



Original Research Paper

Assessment of the Protective Potential of *Aloe barbadensis* Against Diazinon-Induced Biochemical Changes in Albino Rats

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Abstract

Diazinon is one of several organophosphate insecticides and is used extensively for both agricultural and household insect pests. Although diazinon is known to be effective as an insecticide, prolonged exposure to diazinon can lead to systemic toxicity, characterized by oxidative stress, hepatic impairment, changes in lipid metabolism, and damage to the kidneys. The study assessed the protective effects of *Aloe barbadensis* against biochemical changes induced by diazinon in albino rats. The study was based on an exposure to a sub-lethal dose of diazinon established after evaluating acute toxicity. The LD₅₀ for diazinon was found to be 300 mg/kg body weight and one-tenth of the LD₅₀ (30 mg/kg body weight) was used to repeat oral exposures. Observation and subsequent biochemical tests were conducted after 7, 14, 21, and 28 days of repetition of treatment with diazinon. Biochemical tests included measurement of enzymes and other proteins in the liver, as well as renal function. Repeated exposures to diazinon produced significant changes in the biochemical parameters, which were most evident after 28 days. For example, there was a significant increase in the activities of ALT, AST, ALP, and ACP. On the other hand, total protein, albumin, globulin, and albumin/globulin ratio dropped significantly. In addition, diazinon caused dyslipidaemia by causing an increase of total cholesterol, triglycerides, LDL, and VLDL, while causing a decrease of levels of HDL. It also caused kidney damage and dysfunction, as evidenced by increase in blood urea, creatinine, uric acid, and blood urea nitrogen, as well as sodium, potassium, and calcium. Administration of *Aloe barbadensis* helped to ameliorate all the changes observed in biochemical parameters. Most group data for the recovery group coincided with control values. The data show that the *Aloe barbadensis* is capable of providing protection against the biochemical changes caused by repeated exposure to diazinon, which can be explained by the anti-oxidative and anti-inflammatory effect of its bioactive components.

Keywords: *Aloe barbadensis*, diazinon, albino rats, hepatotoxicity, nephrotoxicity, lipid profile, biochemical parameters, oxidative stress

1. Introduction

Pesticides are critical elements of contemporary farming practices as they help crops to escape losses inflicted by insects or other organisms that may irreplacably limit agricultural productivity. Nevertheless, widespread use of pesticides has raised multiple concerns with regard to occupational, ecological, and biological exposure. Organophosphorus compounds are particularly important here as their impact can affect various physiological systems of mammals apart from their classical cholinergic effects. The significance of oxidative stress in the chain of pesticide-induced toxicity has been recognized increasingly due to its ability to provide a mechanism linking pesticide exposure and cellular damage (Abdollahi *et al.* 2004; Costa 2018).

Diazinon is the organophosphate pesticide which is widely used in agriculture for pest control. Laboratory studies have proven that the use of diazinon leads to disturbances in biochemical

equilibrium and affects different organs. Previous experiments on albino male rats showed that diazinon when given orally had an effect on biochemical parameters, and later research reported various biochemical and histological anomalies in the kidneys and liver (Al-Shinnawy 2008; Sarhan & Al-Sahhaf 2011; Wisudanti *et al.* 2019, Singh *et al.*, 2023 Pathak *et al.*, 2025). The findings above suggest that the toxic effects of diazinon are caused not only by cholinesterase inhibition but also involve vital metabolic organs. Oxidative stress is one of the key causes of cellular damage in cases with organophosphorus pesticides. The imbalance between the processes of formation of reactive oxygen species and antioxidant defense mechanisms creates an environment for lipid peroxidation and membrane destruction. Diazinon has been linked with alterations in antioxidant systems and increased lipid peroxidation in laboratory rats (Kalender *et al.* 2005; Kalender & Uzunhisarcikli 2008, Singh *et al.*, 2025, Rajput *et*

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al., 2026). Oxidative disruptions serve as a biologically acceptable explanation for the alteration of circulating enzymes, lipids, proteins and renal metabolites.

The liver is especially prone to toxic injury because it participates significantly in xenobiotic metabolism. Injury to the liver can impair the functioning of enzymes released into the bloodstream, and disturb protein and lipid metabolism. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) serve as biochemical markers of the integrity of liver cells, and alkaline phosphatase (ALP) allows detecting hepatobiliary alterations. The changes in the activity of these enzymes provide indirect evidence of liver injury caused by toxic agents (Giannini *et al.*, 2005, Kumar & Maheshwari, 2025). The synthetic ability of the liver can also be determined through measuring total proteins, albumin, globulin, and the A/G ratio. The continued exposure to toxins may disrupt protein synthesis and metabolism, making the changes in these indicators detectable. In this study, a relationship between the increases in ALT, AST, ALP, and ACP levels in the blood and decreases in the total proteins, albumin, globulin, and the A/G ratio, due to diazinon exposure, has been established. Thus, measuring the activity of enzymes and total protein content allows obtaining more reliable information about the biochemical state of the liver. Another important aspect of diazinon toxicity is lipid metabolism. The liver plays a major role in cholesterol synthesis, triglyceride metabolism, and lipoprotein processing. Therefore, injury caused to the liver by oxidative agents can result in disorders of lipid metabolism. In the current study, repeated exposure to diazinon increased levels of total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C), and very-low-density lipoprotein cholesterol (VLDL-C) at the same time as the levels of high-density lipoprotein cholesterol (HDL-C) decreased. This indicates a clear disruption of lipid and lipoprotein homeostasis.

The kidneys are also a significant target for the harmful effects of pesticides due to their role in detoxifying xenobiotics and excreting metabolic waste. Common tests for renal function usually include the plasma levels of urea, creatinine, uric acid, and blood urea nitrogen (BUN) in addition to other parameters which reflect tubular and homeostatic functions present in plasma. The effects of diazinon on renal function have been studied in some experiments where preventive measures against diazinon-associated kidney injury were attempted (Sarhan and Al-Sahhaf, 2011; Ajibade *et al.*, 2016; Mishra *et al.*, 2022, Khormi *et al.*, 2022, Yadav & Sagar, 2026).

Considering that oxidative stress is one of the major mechanisms behind organophosphate toxicity, a lot of effort has been directed towards

identifying natural antioxidants and protective agents of a vegetable source. Vitamin C, vitamin E, black seed, vegetable oil, thymoquinone, and other natural compounds have shown their ability to fight pesticide toxicity to some extent. For instance, vitamins C and E have been studied with respect to diazinon-induced injury to pancreas; vitamin E was used against diazinon-induced hepatotoxicity, while thymoquinone has been demonstrated to have curative effect in case of liver damage (Gokalp *et al.*, 2005; Damodar *et al.*, 2015; Ghazy *et al.*, 2019, Singh & Sharma, 2025, Aakash *et al.*, 2026).

