



<https://doi.org/10.47430/ujmr/25101.030>

Received: 05th January, 2025

Accepted: 13th June, 2025



Protective Effects of *Curcuma longa* And *Punica granatum* against Thermally Abused Oil-Induced Hepato-Renal Toxicity in Wistar Rats

Sabiu, U. A. ,*¹ Idoko, A. S. ¹ and Abdulrahman, B. O. ¹

¹Department of Biochemistry and Molecular Biology, Federal University, Dutsin-Ma, Katsina State.

*Corresponding author: umarsabiu5@gmail.com; +2347062201568

Abstract

The consumption of foods processed with thermally abused oil has increased significantly in developing countries due to harsh economic realities. Thermally abused oils are known to contain a variety of toxic compounds that may be deleterious when consumed. This study evaluates the nephroprotective and hepatoprotective effects of *Curcuma longa* and *Punica granatum* on forty (40) female Wistar rats fed thermally abused oil. The rats were divided into eight groups, with each group receiving either standard rat chow or standard rat chow prepared with thermally abused oil. Additionally, four groups were subjected to treatment with *Curcuma longa* and/or *Punica granatum* supplements over a period of twelve weeks. Standard chemical methods were used to determine kidney and liver function biomarkers. The rats fed with thermally abused oil supplemented diets shows significantly ($p < 0.05$) higher Na^+ (158.00 ± 0.58 mmol/L), Cl^- (113.00 ± 2.08 mmol/L), HCO_3^- (22.67 ± 0.33 mmol/L), creatinine (30.00 ± 0.58 $\mu\text{mol/L}$) and urea (1.03 ± 0.03 mmol/L) compared with the groups that received standard rat chow and treatments. Only K^+ (4.47 ± 0.19 mmol/L) shows a significantly ($p < 0.05$) lower concentration in the group fed thermally abused oil-supplemented diet compared to the normal control and treatment groups. The liver indices results showed significantly ($p < 0.05$) lower serum total protein (33 ± 0.33 g/L), albumin (11 ± 0.67 g/L) and conjugated bilirubin (0.12 ± 0.01 mg/dL) but significantly ($p < 0.05$) higher serum globulins (21.33 ± 0.88 g/L), AST (33 ± 0.58 μL), ALP (449 ± 0.58 μL), ALT (24.67 ± 0.33 μL) and total bilirubin (1.90 ± 0.06 mg/dL) in groups fed thermally abused oil based diet compared to the normal control and treatment groups. Additionally, the groups supplemented with *Curcuma longa* and/or *Punica granatum* exhibited improved conditions compared to those fed diets supplemented with thermally abused oil. In summary, the study demonstrates the potential nephroprotective and hepatoprotective effects of turmeric and pomegranate in Wistar rats fed thermally abused oil. The results suggest that both turmeric and pomegranate may help mitigate the adverse effects of consuming reused oil on kidney and liver function. Consequently, this study recommends that consuming thermally abused oil in the diet should be avoided, as it poses a potential health risk. Moreover, it is recommended that diets containing thermally abused oil should be supplemented with *Curcuma longa* and/or *Punica granatum* to protect the liver and kidneys from damage induced by such oils.

Keywords: Biomarkers, *Curcuma longa*, *Punica granatum*, thermally abused oil, liver and kidney function tests.

INTRODUCTION

Vegetable oils are oils obtained by extraction from a category of crops, such as seeds, cereals, nuts, and fruits (Ghouila *et al.*, 2019). These oils are considered part of our feeding habits, adding flavor, texture, and aroma to our foods (Wilson *et al.*, 2017). A considerable number of methods for the production and consumption of vegetable oils exist across the world, across history (Gandini *et al.*, 2016). This situation has led to various reports from food scientists and nutritionists regarding the health risks

associated with the consumption of these oils (Zhou *et al.*, 2020).

Frying is a food preparation technique, and deep-frying is a popular method in various parts of the world, including Nigeria (Oke *et al.*, 2018). Factors such as temperature, immersion duration, heating process, and the quality of the cooking container are reported to cause physical and chemical changes in cooked food and oil (Liu *et al.*, 2023). The processes leading to chemical changes in oils include hydrolysis, oxidation, and reduction, resulting in the production of toxic compounds such as lipid oxidation products,

volatile substances, undesired monomers, polymers, and free radicals (Mehta, 2015; Schaich et al., 2020).

When consumed in food, these toxic compounds are absorbed by the gastrointestinal system and later enter the systemic circulation (Grootveld et al., 2020). Polycyclic aromatic hydrocarbons (PAHs) from repeatedly heated oil have been linked to oxidative stress through the enhancement of reactive oxygen species (ROS) generation and lipid peroxidation, leading to the formation of preneoplastic lesions in the rat liver and kidney (Priyadarshane et al., 2022; Venkata, 2024). It has been reported that reactive oxygen species trigger protein degeneration, lipid peroxidation, and DNA damage, which leads to cell injury and tissue damage (Ghosh et al., 2018). The liver, being the primary organ responsible for detoxification and metabolism, is particularly susceptible to damage from toxic compounds (Alamri, 2018). Prolonged exposure to thermally abused oil can lead to liver damage, including inflammation, fibrosis, and cirrhosis (Ambreen et al., 2020). Similarly, the kidneys play a critical role in maintaining electrolyte balance and waste excretion; thus, they are also vulnerable to damage from toxic compounds (Imenez Silva and Mohebbi, 2022). Kidney damage can lead to chronic kidney disease, characterized by progressive loss of kidney function and ultimately kidney failure (Romagnani et al., 2017).

Medicinal plants have been a source of natural remedies used for centuries to treat a wide range of health issues and diseases (Manisha et al., 2025). They offer a natural alternative to synthetic medication with fewer side effects compared to conventional medications (Mensah et al., 2019). Natural products such as *Curcuma longa* and *Punica granatum* have been traditionally used to protect against oxidative stress and inflammation (Memarzia et al., 2021; Moradnia et al., 2024). These plants, with their rich phytochemical profiles, have been extensively researched for their protective effects against various diseases (Maphetu et al., 2022; Fuloria et al., 2022). Curcumin, a bioactive compound in turmeric, and punicalagins, found in pomegranate, have demonstrated potent antioxidant and anti-inflammatory activities. This study therefore aims to investigate the hepatoprotective and nephroprotective effects of turmeric and pomegranate supplements in Wistar rats fed thermally abused oil. By examining the biochemical and histopathological changes in the liver and kidney of rats treated with turmeric and pomegranate supplements, this study aims to provide insights into the potential benefits of these natural products in protecting

against liver and kidney damage caused by thermally abused oils.

