

## Evaluation of the Biological Effects of Local Dandelion (*Taraxacum officinale*) Leaf Extract on Blood Glucose and Serum Lipid Levels in Rats Treated with Carbon Tetrachloride (CCl<sub>4</sub>)

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### Abstract

This study aimed to evaluate the biological effects of local chicory leaf extract (*Taraxacum officinale*) on blood glucose levels and serum lipid profiles in rats treated with carbon tetrachloride (CCl<sub>4</sub>). Thirty male Albino BALB/C rats were randomly assigned to five equal groups, with ad libitum access to food and water. In the non-intoxicated control group, serum magnesium was 2.67 mg/100 mL and glucose 161 mg/100 mL, whereas in the CCl<sub>4</sub>-intoxicated control group, magnesium increased to 2.75 mg/100 mL and glucose decreased to 155 mg/100 mL. Treatment with chicory extract at doses of 75, 150, and 300 mg/kg resulted in magnesium levels of 2.89, 2.81, and 3.10 mg/100 mL, and glucose levels of 123, 126, and 153 mg/100 mL, respectively. A significant reduction in glucose was observed at the 75 and 150 mg/kg doses. Additionally, the extract improved the lipid profile by reducing total cholesterol, triglycerides, LDL, and VLDL, and increasing HDL, indicating that moderate doses of chicory leaf extract exert protective and regulatory effects on glucose and lipid metabolism.

**Keywords:** *Taraxacum officinale*, carbon tetrachloride (CCl<sub>4</sub>), serum glucose, serum magnesium, lipid.

### Introduction

*Cichorium intybus* L. (Chicory) is a perennial herbaceous plant belonging to the family Compositae. It naturally grows in various regions of the country, with the wild type widely distributed in northern Iraq. For optimal commercial production, the plant requires fertile soil, regular fertilization, and irrigation (1). Its native range is believed to include Europe, the Americas, North and

South Africa, Australia, New Zealand, and Iran. The plant typically reaches a height of 30–100 cm, with an erect, branched stem. Its leaves are lanceolate, measuring 10–30 cm in length and 1–5 cm in width (2). Diabetes mellitus is a complex disease characterized by elevated blood glucose levels (hyperglycemia) due to insufficient insulin secretion, impaired insulin action, or both

(4). Reduced insulin secretion or action leads to disturbances in carbohydrate, lipid, and protein metabolism. Diabetes is a prevalent chronic disease and is classified among the leading causes of mortality (5). Leaves and roots of chicory are commonly consumed fresh, cooked, or in salads. Traditional medicine has employed chicory for its beneficial effects in managing chronic diseases. Historical and ethnobotanical evidence suggests that the plant stimulates bile and gastric secretion, acts as a diuretic, and promotes digestion and nutrient absorption (6). It has been used as a remedy for viral or chemical hepatitis, ulcers, skin infections, and gastric pain. Additional reported effects include appetite stimulation, diuretic activity, menstrual regulation, fever and headache reduction, pepsin activation, treatment of intestinal colic, management of spleen disorders, gout, burns, dysuria, vomiting, asthma, general weakness, regulation of heart rhythm, diabetes control, antimicrobial activity, immune enhancement, and kidney detoxification (7). These diverse biological activities are attributed to the plant's bioactive compounds, particularly phenolic constituents such as 5-Caffeoylquinic acid, Chlorogenic acid, Chicoric acid, Quercetin, Apigenin, Luteolin, and Sesquiterpenes, which are concentrated in the leaves. Leaves contain approximately 4.06 % of these compounds by dry weight, serving as natural antioxidants (8). The roots are rich in fructans (inulin), comprising about 15 % of dry weight, while leaf inulin is negligible.