Among the medicinal plants, *Aloe barbadensis* (commonly known as Aloe vera) is of particular interest. Aloe leaf gel contains a mixture of bioactive compounds. Its composition and effect have been reviewed thoroughly as well (Eshun & He, 2004; Hamman, 2008; Sanchez *et al.*, 2020, Dixit & Khan, 2024, Khirwar & Shukla, 2026). Protection potential of Aloe is important from the point of view of pesticide poisoning. The research demonstrated that Aloe vera protects from cartap- and malathion-induced poisoning in Wistar rats and indicates that Aloe prevents the development of adverse effects caused by pesticides (Gupta *et al.*, 2019; Gupta *et al.*, 2020). The effect of Aloe vera juice on malathion-induced injury to liver was examined (Al-Shinnawy *et al.*, 2014). The above indicates that *Aloe barbadensis* has the potential to combat adverse diazinon effects as well.

The previous discussion has led to the following study being performed which aimed at evaluating the potential of *Aloe barbadensis* to protect from the negative effects of diazinon. The main focus was made on liver, protein metabolism, lipid profile, renal function markers, and electrolyte balance. Also, the study aimed to see if the harmful effects intensified with time and if administration of *Aloe barbadensis* would restore these indicators to the norm.

2. Materials and Methods

2.1 Experimental Animals and Study Design

The research study was conducted through the use of healthy adult white albino rats in a controlled laboratory setup. The subjects were divided into test groups to determine the effect of biochemical toxicity of diazinon and the protective function of *Aloe barbadensis*. The procedure involved having the control group, group exposed to diazinon, group treated with diazinon and *Aloe barbadensis*, and recovery group. The observations were made after a gap of 7, 14, 21 and 28 days, thus allowing the assessment of toxicity on the members of different groups through time.

Table 1. Experimental design used for assessment of diazinon toxicity and protective effect of *Aloe barbadensis*

Parameter	Experimental condition
Experimental	Adult male albino rats

animal	
Diazinon LD ₅₀	300 mg/kg body weight
Experimental diazinon dose	30 mg/kg body weight
Basis of dose selection	1/10th of LD ₅₀
Route	Oral administration
Observation periods	7, 14, 21 and 28 days
Major biochemical assessments	Liver function, protein profile, lipid profile, renal function and electrolytes

2.2 Determination of Diazinon LD₅₀

A test for acute oral toxicity was performed in advance of the chronic toxicity test. Infusions of diazinon were used to treat groups of six rats with levels ranging from 100 mg/kg to 500 mg/kg body weight. The animals were then monitored for mortality for 14 days. There was no mortality noted for the lowest dose of 100 mg/kg, with rates of 16.67% for 200 mg/kg, 50% for 300 mg/kg, 83.33% for 400 mg/kg, and 100% for the maximum dose of 500 mg/kg. Probit analysis estimated an LD₅₀ of approximately 300 mg/kg. Therefore, in order to conduct the repeated sublethal experiment, a dose of one-tenth of the LD₅₀, or 30 mg/kg body weight, was chosen. The treatment was provided by means of oral gavage of diazinon during 28 treatments.

2.3 Biochemical Assessment

Biochemical testing included three key functional areas: liver function and protein profile, lipid profile, and kidney function/electrolytes. Liver profile included ALT, AST, ALP, ACP, total serum protein, albumin, globulin and A/G ratio. For lipids, the assessment looked at total cholesterol, triglycerides, HDL-C, LDL-C and VLDL-C levels. The kidney profile looked at blood urea, creatinine, uric acid and BUN, along with sodium, potassium and calcium levels. ALT and AST were measured using modified IFCC kinetic methods, while ALP was done using pNPP-based methods and ACP followed α -naphthylphosphate kinetic methods. For total protein measurement, Biuret principle was used and albumin was measured using the bromocresol green method. The quantitative methods were based on methods outlined by Schumann *et al* (2002), Doumas *et al* (1971) and Tietz (1995). Total cholesterol and triglycerides were assessed through enzymatic techniques, with HDL-C measured using direct homogeneous technique, while LDL-C and VLDL-C were computed. Kidney biochemical analysis included serum urea, creatinine, uric acid and BUN and sodium, potassium and calcium levels. Methodologies for reference were Fawcett and Scott (1960) for urea, Friedewald *et al* (1972) for LDL calculation and standard clinical chemistry approaches for creatinine and electrolytes.

2.4 Statistical Analysis

The experimental groups have been compared using biochemical data statistically. Analysis of variance and subsequent multiple-comparison testing were done in the source study. Results in the observation tables have been presented as mean $\pm$ SD (n=6) with letters as superscripts representing the significance of difference among groups as per one-way ANOVA and Tukey's multiple comparison testing.

3. Results

3.1 Effects on Hepatic Enzyme Activities

Administration of diazinon resulted in significant changes in the activities of hepatic enzymes in the serum. Moreover, the more prolonged exposure increased these changes, indicating cumulative biochemical toxicity.

In this respect, after 28 days of diazinon administration, the values of serum ALT increased from 34.426 $\pm$ 1.178 U/L in control animals to 71.841 $\pm$ 1.919 U/L in animals exposed to diazinon (increase about 108.55%) ($p < 0.0001$). Aloe treatment led to ALT values of 46.287 $\pm$ 1.364 U/L, while recovery period brought ALT to 38.164 $\pm$ 1.210 U/L. The activity of AST demonstrated the same trend: it increased from 96.474 $\pm$ 2.143 U/L (control group) to 168.475 $\pm$ 3.196 U/L (after 28 days of diazinon application). Thus, the increase was approximately 74.35%. After Aloe treatment, the levels of AST decreased to 122.814 $\pm$ 2.481 U/L, whereas the recovery group had 104.136 $\pm$ 2.260 U/L. The level of ALP rose dramatically and reached 188.646 $\pm$ 3.521 U/L from 112.928 $\pm$ 2.575 U/L (increase by 67.38%). Having been treated with Aloe, ALP decreased to 139.384 $\pm$ 2.982 U/L; in the recovery group, it was 121.815 $\pm$ 2.603 U/L. The highest increase was recorded for ACP, growing from 4.118 $\pm$ 0.187 U/L to 8.858 $\pm$ 0.253 U/L (increase about 114.0%). ACP level was decreased to 5.644 $\pm$ 0.221 U/L by means of Aloe treatment, while its level in the recovery group was 4.818 $\pm$ 0.198 U/L.

