) for blood collection, liver weight determination, and histopathological and necropsy examination of liver section. Blood samples were collected into EDTA and plain serum vacutainers for hematological and serological analyses, respectively. These birds were slaughtered using standard procedure and were subjected to liver weight measurements and necropsy examination. The data obtained for different parameters was statistically analyzed as per methods of Snedecor and Cochran (1994). The treatment means were compared by critical differences (CD) and analysis of variance.

RESULTS**Hematological Parameters**

The data pertaining to hematological parameters is depicted in Tables 2 and 3. The hemoglobin count showed a significant drop ($P < 0.05$) in the group B (10.15±0.29 g/dl) challenged with CCL₄ in comparison to control group A (11.85±0.28 g/dl) and other groups at the end of 4th week while no significant difference was observed among treatment groups at the end of 5th week.

Table 2. Hematology (Hb, PCV & TLC) Parameters of Broilers at the End of 4th Week Supplemented with Test Liver Tonic Through Drinking Water.

Treatments	Glucose (mg/dl)		Albumin (g/dl)		SGPT (IU/L)		SGOT (IU/L)	
	4th week	5th week	4th week	5th week	4th week	5th week	4th week	5th week
A	175.09 ± 4.01	247.44 ± 4.75	1.75 ± 0.15	1.46 ± 0.14	23.13b ± 1.27	20.41b ± 1.53	217.43c ± 3.72	165.64b ± 8.48
B	159.86 ± 5.64	234.62 ± 8.31	1.52 ± 0.12	1.35 ± 0.12	35.71a ± 1.61	29.99a ± 2.59	271.81a ± 5.42	198.59a ± 4.99
C	169.66 ± 10.32	241.19 ± 5.54	1.66 ± 0.11	1.43 ± 0.17	25.79b ± 1.68	22.81b ± 2.85	233.50bc ± 7.58	175.95b ± 5.87
D	170.21 ± 4.36	238.06 ± 6.12	1.63 ± 0.11	1.45 ± 0.15	26.39b ± 0.94	21.46b ± 1.28	240.21b ± 9.00	181.25ab ± 7.95

*Means bearing different superscripts in a column differ significantly ($P < 0.05$).

At week 4, SGOT levels were significantly higher ($P < 0.05$) in group B (271.81 ± 5.42 IU/L) than all other groups. Test liver tonic administration (Group C; 233.50±7.58 IU/L) successfully attenuated the CCL₄ challenge by keeping the value of enzyme to levels

Treatments	Hb (g/dl)		PCV (%)		TLC (/dl)	
	4th week	5th week	4th week	5th week	4th week	5th week
A	11.85a ± 0.28	11.53 ± 0.64	35.63 ± 1.65	30.75 ± 0.98	10345.25 ± 423.31	10143.25 ± 233.98
B	10.15b ± 0.29	10.60 ± 0.23	33.63 ± 0.36	28.50 ± 0.61	11978.88 ± 300.47	10813.50 ± 232.46
C	11.88a ± 0.55	11.48 ± 0.33	34.31 ± 1.00	29.64 ± 1.16	11366.25 ± 377.07	10103.75 ± 339.08
D	11.80a ± 0.42	11.03 ± 0.37	33.56 ± 1.56	30.14 ± 1.28	11840.75 ± 561.39	10012.00 ± 354.10

*Means bearing different superscripts in a column differ significantly ($P < 0.05$).

At the end of 4th week, it was observed that supplementation with Dozliv-Forte P (Group C, 11.88 ± 0.55 g/dl) and standard liver tonic (Group D, 11.80±0.42 g/dl) effectively prevented this decrease, maintaining Hb values at levels comparable ($P > 0.05$) to group A. Packed cell volume (PCV) and total leukocyte count (TLC) remained statistically non-significant ($P > 0.05$) across all groups at both the 4th and 5th weeks. Similarly, differential leukocyte counts (DLC)-including heterophils, eosinophils, basophils, lymphocytes, and monocytes exhibited no significant variation ($P > 0.05$) among treatment groups at either evaluation period.

Table 3. Haematology (DLC) Parameters of Broilers at the End of 4th and 5th Week Supplemented with Test Liver Tonic Through Drinking Water.