While other research studies use the extracts of *Curcuma longa* and *Punica granatum* to access the hepatoprotective and nephroprotective activities of these plants, this study use the whole plant powders of turmeric and pomegranate supplements to investigate the hepato and nephroprotective effects in single and combined doses in Wistar rats fed thermally abused oil, exploring their potentials as dietary interventions for mitigating oil-induced metabolic disorders.

MATERIALS AND METHODS

Ethical Approval

The study was conducted in accordance with the guidelines and regulation set forth by the FUOYE Faculty of Science Research Ethics Committee at Federal University Oye-Ekiti with protocol number FUOYEFSC 201122-REC2025/028. Animals were housed in a controlled environment with access to food and water *ad libitum*, and all efforts were made to minimize suffering and distress.

Experimental Animals

Forty (40) female Wistar rats were obtained from the Animal House, Biochemistry Department, Federal University Dutsin-Ma, and were acclimatized under controlled light/dark conditions. They were fed starter feed and water *ad libitum* for a period of two weeks.

Plant Sample Collection, Identification and Preparation

Rhizomes of *Curcuma longa* were purchased from a local market in Dutsin-Ma and identified by a botanist in the Department of Plant Science and Biotechnology, Federal University Dutsin-Ma. The rhizomes were washed, dried under a shed, and ground into powder, and kept for diet formulation. The powder of *Punica granatum* was purchased from Al-Hilal Islamic Chemist, Katsina.

Preparation of Thermally Abused Oil

A fresh vegetable oil was chosen and then heated to 180°C in a thermostatically controlled deep fryer for 2 hours to simulate frying conditions. It was then allowed to cool to room temperature for 1 hour. This heating cycle (at 180°C for 2 hours) and cooling cycle were repeated six times to induce thermal degradation. After the final heating cycle, the oil was cooled to room temperature (Fweja, 2019). The thermally abused oil was collected and stored in sterile, clean containers for use in the formulation of the rats' diet.

Feed Composition

Standard rodent diet was prepared by appropriately mixing corn starch, SBM, cellulose, salt, vitamin mix, and mineral mix (Idoko et al., 2022).

Table 1: Detailed components used in feed formulation for a 100 g diet

Feed ingredients (g)	Control Diet (g)	Reused Oil Diets (g)
Corn Starch	55.45	55.45
SBM	32	32
Cellulose	4.5	4.5
Bone Meal	1.25	1.25
Salt Mix	0.3	0.3
Pre-Mix	0.25	0.25
Methionine	0.25	0.25
Palm oil	60	-
Thermally abused Oil	-	60

Supplemented Diet Formulation

The supplemented diets were formulated by mixing 97 g of the control diet with 3 g of pomegranate and/or turmeric. Another supplemented diet was created by combining 97 g of a thermally abused oil-based diet with 3 g of pomegranate and/or turmeric. Mixed supplementations were achieved by blending 1.5 g each of turmeric and pomegranate with 97 g of the standard diet or the thermally abused oil-based diet.

Experimental design

Forty (40) female Wistar rats, weighing between 60 and 110 g, were used in this experiment. The rats were weighed and grouped randomly into eight (8) groups of 5 rats each as follows;

Group 1 were maintained on standard rat diet (control)

Group 2 were maintained on thermally abused oil based diet (positive control)

Group 3 were maintained on 3 % *Curcuma longa* supplemented diet.

Group 4 were maintained on 3 % *Punica granatum* supplemented diet.

Group 5 were maintained on 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet.

Group 6 were maintained on 3 % *Curcuma longa* and thermally abused oil supplemented diet.

Group 7 were maintained on 3 % *Punica granatum* and thermally abused oil supplemented diet.

Group 8 were maintained on 3 % mixed *Curcuma longa*, *Punica granatum* and thermally abused oil supplemented diet.

The rats were kept on their respective diets and water *ad libitum* for a period of twelve (12) weeks.

Sacrifice, Sample Collection and Sample Preparation

At the end of twelve weeks, the animals were anesthetized using chloroform, sacrificed by cutting the jugular vein until complete bleeding, the blood samples were collected in plain tubes and centrifuged at 1500 rpm for 15 minutes to obtain the serum. The serum was stored at -20

°C until analysis (Idoko *et al.*, 2024). Liver and kidney tissues were obtained and stored in 10 % formaldehyde until analysis.

Determination of Serum Electrolytes, Urea, and Creatinine

The methods of Albert *et al.* (2011) were used for the determination of serum electrolytes. The method of Orsonneau *et al.* (1992) was used for the determination of serum urea. Serum creatinine was determined using the method of Heinegård and Tiderström (1973).

Determination of Liver Function Indices

The methods of Kingsley, (1937) were used for the determination of total protein, albumin and globulins. The methods of Shamsavani *et al.* (2010) were used to determine serum ALP, ALST, and ALT. The methods of Defreese *et al.* (1984) were used for the determination of total and conjugated bilirubin.

Histopathological Investigation

Liver and kidney tissues were dehydrated using ascending grades of methanol, from 70 to 100 percent, and then cleared using xylene. The tissues were infiltrated with molten paraffin wax and then embedded in paraffin wax. The tissues were sectioned at 5 microns using a rotary microtome. The sections obtained were floated out on a floating out bath, picked up using a clean slide from the floating out bath, and dried on the slide drier.

Haematoxylin and eosin staining

Sections were dewaxed using xylene and hydrated using a descending series of alcohols from 100% to 70% concentration, after which the sections were washed in water. The section was stained using haematoxylin stain for 10 minutes. The section was washed in water. The section was differentiated using 1% acetic acid alcohol. The section was washed in water. The section was blued in scott tap water. The section was washed in water. The section was counterstained using eosin for 2 minutes. The section was washed in water. The section was dehydrated using alcohol. The section was

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 23 was used for data analysis. Data were analyzed using one-way analysis of variance (ANOVA), and the Duncan multiple range test was used to indicate where significant differences existed.

RESULTS

Kidney Function indices of Wistar rats fed thermally abused oil fed *Curcuma longa* and/or *Punica granatum*.

Table 2 presents the results of kidney function indices in Wistar rats fed thermally abused oil-supplemented diets. There was significant ($p < 0.05$) increase in the levels of the electrolytes Na^+ , Cl^- and Bicarbonate (HCO_3^-) in the group fed thermally abused oil supplanted diets compared to the normal control and treatment groups while there was significant ($p < 0.05$) decrease in the level K^+ in the group fed thermally abused oil supplemented diet compared to the normal control and treatment groups. Additionally, the metabolites urea and creatinine were significantly ($p < 0.05$) higher in the group maintained on a thermally abused oil-supplemented diet compared to the normal control and treatment groups.

Table 2: Electrolytes/metabolites of kidney function of Wistar rats fed thermally abused oil.