Overall results indicate that diazinon increased all the evaluated enzyme activities, whereas *Aloe barbadensis* greatly lowered their values.

Table 2. Effect of diazinon and *Aloe barbadensis* on hepatic biochemical parameters after 28 days

Parameter	Control	Diazinon	Diazinon + Aloe	Recovery	Significance
ALT (U/L)	34.4 2 $\pm$ 1.18	71.84 $\pm$ 1.92	46.28 $\pm$ 1.36	38.16 $\pm$ 1.21	$P < 0.0001$
AST (U/L)	96.4 8 $\pm$ 2.14	168.5 2 $\pm$ 3.24	122.8 4 $\pm$ 2.48	104.1 8 $\pm$ 2.26	$P < 0.0001$
ALP (U/L)	112. 64 $\pm$	188.7 2 $\pm$	139.4 8 $\pm$	121.8 2 $\pm$	$P < 0.0001$

	2.52	3.81	2.96	2.64	
ACP (U/L)	4.12 ± 0.18	8.84 ± 0.26	5.68 ± 0.22	4.82 ± 0.20	$P < 0.0001$

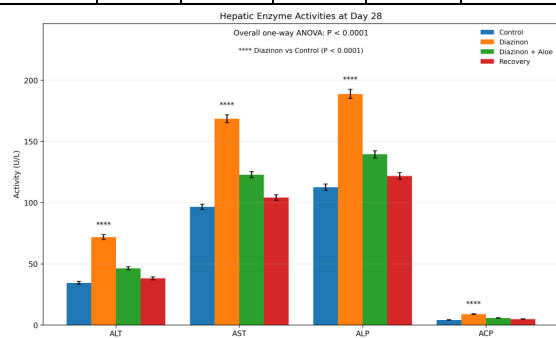


Figure 1. Effect of diazinon and *Aloe barbadensis* on hepatic enzyme activities (ALT, AST, ALP and ACP) after 28 days.

3.2 Effects on Serum Protein Profile

The exposure to diazinon led to a substantial decrease in the levels of certain serum proteins. Total proteins were found to be lowered from 7.42 ± 0.18 g/dL in the control group to 5.14 ± 0.16 g/dL after 28 days of exposure, resulting in a decrease of approximately 30.73%. However, total protein levels increased to 6.52 ± 0.17 g/dL with aloe treatment and reached 7.08 ± 0.17 g/dL in the recovery group. Likewise, the levels of serum albumin decreased significantly from 4.18 ± 0.11 g/dL to 2.84 ± 0.09 g/dL, corresponding to a decrease of about 32.06%. In contrast, albumin levels increased to 3.62 ± 0.10 g/dL after aloe administration, while those in the recovery group reached 3.98 ± 0.10 g/dL. Globulin levels were reduced from 3.24 ± 0.09 g/dL in the control group to 2.30 ± 0.08 g/dL after being exposed to diazinon. The addition of *Aloe barbadensis* caused an increase in globulin levels up to 2.90 ± 0.08 g/dL, and the recovery group showed further increase up to 3.10 ± 0.08 g/dL.

The A/G ratio was also affected significantly. The results presented in this chapter revealed that the values of the A/G ratio decreased from 1.29 ± 0.04 in the control group to 1.23 ± 0.03 after the administration of diazinon followed by an increase to 1.25 ± 0.03 after aloe treatment and to 1.28 ± 0.03 in the recovery group. In general, from the above-mentioned protein parameters, it can be inferred that diazinon has a negative effect on the function of the liver regarding synthesis and metabolism of proteins and the treatment with *Aloe barbadensis* may reverse this.

Table 3. Effect of diazinon and *Aloe barbadensis* on serum protein profile after 28 days

Parameter	Control	Diazinon	Diazinon + Aloe	Recovery	Significance
Total protein	7.42 ±	5.14 ±	6.52 ±	7.08 ±	$P < 0.0001$

(g/dL)	0.18	0.16	0.17	0.17	
Albumin (g/dL)	4.18 ± 0.11	2.84 ± 0.09	3.62 ± 0.10	3.98 ± 0.10	$P < 0.0001$
Globulin (g/dL)	3.24 ± 0.09	2.30 ± 0.08	2.90 ± 0.08	3.10 ± 0.08	$P < 0.0001$
A/G ratio	1.29 ± 0.04	1.23 ± 0.03	1.25 ± 0.03	1.28 ± 0.03	$P < 0.0001$

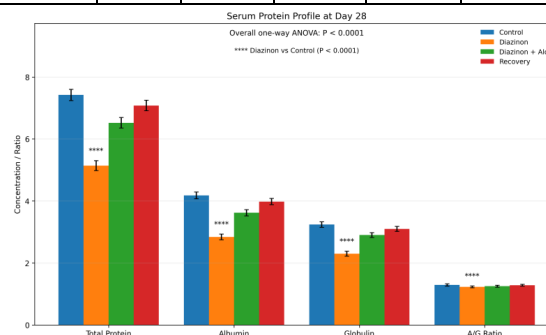


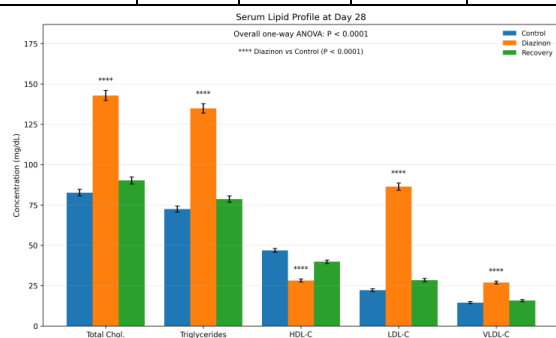
Figure 2. Effect of diazinon and *Aloe barbadensis* on serum total protein, albumin, globulin and A/G ratio after 28 days.

