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Shilajit Inhibits the Toxic Effect of Bisphenol

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Abstract

The experiment was conducted at the Faculty of Veterinary Medicine, University of Kerbala, between January 3, 2025, and February 5, 2025. Special cages were used to house the rabbits during the study. A total of thirty rabbits were divided into three groups:

- **G1:** The Control group received water and pellets only.
- **G2**: Treated with Bisphenol A at a dose of 1 mL/kg.
- **G3**: Treated with Bisphenol A (1 mL/kg) and Shilajit (0.2 g/kg).

Biochemical analysis revealed a significant increase in liver enzymes alanine aminotransferase (ALT, IU/L) and aspartate aminotransferase (AST, IU/L) as well as in kidney function markers (urea and creatinine) in G2 compared to G1. In contrast, no significant differences were observed in G3 compared to G1 across all measured parameters.

Histopathological examination of G2 livers showed bile duct hyperplasia, mononuclear cell infiltration around bile ducts, dilated blood vessels, and hydropic degeneration of hepatocytes. Perivascular aggregation of mononuclear cells, predominantly macrophages, was observed around the central vein. Renal tissue in G2 displayed glomerular tuft shrinkage, extensive interstitial mononuclear infiltration, and atrophy of surrounding renal tubules.

In G3, histopathology revealed mild mononuclear cell infiltration, including giant cells and prominent Kupffer cells in the liver. Additionally, fatty changes and apoptotic features were noted in some hepatocytes. Kidney sections showed hyaline casts, interstitial hemorrhage, and infiltration by mononuclear cells.

Keywords:
Shilajit, bisphenol A, and histopathological change

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Introduction

A Bisphenol, it's Bisphenol A or 2,2-bis(hydroxyphenyl), or what's known as Polycarbonate, and monomers are used to make plastic. Recently, epoxy—one of the chemicals that disrupts hormones—was outlawed. Endocrine-disrupting substances, or estrogenic efficacy, are the reason

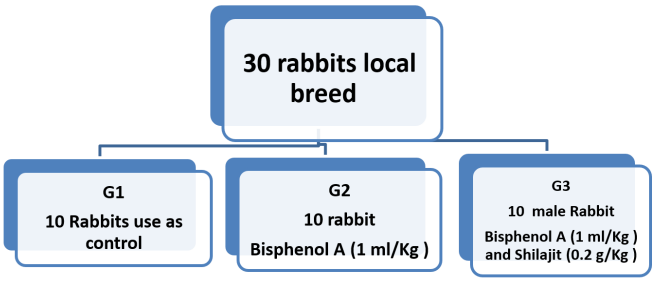
for this. A large number of bisphenol's health effects were first discovered by accident. It was discovered in 1993 AD that bisphenol leaches from polycarbonate flasks. Cancer cells proliferate throughout the breast when autoclaved. Both laboratory animals and humans absorb Bisphenol. Very little of it is taken orally; most of it is transformed into its original, unaltered condition. It is not metabolized more than 90%. binds itself to proteins in plasma **[1]**. As it moves through the liver, the bisphenol that enters the body undergoes metabolism **[2]**. Adult rhesus monkeys were regarded as a reliable ja model when they were employed in the study. This is what occurs to investigate the related presence of bisphenol following oral dosage: Humans have also discovered that mice, monkeys, and humans all have very similar mechanisms for metabolizing bisphenol **[3]**. According to its relative alpha and beta binding strengths, BPA is a weak peripheral estrogen **[4].** According to recent research, bisphenol can sometimes mimic estradiol and can even trigger certain cellular reactions at low concentrations **[5].** A naturally occurring mineral, Shilajit is a gift from the natural resources **[6].** Even though Shilajit is mentioned in ancient traditional literature, it is not widely recognized in the West today. There is little to no data from clinical trials, and the mechanisms underlying its therapeutic efficacy are not well understood. The development of a stronger evidence base on the safety, efficacy, and quality of traditional medicine (TM) products and practices, as well as the documentation of TM and remedies, are crucial components of the various World Health Organization (WHO) strategies to promote safe, effective, and affordable TM in the current millennium **[7].** Furthermore, previous literature reviews and documentation of TM remedies in the form of a simple data bank are necessary for research. This paper provides a comprehensive review of the significance, definition, source, synonyms, varieties, traditional uses, origin, physical characteristics, chemical constituents, bioactivity, toxicity, and contraindications of Shilajit, taking into account the aforementioned facts. It is produced when numerous plants undergo an extended process of humification **[8, 9, 10]**. Additionally**,** some studies have described chemical analyses that indicate 60–70% of Shilajit is humus **[11, 12, 13].** Shilajit's medicinal properties have led to its widespread use in Ayurvedic medicine, a traditional Indian medicine, to treat a range of ailments and long-term conditions **[13, 14].**