Treatments	Heterophils (%)	Eosinophils (%)	Basophils (%)	Lymphocytes (%)	Monocytes (%)
A	30.75 ± 0.45	2.13 ± 0.40	1.00 ± 0.19	62.38 ± 0.68	3.75 ± 0.25
B	29.63 ± 0.91	2.38 ± 0.38	0.88 ± 0.23	63.25 ± 0.80	3.88 ± 0.30
C	30.88 ± 0.55	2.63 ± 0.26	0.63 ± 0.18	61.88 ± 0.58	4.00 ± 0.27
D	31.13 ± 0.52	2.25 ± 0.25	0.88 ± 0.23	61.75 ± 0.41	4.00 ± 0.27
At the end of 5th week					
A	30.75 ± 0.31	2.50 ± 0.19	0.63 ± 0.18	62.25 ± 0.56	3.88 ± 0.23
B	31.63 ± 0.18	2.00 ± 0.27	0.50 ± 0.19	61.63 ± 0.50	4.25 ± 0.25
C	31.38 ± 0.60	2.38 ± 0.26	0.75 ± 0.16	61.50 ± 0.57	4.00 ± 0.27
D	31.75 ± 0.37	2.25 ± 0.25	0.75 ± 0.16	61.38 ± 0.46	3.88 ± 0.23

Serological Parameters

Serum enzyme markers demonstrated marked responses to CCL₄ toxicity and liver tonic interventions (Table 4). At week 4, CCL₄ challenge significantly elevated ($P < 0.05$) serum SGPT levels in group B (35.71 ± 1.61 IU/L) compared to control group A (23.13 ± 1.27 IU/L). Supplementation with test liver tonic (Group C; 25.79 ± 1.68 IU/L) and the standard liver tonic (Group D; 26.39 ± 0.94 IU/L) significantly lowered SGPT activity near to baseline control levels in comparison to group B. A similar pattern persisted at week 5, with group B showing significantly higher ($P < 0.05$) SGPT (29.99 ± 2.59 IU/L) level than groups A (20.41 ± 1.53 IU/L), C (22.81 ± 2.85 IU/L), and D (21.46 ± 1.28 IU/L) which differed non-significantly among themselves ($P > 0.05$). The SGOT levels also showed the similar elevation in CCL₄ challenged groups in comparison to control.

Table 4. Serum Biochemical Parameters of Broilers at the End of 4th and 5th Week Supplemented with Test Liver Tonic Through Drinking Water.

Treatments	Glucose (mg/dl)		Albumin (g/dl)		SGPT (IU/L)		SGOT (IU/L)	
	4th week	5th week	4th week	5th week	4th week	5th week	4th week	5th week
A	175.09 ± 4.01	247.44 ± 4.75	1.75 ± 0.15	1.46 ± 0.14	23.13b ± 1.27	20.41b ± 1.53	217.43c ± 3.72	165.64b ± 8.48
B	159.86 ± 5.64	234.62 ± 8.31	1.52 ± 0.12	1.35 ± 0.12	35.71a ± 1.61	29.99a ± 2.59	271.81a ± 5.42	198.59a ± 4.99
C	169.66 ± 10.32	241.19 ± 5.54	1.66 ± 0.11	1.43 ± 0.17	25.79b ± 1.68	22.81b ± 2.85	233.50bc ± 7.58	175.95b ± 5.87
D	170.21 ± 4.36	238.06 ± 6.12	1.63 ± 0.11	1.45 ± 0.15	26.39b ± 0.94	21.46b ± 1.28	240.21b ± 9.00	181.25ab ± 7.95

comparable ($P > 0.05$) to group D (240.21±9.00 IU/L) and control group A (217.43±3.72). At week 5, group B continued to display significantly elevated ($P < 0.05$) SGOT (198.59±4.99 IU/L), while group C (175.95±5.87 IU/L) effectively reduced SGOT levels toward the control group A (165.64±8.48 IU/L). Serum glucose and albumin levels showed numerical variations but did not differ significantly ($P > 0.05$) among treatment groups at either sampling interval. The

highest and lowest values of glucose and albumin were recorded in control group A and CCL₄ challenged negative control group B, respectively.

Table 5. Mean Value of Liver Weight Percent Relative to Live Body Weight of Broilers at the End of 4th and 5th Weeks of Age Supplemented with Dozliv-Forte P Through Drinking Water.