Roots also contain sucrose and fructose as the main carbohydrates. Chicory roots are commercially exploited for inulin extraction, used as a coffee substitute and in fructose syrup production. Inulin is a soluble dietary fiber composed of fructose units linked via  $\beta$ -(2 $\rightarrow$ 1) glycosidic bonds. These fibers provide several health benefits, including promoting beneficial gut bacteria, inhibiting pathogenic bacteria, enhancing mineral absorption (calcium, copper, magnesium, iron), improving vitamin uptake (particularly B vitamins), reducing lipid levels, regulating blood glucose, and facilitating excretion of metabolic toxins (9). Recent scientific evidence has increasingly supported these traditional uses. For example, a 2025 study demonstrated that self-regulating chicory root fibers improved insulin sensitivity in obese individuals by modulating short-chain fatty acid (butyrate) pathways in the small intestine. Another 2025 study reviewed the plant's efficacy in translational medicine, analyzing its bioactive components (inulin, flavonoids, sesquiterpenes) and revealing effects on inflammatory and oxidative stress pathways(10). This study addressed metabolic disturbances induced by carbon tetrachloride CCl<sub>4</sub> and hypothesized that local chicory *Taraxacum officinale* leaf extract could regulate glucose and lipid metabolism. The objective was to evaluate the effects of three extract doses 75 150 and 300 mg/kg on blood glucose serum magnesium and lipid profiles in rats.

## Materials and Methods

### Chicory Plant

Leaves of *Cichorium intybus* L. were collected in September 2025. After harvesting, the leaves were subjected to preliminary processing, which included

#### Preparation of Chicory Leaf Extract

Fifty grams of powdered chicory leaves were mixed with 200 mL of 70% ethanol. The mixture was placed on a magnetic stirrer for 10 minutes at 40 °C, then left for 48 hours at room temperature in a dark place. After extraction, the mixture was

#### Experimental Animals

The study used 30 male Albino BALB/C mice, aged 5 weeks, weighing 25–35 g.

#### CCl<sub>4</sub> -Induced Treatment

The mice were randomly divided into five groups of six animals each. Food and distilled water were available ad libitum.

- **Group I (Negative Control):** Received intraperitoneal injection of olive oil (1 mL/kg).
- **Group II (Positive Control):** Received a mixture of CCl<sub>4</sub> and olive oil at a ratio of 0.5:0.5 (1 mL/kg).
- **Groups III–V (Treated Groups):** Received chicory leaf extract at

#### Biochemical Analyses

Serum glucose, magnesium, and lipids were measured using colorimetric methods with a spectrophotometer according to the manufacturer's instructions (Biomerieux, France). LDL-C and VLDL-C were calculated using the modified Friedewald equation (12):

cleaning, separation, and shade drying, followed by grinding into a fine powder. This powder was used in subsequent experimental procedures.

filtered and the extract was dried in a hot air oven at a temperature not exceeding 54 °C. The resulting powder was stored at refrigerated conditions until use (11). Pure carbon tetrachloride (CCl<sub>4</sub>) was purchased from BDH.

doses of 100, 200, and 300 mg/kg, respectively. The extract was dissolved in water and administered for three days prior to CCl<sub>4</sub> injection.

The experiment lasted 21 days. Twenty-four hours after the last injection, animals were anesthetized with chloroform, and blood samples were collected. Serum was separated by centrifugation at 3000 rpm for 15 minutes and stored at refrigerated conditions until biochemical analyses (11).

$$\text{LDL-C} = \text{Total Cholesterol} - \text{HDL-C} - \frac{\text{Triglycerides}}{5}$$

$$\text{VLDL-C} = \frac{\text{Triglycerides}}{5}$$

#### Statistical Analysis

A completely randomized design (CRD) was used to analyze the variance among treatments. Significant differences between means were determined using the Least

Significant Difference (LSD) test. Statistical analysis was performed using SAS software (2001).

## Results and discussion

### Table 1. Effect of *Cichorium intybus* Leaf Extract on Serum Magnesium and Glucose Levels in Female Rats Exposed to Carbon Tetrachloride.

The table illustrates the effect of *Cichorium intybus* (chicory) leaf extract on serum magnesium and glucose concentrations in female rats following exposure to carbon tetrachloride (CCl<sub>4</sub>). Magnesium is an essential indicator of muscle and nerve function, whereas glucose represents a key metabolic marker of diabetic status. In the non-intoxicated control group, reflecting the hepatic toxicity-induced disturbance in glucose metabolism with a relatively preserved magnesium balance. Treatment with 75 mg/kg of chicory extract elevated serum magnesium to 2.89 mg/100 mL and reduced glucose to 123 mg/100 mL. This pronounced decline in glucose supports recent findings suggesting the antidiabetic potential of chicory extracts, as reported in experimental studies demonstrating hypoglycemic activity of the plant's leaf constituents (bioRxiv +1). At a dose of 150 mg/kg, magnesium measured 2.81 mg/100 mL and glucose 126 mg/100 mL, indicating a similar efficacy to the lower dose, though with a slightly lesser increase in magnesium. This suggests an optimal dose range for improving glucose metabolism without excessive alteration in mineral homeostasis. The 300 mg/kg dose yielded the highest magnesium level (3.10 mg/100 mL) but a rise in glucose to 153 mg/100 mL, implying

