Research Article

Comparative Study: Managing Hepatic and Renal Disorders Associated with Fatty Liver Using Natural and Conventional Preparations in Dogs

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Abstract | Fatty liver is a significant metabolic disorder in dogs, often linked to insulin resistance, endocrine dysfunction, nutritional imbalance, or prolonged medication use. Herb-All™ LIVER, a natural herbal blend, has been widely used in livestock and aquaculture but its efficacy in pet animals remains untested. This study evaluated its efficacy in 11 mixed-breed dogs presenting with hepatic and renal disorders, following prior treatment with steroidal anti-inflammatory drugs. Dogs were randomly assigned to receive either conventional therapy (Ornipural® injections) or Herb-All™ LIVER as a dietary supplement over a one-month period under veterinary supervision. Clinical assessments, blood biochemistry, hematology, liver and kidney function tests, serum lipid profiles, and ultrasonographic examinations were conducted before and after treatment. Both treatment groups showed improvements in clinical signs and organ function. Notably, the daily cost of therapy using Herb-All™ LIVER was approximately 92% lower than Ornipural®, suggesting that this herbal preparation may serve as a cost-effective alternative in managing fatty liver-associated complications in dogs.

Keywords | Canine hepatopathy, Fatty liver disease, Herbal hepatoprotective, Ornipural®, Ultrasonography, Dogs

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INTRODUCTION

The liver is a vital organ in the body, being responsible for more than 500 different physiological functions, including fat digestion, metabolism, detoxification, immunity, blood clotting, and protein synthesis (Kalra and Tuma, 2018). Alongside the kidneys, it serves as a primary blood filter responsible for eliminating circulating toxins and waste products. The liver is susceptible to infectious and non-infectious diseases. Hepatic abnormalities resulting from various liver diseases can be easily diagnosed through liver function tests and by monitoring various hematological and blood biochemical parameters. These changes may involve the elevation of serum levels of the liver enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST), as well as disruptions in blood protein and lipid profiles. Sonography is an additional tool for diagnosing other hepatic disorders such as fatty liver, hepatomegaly, or neoplasms (Nausikaa *et al*., 2022; Tinted *et al*., 2023). Unlike farm animals, pets are regarded as family members and are cared for in households until their natural death. Therefore, older pets are susceptible to diseases associated with senility including liver, kidney, and heart diseases. They are also susceptible to several long-standing inflammatory diseases such as Canine Atopic Dermatitis and Idiopathic inflammatory bowel disease which usually treated by steroidal and non-steroidal anti-inflammatory drugs (Santoro, 2019; Khan and McLean, 2012; Jergens *et al*., 1992). However, the use of several anti-inflammatory drugs in pets could result in serious adverse effects specially on the nervous system, liver and kidneys. The animals usually develop hepatic and renal disorders and gastro-intestinal disturbances in the form of vomiting and diarrhoea (Jones *et al*., 1992; McLean and Khan, 2018; Lascelles *et al*., 2007; Villar *et al*., 1998; Khan and McLean, 2012; Stokes and Forrester, 2004; Cortinovis *et al*., 2015; Herrero *et al*., 2022; Chalifoux *et al*., 2023).

The pathological changes in the liver starts to occur within 2 – 3 days after the beginning of the therapy with corticosteroids (Dillon *et al*., 1980; Center *et al*., 2005). Even a single standard dosage can induce statistically significant increase in the values of alkaline phosphatase (ALP) after 24 hours from the injection time and the values of both (ALT) and (ALP) in dogs' blood serum after 48 hours from the injection time (Kondratjeva and Birgele, 2014a). Cases of steroid hepatopathy are well documented in dogs subjected to long term or high doses treatment with steroidal anti- inflammatory which is attributed to corticosteroid induced alterations in the liver morpho-functional condition (Fittschen and Bellamy, 1984; Feldman and Nelson, 2004). This condition is not only limited to hepatocyte injury but can also lead to liver fibrosis due to the specific reaction of liver stellate Ito cells as well (Sobczak-Filipiak *et al*., 2014).

