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Comparative Adverse Effect of some Common Household Chemicals on Both liver and kidney of Albino rat

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Abstract : Kidney and liver are target organs playing a major role in excretion and elimination of the body waste metabolites and they are sensitive to action of the toxic agents. Thus the present study was designed to compare and assess hepatic and renal tissues injuries induced by common household chemicals namely Bisphenol A (BPA) and 2-Beutoxyethanol (2-BE) in adult male albino rat *(Rattus norvegicus*) Oral treatment with sub-lethal dose (200 mg/kg/day) for 15days resulted in different histopathological effects in both liver and kidney of male albino rat(*Rattus norvegicus*). Fatty change liver, necrotic hepatocytes, congested blood, infiltration of polymorph leukocytes, pyknotic hepatocytes and aggregation of melanomacrophages in the hepatic tissue were observed. While in kidney; shrinkage and atrophy of glomeruli, hypertrophy of glomeruli with glomerular distortion, necrotic renal tubules, stagnation fluid in renal tubules, severe atrophy of renal tubules and some macrophages cells were observed. **Conclusion:** Liver and kidney in albino rat which exposed to BPA and 2-Butoxyethanol showed different signs of histopathological deformations, which varies in intensity according to the dose of exposure.

Keywords: Bisphenol A (BPA); 2-Beutoxyethanol (2-BE); Kidney; liver; Albino rat.

1. Introduction

Endocrine disrupters (EDs) reach living organisms through the air, soil, water and food, thus the major route transmission is the aquatic environment, were these substances bio accumulate through the food chain, fish ingestion is one of the main sources of human exposure to endocrine disrupters (EDs) [1,2]. BPA one of the most abundant endocrine disruptors in the environment, is produced by the acid-catalyzed condensation of acetone with two phenols [3].

Chemicals are part of life and environment they enter the human body by ingestion, inhalation or dermal exposure. The presence of chemicals in the environment and in food is well monitored, but only fragmented information is available on the levels in humans. Human bio-monitoring measures directly the levels of chemicals in blood, urine or other human tissues or fluids [4,5].

Chemicals are ubiquitous as air, carbohydrates, enzymes, lipids, minerals, proteins, vitamins, water, and wood. Naturally occurring chemicals are supplemented by man-made substances. There are about 70,000 chemicals in use with another 500–1000 added each year. Their properties have been harnessed to enhance the quality of life; e.g. cosmetics, detergents, energy fuels, explosives, fertilizers, foods and drinks, glass, metals, paints, paper, pesticides, pharmaceuticals, plastics, rubber,

solvents, textiles; thus chemicals are found in virtually all workplaces. Besides the benefits, chemicals also pose dangers to man and the environment [6].

Many common household chemicals are known as endocrine disruptors, a number of which are found in plastic products. These chemicals are similar in structure to natural sex hormones such as estrogen, thereby interfering with their normal functions leading to increasing production of certain hormones; decreasing production of others, imitating hormones; turning one hormone into another; interfering with hormone signaling; telling cells to die prematurely; competing with essential nutrients; binding to essential hormones; accumulating in organs that produce hormones, both 2-butoxyethanol and Bisphenol A represented as a dirty house hold chemicals [1].

Endocrine disruptors are found also in synthetic chemicals used as industrial solvents, lubricants, and cleaners, (especially the fragranced products), contain complex mixtures of chemicals that have endocrine disruption properties as 2-butoxyethanol. Other examples of endocrine disruptors include bisphenol A (BPA) from plastics; also disrupt endocrine system [7].

Bisphenol A is one of the environmental contaminants used as an intermediate (binding, plasticizing, hardening) in plastics, paints/lacquers, binding materials and filling-in materials [8], BPA is an organic compound composed of two phenol rings connected by a methyl bridge, with two methyl functional groups attached to the bridge and add Bisphenol A (BPA), 2, 2-bis (4-hydroxyphenyl) propane, is an endocrine disruptor that has estrogenic activity [9,10]. Because BPA is used to manufacture polycarbonate plastic, epoxy resins and certain dental sealants [11], humans are frequently exposed to BPA released from plastics and food cans in daily life [12]. Therefore, through these daily exposures BPA potentially affects human health.

Glycol ethers are commonly used as solvents detergents or emulsifiers in a huge number of products due to their excellent chemical and physical properties. Ethylene glycol monobutyl ether (EGBE), (or 2-butoxyethanol, 2-BE) is one of the most widely used glycol ethers [13-14].