3.3 Effects on Lipid Profile

A noticeable dyslipidemic pattern has been seen after being exposed to diazinon. Total cholesterol was raised from 82.64 ± 2.08 mg/dL in control subjects to 142.84 ± 3.14 mg/dL after 28 days of exposure. This corresponds to an increase of 72.85%. Aloe treatment has brought down cholesterol levels to 102.48 ± 2.32 mg/dL and animals in recovery group showed cholesterol levels of 90.18 ± 2.16 mg/dL. Serum triglycerides increased from 72.42 ± 1.86 mg/dL to 134.82 ± 2.92 mg/dL which corresponds to an increase of approximately 86.16%. *Aloe barbadensis* treatment has significantly reduced triglyceride levels to 92.64 ± 2.18 mg/dL, while recovery group showed results of 78.64 ± 1.94 mg/dL. HDL-C showed an opposite trend as it decline from 46.82 ± 1.24 mg/dL in control subjects to 28.16 ± 0.94 mg/dL after 28 days of exposure representing a decline of around 39.85%. The HDL-C levels after treatment of Aloe have improved significantly. LDL-C levels showed an increase from 22.18 ± 0.92 mg/dL to 86.34 ± 2.18 mg/dL representing an increase in value of about 289.27%. Aloe treatment reduced the LDL levels of treated animals to 42.18 ± 1.26 mg/dL, while recovery group showed values of 28.42 ± 1.04 mg/dL. VLDL-C showed an increase in values from 14.48 ± 0.62 mg/dL to 26.96 ± 0.88 mg/dL with Aloe treatment and reduction of values after Aloe treatment to 18.52 ± 0.74 mg/dL and recovery group of 15.72 ± 0.68 mg/dL. In conclusion, diazinon caused a very significant ($P < 0.0001$) dyslipidemia characterized by the high levels of total cholesterol, triglycerides, LDL-C and VLDL-C and lower levels of HDL-C.

Table 4. Effect of diazinon and *Aloe barbadensis* on lipid profile after 28 days

Parameter	Control	Diazinon	Recovery with <i>Aloe</i>	Change after diazinon
Total cholesterol (mg/dL)	82.64 ± 2.08	142.84 ± 3.14	90.18 ± 2.16	↑ 72.85 %
Triglycerides (mg/dL)	72.42 ± 1.86	134.82 ± 2.92	78.64 ± 1.94	↑ 86.16 %
HDL-C (mg/dL)	46.82 ± 1.24	28.16 ± 0.94	39.82 ± 1.08	↓ 39.85 %
LDL-C (mg/dL)	22.18 ± 0.92	86.34 ± 2.18	28.42 ± 1.04	↑ 289.27 %
VLDL-C (mg/dL)	14.48 ± 0.62	26.96 ± 0.88	15.72 ± 0.68	↑ 86.19 %

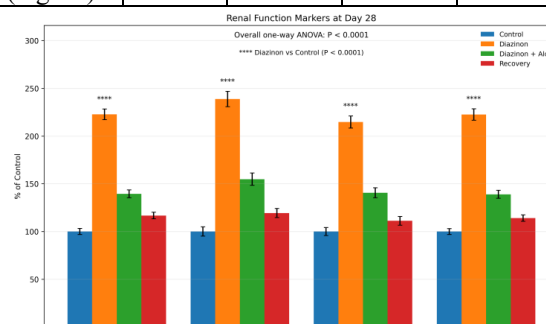
Figure 3. Effect of diazinon and *Aloe barbadensis* on serum lipid profile after 28 days.

3.4 Effects on Renal Function

The biochemical analysis of renal function suggested significant nephrotoxic effects due to repeated diazinon treatment. BUN increased from initial value of 26.42 ± 0.84 mg/dL to final value of 58.82 ± 1.48 mg/dL during period of 28 days, approximately 122.63% increase. The Aloe treatment lowered it to 36.84 ± 1.08 mg/dL while the recovery group showed BUN at 30.84 ± 0.92 mg/dL. Creatinine rose from 0.62 ± 0.03 mg/dL to 1.48 ± 0.05 mg/dL, resulting in approximately 138.71% rise in level of this metabolite. After the Aloe treatment creatinine decreased to 0.96 ± 0.04 mg/dL with the recovery group reaching level of 0.74 ± 0.03 mg/dL at the end of the study. The levels of uric acid increased from 2.86 ± 0.12 mg/dL to 6.14 ± 0.18 mg/dL, which means approximately 114.69% increase as compared to control value. The Aloe treatment obviously decreased it to 4.02 ± 0.15 mg/dL, while the levels in recovery animals were at 3.18 ± 0.13 mg/dL. The BUN levels increased from 12.42 ± 0.38 mg/dL to 27.64 ± 0.74 mg/dL, however they decreased to 17.26 ± 0.52 mg/dL after Aloe treatment and to 14.16 ± 0.42 mg/dL in the recovery group.

table 5. Effect of diazinon and *Aloe barbadensis* on renal biochemical parameters and electrolytes after 28 days

Parameter	Control	Diazinon	Diazinon + <i>Aloe</i>	Recovery
Blood urea (mg/dL)	26.42 ± 0.84	58.82 ± 1.48	36.84 ± 1.08	30.84 ± 0.92
Creatinine (mg/dL)	0.62 ± 0.03	1.48 ± 0.05	0.96 ± 0.04	0.74 ± 0.03
Uric acid (mg/dL)	2.86 ± 0.12	6.14 ± 0.18	4.02 ± 0.15	3.18 ± 0.13
BUN (mg/dL)	12.42 ± 0.38	27.64 ± 0.74	17.26 ± 0.52	14.16 ± 0.42
Sodium (mmol/L)	143.82 ± 1.84	126.24 ± 1.62	136.84 ± 1.68	140.12 ± 1.73
Potassium (mmol/L)	4.22 ± 0.14	6.82 ± 0.21	5.08 ± 0.17	4.46 ± 0.15
Calcium (mg/dL)	9.82 ± 0.18	7.12 ± 0.16	8.68 ± 0.17	9.34 ± 0.17

Figure 4. Comparative effect of diazinon and *Aloe barbadensis* on renal-function markers after 28 days, expressed as percentage of control.

3.5 Effects on Serum Electrolytes

The administration of Diazinon also impacted the balance of electrolytes in the body. In this regard, serum sodium decreased from the level of 143.82 ± 1.84 mmol/L in the control group to 126.24 ± 1.62 mmol/L, which makes a difference of 12.22%. Aloe treatment helped to gain sodium back and it returned to 136.84 ± 1.68 mmol/L. The recovery group animals appeared to have the same parameter at the level of 140.12 ± 1.73 mmol/L. Serum potassium increased from 4.22 ± 0.14 mmol/L to 6.82 ± 0.21 mmol/L, which is approximately 61.61%. Aloe treatment helped to lower potassium level to 5.08 ± 0.17 mmol/L, while animals from the recovery group presented the level of 4.46 ± 0.15 mmol/L. Finally, serum calcium decreased from 9.82 ± 0.18 mg/dL to 7.12 ± 0.16 mg/dL that makes the different in level 27.49%. *Aloe barbadensis* affected the level of calcium positively, bringing it up to 8.68 ± 0.17 mg/dL,

while recovery group in turn managed to reach the level of 9.34 ± 0.17 mg/dL. Thus, analysis results of kidneys showed at the same time both increase in potassium and nitrogen waste products and decrease of sodium and calcium. Aloe media changed all these parameters towards the control level.