To our knowledge, Herb-All™ LIVER is widely used in farm animals but not in the pet sector. The preparation is used to control fatty liver in layers and in transient dairy cows also to protect and revitalize the liver tissues from the harming effects of mycotoxin and insecticides/ chemical residues in their feed (Fayed *et al*., 2023; Liaqat *et al*., 2023). It can even be supplemented to support the liver against infectious agents targeting the liver like Inclusion Body Hepatitis in poultry and Hepatopancreatitis in shrimps as declared by the manufacturer. On the other hand, hepatic disorders in pet sector are commonly treated with conventional therapeutics such as Ornipural® injections. The product is commonly used for the treatment of liver problems of both infectious and non-infectious causes (Anugrah *et al*., 2023). In the present work, the effect of supplementation of dog feed with the natural product Herb-All™ LIVER was studied in dogs suffering from different hepatic disorders. The efficiency of this approach was compared with the results achieved via the application of conventional approach using Ornipural® injections in the control group.

MATERIAL AND METHODS

Ethical Statements

This study was approved by the Veterinary Medicine Cairo University Institutional Animal Care and Use Committee (Vet CU13102024949) and adhered to ARRIVE guidelines for animal research.

Investigated Dogs

In the present work, dogs housed in a pet animal shelter were chosen for the investigation. The shelter caters to old, diseased and homeless pets. Among the 94 dogs kept in the shelter, several dogs had hepatic and renal disorders with a previous history of viral infections, exposure to chemicals (mainly insecticides) / high doses of medications (mainly anti-inflammatories), or fatty liver in sequence of long-term treatment with corticosteroids due to chronic inflammatory diseases. A total of 23 mixed breed stray dogs exhibiting the most severe clinical signs were selected and delivered to the clinic of Internal Medicine, Faculty of Veterinary Medicine, Cairo University for treatment of hepatic and renal disorders. Out of these, 11 dogs had a history of previous medication with steroidal anti-inflammatory preparations. The dogs suffered from hepatopathy associated with signs of fatty liver and renal disorders called D [diseased control]. The dogs were randomly divided into group 1 (G1) consisted of six dogs which were supplemented with Herb-All™ LIVER in their feed, while the second group (G2) consisted of five dogs (treated with Ornipural® injections). The treatment duration was 30 days, during which all dogs fed the same commercial dry feed. The feed was supplemented with Herb-All™ LIVER only for G1. Prior to the trial begin the dogs underwent a preparatory phase for two weeks involved deworming, and vaccination against rabies. The data obtained from both G1 and G2 groups were compared with the primary values of the diseased dogs before treatment (D group).

Clinical Pictures

The dogs were presented with complaints of emaciation, poor health condition, and icterus. Their medication history indicated their previous treatment for dermatological inflammatory diseases with steroidal anti-inflammatory. The expressed clinical picture included vomiting, diarrhoea, weakness, skin lesions especially on the abdominal aspect, partial alopecia and severe emaciation. Ultrasonic examination revealed the presence of fatty liver. Laboratory examinations referred to an increase in the liver and kidney function parameters.

Medications

G1 was supplemented with Herb-All™ LIVER in their feed (Life Circle Nutrition, Switzerland, 2.5 gm/ dog/day). Herb-All™ LIVER consists of several herbs including *Tinospora cordifolia* and *Andrdeveloped paniculata*. No data could be obtained about the other herbs involved in the formulation.

G2 was treated with Ornipural® injections, Vetoquinol, France (5ml / dog/ day given I/M). Ornipural® is routinely administered to treat hepatic and kidney disorders in pet animals. Composition: Arginine (hydrochloride), Ornithine (hydrochloride), Citrulline, Sorbitol, and Metacresol.

Laboratory Examinations and Ultrasonography

The laboratory examinations were conducted by ProCyte Hematology Analyzer, IDEXX Reference Laboratories, USA. Every time before blood sampling the dogs were fasted for 18 hours. The ultrasonic examination was carried out using Esaote Veterinary MyLabOne, mod. 8100, and using micro convex probe, from Esaote Europe B.V., Netherland.