There is widespread use of 2-butoxyethanol in household products, including glass cleaners, carpet/ rug cleaners, floor cleaners and oven cleaners among others. 2-Butoxyethanol and Bisphenol A, may also be released to the environment from facilities that use these chemicals in the production of other materials, including resins, lacquers, varnishes, enamels, dry-cleaning compounds, soap, emulsifying agents, inks, and (to a minor extent) herbicides. These chemicals may also be directly released to the atmosphere by evaporation during the use of these products in occupational or household settings [15].

Accordingly, the current work was focused on the histopathological effects observed in kidney and liver of male rat ***(Rattus norvegicus)*** exposed to both Bisphenol A and 2-Beutoxyethanol. In addition to assess and compare the histological changes caused to the animal exposed to (200 mg/kg/day) for 15 day.

2. Materials and Methods

2.1 Chemicals

1- Bisphenol A (>99% pure) was purchased from Aldrich Chemical (Milwaukee, WI, USA) No: 02077, Product No: 028643, Molecular formula: C15H16O2, Molecular mass: 228.29g/mol) and dissolved in few drops of alcohol and made as micro-crystalline suspension up to desired volume with olive oil, purchased from Sigma-Aldrich Chemical Company. 2-Butoxyethanol was purchased from Alfa Aesar, AJohanson Mattey Company {26 Parkridge Road Ward Hill Massachusettes, 01835 United States} (Molecular formula: C6H14O2 Molecular mass: 118.18 g/mol) and dissolved in few drops of alcohol and made as micro-crystalline suspension up to desired volume with olive oil, purchased from Sigma-Aldrich Chemical Co.

2.2 Animals and Experimental design

Forty healthy male albino rats (120-140g body weight) *(Rattus norvegicus*) were used. The animals were kept under the normal laboratory conditions in wire cages throughout the experimental period. They were divided into four groups (each of 10 rats). Rats of the first group served as control (G1). Rats of the 2nd group were treated orally with olive oil (200 mg/kg body weight) served as a sub control group (G2). Rats of the 3rd group were treated orally with a sub lethal dose 200 mg/kg body weight of BPA (G3) [16]. Rats of the 4th group were treated orally dose 200 mg/kg body weight of 2-Butoxyethanol (G4) [17]. The control and treated rats were dissected after 15 days of exposure, and then their small pieces (5 mm) of liver and kidney were immediately fixed in alcoholic Bouin's solution for 24 hours. These tissues were dehydrated in ascending concentrations of ethyl alcohol, cleared in xylol and embedded in paraffin wax (M.P.: 58°C). Sections were cut at 5μ in thickness, and stained with Harri's haematoxylin and subsequently counter stained with eosin [38] for routine histological examination.

3. Results

3.1. Examination of liver tissue

In G1 and G2 group, the liver sections of Albino rat revealed normal lobular architecture with ill-distinct interlobular connective tissue septa. Each hepatic lobule consisted of hepatocyte plates radiating from the thin-walled central vein. Hepatocytes were large, polygonal cells with acidophilic cytoplasm containing rounded vesicular nuclei and some of them were binucleated. The blood sinusoids separating the hepatocyte plates lined with endothelial cells and von kupffer cells (Plate 1 A-B).

In G3, rats sections showing vacuolation in hepatic cells. The vacuoles appear empty, as the damage to the cells progresses, the hepatocytes become swollen and a single large vacuole will occupy their entire cytoplasm, pushing aside the nucleus and making the hepatocyte signet-ring shaped. Some hepatocytes have pyknotic nuclei, necrotic in other and mild infiltrate of polymorph leukocytes is present in hepatic tissue (Plate 1C). While in G4 rats, sections showed moderate histopathological lesion represented by parenchymatous degeneration of hepatocytes with mild necrosis, leukocytic infiltration in the portal area with aggregation of melanomacrophages cells, and congestion in central vein, was observed. (Plate 1 D).

3.2. Examination of renal tissue

In G1 rats, the normal histological picture of renal corpuscles and tubules were observed. The renal corpuscle contained tuft of blood capillaries, glomerulus, surrounded by two layers of Bowman's capsule that separated by urinary space. The outer parital layer, lined with simple squamous epithelium and the inner vascular layer lined with podocytes and mesangial cells.The renal tubules consisted of proximal convoluted tubules lined with large pyramidal cells with apical brush borders, while the distal convoluted tubules lined with simple cuboidal cells (Plate 2 A). Also Kidney of olive oil-treated rats (group 2) showed normal renal glomeruli and tubules (Plate 2 B).

Kidney sections of G3, showing severe degenerative changes in the renal corpuscles and the renal tubules. Hypertrophy of renal cells with stagnation fluid, shrinkage with atrophy of glomeruli leading to increase of bowman space, and infiltration of lymphocytes were also recorded (Plate 2C). While when Kidney sections of G4, showing more degeneration of renal cells represented by complete atrophy or necrotic of renal tubules, stagnation fluid of renal tubules, hypertrophy of glomeruli , sloughing of a tubular epithelial cells in tubular lumen and some macrophages cells also observed as seen in (Plate 2 D).