Group	Na^+ (mmol/L)	K^+ (mmol/L)	Cl^- (mmol/L)	HCO_3^- (mmol/L)	Urea (mmol/L)	Creatinine ($\mu\text{mol/L}$)
1	146.33±1.20 ^{bc}	4.97±0.12 ^{ab}	110.67±1.76 ^{ab}	21.33±0.88 ^{bc}	0.60±0.06 ^{ab}	26.33±0.33 ^{cd}
2	158.00±0.58 ^d	4.47±0.19 ^a	113.00±2.08 ^b	22.67±0.33 ^c	1.03±0.03 ^c	30.00±0.58 ^e
3	139.33±0.88 ^a	6.47±0.22 ^d	104.33±2.85 ^a	13.67±2.19 ^a	0.67±0.03 ^{ab}	26.33±0.67 ^{cd}
4	145.00±0.58 ^b	5.83±0.09 ^c	108.00±0.58 ^{ab}	17.67±0.33 ^b	0.70±0.06 ^b	27.33±0.88 ^d
5	145.00±3.51 ^b	5.20±0.17 ^b	109.00±4.04 ^{ab}	19.67±0.88 ^{bc}	0.63±0.03 ^{ab}	25.00±0.58 ^{bc}
6	147.67±0.33 ^{bc}	4.63±0.14 ^{ab}	110.33±0.88 ^{ab}	22.33±1.45 ^c	0.57±0.03 ^{ab}	21.00±0.58 ^a
7	156.33±1.45 ^d	4.53±0.09 ^{ab}	109.00±3.61 ^{ab}	22.33±0.88 ^c	0.50±0.06 ^a	23.67±0.88 ^b
8	150.67±1.76 ^c	4.77±0.19 ^{ab}	109.00±4.04 ^{ab}	21.67±1.20 ^c	0.53±0.09 ^{ab}	20.67±0.88 ^a

Key:

- 1; group fed normal control diet. - 2; group fed thermally abused oil supplemented diet.
- 3; group fed 3 % *Curcuma longa* supplemented diet - 4; group fed 3 % *Punica granatum* supplemented diet.
- 5; group fed 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet.
- 6; group fed 3 % *Curcuma longa* + thermally abused oil supplemented diet.
- 7; group fed 3 % *Punica granatum* + thermally abused oil supplemented diet.
- 8; group fed 3 % mixed *Curcuma longa* and *Punica granatum* + thermally abused oil supplemented diet.

Liver function indices of Wistar rats fed thermally abused oil fed *Curcuma longa* and/or *Punica granatum*

The results outlined in Table 3 show the liver function indices of Wistar rats fed diets supplemented with thermally abused oil. Serum activities of liver enzymes ALP, AST, and ALT are significantly ($p < 0.05$) higher in the group fed a thermally abused oil-supplemented diet compared to the control and treatment groups. The total protein (albumin) production by the liver was significantly ($p < 0.05$) reduced in group fed thermally abused oil oil supplemented diet compared to the control group and treatment

groups while there was significant ($p < 0.05$) increase in the amount of globulins in the serum of the group fed thermally abused oil supplemented diet compared to the control and treatment groups. Also, a significant ($p < 0.05$) increase was observed in the level of total bilirubin in the group fed a thermally abused oil-supplemented diet compared to the control and treatment groups, while there was a significant ($p > 0.05$) decrease in the level of conjugated bilirubin in the group fed a reused oil-supplemented diet compared to the control and treatment groups.

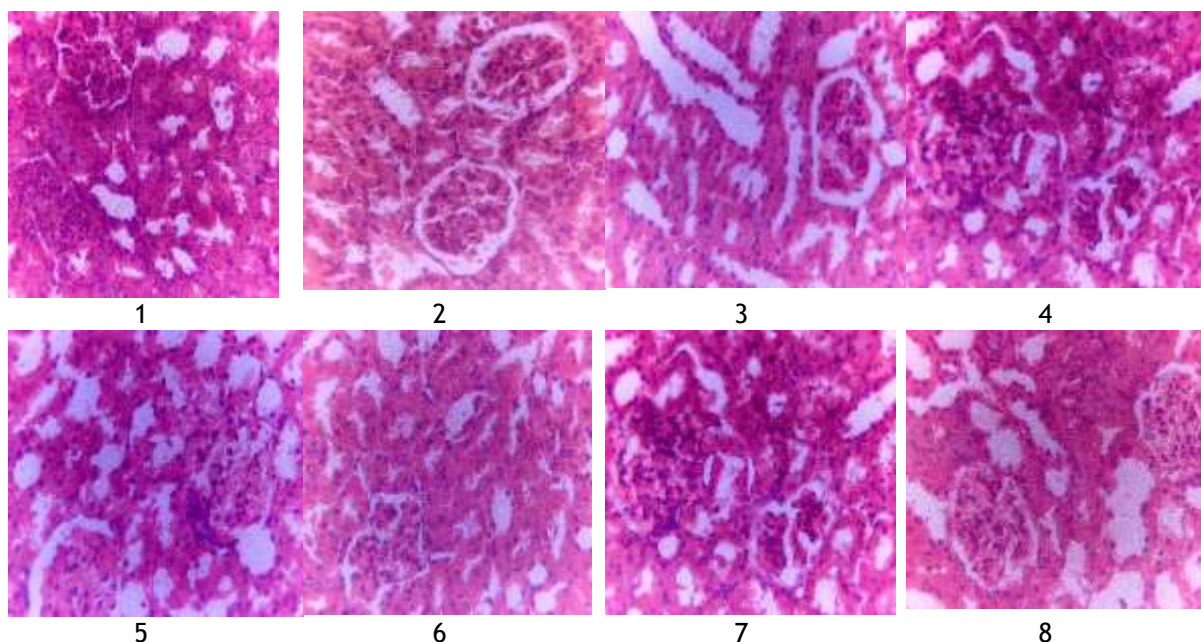


Plate 1: Microscopic (Magnification ×400) view of kidney tissues showing nephroprotective effect of *Curcuma longa* and *Punica granatum* in Wistar rats fed thermally abused oil (1 to 8 numbering represents groups of rats).

Table 3: Liver enzymes and metabolites of liver function indices of Wistar rats fed thermally abused oil.