The liver function test included: Glutamate pyruvate transaminase (GPT), also known as alanine aminotransferase (ALT) and glutamate oxaloacetate transaminase (GOT), also known as aspartate aminotransferase (AST) and the Total bilirubin (T Bil). The Kidney function test was represented by Blood urea nitrogen (BUN) and Creatinine (Cr). The blood biochemistry involved the blood lipid parameters (Triglycerides (TG), total cholesterol (TC), very low-density lipoprotein (VLDL) cholesterol, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) cholesterol. Meanwhile, the monitored hematological parameters were the red blood cells (RBCs), Hemoglobin (HB), Platelets, Hematocrit, mean corpuscular hemoglobin concentration (MCHC), the mean hemoglobin content (MCH), in addition to the total white blood cell counts (WBCs) and the differential count for the different WBCs types including the Basophil, Eosinophil, Staff, Segmented, Lymphocytes and Monocytes.

Statistical Analysis

To test the effect of both treatments on each studied hematological and serum parameter, a one-way analysis of variance (ANOVA) was used to evaluate the difference between the diseased group (D) and the two treatment groups (G1 and G2). Paired sample T-test was used to test the difference between each diseased and treatment group. The Shapiro–Wilk test was utilized for normality analysis of the variables and Levene's test was used to evaluate the homogeneity of variance. Parametric statistical tests were used for analyzing data with a normal distribution, and if there were significant differences, the Least significant difference (LSD) test was used for post-hoc analysis. The nonparametric tests were used for data that were not normally distributed. Data was presented as the mean ± standard error (SE). Statistical significance was set at $P < 0.05$. All analyses were performed with SPSS® version 20.

RESULTS

The statistical analysis of hematological and biochemical variables obtained data is presented in Tables 1 and 2. The white blood cells (WBCs) showed a significant decrease in G1 (Herb-All™ LIVER supplemented) and G2 (injected with Ornipural®) when compared to the primary values of the diseased dogs (D group). Eosinophils significantly increased in G1 than D group while G2 showed non-significant difference if compared to G1 and D group. Segmented neutrophils decreased significantly in G1 compared to G2 which showed significant decrease in neutrophils compared to D group. Lymphocytes increased significantly in G1 and G2 groups than D group. MCH decreased significantly in G1 and G2 groups than D group. MCHC in G2 was significantly lower than its starting value, while in G1 its value showed a nonsignificant decrease and increase if compared to D and G2 groups, respectively. Other hematological variables revealed non-significant differences between groups. Statistical analysis of obtained results of serum biochemical variables is shown in Table 2. GPT, GOT, HDL and total bilirubin in G1 and G2 groups were significantly lower than their values in D group. BUN in G1 showed significant and non-significant decrease if compared to D and G2 groups, respectively. Creatinine and cholesterol in G1 and G2 increased significantly compared to D group. Triglycerides in G2 were significantly lower than their value in G1 which revealed a significant decrease compared to D group. VLDL in G2 showed significant increase if compared to D group but a non-significant increase compared to G1. LDL revealed non-significant differences within groups. The data obtained from the laboratory investigations were confirmed by the data delivered by ultrasonic examination as shown in Figures 1 and 2.

DISCUSSION

The resulting damage of the liver tissues of dogs due to steroid hepatopathy is indicated by the significant increase in the levels of many serum enzymes such as alanine amino transferase (ALT), aspartate amino transferase (AST), gamma glutamyl transferase (GGT), alkaline phosphatase (ALP) and corticosteroid-induced thermostable alkaline phosphatase (cAP) (Badylak and van Vleet, 1981; Lucena *et al*., 1999).