that higher doses may exert a reverse or compensatory effect—possibly through enhanced magnesium absorption with diminished modulation of glucose metabolism. Such biphasic responses align with previous reports describing reduced or altered efficacy of chicory at elevated doses due to complex metabolic interactions (ScienceDirect +1). From a statistical perspective, variation in magnesium levels was non-significant (1.59 NS\*), whereas glucose variation was significant (LSD = 8.52, p<0.05). This indicates that the extract exerts a stronger influence on glucose metabolism than on magnesium regulation (12). The hypoglycemic response can be attributed to chicory constituents such as flavonoids and inulin, which are known to enhance insulin sensitivity, inhibit hepatic gluconeogenesis, or promote peripheral glucose uptake (MDPI +1) (13). Scientifically, the observed glucose reduction at 75 mg/kg and 150 mg/kg may result from increased glucose uptake in peripheral tissues, stimulation of insulin secretion, or suppression of key gluconeogenic enzymes such as Glucose-6-phosphatase, as documented in related literature (ResearchGate +1). The moderate increase in magnesium levels likely reflects improved mineral balance or enhanced

renal/hepatic function reducing magnesium loss; however, the lack of statistical significance suggests that this effect is mild or inconsistent within experimental variation (13). In summary, these findings support the notion that *Cichorium intybus* leaf extract exhibits protective and regulatory

### **Table 2. Effects of *Cichorium intybus* Leaf Extract on Serum Lipid Profile in Rats Treated with Carbon Tetrachloride**

The study results demonstrated that *Cichorium intybus* leaf extract produced a marked improvement in serum lipid parameters in rats treated with carbon tetrachloride ( $\text{CCl}_4$ ). A significant reduction was observed in total cholesterol, triglycerides (TG), low-density lipoprotein (LDL), and very-low-density lipoprotein (VLDL), accompanied by a relative increase in high-density lipoprotein (HDL). These changes indicate that chicory extract exerts a protective and regulatory effect on lipid metabolism under hepatotoxic conditions. The pronounced elevation of triglycerides and cholesterol in the  $\text{CCl}_4$ -intoxicated control group is attributed to the toxic effects of free radicals generated during hepatic metabolism of  $\text{CCl}_4$ , which induce lipid peroxidation of cellular membranes and inhibit the activity of Lipoprotein Lipase (LPL), leading to the accumulation of lipoproteins in the bloodstream (15). Hepatic injury also impairs the secretion of lipoprotein transport proteins from the liver, causing an elevation of serum VLDL due to lipid accumulation in hepatocytes. In contrast, the chicory-treated groups exhibited a gradual restoration of lipid homeostasis, with total cholesterol levels reduced to 91–93 mg/dL and triglycerides to

effects on blood biochemical markers in rats subjected to  $\text{CCl}_4$ -induced toxicity—particularly in lowering glucose levels—while its influence on magnesium homeostasis appears less pronounced and warrants further investigation (14.)

185–239 mg/dL, indicating an improvement in hepatic enzyme activity responsible for lipid metabolism. This improvement is likely due to the presence of phenolic and flavonoid compounds—such as luteolin and chicoric acid—which act as natural inhibitors of HMG-CoA reductase, the rate-limiting enzyme in hepatic cholesterol biosynthesis, thereby reducing endogenous cholesterol production (16). Moreover, inulin, a complex carbohydrate found in chicory leaves, enhances the intestinal binding and excretion of bile acids, prompting the liver to utilize additional cholesterol for new bile acid synthesis, consequently lowering serum cholesterol levels (17). From a physiological perspective, the extract also improved HDL concentration, which increased to 36–41 mg/dL in treated groups compared to 22 mg/dL in the control group. This reflects enhanced reverse cholesterol transport from peripheral tissues to the liver, likely through stimulation of Lecithin–Cholesterol Acyltransferase (LCAT) activity, the enzyme responsible for cholesterol esterification and HDL maturation (18). The marked reduction in LDL and VLDL levels (to 13.4–25.4 mg/dL and 31.6–40.6 mg/dL, respectively) suggests enhanced fatty acid