Materials & methods

The experiment was conducted at the Faculty of Veterinary Medicine, University of Kerbala, from January 3, 2025, to February 5, 2025. They used special cages for the rabbits used in the experiment.

Experimental Animals.

Thirty rabbits were divided into two groups: G1 treated with water and pellets, this group used as a control, G2 treated with Bisphenol A (1 ml/kg), and G3 treated with Bisphenol A (1 ml/Kg) and Shilajit (0.2 g/Kg)



Schematic of Study design

Immunizations and preventive examinations.

All animals were examined to ensure they were free from injuries and deformities prior to the experiment beginning. The animals were dosed prophylactically with an internal, hepatic, and intestinal antihelmintic drug, Albendazole 3%, and Ivermectin 0.1 ml/rabbit was injected under the

skin to prevent internal and external worms. And they were injected with Amprolium at a dose of 0.6 ml/liter of drinking water for 4 days to prevent coccidiosis, and used Billets as animal feed. Tap water is used for drinking.

Preparation of Bisphenol

Distilled water (75 ml) was added to 25 (Dimethyl sulfoxide (DMSO), then 30 ml was mixed with 3 g bisphenol A, then put on a Magnetic stirrer.

Preparation of Shilajit

6 g of Shilajit is put in distilled water (30) ml, then put on a Magnetic stirrer.

Blood tests.

Five milliliters of blood were drawn from all experimental animals directly from the heart at the end of the experiment. A gel tube was used for liver and kidney enzymes.

Measurement of alanine aminotransferase (ALT), aspartate aminotransferase(AST), urea concentration, and creatinine concentration.

A serum sample was taken and placed in the DC-40-Mindray device, and the measurement was done automatically.

Histopathology:

Pieces of normal internal organs (liver and kidney) were collected and preserved in 10% formalin. The fixed tissue samples were processed by the routine paraffin embedding technique. Briefly, the samples were cut into pieces 2-3 mm thick and washed under running water for a few hours before being dehydrated in ascending grades of alcohol. They were then cleared in xylem and embedded in paraffin. Tissue sections 4-5 um thickness were stained with hematoxylin and the standard methods protocol **[15].**

Statistical analysis.

The statistical analysis of the experimental data was conducted using the Excel program, employing one-way ANOVA for Experiment 2. The Least Significant Differences (LSD) test was then performed to assess the significance of differences among the group means. The results were expressed as mean ± standard error.

Results and Discussion

The results were collected to investigate the effect of combining Bisphenol A and Shilajit on liver and kidney enzymes and histopathology, to enhance the protective effects of Shilajit in local rabbits**.** Capital letters denote a significant difference between groups (N =30) for each group**.**

Effect of combination of Bisphenol A and Shilajit on Alanine Aminotransferase (ALT) (IU/L), Aspartate transferase AST (IU/L), Urea and creatinine shows there is a significant increase in all parameters in G2, which was treated with bisphenol, compared with the G1 control group. There is no significant difference in outcomes after treatment with a combination of Bisphenol A and Shilajit compared with the G1 control group.