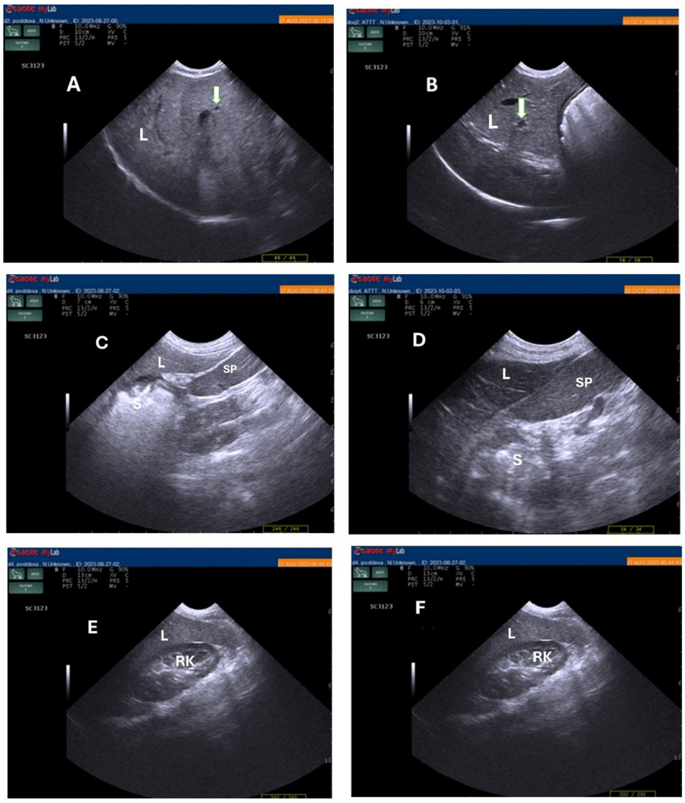

Figure 1: Changes in liver and kidneys of the dogs after their treatment for one month with Herb-All™ LIVER; **A:** Pre-treatment sagittal view of the liver showing hyperechoic parenchyma, reduced portal vein visibility, and anisotropism; **B:** Post-treatment with Herb-All™ LIVER: Liver parenchyma is hypoechoic with improved portal vein differentiation and reduced size; **C:** Pre-treatment comparison of liver and spleen: Hyperechoic liver relative to spleen; **D:** Post-treatment: Liver is hypoechoic to spleen; **E:** Pre-treatment caudate lobe and kidney: Markedly hyperechoic liver; **F:** Post-treatment: Liver slightly hyperechoic to renal cortex with normalized size. **L:** Liver, **Arrow (⇩):** Portal Vein, **SP:** Spleen, **S:** Stomach, **RK:** Right Kidney.

In the present work, herbal based hepato-protectant (Herb-All™ LIVER, G1 group) was compared with a traditional one (Ornipural®, G2 group) for treatment of hepatic and renal disorders associated with fatty liver and steroidal anti-inflammatory induced hepatopathy in 11 dogs. Although both Ornipural® and Herb-All™ LIVER possesses well documented hepato-renal protective potential in the veterinary field, the use of Herb-All™ LIVER is usually limited to farm animals (El Okle *et al*., 2022; Fayed *et al*., 2023). In contrast to the results achieved from the present work, previous attempts to treat dogs suffering from hepatopathy using herbal hepato-protectant containing silymarin, curcuma and artichoke for 30 days could only achieve partial success in the reduction of elevated enzymes, yet the reduction was not enough to fall again in the normal/ physiological reference ranges (Kondratjeva and Birgele, 2014a, b).