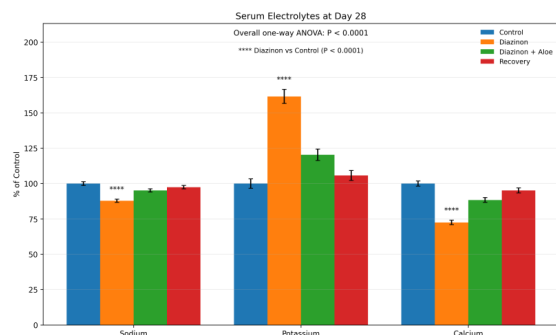


Figure 5 Comparative effect of diazinon and *Aloe barbadensis* on sodium, potassium and calcium after 28 days, expressed as percentage of control.

4. Discussion

This study shows that multiple episodes of taking diazinon in doses of 30 mg/kg lead to developing serious and progressively more severe biochemical toxicity in white rats. Changes at a biochemical level include three main areas of dysfunction: damage of liver tissues, disruption of lipid metabolism, and problems of kidneys functioning. It is worth mentioning that addition of *Aloe barbadensis* diminished those abnormalities while the levels in treatment groups were almost equal to those in control group. The issue of duration-dependence of toxicity is quite significant. Your study showed that the changes in the biochemistry got worse with prolonged exposure from 7 days to 28 which rendered the maximum effect at the end of the experiment implying that the process of repeated sublethal exposure can cause biochemical damage even at insignificant dose much lower than the LD₅₀.

4.1 Hepatoprotective Potential of *Aloe barbadensis*

The considerable increase in ALT and AST levels seen in the study following administration of diazinon is a proof of injury to the integrity of liver cells. The level of ALT has risen by more than 100% as compared to that of the control, while that of AST increased at about 74.67%. The elevation of the levels of aminotransferases corresponds to the increase of membrane permeability and release of enzymes from the damaged liver cells. Therefore, the results of the study can be interpreted as the evidence of gradual damage done to the liver as a result of repeated exposure to diazinon. The results of the present study are supported by earlier findings. Al-Shinnawy (2008) has reported biochemical changes in male albino rats due to the oral exposure to diazinon, while Mossa *et al.* (2012) provided evidence of

physiological and histological changes in the liver due to diazinon exposure in rats. Damodar *et al.* (2015) also studied the level of hepatotoxicity concluded from biochemical and histological findings. The increase in the level of ALP in the liver also provides additional confirmation of the liver injury. ALP level increased from 112.64 to 188.72 U/L after 28 days of the experiment. The increase in the level of ALP in addition to the rise in the levels of ALT and AST indicates that the liver is affected in several aspects rather than one enzyme system only. ACP level more than doubled during diazinon exposure (4.12 – 8.84 U/L). The author of the paper interprets this increase as a proof of cellular damage caused by alterations in lysosomal membrane integrity. The increase in the levels of ALT, AST, ALP and ACP offers a relevant biochemical picture of damage to the membranes and alterations in metabolism. The decrease in the levels of those enzymes after taking *Aloe barbadensis* is of great importance for the aim of the study. The level of ALT has decreased from 71.84 U/L to 46.28 U/L after taking Aloe. There has also been a significant decrease in the levels of AST, ALP and ACP indicating that taking Aloe has positively influenced biochemical conditions of the liver. The findings of the current study confirm the results of other studies that showed the protective properties of Aloe products against other pesticides. Al-Shinnawy *et al.* (2014) provided evidence for positive therapeutic effects of Aloe vera juice against the effects of malathion while Gupta *et al.* (2019) reported the protective effects of Aloe vera against cartap toxicity. Gupta *et al.* (2020) confirmed the anti-inflammatory and antioxidant properties of Aloe vera in relation to pesticide toxicity. Oxidative stress seems to be a good explanation of diazinon-caused liver damage and of the protective effect of Aloe. Organophosphorus pesticides may cause damage to the antioxidant defenses and changes in the levels of oxidative stress markers.

4.2 Restoration of Hepatic Protein Metabolism

The observed decrease in overall protein, albumin, and globulin following exposure to diazinon proves that the impact of the pesticide was extensive and went beyond just damaging the membranes. The amount of total protein has decreased by about 30.73%, the amount of albumin has decreased by around 32.06%, and a significant decrease has also been observed in the quantity of globulin. Albumin is mainly produced by the liver, and prolonged decrease of the serum albumin levels during exposure to toxic agents may mean that hepatic protein synthesis has been damaged. In our research with the use of Aloe supplementation, the albumin level was increased from 2.84 to 3.62 g/dL, while the recovery group achieved the level of 3.98 g/dL in comparison to 4.18 g/dL in the control group. The fact that the recovery is almost

complete correlates with the better hepatic synthetic capacity. In the same way, the fact that the total protein level which was 5.14 g/dL after exposure to diazinon and that of 6.52 g/dL after Aloe treatment and of 7.08 g/dL in recovering animals confirms that there has been a serious restoration of the metabolic disturbance. An analysis of globulin and A/G ratio allows concluding that Aloe has proved it can help with not only stopping the enzyme leak but also restoring the biochemical balance of the liver. Thus, regarding the two sets of data, it can be stated that they complement each other since the increase of ALT, AST, ALP, and ACP shows an injury, and lower overall protein, albumin, and globulin level indicates some disturbed processes of metabolism and synthesis. Thus, the positive changes in both sets of data after the use of *Aloe barbadensis* support the theory of its effectiveness in liver protection.