Table (1): Effect of combination of Bisphenol A and Shilajit on Alanine Aminotransferase (ALT) (IU/L), Aspartate Transferase AST (IU/L), Urea, and Creatinine

Group / Parameters	Mean ± SE			L.S.D Values
	Control group G1	Bisphenol group G2	Mix Bisphenol A and Shilajit group G3	
ALT (IU/L)	45 ± 1.14 A	85 ± 6.03 A	58.6±1.86 B	11.41
AST (IU/L)	46.6±4.47 B	96.4±27.20 A	51.2±3.89 B	9.60
Urea (mg/dl)	25 ± 1.25 B	47 ± 6.31 A	30 ± 1.14 B	6.23
Creatinine (mg/dl)	1.5±1.33 B	3.5±0.9 A	2.1±1.08 B	0.98

Histopathology:

Control group

Liver: the section of liver showed regular architecture that radiated hepatic cords from the central vein with evidence of sinusoids between hepatocyte cords(Figure. 1) . Kidney: the section of kidney showed glomeruli accompanied by proximal & distal tubules in the cortical region (Fig. 2).

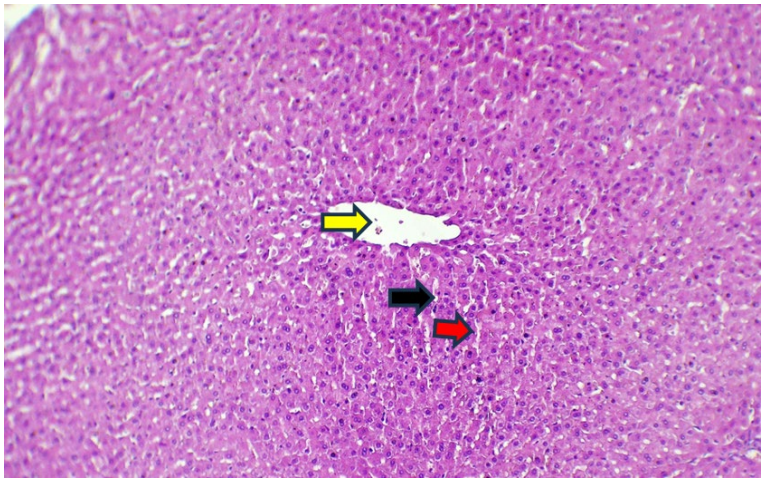


Figure 1: Histological section in th).iver of the control group at 21 days post-challenge shows regular architecture that radiates from the central vein (yellow arrow)with hepatic cords (black arrow) and sinusoids between hepatocyte cords.red arrow) (H&E stain X10)

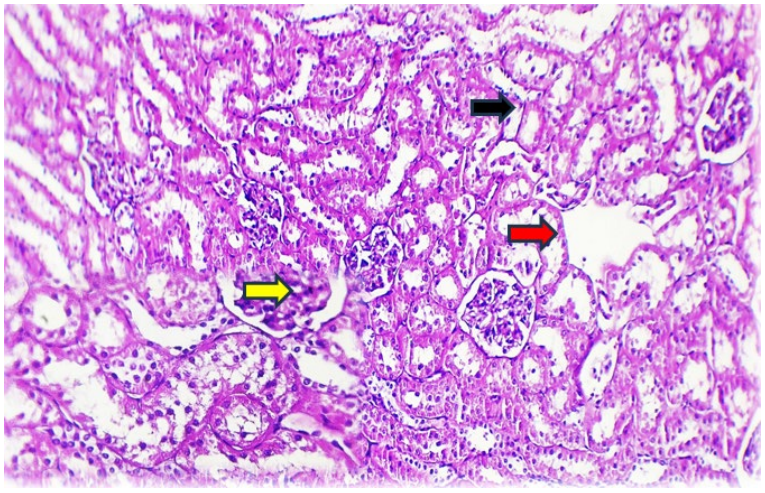


Figure 2: Histological section in the kidney of the control group at 21 days post challenge shows glomeruli (yellow arrow) with proximal (black arrow) & distal tubules (red arrow) in the cortical region (H&E stain X10+40)
Bisphenol group

Liver: The characteristic hepatic finding showed bile duct hyperplasia, monocellular inflammatory cell infiltration around the bile ducts, and dilated blood vessels (figure. 3). Additionally, the results showed severe hydropic degeneration of hepatocytes with perivascular monocellular necrotic cell aggregation, composed mainly of macrophages, around the central vein (figure. 4).