Group	TP (g/L)	ALB (g/L)	GLO (g/L)	ALP (μ/L)	AST (μ/L)	ALT (μ/L)	TB (mg/dL)	CB (mg/dL)
1	35±0.58 _b	21±0.67 ^d	14.33±0.88 _b	414±2.72 _c	22±0.88 _b	21.67±0.88 _d	1.27±0.07 ^c	0.43±0.03 ^c
2	33±0.33 _a	11±0.67 ^a	21.33±0.88 _d	449±0.58 _d	33±0.58 _e	24.67±0.33 _e	1.90±0.06 ^e	0.12±0.01 ^a
3	42±0.88 _c	32±0.58 ^f	9.67±0.33 ^a	372±10.9 _b	20±0.33 _b	13.33±1.2 ^b	0.70±0.12 ^a	0.53±0.03 ^d
4	43±0.58 _c	32±0.58 ^f	11.00±0.00 ^a	362±14.2 _b	23±0.00 _a	17.00±0.58 _a	0.80±0.06 ^a	0.59±0.01 ^d
5	45±0.58 _d	30±0.33 ^e	14.67±0.33 _b	287±6.02 _a	22±0.33 _b	13.00±0.58 _a	0.80±0.06 ^a	0.62±0.02 ^e
6	37±0.33 _b	20±0.58 ^b	16.67±0.33 _c	410±5.49 _c	25±0.33 _b	19.67±0.33 _c	0.93±0.07 ^d	0.43±0.01 ^b
7	36±0.33 _b	19±0.33 ^c	17.67±0.33 _c	398±4.40 _c	24±0.33 _c	22.00±0.00 ^d	1.53±0.03 ^b	0.36±0.01 ^c
8	36±0.33 _b	18±0.33 ^b	17.67±0.67 _c	417±1.52 _c	27±0.33 _d	21.67±0.33 _d	1.40±0.06 ^c	0.31±0.01 ^b

Key: TP = total protein, ALB = Albumin, GLO = Globulins, ALP = Alkaline phosphatase, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, TB = Total bilirubin and CB = Conjugated bilirubin.

1; group fed normal control diet.

2; group fed thermally abused oil supplemented diet.

3; group fed 3 % *Curcuma longa* supplemented diet.

4; group fed 3 % *Punica granatum* supplemented diet.

5; group fed 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet.

6; group fed 3 % *Curcuma longa* thermally abused oil supplemented diet.

7; group fed 3 % *Punica granatum* + thermally abused oil supplemented diet.

8; group fed 3 % mixed *Curcuma longa* and *Punica granatum* + thermally abused oil supplemented diet.

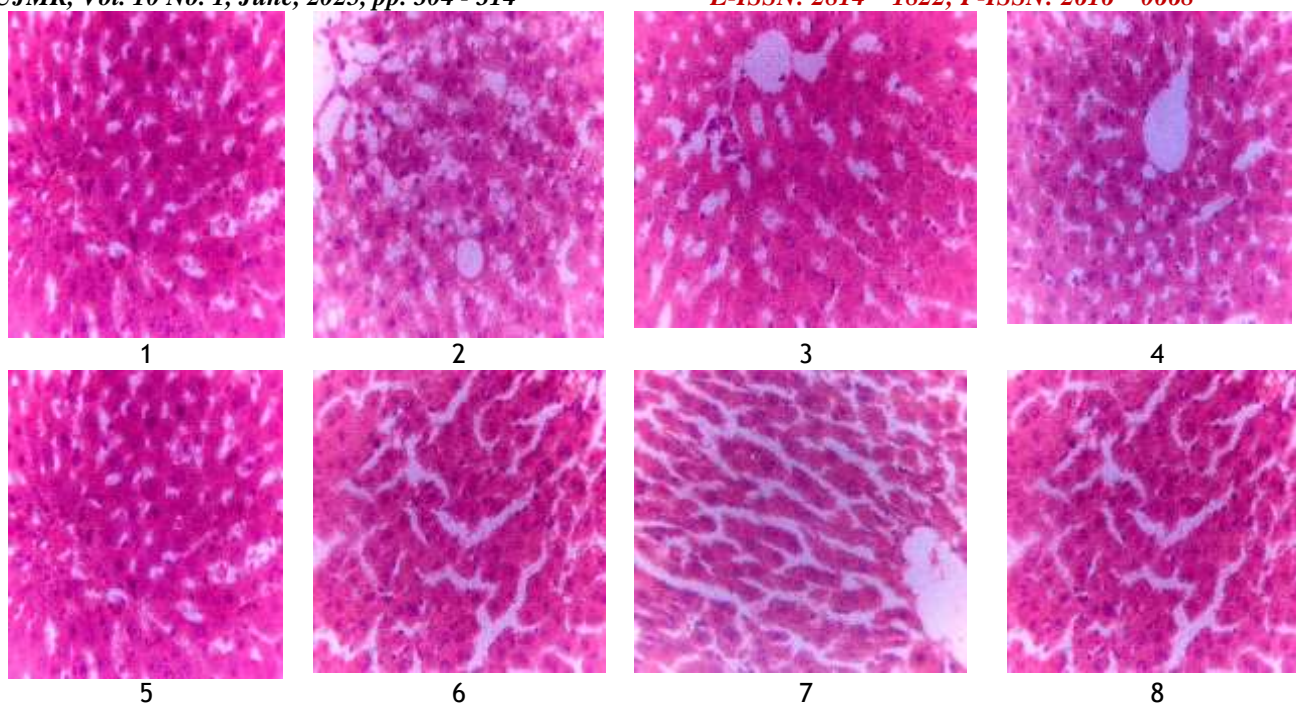


Plate 2: Microscopic (Magnification ×400) view of liver tissues showing hepatoprotective effect of *Curcuma longa* and *Punica granatum* in Wistar rats fed thermally abused oil (1 to 8 numbering represents groups of rats).

1; group fed normal control diet.

2; group fed thermally abused oil supplemented diet.

3; group fed 3 % *Curcuma longa* supplemented diet.

4; group fed 3 % *Punica granatum* supplemented diet.

5; group fed 3 % mixed *Curcuma longa* and *Punica granatum* supplemented diet.

6; group fed 3 % *Curcuma longa* + thermally abused oil supplemented diet.

7; group fed 3 % *Punica granatum* + thermally abused oil supplemented diet.

8; group fed 3 % mixed *Curcuma longa* and *Punica granatum* + thermally abused oil supplemented diet.

DISCUSSION

Parameters of kidney function in Wistar rats fed thermally abused oil and supplemented with *Curcuma longa* and/or *Punica granatum*.