4.3 Amelioration of Diazinon-Induced Dyslipidaemia

The study conducted on the effects of diazinon revealed that one of its most obvious effects was dyslipidaemia. There was an increase in total cholesterol by about 72.85%, triglycerides rose by an increase of about 86.16%, while the increase in LDL cholesterol was more remarkable at about 289.27%. Although HDL cholesterol was affected negatively, showing a drop of around 39.85, it can still be interpreted that significant change in lipid profile was observed. Because the liver is responsible for lots of processes related to lipids, if damaged, it can have an influence on the composition of lipoproteins in the blood. Oxidative stress can also play a role in metabolism of lipids. One of the most impressive rises was in LDL cholesterol, which jumped from a fairly low value of 22.18 mg/dL to 86.34 mg/dL after 28 days, which is almost four times the control value. However, treatment with Aloe reduced it to 42.18 mg/dL, while recovery animals demonstrated even better results of 28.42 mg/dL, which is hard evidence that Aloe helped improve cholesterol distribution in the body. Triglycerides and VLDL cholesterol showed more or less similar trends. VLDL is responsible for the transport of triglycerides (the latter is produced in the liver), hence there are simultaneous increases in triglycerides and VLDL cholesterol in the body. HDL cholesterol behaved differently. The study indicates that it should decrease during intoxication with diazinon. Its drop, from 46.82 mg/dL to 28.16 mg/dL indicates disruption in the process of cholesterol metabolism. The findings of the present study allow one to conclude that similar approaches were used in the studies of other plant products as well. Both Al-Attar and Abu-Zeid (2013) and Al-Attar (2015) conducted their studies employing plants as tools against physiological and metabolic

disturbances caused by diazinon, while Al-Attar *et al.* (2016) were engaged in the study of the ability of plant oils to treat diazinon-caused hepatorenal toxicity.

4.4 Nephroprotective Effects

The renal findings provide further support for the idea that diazinon toxicity was systemic rather than restricted to the liver. Urea, creatinine, uric acid, and BUN values were found to have risen significantly following multiple doses. This is indicative of the impairment in the functioning of the kidneys. Blood urea concentration increased significantly by almost 122.63 percent while creatine concentrations increased significantly by an approximate of 138.71 percent. The increase in creatinine levels is extremely significant due to creatinine being regarded as an important biochemical marker for the functioning of the kidneys. Since both the blood urea concentrations and creatinine concentrations increased simultaneously, it implies that the dysfunction in the kidneys exists due to the effect of diazinon. Earlier studies have also reported similar findings in relation to diazinon. Sarhan and Al-Sahhaf (2011) highlighted the biochemical and microscopic effects of diazinon on the liver and kidney. Similarly, Wisudanti *et al.* (2019) also performed the toxicity study on diazinon in kidney and liver by integrating the biochemical and histopathological parameters. Lastly, Ajibade *et al.* (2016) performed a study to study the ant toxic effect of gallic acid on diazinon. The use of Aloe resulted in significant decrease in all the nitrogenous markers being tested. The level of creatinine decreased from 1.48 mg/dL after treatment with diazinon to 0.96 mg/dL following the use of Aloe and 0.74 mg/dL in recovering animals. Similarly, the blood urea level decreased from 58.82 to 36.84 mg/dL with Aloe treatment while it decreased to 30.84 mg/dL in recovering animals. Similar declines have been observed in uric acid and BUN levels. The levels of uric acid decreased from 6.14 mg/dL after diazinon treatment to 4.02 mg/dL following Aloe treatment and 3.18 mg/dL in recovering animals. Similarly, levels of BUN were found to have decreased from 27.64 to 17.16 and 14.16 mg/dL respectively in animals undergoing treatment and recovering from treatment.

4.5 Restoration of Electrolyte Homeostasis

Renal damage may result not only in the inability to excrete waste products but also detrimental effects on electrolyte balance. The research reported the significant fall in both serum sodium and calcium levels and considerable rise in potassium concentration in serum after exposure to diazinon. The sodium level fell by approximately 12.22% while potassium rose by 61.61%. The author of the original research interprets these findings as signs of impaired renal tubular function.

Given that the kidneys maintain electrolyte balance, simultaneous changes of sodium and potassium levels and increases in urea and creatinine levels provide support to the conclusion regarding renal malfunction. Calcium decrease by about 27.49% confirms the alterations in mineral balance. The use of Aloe ensured an increase in calcium from 7.12 mg/dL to 8.68 mg/dL and calcium levels of recovery animals was 9.34 mg/dL (close to control level of 9.82 mg/dL). *Aloe barbadensis* ability to increase sodium and potassium and calcium concentration together with the established changes in standard renal markers indicates that the protective effect of this substance relies on both improved processes of filtration and tubular/homeostatic activities. Summarizing the results of previous research, the authors conclude about extremely significant nephrotoxicity demonstrated through high levels of urea, BUN, creatinine, uric acid, and potassium and low levels of sodium and calcium which were all significantly restored as the result of Aloe application.

4.6 Possible Basis of the Protective Action of *Aloe barbadensis*

The observed protective effect in this study agrees with the known pharmacodynamic properties of Aloe and its derivatives. *Aloe barbadensis* is believed to be composed of different bioactive elements that can be used in various therapeutic purposes, which were described in multiple reviews (Sanchez *et al.*, 2020). The composition and applications of Aloe gel were reviewed by Hamman (2008), which indicates the significance of Aloe as a biogenic substance. The antioxidant explanation is directly related to the current findings. The oxidative stress caused by diazinon may induce damaging effects on cellular membranes, proteins, and lipids. If it is true that bioactive ingredients derived from Aloe strengthen antioxidant capability and lower the impact of oxidative stress, then the membranes of hepatocytes and renal cells should be preserved. This might explain the lower levels of liver enzymes, improved pattern of proteins, normalization of metabolism of lipids, and improvement of biochemical indices of kidneys which were observed in the groups treated with Aloe. Another aspect which should be analyzed is the potential role of Aloe as an agent that has anti-inflammatory capabilities. Gupta *et al.* (2020) reported that Aloe vera has antioxidant and anti-inflammatory properties in relation to pesticide-induced toxicity. Therefore, there are good reasons to consider the accomplishing of antioxidant and anti-inflammatory properties of Aloe as a significant biological explanation for the results obtained in the current experiment.

In general, group of recovery showed values that were closer to the controls than those in the group of simultaneous treatments. This means that *Aloe*

barbadensis may have importance not only for elimination of reactive toxic effects but also for recuperation from toxicity. However, the currently available bionic data allows us only to state the association of protection and recuperation, while the precise mechanisms should be studied with the help of other experiments studying oxidative stress, inflammation mediators, gene expression and antioxidants.