Kidney: The main renal histopathological changes revealed shrinkage of the glomerular tuft and massive interstitial infiltration of mononuclear cells (MNCs) in kidney tissue, accompanied by atrophy in adjacent renal tubules (Figure. 5). Other sections showed severe vacuolation of the tubular epithelial lining, with infiltration of tubular MNCs (Figure. 6).

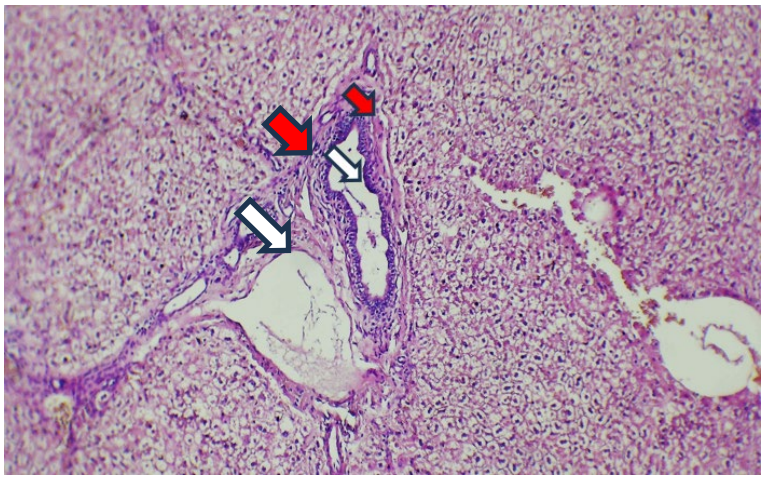


Figure 3: Histopathological section in the liver of the bisphenol group at 21 days post challenge shows bile duct hyperplasia (white arrow), cellular inflammatory cells infiltration around the bile duct & dilated blood vessels(red arrow) (H&E stain X10)

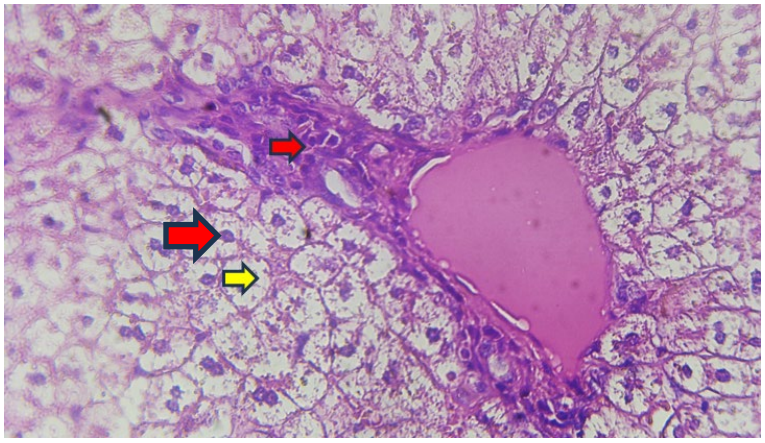


Figure 4: Histopathological section in the liver of the bisphenol group at 21 days post challenge shows severe hydropic degeneration of hepatocyte (yellow arrow) with perivascular MNCs aggregation composed mainly of macrophages around the central vein (red arrow)(H&E stain X40

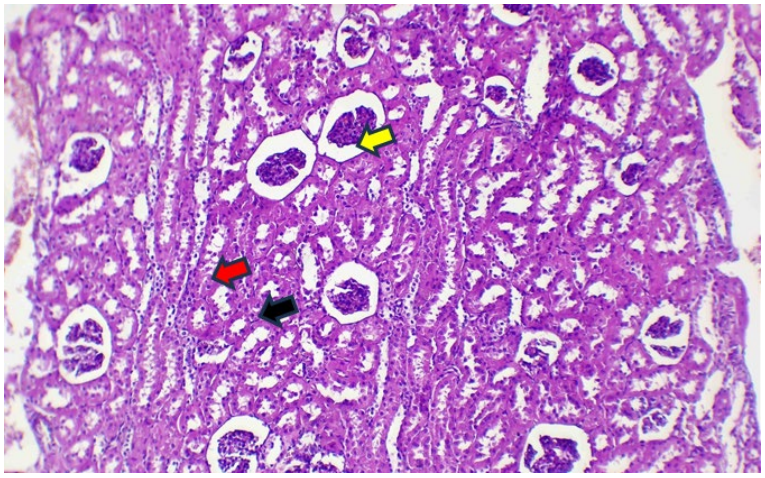


Figure 5: Histopathological section in the kidney of the bisphenol group at 21 days post-challenge shows shrinkage of the glomerular tuft (yellow arrow) &massive interstitial infiltration of MNCs in kidney tissue(red arrow) with atrophy in adjacent renal tubules (black arrow)(H&E stain X10)