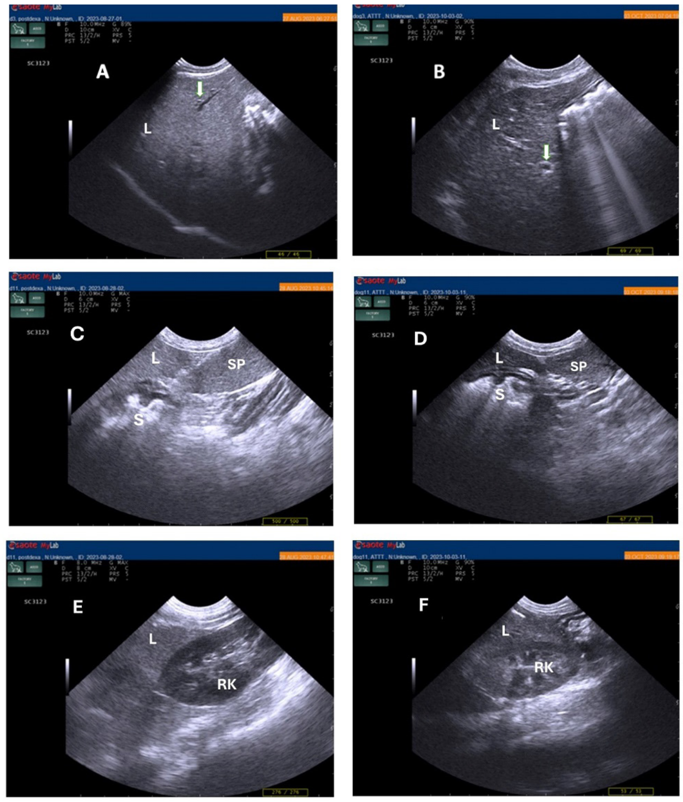

Figure 2: Changes in the liver and kidneys of the dogs after their treatment for one month with Ornipural®. **A:** Pre-treatment liver: Isoechoic to falciform fat, homogenized tissue, and enlarged size; **B:** Post-treatment with Ornipural®: Hypoechoic liver with heterogeneous texture and reduced size; **C:** Pre-treatment liver/spleen: Isoechoic parenchyma and rounded hepatic border; **D:** Post-treatment: Hypoechoic liver with sharp border; **E:** Pre-treatment caudate lobe/kidney: Hyperechoic liver; **F:** Post-treatment: Slightly hyperechoic liver with improved echotexture. **L:** Liver, **Arrow (⇩):** Portal Vein, **SP:** Spleen, **S:** Stomach, **RK:** Right Kidney.

However, supplementation with *Andrographis paniculata* extract could correct the damage, as evidenced by laboratory, histopathological investigations, and ultrasonic examinations (Pattanaik *et al*., 2013). The difference in results between the herbs is attributed to the superior hepato-protective capacity of *Andrographis paniculata* when compared to that of silymarin (Jayakumar *et al*., 2013). Considering serum biochemical parameters studied in the present work, tested liver enzymes and total bilirubin returned to reference range in both treatment group, however, GPT was lower after herbal treatment than traditional one (Table 2) and this may be achieved due to the potent anti-inflammatory effect of *Andrographis paniculata* (Jarukamjorn and Nemoto, 2008) and *Tinospora cordifolia* present in Herb-All™ LIVER (Shukla *et al*., 1992; Trivedi and Rawal, 2001; Kumar *et al*., 2013; Kavitha *et al*., 2011; Singh *et al*., 2015).

Table 1: Hematological parameters in diseased control group of dogs before treatment (D group) in comparison to both treatment groups after one month (Herb-All™ LIVER group (G1) and Ornipural® group (G2)). The different letters (a, b, c) are used to refer to significance, when the letters in one raw differ, it means significant difference at P < 0.05.

Variables	Average starting value before treatment (D group)	Average Herb-All™ LIVER group after one month (G1)	Average Ornipural® group after one month (G2)	Reference range
RBCs	5.82 ± 0.25[a]	6.31 ± 0.17[a]	5.92 ± 0.24[a]	5.5-8.5 ×10^6/mm^3
Hemoglobin	13.52 ± 0.51[a]	13.35 ± 0.36[a]	12.44 ± 0.58[a]	12-18 gm
Platelets	222727.27 ± 23298.31[a]	301833.33 ± 30852.17[a]	273600.00 ± 54227.37[a]	200-500 /mm^3
Hematocrit	41.18 ± 1.27[a]	42.83 ± 0.72[a]	41.00 ± 0.89[a]	39% - 55 %
WBCs	20890.91 ± 1746.28[a]	10350.00 ± 695.12[b]	10240.00 ± 1138.63[b]	6-15 ×10^3/mm^3
Basophil	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0 – 1 %
Eosinophil	2.36 ± 0.23[b]	4.83 ± 1.07[a]	3.20 ± 0.44[ab]	2-10 %
Staff	2.00 ± 0.00[a]	2.33 ± 0.30[a]	2.00 ± 0.00[a]	
Segmented	65.45 ± 2.61[a]	28.00 ± 3.68[c]	44.00 ± 2.77[b]	40-80 %
Lymphocytes	8.55 ± 0.78[b]	36.83 ± 7.64[a]	29.20 ± 2.86[a]	10 – 36 %
Monocytes	21.64 ± 2.42[a]	28.00 ± 3.97[a]	21.60 ± 1.31[a]	0– 13%
MCV	71.10 ± 0.96[a]	68.02 ± 1.06[a]	69.52 ± 1.68[a]	60-77 fl
MCH	23.21 ± 0.25[a]	21.13 ± 0.39[b]	20.96 ± 0.43[b]	19.1-26.2 pg
MCHC	32.72 ± 0.41[a]	31.10 ± 0.58[ab]	30.24 ± 0.86[b]	32 - 36 g %