4.7 Overall Interpretation

The biochemical assays reveal that the characteristic pattern of diazinon toxicity has been established. Liver damage was reflected by the increased level of ALT, AST, ALP and ACP and decreased serum proteins. Metabolic impairment was indicated by severe dyslipidaemia. Kidney damage was indicated by increase of urea, creatinine and uric acid levels along with BUN and disbalance in sodium, potassium and calcium levels.

Aloe barbadensis always brought values of mentioned indices close to control values. The impact of Aloe was not only limited to one biochemical cascade or organ system but also comprised action on liver enzymes, protein metabolism, lipid metabolism, renal clearance and electrolyte homeostasis. This wide response strengthens the conclusion that Aloe has systemic protective action in case of repeated diazinon intoxication. The present study is consistent with previous research which found that natural antioxidants can alleviate organophosphates' organ toxicity. Previous studies investigated the protective potential of Vitamin C, vitamin E, thymoquinone, gallic acid and other plant compounds against diazinon or similar pesticides (Gokalp *et al.*, 2005; Ajibade *et al.*, 2016; Ghazy *et al.*, 2019; Nassar *et al.*, 2023). The current finding positions *Aloe barbadensis* in the same range of natural protective agents evaluated earlier.

5. Conclusion

The current study provides evidence that repeated oral administration of diazinon (30 mg/kg b.w), which represents 1/10 of the experimentally determined LD₅₀, resulted in significant biochemical changes in albino rats. The toxic effects appeared to increase with time of exposure with peak appearance after 28 days. The source experiment established the diazinon LD₅₀ at approximately 300 mg/kg b.w. and used the 30 mg/kg sublethal dose for assessment of chronic biochemical toxicity. The diazinon caused hepatotoxicity, presented by a highly significant increase in ALT, AST, ALP and ACP enzyme activities accompanied by decreased total protein, albumin, globulin and A/G ratio. Dyslipidaemia appeared to be present, indicated by increased total cholesterol, triglycerides, LDL-C and VLDL-C levels, while HDL-C decreased. Renal toxicity was evidenced by the elevations in blood urea,

creatinine, uric acid and BUN as well as changes in sodium, potassium and calcium concentrations. The administration of *Aloe barbadensis* noticeably improved the biochemical changes. The activities of liver enzymes came back closer to normal, protein parameters improved, lipids normalized, the concentration of the waste products decreased and electrolyte balance returned to normal. The group receiving Aloe treatment was seen to have the biochemical parameters closer to control group compared to water group.

The findings thus prove the assumption that *Aloe barbadensis* possesses a great hepatoprotective, hypolipidemic and nephroprotective potential against the diazinon-induced biochemical toxicity in albino rats. It was shown that the protective action of Aloe is due to its antioxidant and anti-inflammatory properties. It would be interesting to conduct more research focused on the oxidative stress markers, inflammatory mediators and molecular mechanisms of the mentioned effects.

References

- Aakash, Arya, H., & Kumar, A. (2026). A review on water quality assessment in local wetlands using physiochemical parameters. *J. Sci. Innov. Nat. Earth*, 6(2), 73–77. <https://doi.org/10.59436/jsiane.v6i2.12.25> 83-2093
- Abdel-Daim, M. A., Abushouk, A. I., Alkhalf, M. I., Toraih, E. A., Fawzy, M. S., Ijaz, H., Aleya, L., & Bungau, S. J. (2018). Antagonistic effects of *Spirulina platensis* on diazinon-induced hemato-biochemical alterations and oxidative stress in rats. *Environmental Science and Pollution Research*, 25(27), 27463–27470.
- Abdollahi, M., Ranjbar, A., Shadnia, S., Nikfar, S., & Rezaie, A. (2004). Pesticides and oxidative stress: A review. *Medical Science Monitor*, 10(6), RA141–RA147.
- Ajibade, T. O., Oyagbemi, A. A., & Omobowale, T. O. (2016). Mitigation of diazinon-induced cardiovascular and renal dysfunction by gallic acid. *Interdisciplinary Toxicology*, 9(2), 66–77.
- Al-Attar, A. M. (2015). Effect of grapeseed oil on diazinon-induced physiological and histopathological alterations in rats. *Saudi Journal of Biological Sciences*, 22(3), 284–292.
- Al-Attar, A. M., & Abu-Zeid, I. M. (2013). Effect of tea (*Camellia sinensis*) and olive (*Olea europaea* L.) leaves extracts on male mice exposed to diazinon. *BioMed Research International*, 2013, 1–7.
- Al-Attar, A. M., Moustafa, H. R., Elnaggar, E., & Almalki, A. (2016). Protective effect of some plant oils on diazinon-induced hepatorenal toxicity in male rats. *Saudi Journal of Biological Sciences*, 24(6), 1162–1171.
- Al-Shinnawy, M. S. A. (2008). Effects of orally fed diazinon on some biochemical parameters of male albino rats. *Egyptian Journal of Hospital Medicine*, 33, 559–568.
- Al-Shinnawy, M. S., Hassan, A. R., Ismail, D. A., & Shahin, M. A. (2014). The potential protective and therapeutic effects of Aloe vera juice on malathion-induced hepatotoxicity in rabbits. *Egyptian Journal of Hospital Medicine*, 55, 146–158.
- Costa, L. G. (2018). Organophosphorus compounds at 80: Some old and new issues. *Toxicological Sciences*, 162(1), 24–35.
- Damodar, D., D'Souza, U. J., & Bhat, S. (2015). Protective role of vitamin E on diazinon-induced hepatotoxicity by biochemical and histological alterations in Wistar rats. *National Journal of Physiology, Pharmacy and Pharmacology*, 5(5), 398–406.
- Dixit, R., & Khan, R. (2024). Concentration of pollutants and their toxic impact in the residents of Firozabad City: India. *J. Sci. Innov. Nat. Earth*, 4(2), 54–57. <https://doi.org/10.59436/Jsiane.v4i2/366>
- Doumas, B. T., Watson, W. A., & Biggs, H. G. (1971). Albumin standards and the measurement of serum albumin with bromocresol green. *Clinica Chimica Acta*, 31(1), 87–96.
- Fauzdar, L., Singh, S., Singh, K., Singh, A. P., Sagar, P., Biswas, S., & Singh, Y. (2025). A review on protective effect of Aloe vera barbadensis on hematological parameters of albino rat after diazinon intoxication. *J. Sci. Innov. Nat. Earth*, 5(2), 76–78. <https://doi.org/10.59436/jsiane.400.2583-2093>
- Fawcett, J. K., & Scott, J. E. (1960). A rapid and precise method for the determination of urea. *Journal of Clinical Pathology*, 13(2), 156–159.
- Friedewald, W. T., Levy, R. I., & Fredrickson, D. S. (1972). Estimation of the concentration of low-density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. *Clinical Chemistry*, 18(6), 499–502.
- Ghazy, E. W., Mokh, A. A., Abdelhady, D. H., Goda, W. M., & Hashem, E. M. (2019). The role of thymoquinone in