The electrolytes (Na^+ , K^+ , Cl^- and HCO_3^-) and the waste products (urea and creatinine) are used to assess kidney damage or impaired function (El-Ishaq *et al.*, 2021). Elevated levels of Na^+ , Cl^- and HCO_3^- , urea, and creatinine in the group maintained with a thermally abused oil-supplemented diet may indicate kidney damage or impaired function (Beshel and Beshel, 2019). Increased Na^+ levels may be due to the kidneys' inability to reabsorb Na^+ leading to its accumulation in blood and urine (Borrell *et al.*, 2020). The increased level of chloride may be due to the inability of the kidney to remove excess chlorine, leading to accumulation in the blood (Yadav *et al.*, 2024). The increased levels of bicarbonate in the group may be due to metabolic alkalosis resulting from kidney damage (Melamed and Raphael, 2021). Urea is a byproduct of protein metabolism. When kidneys are damaged, they are unable to effectively

remove urea, leading to accumulation in the blood (Lau and Vaziri, 2017). Creatinine is a waste product of muscle metabolism; the inability of the kidneys to remove creatinine causes its accumulation in the blood (Shahbaz *et al.*, 2024). The decrease in the level of potassium in the reused oil group may indicate altered kidney function or increased excretion (El-Demerdash *et al.*, 2021). All these alterations in electrolytes and waste products in the thermally abused oil-based diet group may be due to the formation of polar compounds, such as aldehydes, ketones, which are known to be toxic to the kidneys (Schaich, 2020). Also, the consumption of the toxic compounds may lead to the production of free radicals that may damage the kidneys or impair their function (Phaniendra *et al.*, 2015). The presence of harmful compounds in thermally abused oil may also trigger inflammation, further contributing to kidney damage (Zakaria *et al.*, 2024). Meanwhile, in the treatment groups, normalized levels of the biomarkers may suggest that turmeric and pomegranate have a restorative

effect on kidney function (Ahama *et al.*, 2023; Baradaran Rahimi and Askari, 2024). This may be due to the antioxidant properties that mitigate oxidative stress and inflammation associated with the consumption of reused oil (Moradnia *et al.*, 2024; Dama *et al.*, 2024). Curcumin, a bioactive ingredient in turmeric, and polyphenols such as punicalagins and anthocyanins in pomegranate have been reported to neutralize free radicals, unstable molecules that can cause oxidative stress and cell damage (Akbari *et al.*, 2022; Moradnia *et al.*, 2024). Curcumin and pomegranate may also inhibit enzymes involved in oxidative stress, further reducing oxidative damage to the kidneys (Otunctemur *et al.*, 2015). Curcumin and pomegranate have also been reported to inhibit enzymes involved in inflammation, such as COX-2 and LOX. They also have the potential to suppress the production of pro-inflammatory cytokines, such as TNF- α and IL-1B (Laveti *et al.*, 2013). AlMatar *et al.* (2018) and Barchitta *et al.* (2019) show that curcumin and pomegranate can also modulate immune response, reducing inflammation and promoting tissue repair.

Parameters of liver function in Wistar rats fed reused oil and supplemented with *Curcuma longa* and/or *Punica granatum*.

Liver enzymes (ALP, AST, and ALT) and liver metabolites (total protein, albumin, globulins, total bilirubin, and conjugated bilirubin) were used to assess liver function (Lala *et al.*, 2023). Increased liver enzymes, globulins, and total bilirubin, along with decreased total proteins and albumin, indicate potential liver damage in the group fed thermally abused oil-supplemented diets (Lima *et al.*, 2022). Increased levels of alkaline phosphatase in the reused oil supplemented group was not only implicated in liver damage, cholestasis or any other liver disease, but has also been implicated in bone disease (Poupon *et al.*, 2015). Elevated AST and ALT in serum indicate liver cell injury or death along with liver inflammation or damage (Church and Watkins, 2017). Serum elevation of globulins indicates a suggested immune response to infection, inflammation, or liver necrosis, which brings about the outflow of hepatocytes' proteins into the serum (Wilde and Katsounas, 2019). Elevated levels of total bilirubin in group fed thermally abused oil may indicate hemolytic anemia, bile obstruction, or impaired bilirubin clearance resulting from liver damage (Méndez-Sánchez *et al.*, 2019). On the other hand, decreased total protein and albumin indicate a loss of liver ability to produce proteins, especially albumin, due to necrosis (Arroyo *et al.*, 2014). Consumption of thermally abused oil has been implicated in the production of

reactive oxygen species, lipid peroxidation, activation of pro-inflammatory pathways, and recruitment of immune cells due to the formation of toxic compounds, such as aldehydes and polycyclic aromatic hydrocarbons, which can cause liver damage (Nirwanti *et al.*, 2025). The group fed Turmeric and pomegranate has shown improved activities of liver enzymes and metabolites compared to the group fed a thermally abused oil-supplemented diet. This may be due to the strong antioxidant activities of turmeric and pomegranate, which help to neutralize free radicals and reduce oxidative stress in the liver (Gowifel *et al.*, 2020). The hepatoprotective effect may also be attributed to the anti-inflammatory activity of the bioactive ingredients, specifically curcumin and polyphenols, in turmeric and pomegranate, respectively (Safar, 2020). Sadia *et al.* (2016) reported that liver protection was clearly demonstrated by a significant decrease in serum aminotransferases (AST, ALT) after *Curcuma longa* and *Punica granatum* were administered to rats. The *Curcuma longa* and *Punica granatum*'s hepatoprotective effect is mainly a result of its antioxidant properties, as well as its ability to decrease the formation of pro-inflammatory cytokines, free radical scavenging, ROS scavenging ability, and cell proliferation activity in cell line (Lam *et al.*, 2016; Zamanian *et al.*, 2023). It was noted that rats treated with *Curcuma longa* and *Punica granatum* have enzymatic activities lower than those not given the treatment. This means that *Curcuma longa* and *Punica granatum* are effective against any inflammatory condition that can affect the liver. These anti-inflammatory properties may be attributed to their ability to inhibit both the biosynthesis of inflammatory prostaglandins from arachidonic acid and neutrophil function during inflammatory states (Tung *et al.*, 2023; Moradnia *et al.*, 2024). The result of this study showed that the application of turmeric and pomegranate markedly inhibited acute hepatic failure in a rat model, which was induced at least in part by free radical formation. The results suggest that turmeric and its active component, curcumin, may be effective against acute liver stress by enhancing redox capacity and antioxidant enzyme activity. Acute thermally abused oil administration is a widely used experimental model that mimics the acute liver failure caused by toxic substances (Wang *et al.*, 2019). Although the liver plays a key role in biotransforming and detoxifying chemicals, certain medicinal agents, when taken in excess, may harm the organ. Other chemical agents or industrial agents can also induce hepatotoxicity. These chemicals often cause subclinical injury to the liver, increasing liver enzymes, but not

causing pathological abnormalities such as histological and hepatosteatosis status changes. Curcumin and pomegranate also control the out flow of ALT, AST, and ALP from the liver cells. A similar pattern was reported recently in cases of acute hepatic and transient stress (Khalphallah *et al.*, 2025). AST is localized in the mitochondria, whereas ALT is distributed throughout the cytoplasm. In the case of hepatic stress, mitochondrial damage with ROS accumulation tends to increase the level of AST more than ALT (García-Ruiz and Fernández-Checa, 2018). The manifestation of acute hepatotoxicity in acute stress is highly variable, ranging from asymptomatic elevation of liver enzymes to fulminant hepatic failure (García-Ruiz and Fernández-Checa, 2018).