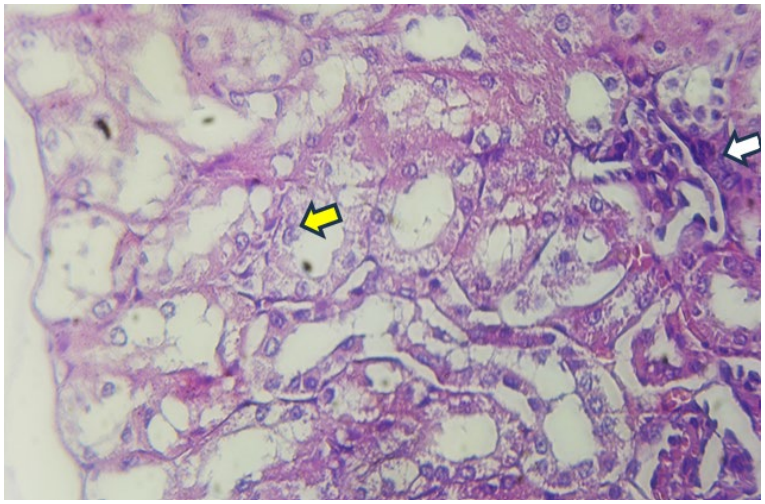


Figure (6): Histological section in the kidney of the bisphenol group at 21 days shows severe vacuolation of tubular epithelial lining (yellow arrow) with tubular MNCs infiltration (white arrow)(H&E stain X40

Bisphenol + Shilajit group

Liver: The hepatic tissue lesion showed focal infiltration of mononuclear cells, composed of giant cells, with a prominence of Kupffer cells (Figure 7). In addition, fatty change with apoptosis of some hepatocytes may be recognized in the hepatic parenchyma (Figure 8).

kidney: renal tissue lesion showed hyaline cast with interstitial hemorrhage (white arrow) & interstitial mononuclear cells infiltration (Figure 9)

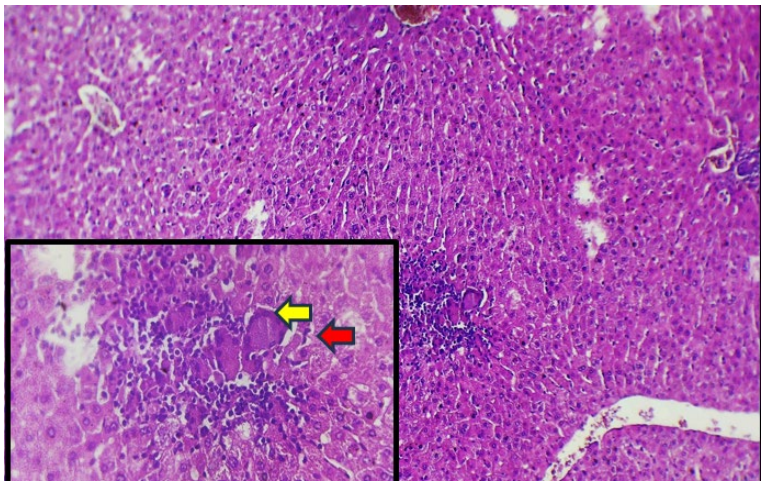


Figure 7: Histopathological section in the liver of the bisphenol + Shilajit group at 21 days post challenge shows focal mononuclear cells infiltration composed of giant cells (yellow arrow) with prominence of Kupffer cells (red arrow) (H&E stain X10+40)