- ameliorating the hepatotoxic effect of diazinon in male rats. *Slovenian Veterinary Research*, 56(Suppl. 22), 735–745.
- Gokalp, O., Buyukvanli, B., Cicek, E., Ozer, M. K., Koyu, A., Altuntas, I., & Koylu, H. (2005). The effects of diazinon on pancreatic damage and ameliorating role of vitamin E and vitamin C. *Pesticide Biochemistry and Physiology*, 81, 123–128.
 - Gupta, V. K., Kumar, A., Pereira, M. L., Siddiqi, N. J., & Sharma, B. (2020). Anti-inflammatory and antioxidative potential of Aloe vera on cartap and malathion-mediated toxicity in Wistar rats. *International Journal of Environmental Research and Public Health*, 17, 5177.
 - Gupta, V. K., Siddiqi, N. J., Ojha, A. K., & Sharma, B. (2019). Hepatoprotective effect of Aloe vera against cartap and malathion-induced toxicity in Wistar rats. *Cell Physiology*, 6, 1–15.
 - Kalender, Y., Uzunhisarcikli, M., Ogutcu, A., Acikgoz, F., & Kalender, S. (2006). Effects of diazinon on pseudocholinesterase activity and haematological indices in rats: The protective role of vitamin E. *Environmental Toxicology and Pharmacology*, 22, 46–51.
 - Khirwar, K., & Shukla, U. (2026). Ameliorative effects of broccoli (Brassica oleracea) on incense smoke-induced oxidative stress and hepatotoxicity in albino rats. *Int. J. Prim. Second. Res. (IJPSR)*, 2(2), 20–23. <https://doi.org/10.59436/ijpsr.v2i2.4.3139-342X>
 - Khormi, M. A., Elnaggar, M. H. R., & Al-Hazmi, M. A. (2022). Protective effect of Arabian balsam (*Commiphora gileadensis*) against hepatorenal toxicity of diazinon in male rats. *Acta Scientific Medical Sciences*, 6(6), 69–81.
 - Mishra, D., Singh, S. P., Pandey, S., & Biswas, B. B. (2022). Extract of Sahijan (drumstick): An approach to water dessipation. *J. Sci. Innov. Nat. Earth*, 2(2), 21–24. <https://doi.org/10.59436/jsiane.142.2583-2093>
 - Mossa, A. H., Heikal, T. M., & Omara, E. A. A. (2012). Physiological and histopathological changes in the liver of male rats exposed to paracetamol and diazinon. *Asian Pacific Journal of Tropical Biomedicine*, S1683–S1690.
 - Nassar, W. M., El-Kholy, W. M., El-Sawi, M. R., El-Shafai, N. M., Alotaibi, B. S., Ghamry, H. S., & Shukry, M. (2023). Ameliorative effect of thymoquinone and thymoquinone nanoparticles against diazinon-induced hepatic injury in rats: A possible protection mechanism. *Toxics*, 11, 783.
 - Pathak, A., Tripathi, V., Khan, S. A., Sunil, Ashlesha, Shukla, K., Singh, S., & Sanskar. (2025). Health, social, along with dietary risks of junk food consumption: Assessing advantages and disadvantages in contemporary dietary habits. *Int. J. Prim. Second. Res. (IJPSR)*, 1(1), 20–26. <https://doi.org/10.59436/ijpsr.v1i1.4.3139-342X>
 - Rajput, S., Sharma, H. N., Gaur, H., & Shueb, M. (2026). Protective efficacy of vitamin E against triazine-induced hepatic damage in freshwater fish *Channa punctatus* (Bloch.). *Int. J. Prim. Second. Res. (IJPSR)*, 2(2), 1–5. <https://doi.org/10.59436/ijpsr.v2i2.1.3139-342X>
 - Sanchez, M., González-Burgos, E., Iglesias, I., & Gómez-Serranillos, M. P. (2020). Pharmacological update properties of *Aloe barbadensis* and its major active constituents. *Molecules*, 25, 1324.
 - Sarhan, O. M. M., & Al-Sahhaf, Z. Y. (2011). Histological and biochemical effects of diazinon on liver and kidney of rabbits. *Life Science Journal*, 8(4), 1183–1189.
 - Singh, A. P., Singh, P. K., & Sharma, H. N. (2023). Ameliorative effect of *Tribulus terrestris* on liver biochemical parameters in albino rat after treatment with drug flutamide. *J. Sci. Innov. Nat. Earth*, 3(3), 46–48. <https://doi.org/10.59436/trpq5296>
 - Singh, A., Hemlata, Singh, A. P., & Kumar, A. (2025). Protective role of medicinal plant extracts against organophosphate-induced toxicity in aquatic organisms. *J. Sci. Innov. Nat. Earth*, 5(4), 36–39. <https://doi.org/10.59436/jsiane.452.2583-2093>
 - Singh, B., & Sharma, H. N. (2025). Cadmium and nickel contamination in the Kali River and its ecotoxicological impact on hepatic and hematological health of *Channa punctatus* (Bloch.). *International Int. J. Prim. Second. Res. (IJPSR)*, 1(1), 17–19. <https://doi.org/10.59436/ijpsr.v1i1.3.3139-342X>
 - Vishan Kumar, & Maheshwari, M. (2025). Climate change impacts on freshwater ecosystems: Emerging challenges and adaptation strategies. *Int. J. Prim. Second.*

Res. (IJPSR), 1(1), 27–31.
<https://doi.org/10.59436/ijpsr.v1i1.5.3139-342X>

- Wisudanti, D. D., Herdiana, F. M., & Qodar, T. S. (2019). Diazinon toxicity to kidney and liver of Wistar male rats in terms of biochemical and histopathological parameters. *Journal of Agromedicine and Medical Sciences*, 5(2), 112–117.
- Yadav, S., & Sagar, P. (2026). A review on fluoride-induced hepato-renal toxicity and the ameliorative effects of vitamin D and Tamarindus indica in albino rats. *Int. J. Prim. Second. Res. (IJPSR)*, 2(1), 23–30.
<https://doi.org/10.59436/ijpsr.v2i1.6.3139-342X>