RBCs: Red Blood Cells; **WBCs:** White Blood Cells; **MCV:** Mean Corpuscular Volume; **MCH:** Mean Corpuscular Hemoglobin; **MCHC:** Mean Corpuscular Hemoglobin concentration.

Table 2: Serum biochemical parameters in diseased control group of dogs before treatment (D group) in comparison to both treatment groups after one month (Herb-All™ LIVER group (G1) and Ornipural® group (G2)). The different letters (a, b, c) are used to refer to significance, when the letters in one raw differ, it means significant difference at P < 0.05.

Variables	Average starting value before treatment (D group)	Average Herb-All™ LIVER group after one month (G1)	Average Ornipural® group after one month (G2)	Reference range
ALT (GPT)	284.27 ± 34.79[a]	31.33 ± 2.77[b]	42.60 ± 6.92[b]	(10 - 109 IU/L)
AST (GOT)	150.73 ± 26.99[a]	22.17 ± 0.98[b]	20.60 ± 1.12[b]	(16 - 54 IU/L)
T. Bilirubin	1.83 ± 0.26[a]	0.14 ± 0.02[b]	0.12 ± 0.01[b]	(0-0.3 mg/dL)
BUN	10.64 ± 0.53[a]	8.83 ± 0.28[b]	10.00 ± 0.28[ab]	(8 - 28 mg/dL)
Creatinine	0.54 ± 0.02[b]	0.93 ± 0.04[a]	0.96 ± 0.03[a]	(0.7 - 1.5 mg/dL)
Cholesterol	141.45 ± 11.49[b]	317.67 ± 24.97[a]	294.40 ± 21.66[a]	(133–367 mg/dL)
Triglycerides	55.82 ± 5.32[c]	90.00 ± 2.53[b]	123.00 ± 18.50[a]	(30–141 mg/dL)
HDL (mg/dL)	37.82 ± 3.14[a]	21.50 ± 0.66[b]	24.00 ± 1.44[b]	Not Normalized
VLDL (mg/dL)	13.82 ± 1.97[b]	23.00 ± 0.47[ab]	31.40 ± 6.24[a]	Not Normalized
LDL (mg/dL)	21.73 ± 1.40[a]	21.00 ± 1.70[a]	18.40 ± 1.31[a]	Not Normalized

ALT: Alanine Aminotransferase; **GPT:** Glutamate Pyruvate Transaminase; **AST:** Aspartate Aminotransferase; **GOT:** Glutamate Oxaloacetate Transaminase; **T. Bilirubin:** Total Bilirubin; **BUN:** Blood Urea Nitrogen; **HDL:** High-Density Lipoprotein; **VLDL:** Very Low-Density Lipoprotein; **LDL:** Low-Density Lipoprotein.

Although the corticosteroids can directly affect the dog`s kidney performance through influencing the tubular electrolyte handling and absorptive capacities and indirectly through their effect on blood pressure, renal blood flow and glomerular function, the seen damages in the investigated dogs as evidence by the pathological changes in laboratory tests and ultrasonic investigation are most probably induced by chronic exposure to chemicals or infectious agents rather than being induced by the given steroidal anti-inflammatory drugs (Smets *et al*., 2010).

The reported improvement of kidney performance upon supplementation with the herbal mixture is attributed to the protective effect of both declared herbs in Herb-All™ LIVER against nephropathy and chemical-induced renal failure (Hidayat and Wulandari, 2021; Singh *et al*., 2009; Adeoye *et al*., 2018; Gupta and Sharma, 2011). This explains the reduction in blood urea nitrogen (BUN) in response to Herb-All™ LIVER treatment. Urea nitrogen concentrations were significantly lower than its value before treatment and non-significantly lower than its value after traditional treatment in agreement with the results delivered by Fayed *et al.* (2023). The use of both parameters BUN and creatinine in combination to detect the kidney performance was recommended by several authors due to the limited sensibility and specificity of BUN as a marker when applied alone for this purpose (De Santis *et al.*, 2022).