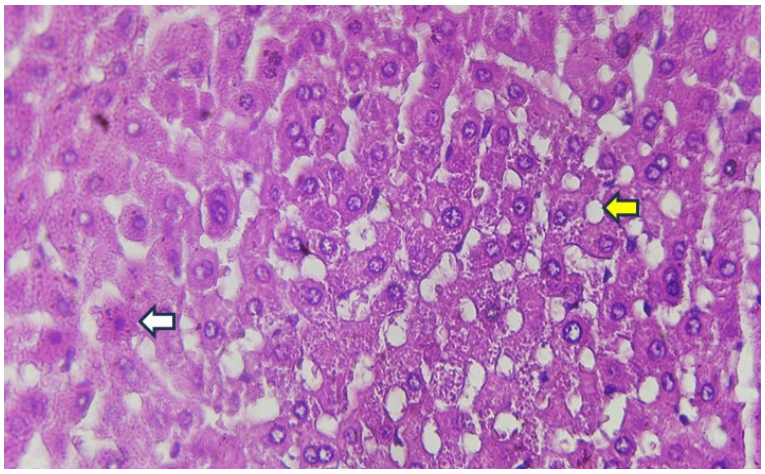


Figure 8: Histopathological section in the liver of the bisphenol + Shilajit group at 21 days post challenge shows fatty change (yellow arrow) with apoptosis of some hepatocytes (white arrow) (H&E stain X40)

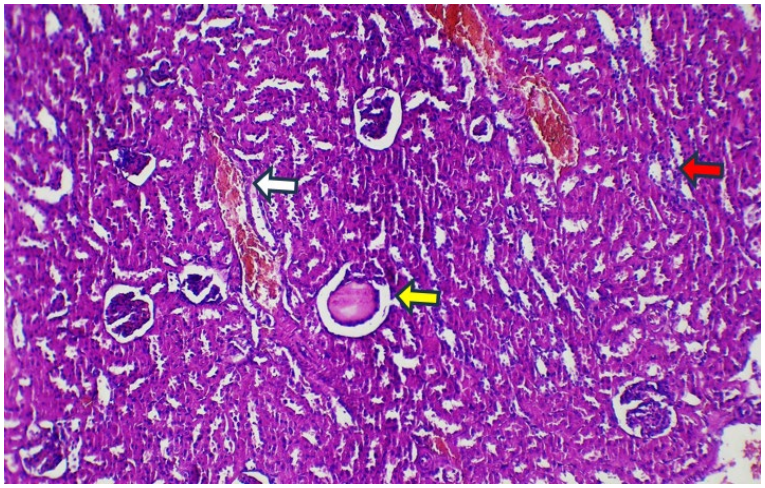


Figure 9: Histopathological section in the kidney of the bisphenol + Shilajit group at 21 days post-challenge shows a hyaline cast (yellow arrow) with interstitial hemorrhage (white arrow) & interstitial mononuclear cell infiltration (red arrow) (H&E stain X10).

Discussion:

The results of our research revealed the toxic effects of bisphenol A, which include increased levels of liver enzymes, kidney urea, and creatinine, as well as histopathological changes such as degeneration and necrosis in liver and kidney tissue. On the other hand, Shilajit prevents the toxic effects of bisphenol A.

These results align with those of Yamasaki et al. **[16],** who observed an increase in AST activity in male rats given doses of at least 200 mg/kg per day. Similar to Hassan et al. [**17**], it was shown that BPA administered orally to rats for four weeks at a dose of 50 mg/kg/day resulted in notably elevated levels of liver enzymes, additionally, by the Serum AST and ALT levels, which rose in the BPA group when compared to the control group, according to the current study. According to some theories, PBA damages the liver, kidneys, and Rigid oxygen production in the brain and other organs, leading to the formation of ROS species **[18]**. This is about the notable rise in serum levels of AST and ALT, indicating damage to both the cytosol and mitochondria **[19].** After being conjugated by the liver, BPA is typically eliminated by the kidneys. Kidney problems may arise from oxidative stress during the excretion of conjugated BPA. For the rabbits in the BPA groups, mesangial cell proliferation in kidney tissues, pink homogeneous proteinaceous masses in Bowman spaces, edema and bleeding in certain places, and pycnotic tubular epithelial cell nuclei indicated kidney damage.