Treat-ments	Avg. body weight (g) - 4th week	Liver (%) - 4th week	Avg. body weight (g) - 5th week	Liver (%) - 5th week
A	1445.63 ± 33.78	2.44b ± 0.02	2117.88 ± 34.01	1.94 ± 0.05
B	1398.13 ± 34.34	2.71a ± 0.10	2087.50 ± 44.28	2.08 ± 0.09
C	1457.50 ± 36.43	2.46b ± 0.07	2075.83 ± 61.29	2.06 ± 0.05
D	1402.50 ± 16.11	2.52b ± 0.06	2094.17 ± 55.55	2.07 ± 0.07

*Means bearing different superscripts in a column differ significantly ($P < 0.05$).

The average body weight of broilers ranged from 1398.13 g (group B) to 1457.50 g (group C) at the end of 4th week and from 2087.50 g (group C) to 2117.88 g (group A) at the end of 5th week and showed no significant differences across all the groups ($P > 0.05$) at either period. At the end of 4th week, the liver weight percentage was statistically similar in groups A, C and D while increased significantly in group B challenged with CCL₄ ($P < 0.05$). Liver weight percentages at the end of 5th week showed no significant difference across all the groups (Table 5).

Liver Histopathology

The liver histopathological examination at the 4th week revealed that CCL₄ administration showed some mild congestion, fatty and degenerative changes in group B while test liver tonic (Group C) and standard liver tonic (Group D) supplementation sustained the liver integrity and showed an apparently normal histoarchitecture comparable to control group A. However, the hepatic section examination at 5th week showed an apparently normal histoarchitecture in all the treatment groups. The hepatic alterations noted in the different treatment groups are presented below in the following pics.

1. Histopathological Observations of Liver Section at 4th Week of Experimental Trial

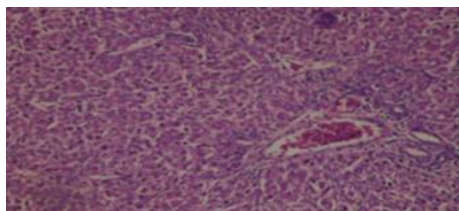


Plate 1: Section of Liver from Bird of Control Group A with Normal Histoarchitecture (H & E, X 400)

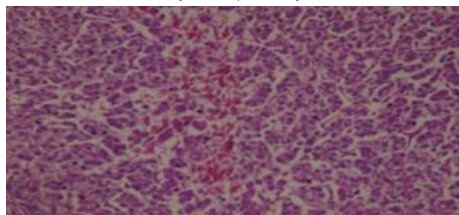


Plate 2: Section of Liver from Bird of CCL4 Challenged Group B with Mild Congestion and Degenerative Changes in Hepatic Parenchyma (H & E, X 400)

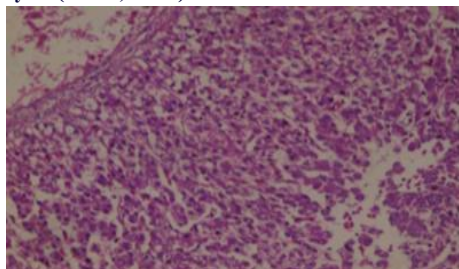


Plate 3: Section of Liver from Bird of CCL4 Challenged Group B with Mild Fatty and Degenerative Changes in Hepatic Parenchyma and Dilatation of Central Vein (H & E, X 400)

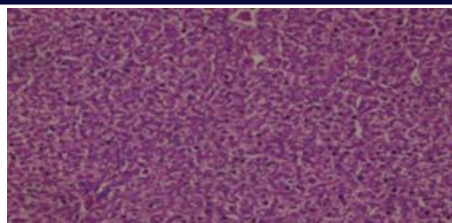


Plate 4: Section of Liver from Bird of Test Liver Tonic Supplemented Group C with Apparently Normal Histoarchitecture (H & E, X 400)

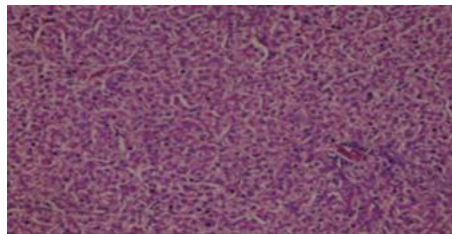


Plate 5: Section of Liver from Bird of Standard Liver Tonic Supplemented Group D with Apparently Normal Histoarchitecture (H & E, X 400)