CONCLUSION

The study demonstrates the potential nephroprotective and hepatoprotective effects of turmeric and pomegranate in Wistar rats fed thermally abused oil. The results suggest that both turmeric and pomegranate may help mitigate the adverse effects of consuming

REFERENCES

- Ahama, E., Igben, V. J. O., Ubogu, J., Ifechukwude, I. O., Nwabuoku, U. S., Okwuribo, P., ... & Odokuma, I. E. (2023). Potential nephrotoxic sequel of the kidney following exposure to turmeric extract in adult Wistar rats. *Journal of College of Medical Sciences-Nepal*, 19(4), 482-488. [Crossref]
- Akbari, B., Baghaei-Yazdi, N., Bahmaie, M., & Mahdavi Abhari, F. (2022). The role of plant-derived natural antioxidants in reduction of oxidative stress. *BioFactors*, 48(3), 611-633. [Crossref]
- Alamri, Z. Z. (2018). The role of liver in metabolism: An updated review with physiological emphasis. *International Journal of Basic & Clinical Pharmacology*, 7(11), 2271-2276. [Crossref]
- Albert, V., Subramanian, A., Rangarajan, K., & Pandey, R. M. (2011). Agreement of two different laboratory methods used to measure electrolytes. *Journal of Laboratory Physicians*, 3(2), 104-109. [Crossref]
- AlMatar, M., Islam, M. R., Albarri, O., Var, I., & Koksai, F. (2018). Pomegranate as a possible treatment in reducing risk of developing wound healing, obesity, neurodegenerative disorders, and diabetes mellitus. *Mini Reviews in Medicinal Chemistry*, 18(6), 507-526. [Crossref]

reused oil on kidney and liver function. These findings highlight the potential benefits of incorporating antioxidant-rich foods, such as turmeric and pomegranate in the diet to support overall health and well-being.

Recommendations

This study recommends that consuming thermally abused oil in the diet should be avoided, as it poses a potential health risk. Also, further research should be conducted to elucidate the underlying mechanisms of turmeric and pomegranate's nephroprotective and hepatoprotective effects. Investigating the optimal dosages of turmeric and pomegranate that provide maximum protective effects is also recommended, likewise clinical trials should be conducted to explore the potential benefits of turmeric and pomegranate in humans consuming thermally abused oil. Finally, stakeholders should consider including turmeric and pomegranate into dietary guidelines as potential protective agents against kidney and liver damage.

- Ambreen, G., Siddiq, A., & Hussain, K. (2020). Association of long-term consumption of repeatedly heated mix vegetable oils in different doses and hepatic toxicity through fat accumulation. *Lipids in Health and Disease*, 19(1), 1-9. [Crossref]
- Arroyo, V., García-Martínez, R., & Salvatella, X. (2014). Human serum albumin, systemic inflammation, and cirrhosis. *Journal of Hepatology*, 61(2), 396-407. [Crossref]
- Baradaran Rahimi, V., & Askari, V. R. (2024). Role of herbal medicines for the treatment of chronic kidney disease. In V. R. Askari (Ed.), *Role of Herbal Medicines: Management of Lifestyle Diseases* (pp. 293-312). Springer Nature Singapore. [Crossref]
- Barchitta, M., Maugeri, A., Favara, G., Magnano San Lio, R., Evola, G., Agodi, A., & Basile, G. (2019). Nutrition and wound healing: An overview focusing on the beneficial effects of curcumin. *International Journal of Molecular Sciences*, 20(5), 1119. [Crossref]
- Beshel, F. N., & Beshel, J. A. (2019). Chronic consumption of open market "fresh" palm oil alters renal handling of Na⁺, Cl⁻, K⁺ and HCO₃⁻. *Saudi Journal of Medical and Pharmaceutical Sciences*, 5(9), 763-768. [Crossref]
- Borrelli, S., Provenzano, M., Gagliardi, I., Michael, A., Liberti, M. E., De Nicola, L., ... & Andreucci, M. (2020). Sodium intake and chronic kidney disease. *International*