oxidation mediated by activation of Peroxisome Proliferator-Activated Receptor Alpha (PPAR- $\alpha$ ), which promotes mitochondrial  $\beta$ -oxidation and reduces hepatic lipid accumulation (19). These findings align with recent reports indicating that chicory possesses both hypolipidemic and hepatoprotective properties through interconnected genetic and enzymatic mechanisms. Furthermore, the strong antioxidant properties of chicory leaf extract contribute to the inhibition of malondialdehyde (MDA) formation—a key marker of lipid peroxidation—thereby maintaining hepatocellular membrane

### Conclusions

The findings of this study indicate that *Cichorium intybus* leaf extract exerts significant protective and regulatory effects on key metabolic markers, particularly glucose and lipid profiles, in rats exposed to carbon tetrachloride. Moderate doses of the extract (75–150 mg/kg) were the most effective, lowering blood glucose, reducing total cholesterol, triglycerides, LDL, and VLDL, while increasing HDL, suggesting an optimal therapeutic window for enhancing metabolic health. These results highlight the potential application of chicory extract as a natural functional supplement or nutraceutical for managing glucose and lipid

integrity and mitigating inflammation associated with oxidative stress (20). The significant LSD values ( $p < 0.05$ ) for all lipid parameters confirm the statistical reliability of these biochemical changes and reinforce the extract's protective efficacy. Notably, moderate doses (75–150 mg/kg) were the most effective, producing a substantial reduction in total lipids while maintaining HDL balance. Higher doses showed comparatively weaker qualitative effects, possibly due to saturation of biological binding sites or compensatory feedback in metabolic pathways.

disorders. Future research should focus on developing standardized extract formulations, optimizing dosing strategies, and investigating the molecular mechanisms underlying its hypoglycemic and hypolipidemic actions. Moreover, these findings can inform the design of preclinical and clinical trials aimed at translating the observed protective effects into practical interventions for human health, while also exploring its integration into food or pharmaceutical products to promote metabolic regulation and prevent hepatic and cardiovascular complications(20;12).

**Table 1. Effect of Cichorium intybus Leaf Extract on Serum Magnesium and Glucose Levels in Female Rats Exposed to Carbon Tetrachloride (CCl<sub>4</sub>)**

Group Description	Serum Glucose (mg/100 mL)	Serum Magnesium (mg/100 mL)
Non-intoxicated control group	161 a	2.67 a
CCl <sub>4</sub> -intoxicated control group (untreated)	155 ab	2.75 a
CCl <sub>4</sub> + Chicory extract 75 mg/kg (treated)	123 c	2.89 a
CCl <sub>4</sub> + Chicory extract 150 mg/kg (treated)	126 c	2.81 a
CCl <sub>4</sub> + Chicory extract 300 mg/kg (treated)	153 b	3.10 a

LSD (0.05): Magnesium = 1.59 (non-significant, NS); Glucose = 8.52 (significant,  $p < 0.05$ ).

**Table 2. Effects of Cichorium intybus Leaf Extract on Serum Lipid Profile in Rats Treated with Carbon Tetrachloride (CCl<sub>4</sub>)**

Group Description	Total Cholesterol (mg/dL)	Triglycerides (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	VLDL (mg/dL)
Non-intoxicated control group	172 a	241 bc	22 d	103 a	41 bc
CCl <sub>4</sub> -intoxicated control group (untreated)	164 a	281 a	43 a	83.4 b	47.6 a
CCl <sub>4</sub> + Chicory extract 57 mg/kg (treated)	93 c	239 c	41 ab	13.4 e	40.6 c
CCl <sub>4</sub> + Chicory extract 171 mg/kg (treated)	91 c	185 d	36 c	25.4 d	31.6 e
CCl <sub>4</sub> + Chicory extract 301 mg/kg (treated)	123 b	189 d	37 bc	55.7 c	32.3 de

LSD (0.05): VLDL = 4.520, LDL = 12.361, HDL = 5.052, Triglycerides = 11.716, Total Cholesterol = 13.946 (all  $p < 0.05$ ).

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