Despite the non-significant differences in the variables of erythrogram between G1 and G2, these values revealed higher levels after Herb-All™ LIVER supplementation than the values reported following treatment with the conventional therapy which could be attributed to the hematinic property of herbs involved in Herb-All™ LIVER or due to revitalization of liver cells, leading to a general improvement in the health condition of the dogs.

Regarding leukogram, total white blood cells and lymphocytes returned to the reference range in both treated groups, however eosinophil count showed significant increase after Herb-All™ LIVER treatment. On the other hand, the count of segmented neutrophils after traditional treatment was significantly lower than before starting the treatment (D group; Table 1) which could be attributed to relief of suspected secondary bacterial infection induced by immunosuppressive effect of corticosteroid, in addition to segmented neutrophils after herbal treatment (G1) was significantly lower than its value after traditional treatment (G2) and this could be referred to immunomodulatory activity of Herb-All™ LIVER (Fayed *et al.*, 2023; Yadav *et al.*, 2016; Rajanna *et al.*, 2021). Another explanation for the reduction in neutrophil count is the post therapeutic effect of steroidal anti-inflammatory preparations. It is well documented that the number of segmented WBCs (neutrophils) usually decrease after stoppage of cortisone treatment, as cortisone leads to stop in neutrophil apoptosis and therefore increase their number (Liles *et al.*, 1995). The high concentrations of antioxidants present in Herb-All™ LIVER and its hepatocytes revitalization capacity according to the manufacturer might be the cause of the improvement of the general health condition which is, in turn, reflected on the improvement of hematological and biochemical parameters (Sharma and Joshi, 2011; Hussien *et al.*, 2023). Although cholesterol and creatinine levels increased in both treatment groups, their values were still within the reference range. However, the VLDL value was significantly increased only in Ornipural® group, in contrast to Herb-All™ LIVER supplemented group which did not reveal significant difference. Triglycerides was significantly lower after Herb-All™ LIVER supplementation than its value after injecting the dogs with Ornipural® which can be attributed to the hypolipidemic property of *Andrographis paniculata* and *Tinospora cordifolia* which favored their use for the treatment of insulin resistance, diabetes melitus and fatty liver in Ayurvedic medicine (Sinha *et al.*, 2004; Shirolkar *et al.*, 2020; Sivakumar and Rajan, 2011; Sharma *et al.*, 2015; Jaiyesimi *et al.*, 2020; Kumar *et al.*, 2021). Finally, the enhancement in the overall body condition of the dogs was linked to the correction of the disturbed physiological parameters and the revitalization of liver tissues. This led to improved metabolic efficiency and increased appetite, attributable to the increase of bile production due to the choleretic effect of Herb-All™ LIVER (Shukla *et al.*, 1992).

The ultrasonographic assessment done in this study gave crucial real-time imaging of both renal and hepatic structural changes in dogs with corticosteroid-induced renal insufficiency and hepatopathy. The dogs, before treatment commenced, had classic sonographic findings of fatty liver disease that comprised heightened hepatic echogenicity, liver enlargement, poorly defined portal vein borders, and anisotropic variation among hepatic lobes. The results produced match the ultrasonographic characteristics of hepatic lipidosis and vacuolar hepatopathy found in previous studies (Nyland and Mattoon, 2014; Murayama *et al.*, 2020).

Following one month of treatment, there was significant improvement in hepatic echotexture in both Ornipural® and Herb-All™ LIVER groups. Treated dogs (Canis lupus familiaris) particularly showed reduced echogenicity, normalization of liver size, and enhanced visibility of portal vein walls, indicative of hepatic steatosis and fibrosis regression.