- Journal of Molecular Sciences*, 21(13), 4744. [Crossref]
- Church, R. J., & Watkins, P. B. (2017). The transformation in biomarker detection and management of drug-induced liver injury. *Liver International*, 37(11), 1582-1590. [Crossref]
- Dama, A., Shpati, K., Daliu, P., Dumur, S., Gorica, E., & Santini, A. (2024). Targeting metabolic diseases: The role of nutraceuticals in modulating oxidative stress and inflammation. *Nutrients*, 16(4), 507. [Crossref]
- Defreese, J. D., Wang, T. S. C., & Renoe, B. W. (1984). Properties and determination of serum bilirubin. *CRC Critical Reviews in Clinical Laboratory Sciences*, 19(4), 267-296. [Crossref]
- El-Demerdash, F. M., El-Sayed, R. A., & Abdel-Daim, M. M. (2021). *Rosmarinus officinalis* essential oil modulates renal toxicity and oxidative stress induced by potassium dichromate in rats. *Journal of Trace Elements in Medicine and Biology*, 67, 126791. [Crossref]
- El-Ishaq, A., Garba, A. M., & Emanuel, D. D. (2021). Assessment of electrolytes, urea and creatinine in patients with renal impairment attending Yobe State Specialist Hospital Damaturu. *Sumerianz Journal of Medical and Healthcare*, 4(2), 114-122. [Crossref]
- Fuloria, S., Mehta, J., Chandel, A., Sekar, M., Rani, N. N. I. M., Begum, M. Y., ... & Fuloria, N. K. (2022). A comprehensive review on the therapeutic potential of *Curcuma longa* Linn. in relation to its major active constituent curcumin. *Frontiers in Pharmacology*, 13, 820806. [Crossref]
- Fweja, L. W. (2019). The effects of repeated heating on thermal degradation of cooking oil and its implication on human health-A review. *Huria: Journal of the Open University of Tanzania*, 26(1), 1-14. [Crossref]
- Gandini, A., Lacerda, T. M., Carvalho, A. J., & Trovatti, E. (2016). Progress of polymers from renewable resources: Furans, vegetable oils, and polysaccharides. *Chemical Reviews*, 116(3), 1637-1669. [Crossref]
- García-Ruiz, C., & Fernández-Checa, J. C. (2018). Mitochondrial oxidative stress and antioxidants balance in fatty liver disease. *Hepatology Communications*, 2(12), 1425-1439. [Crossref]
- Ghosh, N., Das, A., Chaffee, S., Roy, S., & Sen, C. K. (2018). Reactive oxygen species, oxidative damage and cell death. In S. E-ISSN: 2814 – 1822; P-ISSN: 2616 – 0668 Chatterjee, W. Jungraithmayr, & D. Bagchi (Eds.), *Immunity and Inflammation in Health and Disease* (pp. 45-55). Academic Press. [Crossref]
- Ghouila, Z., Sehalia, M., & Chemat, S. (2019). Vegetable oils and fats: Extraction, composition and applications. In M. A. R. Meier & P. L. A. Pop (Eds.), *Plant Based "Green Chemistry 2.0" Moving from Evolutionary to Revolutionary* (pp. 339-375). Springer. [Crossref]
- Gowifel, A. M., Khalil, M. G., Nada, S. A., Kenawy, S. A., Ahmed, K. A., Salama, M. M., & Safar, M. M. (2020). Combination of pomegranate extract and curcumin ameliorates thioacetamide-induced liver fibrosis in rats: Impact on TGF- β /Smad3 and NF- κ B signaling pathways. *Toxicology Mechanisms and Methods*, 30(8), 620-633. [Crossref]
- Grootveld, M., Percival, B. C., Leenders, J., & Wilson, P. B. (2020). Potential adverse public health effects afforded by the ingestion of dietary lipid oxidation product toxins: Significance of fried food sources. *Nutrients*, 12(4), 974. [Crossref]
- Heinegård, D., & Tiderström, G. (1973). Determination of serum creatinine by a direct colorimetric method. *Clinica Chimica Acta*, 43(3), 305-310. [Crossref]
- Idoko, A. S., Bonomi, Z. M., & AbdulRazak, I. (2024). Supplementation of high-fat diet with cinnamon powder has weight-controlling and anti-hyper-insulinemic effects in Wistar rats. *Nigerian Journal of Basic and Applied Sciences*, 32(1), 8-12. [Crossref]
- Idoko, A. S., Umar, S., Adejo, G. O., Imam, N. U., Zaharaddeen, A. S., Abubakar, Z. S., & Abdullahi, A. (2022). Diet fortification with *Curcuma longa* and *Allium cepa* ameliorates 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin-induced dyslipidaemia and oxidative stress in Wistar rats. *Nigerian Journal of Basic and Applied Sciences*, 30(2), 178-183. [Crossref]
- Imenez Silva, P. H., & Mohebbi, N. (2022). Kidney metabolism and acid-base control: Back to the basics. *Pflügers Archiv - European Journal of Physiology*, 474(8), 919-934. [Crossref]
- Khalphallah, A., Mousa, S. A., Almuhanha, A. H., Hassan, D., Al-Shuraym, L. A., Alkeridis, L. A., ... & Elmeligy, E. (2025). ORNIPURAL® as conventional therapy versus mixture of *Curcuma longa* extract and pomegranate peel extract as homeotherapy in dogs with dexamethasone-induced hepatopathy:

- Clinico-laboratory, ultrasonographic, and histopathological monitoring. *Frontiers in Veterinary Science*, 12, 1564648. [Crossref]
- Kingsley, G. R. (1939). The determination of serum total protein, albumin, and globulin by the biuret reaction. *Journal of Biological Chemistry*, 131(1), 197-200. [Crossref]
- Lala, V., Zubair, M., & Minter, D. A. (2023). *Liver function tests*. StatPearls Publishing.
- Lam, P., Cheung, F., Tan, H. Y., Wang, N., Yuen, M. F., & Feng, Y. (2016). Hepatoprotective effects of Chinese medicinal herbs: A focus on anti-inflammatory and anti-oxidative activities. *International Journal of Molecular Sciences*, 17(4), 465. [Crossref]
- Lau, W. L., & Vaziri, N. D. (2017). Urea, a true uremic toxin: The empire strikes back. *Clinical Science*, 131(1), 3-12. [Crossref]
- Laveti, D., Kumar, M., Hemalatha, R., Sistla, R., Naidu, V. G. M., Talla, V., ... & Nagpal, R. (2013). Anti-inflammatory treatments for chronic diseases: A review. *Inflammation & Allergy - Drug Targets*, 12(5), 349-361. [Crossref]
- Lima Rocha, J. É., Mendes Furtado, M., Mello Neto, R. S., da Silva Mendes, A. V., Brito, A. K. D. S., Sena de Almeida, J. O. C., ... & Martins, M. D. C. D. C. E. (2022). Effects of fish oil supplementation on oxidative stress biomarkers and liver damage in hypercholesterolemic rats. *Nutrients*, 14(3), 426. [Crossref]
- Liu, W., Luo, X., Huang, Y., Zhao, M., Liu, T., Wang, J., & Feng, F. (2023). Influence of cooking techniques on food quality, digestibility, and health risks regarding lipid oxidation. *Food Research International*, 167, 112685. [Crossref]
- Manisha, D. R. B., Begam, A. M., Chahal, K. S., & Ashok, M. A. (2025). Medicinal plants and traditional uses and modern applications. *Journal of Neonatal Surgery*, 14(3), 1-10. [Crossref]
- Maphetu, N., Unuofin, J. O., Masuku, N. P., Olisah, C., & Lebelo, S. L. (2022). Medicinal uses, pharmacological activities, phytochemistry, and the molecular mechanisms of *Punica granatum* L. (pomegranate) plant extracts: A review. *Biomedicine & Pharmacotherapy*, 153, 113256. [Crossref]
- Mehta, B. M. (2015). Nutritional and toxicological aspects of the chemical changes of food components and nutrients during heating and cooking. In *E-ISSN: 2814 – 1822; P-ISSN: 2616 – 0668* P. C. K. Cheung & B. M. Mehta (Eds.), *Handbook of Food Chemistry* (pp. 897-936). Springer. [Crossref]
- Melamed, M. L., & Raphael, K. L. (2021). Metabolic acidosis in CKD: A review of recent findings. *Kidney Medicine*, 3(2), 267-277. [Crossref]
- Memarzia, A., Khazdair, M. R., Behrouz, S., Gholamnezhad, Z., Jafarnejhad, M., Saadat, S., & Boskabady, M. H. (2021). Experimental and clinical reports on anti-inflammatory, antioxidant, and immunomodulatory effects of *Curcuma longa* and curcumin, an updated and comprehensive review. *BioFactors*, 47(3), 311-350. [Crossref]
- Méndez-Sánchez, N., Qi, X., Vitek, L., & Arrese, M. (2019). Evaluating an outpatient with an elevated bilirubin. *American Journal of Gastroenterology*, 114(8), 1185-1188. [Crossref]
- Mensah, M. L., Komlaga, G., Forkuo, A. D., Firempong, C., Anning, A. K., & Dickson, R. A. (2019). Toxicity and safety implications of herbal medicines. In P. F. Builders (Ed.), *Herbal Medicine* (pp. 63-84). IntechOpen. [Crossref]
- Moradnia, M., Mohammadkhani, N., Azizi, B., Mohammadi, M., Ebrahimpour, S., Tabatabaei-Malazy, O., ... & Ale-Ebrahim, M. (2024). The power of *Punica granatum*: A natural remedy for oxidative stress and inflammation; a narrative review. *Journal of Ethnopharmacology*, 331, 118243. [Crossref]
- Nirwanti, N. A., & Jusuf, A. A. (2025). Thermally oxidized cooking palm oil-induced histopathological alterations in brain, heart, liver, and kidney: A systematic review of lipid peroxidation and inflammatory mechanisms. *Bioscientia Medicina: Journal of Biomedicine and Translational Research*, 9(5), 7286-7298. [Crossref]
- Oke, E. K., Idowu, M. A., Sobukola, O. P., Adeyeye, S. A. O., & Akinsola, A. O. (2018). Frying of food: A critical review. *Journal of Culinary Science & Technology*, 16(2), 107-127. [Crossref]
- Orsonneau, J. L., Massoubre, C., Cabanes, M., & Lustenberger, P. (1992). Simple and sensitive determination of urea in serum and urine. *Clinical Chemistry*, 38(5), 619-623. [Crossref]
- Otuntemur, A., Ozbek, E., Cakir, S. S., Polat, E. C., Dursun, M., Cekmen, M., ... & Ozbay, N. (2015). Pomegranate extract attenuates unilateral ureteral obstruction-induced renal damage by