2. Histopathological Observations of liver section at 5th Week of Experimental Trial

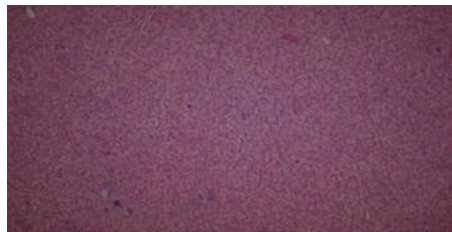


Plate 1: Section of Liver from Bird of Control Group A with Normal Histoarchitecture (H & E, X 400)

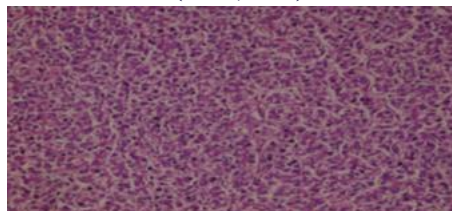


Plate 2: Section of Liver from Bird of CCL4 Challenged Group B with Apparently Normal Histoarchitecture (H & E, X 400)

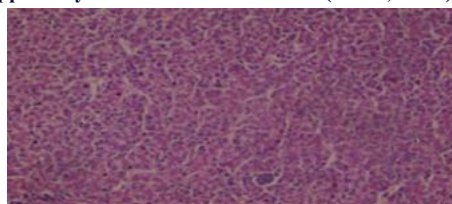


Plate 3: Section of Liver from Bird of Test Liver Tonic Supplemented Group C with Apparently Normal Histoarchitecture (H & E, X 400)

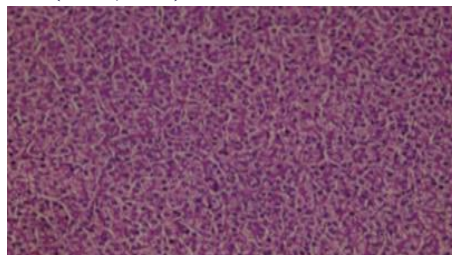


Plate 4: Section of Liver from Bird of Standard Liver Tonic Supplemented Group D with Apparently Normal Histoarchitecture (H & E, X 400)

3. Comparison of Gross Pathological Alterations Noted in the Liver of Treatment Group B and Test Liver Tonic Supplemented Group C at the End of 4th Week



Plate 1: Liver of Birds of Negatively Challenged Treatment Group B Intoxicated by CCL₄ with Paleness and Focal Necrosis



Plate 2: Liver of Birds from Treatment Group C Supplemented with Test Liver Tonic with Apparently Normal Architecture

DISCUSSION

The present study evaluated the hepatoprotective efficacy of a lipotropic and hepatic-support formulation (Dozliv-Forte P) containing L-carnitine, betaine, choline chloride, sorbitol, and magnesium sulphate against CCL₄ induced liver injury in Vencobb-430Y broiler chickens. The significant drop ($P < 0.05$) in hemoglobin (Hb) levels observed in the CCL₄ challenged negative control group (Group B) at the 4th week reflects systemic toxicity and impaired protein synthesis associated with acute hepatic injury. Because the liver plays a primary role in synthesizing essential proteins and maintaining systemic homeostasis, any structural damage to hepatocytes disrupts metabolic pathways essential for red blood cell integrity and Hb synthesis (Zaefarian *et al.* 2019). Supplementation of test liver tonic (Group C) prevented this decline, maintaining Hb levels at values comparable to both the unchallenged control (Group A) and standard liver tonic (Group D). Our findings are supported by Karadeniz *et al.* (2008), who observed that dietary supplementation with L-carnitine and lipotropic factors significantly enhanced or maintained erythrocyte count, Hb concentration, and PCV in broiler chickens, attributing this effect to improved erythropoiesis and cellular protection against metabolic stress. Conversely, Wang *et al.* (2013) and Yousefi *et al.* (2013) observed a decrease in Hb and PCV following a single ingredient L-carnitine supplementation. This discrepancy strongly suggests that the combined, synergistic effect of the active ingredients in test liver tonic, where L-carnitine acts in tandem with methyl donors (choline, betaine) and osmotic/metabolic regulators (sorbitol, magnesium sulphate), differs fundamentally from the physiological impact of L-carnitine administered as a sole dietary additive. The lack of significant alterations in packed cell volume (PCV), total leukocyte count (TLC), and differential leukocyte counts (DLC) across all groups indicates that the toxic challenge was primarily hepato-specific rather than systemically myelosuppressive.