The primary cause of elevated serum urea-creatinine levels may be the potential harm that BPA exposure causes to kidney tissues. Furthermore, the rise in serum creatinine levels may indicate that the kidneys were insufficient to eliminate harmful metabolites from the body caused by BPA, which cannot be adequately eliminated. Important enzymes that reveal details about liver function are serum ALT, AST, and ALP levels. Serum levels of these enzymes are found to rise in response to liver tissue degeneration **[20]**. High levels of BPA in the urine have been associated with adverse alterations in liver function **[21].** According to our research, the serum levels of liver enzymes in male rabbits increased in response to the two highest BPA dosages. The elevated levels of these liver enzymes are also supported by damage observed in the liver tissues. Liver tissue histopathological results reveal significant degenerative alterations brought on by BPA. Certain sections of the liver tissues analyzed in this study showed hepatocytes with pycnotic hyperchromatic nuclei, focal mononuclear cell infiltrations, edema, and hyalinization surrounding the portal vein. Human epidemiological research has also revealed a favorable correlation between liver enzymes, such as ALT and AST, and urine BPA **[22]**. Additionally, BPA has been shown to damage rats' livers and change their liver enzymes **[23].**

While histopathological findings show toxic effects of bisphenol A, including degeneration, dilation of sinusoids, infiltration of inflammatory cells, a round bile duct, central vein, and necrosis of hepatocytes, the renal section showed shrinkage of the glomerular tuft with massive interstitial inflammatory cells and atrophy of tubules with vacuolation.

These results are consistent with previous studies, which have reported histopathological alterations in the liver that exhibit varying degrees of damage following BPA administration. The microscopic analysis we performed revealed that low dosages may harm the liver. This finding was reported by several authors, including Mourad and Khadrawy **[24]**. In the present investigation, it was noted that BPA demonstrated degenerative alterations in the liver's cells. Additionally, this was as stated by Boshra et al. **[25]**. According to Verma and Sangai **[26]**, cell rupture results from bisphenol A treatment and damage to the human erythrocyte membrane, which can be caused by oxidative stress. In addition, light microscopy revealed indications of infiltration by inflammatory cells, vacuolated and dilated sinusoids, hepatocytes, and clogged blood vessels, as well as an increased quantity of Kupffer cells and decomposition. It has been documented by earlier research that BSA results in necrosis and cell infiltration **[27].**

Vacuolated hepatocytes, as seen in the liver, describe damage **[28].** Korkmaz et al. **[29]** reported that BPA produces oxidative damage related to ROS in the brain and kidneys. Hassan et al. **[28]** support the current study's findings, which indicate that BPA causes degeneration and necrosis in both the proximal and distal convoluted tubules. Destructed tubular cells were also exfoliated in their lumens. The BPA-treated group showed leukocyte infiltration around dilated, clogged blood vessels in the renal cortex and between renal tubules. The BPA-treated group exhibited noticeably greater leukocyte infiltration areas than the control group, as determined by morphometric analysis. The outcomes we obtained concurred with those of Ola et al. **[30].**

The Shilajit action against BPA toxicity prevents liver and kidney injuries. In rats with non-alcoholic fatty liver disease (NAFLD) brought on by a high-fat diet, Shilajit was able to provide a protective effect and stop histopathological damage to liver tissue **[31].** In an NAFLD rat model, Shilajit also improved insulin resistance and adipocytokine levels by reducing inflammation **[31].** Shilajit has been shown to have potential chemotherapeutic effects against various cancer types, in addition to its protective effects on the liver and kidneys. For instance, in bladder cancer, Shilajit induces apoptosis and cell cycle arrest **[32].** The enhanced liver function following Shilajit treatment may be the cause of this effect. Our findings regarding body weight are in contrast to a study that found no discernible change in human body weight following a 45-day Shilajit consumption period **[33].**

Conclusion

Administration of BPA for 21 days in rabbits caused an increase in liver enzymes (Aminotransferase (ALT) (IU/L), Aspartate transferase (AST) (IU/L), and kidney function parameters (Urea and creatinine), while the decrease in G3, which was treated with Bisphenol A and Shilajit

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