The decrease in echogenicity, from hyperechoic to isoechoic or mildly hypoechoic compared to the spleen and falciform fat, was strongly associated with the marked reductions in serum ALT, AST, and total bilirubin levels, indicating enhanced hepatocellular integrity and biliary function (Kondratjeva and Birgele, 2014; Kim *et al.*, 2019). Within the Herb-All™ LIVER -treated group, there were notable changes in echogenicity with the liver parenchyma transforming to heterogeneous but hypoechoic texture, a sign of hepatocellular regeneration and augmented perfusion. These enhancements were supported by the normalization of lipid profiles - most notably characterized by reduced triglycerides and elevated HDL - thereby enhancing the resolution of hepatic steatosis (Sahin *et al.*, 2018; Zhang *et al.*, 2020).

Sonographic findings will reveal a decrease in intracellular lipid content alongside an increase in hepatic blood flow, thereby enhancing the liver's detoxification processes and its ability to synthesize proteins.

Renal ultrasonography also showed mild enhancements. In a few, before treatment commenced, the renal cortices had a mildly hyperechoic pattern, which has been due to chronic renal stress or incipient nephropathy (Baral *et al.*, 2020). Post-treatment ultrasound revealed improvement in cortical echotexture and a restoration of cortico-medullary differentiation, which correlated with the said reductions in blood urea nitrogen (BUN) levels and stabilization of serum creatinine, especially in the Herb-All™ LIVER group. These improvements can be explained by the nephroprotective effects of *Tinospora cordifolia* and *Andrographis paniculata*, which have been previously reported to modulate renal oxidative stress and enhance glomerular function (Saha *et al*., 2016; Ahmad *et al*., 2018). Conclusively, the sonographic results not only corroborated the laboratory findings but also established a non-invasive means of dynamic evaluation of hepatic and renal recovery. Ultrasonography has thus demonstrated its indispensability in the monitoring of therapeutic responses, thereby solidifying its position as a fundamental diagnostic and follow-up technique in veterinary internal medicine (Lamb and Wisner, 2013; Murayama *et al*., 2020).

CONCLUSIONS AND RECOMMENDATIONS

This study offers compelling initial evidence for the herbal supplement Herb-All™ LIVER in the management of corticosteroid-induced fatty liver in canines. Both Herb-All™ LIVER and Ornipural® significantly decreased liver enzyme levels, serum bilirubin, and renal function, and showed significant clinical and ultrasound improvement. Herb-All™ LIVER offers obvious benefits in lipid profile management and cost and is a rational and cost-effective choice for long-term liver support in the veterinary clinic.

In view of the increasing concern regarding the side effects of long-term corticosteroid therapy in companion animals, the incorporation of natural hepatoprotective drugs such as Herb-All™ LIVER in therapeutic regimens can provide a more benign and sustainable alternative. However, additional research involving larger populations, exhaustive histopathological assessments, and clarification of the molecular modes of action is needed to comprehensively substantiate these results and facilitate evidence-based implementation of such phytogenic treatments in small animal practice.

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NOVELTY STATEMENT

This is the first study to evaluate the efficacy of Herb-All™ LIVER, a herbal blend previously limited to livestock, in treating steroid-induced fatty liver and renal disorders in dogs. Our findings demonstrate its cost-effectiveness (92% lower daily cost vs. Ornipural®) and comparable therapeutic outcomes, offering a novel, sustainable alternative for veterinary practice.

AUTHOR'S CONTRIBUTIONS

Mohamed Awny Ahmed Elkhiat: Conceptualization, Data curation, Writing – original draft, Sabry Ahmed Mousa: Methodology, Formal analysis, Mahmoud Saber Abdulkader: Investigation, Visualization, Amr A. El-Sayed: Resources, Supervision, Mostafa El-Gaffary: Validation, Writing – review, editing and Mohamed Ibrahim Oraby: Project administration, Writing – review, editing and correspondence for submission.

Data Availability

All data generated during this study are presented in the manuscript.

Ethical Approval

This study was approved by the Veterinary Medicine Cairo University Institutional Animal Care and Use Committee (Vet CU13102024949) and adhered to ARRIVE guidelines for animal research.

Conflict of Interest

The authors declare no competing financial or personal interests that could influence this work.

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