The serum glucose and albumin levels were decreased in all CCL₄ challenged groups but there was not any significant difference. However, liver supplements in groups C and D ameliorated this drop and maintained numerically higher values than negative control group B. Our results align with the findings of Taraz and Dastar (2008), Arsan and Tufan (2018), and Aghdam *et al.* (2015), who observed no significant impact of L-carnitine on serum glucose, total protein, or albumin concentrations in broilers. However, literature on L-carnitine's effect on blood metabolites remains varied as Wang *et al.* (2013) noted a decrease in glucose alongside increases in total protein and globulin, Parsaemehr *et al.* (2014) reported elevated albumin and globulin without glucose alterations, and Jalali *et al.* (2015) observed increased total protein and globulin when L-carnitine was combined with dietary herbal oils. These broad variations across published literature underscore that serum metabolic markers are highly sensitive to dietary composition, basal energy levels, and the inclusion of co-factors. Single-nutrient L-carnitine supplementation affects hepatic gluconeogenesis and beta-oxidation in isolation, whereas complete formulations like one used in this study (Dozliv-Forte P) supply methyl donors (betaine and choline) alongside osmotic and metabolic facilitators (sorbitol and magnesium sulphate). This combined matrix exerts a multi-pathway stabilizing effect on hepatocyte function and intermediate metabolism, buffering against the sharp biochemical fluctuations often recorded with isolated additive supplementation.

Serum transaminases (SGPT and SGOT) serve as definitive

biomarkers for liver parenchymal damage. Any hepatocellular injury disrupts cell membrane permeability, causing intracellular leakage of these enzymes into the systemic circulation (Jogu *et al.* 2026). The marked elevation ($P < 0.05$) of SGPT and SGOT levels in group B at both 4th and 5th weeks confirms successful induction of hepatotoxicity by CCL₄. Oral administration of test liver tonic in drinking water significantly attenuated this enzyme surge, restoring SGPT and SGOT activity toward control baseline levels. This observed hepatoprotection is directly attributable to the synergistic metabolic activities of its active constituents. These results agree with Aziz *et al.*, (2019), who reported that L-carnitine, choline chloride, methionine and silymarin based combination significantly reduced the elevated transaminases during hepatotoxin challenge. Similarly, Azadmanesh *et al.* (2014), and Ahmadipour *et al.* (2025) observed marked reductions in SGPT and SGOT levels following L-carnitine and choline chloride supplementation in broilers.

The relative liver weight percentage and histopathological findings further corroborate these serum biochemical trends. The significant increase ($P < 0.05$) in relative liver weight in group B at the 4th week directly correlates with histological evidence of mild congestion, fatty vacuolation, and degenerative changes secondary to CCL₄ induced injury and lipid accumulation. The test liver tonic (Group C) mitigated relative hepatomegaly and preserved normal hepatic architecture at day 28. By day 35 (one-week post-CCL₄ withdrawal), histopathology and relative liver weights normalized across all treatment groups, highlighting the avian liver's innate capacity for tissue regeneration once the toxic agent is cleared. Our results align with Ray *et al.*, (2026), who found improved hepatic architecture in the group supplemented with a similar combination of therapeutic ingredients (L-carnitine, choline chloride, silymarin, tricholine citrate, and sorbitol @ 0.1ml/bird/day) when compared with negative control group. Overall, test liver tonic supplementation demonstrated potent lipotropic and hepatoprotective properties, mitigating CCL₄ induced hepatic injury and restoring normal liver function in broilers.

CONCLUSION

The study demonstrated that CCL₄ challenge significantly impaired liver health in broilers, as evident by altered biochemical parameters and liver histoarchitecture compared to the control group. Although both liver supplements attenuated these adverse effects, test liver tonic demonstrated numerical superiority over the standard liver tonic. These findings highlight Dozliv-Forte P as a viable feed additive for maintaining hepatic function in commercial broilers, where stress and toxins frequently compromise liver integrity and impair farm productivity.

Acknowledgement

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Conflict of Interest

The corresponding author of this manuscript is employed as an Assistant Technical Manager by Carus Laboratories Pvt. Ltd., Karnal, and is primary writer of this manuscript. All experimental work and study oversight were conducted independently at MAFSU, Parbhani, Maharashtra, India by K.K. Khose, M.G. Nikam and G.R. Gangane, who declare no competing interests.

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