- reducing oxidative stress. *Urology Annals*, 7(2), 166-171. [Crossref]
- Phaniendra, A., Jestadi, D. B., & Periyasamy, L. (2015). Free radicals: Properties, sources, targets, and their implication in various diseases. *Indian Journal of Clinical Biochemistry*, 30(1), 11-26. [Crossref]
- Poupon, R. (2015). Liver alkaline phosphatase: A missing link between cholestasis and biliary inflammation. *Hepatology*, 61(6), 2080-2090. [Crossref]
- Priyadarshane, M., Mahto, U., & Das, S. (2022). Mechanism of toxicity and adverse health effects of environmental pollutants. In S. Das (Ed.), *Microbial Biodegradation and Bioremediation* (pp. 33-53). Elsevier. [Crossref]
- Romagnani, P., Remuzzi, G., Glassock, R., Levin, A., Jager, K. J., Tonelli, M., ... & Anders, H. J. (2017). Chronic kidney disease. *Nature Reviews Disease Primers*, 3(1), 17088. [Crossref]
- Sadia, H., Akter, Q. S., Afroz, R., & Siddika, T. (2016). Effect of *Punica Granatum* (Pomegranate) on serum ALT and AST in carbon tetrachloride induced liver damage in Wistar Albino rats. *Journal of Bangladesh Society of Physiologist*, 11(1), 23-28. [Crossref]
- Safar, M. M. (2020). Combination of pomegranate extract and curcumin ameliorates thioacetamide-induced liver fibrosis in rats: Impact on TGF- β /Smad3 and NF- κ B signaling pathways. *Toxicology Mechanisms and Methods*, 30(8), 620-633. [Crossref]
- Schaich, K. M. (2020). Toxicity of lipid oxidation products consumed in the diet. In F. Shahidi (Ed.), *Bailey's Industrial Oil and Fat Products* (pp. 1-88). Wiley. [Crossref]
- Shahbaz, H., Rout, P., & Gupta, M. (2024). Creatinine clearance. In *StatPearls*. StatPearls Publishing.
- Shahsavani, D., Mohri, M., & Gholipour Kanani, H. (2010). Determination of normal values of some blood serum enzymes in *Acipenser stellatus* Pallas. *Fish Physiology and Biochemistry*, 36(1), 39-43. [Crossref]
- Spencer, L., Bancroft, J. & Gamble, M. (2012). Tissue processing. *Bancroft's Theory and Practice of Histological techniques*. 7nd ed. Netherlands, Amsterdam:Elsevier Health Sciences, 105-23 [Crossref]
- Tung, B. T., Linh, T. V., Thao, T. P., & Thuan, N. D. (2023). Anti-inflammatory agents from medicinal plants. In S. K. Singh & T. E. T. A. (Eds.), *Phytochemical Drug Discovery for Central Nervous System* *E-ISSN: 2814 – 1822; P-ISSN: 2616 – 0668 Disorders: Biochemistry and Therapeutic Effects* (pp. 219-250). Wiley. [Crossref]
- Venkata, R. P. (2024). Assessment of the genotoxic potential of repeatedly heated cooking oil in Wistar rats. *Biochemical Genetics*. Advance online publication. [Crossref]
- Wang, M., Ma, L. J., Yang, Y., Xiao, Z., & Wan, J. B. (2019). n-3 Polyunsaturated fatty acids for the management of alcoholic liver disease: A critical review. *Critical Reviews in Food Science and Nutrition*, 59(sup1), S116-S129. [Crossref]
- Wilde, B., & Katsounas, A. (2019). Immune dysfunction and albumin-related immunity in liver cirrhosis. *Mediators of Inflammation*, 2019, 7537649. [Crossref]
- Wilson, D. W., Nash, P., Buttar, H. S., Griffiths, K., Singh, R., De Meester, F., ... & Takahashi, T. (2017). The role of food antioxidants, benefits of functional foods, and influence of feeding habits on the health of the older person: An overview. *Antioxidants*, 6(4), 81. [Crossref]
- Yadav, S., Yadav, J., Kumar, S., & Singh, P. (2024). Potassium, chloride and phosphorus. In S. K. Singh, P. K. Prabhakar, & S. P. Singh (Eds.), *Clinical Applications of Biomolecules in Disease Diagnosis: A Comprehensive Guide to Biochemistry and Metabolism* (pp. 177-192). Springer. [Crossref]
- Zakaria, E. M., Mohammed, E., Alsemeh, A. E., Eltaweel, A. M., & Elrashidy, R. A. (2024). Multiple-heated cooking oil promotes early hepatic and renal senescence in adult male rats: The potential regenerative capacity of oleuropein. *Toxicology Mechanisms and Methods*, 34(8), 936-953. [Crossref]
- Zamanian, M. Y., Sadeghi Ivraghi, M., Khachatryan, L. G., Vadiyan, D. E., Bali, H. Y., & Golmohammadi, M. (2023). A review of experimental and clinical studies on the therapeutic effects of pomegranate (*Punica granatum*) on non-alcoholic fatty liver disease: Focus on oxidative stress and inflammation. *Food Science & Nutrition*, 11(12), 7485-7503. [Crossref]
- Zhou, Y., Zhao, W., Lai, Y., Zhang, B., & Zhang, D. (2020). Edible plant oil: Global status, health issues, and perspectives. *Frontiers in Plant Science*, 11, 1315. [Crossref]