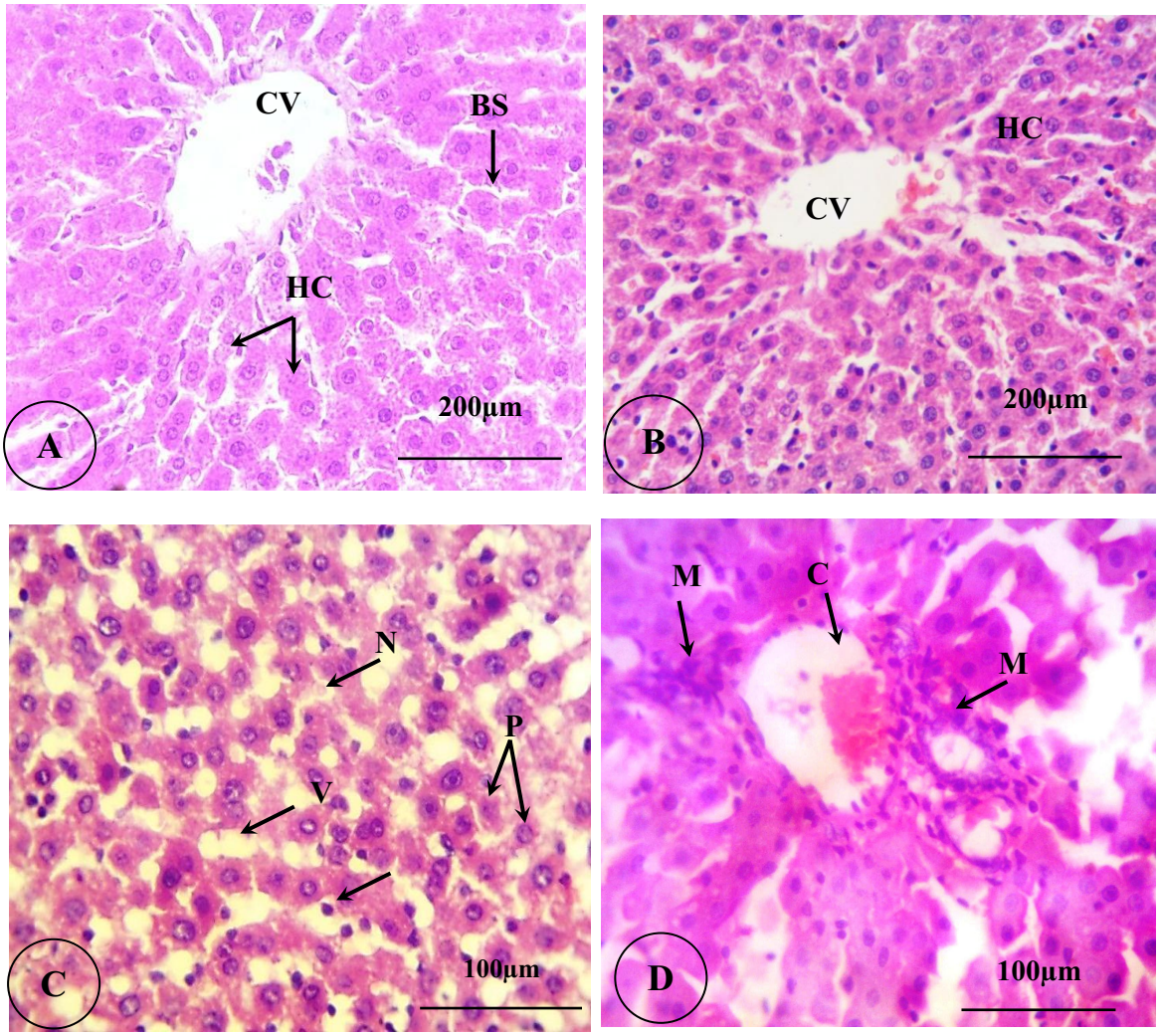

Figure 1.

A: The normal liver structure of control specimen, showing polygonal hepatic cells (HC) with round nuclei, normal central vein (CV) and blood sinusoids (BS).

B: photomicrograph of liver section of G2 showing no histopathological effect and the liver structure as control group.

C: photomicrograph of liver section of G3 rat showed fatty liver appeared as vacuoles (V), some hepatocytes have pyknotic nuclei (P) and other were necrotic (N) and mild infiltrate of polymorph leukocytes is present.

D: The liver section of G4 rat showing, congested blood vessels (C) and aggregation of melano-macropahges cells (M) around the central vein.

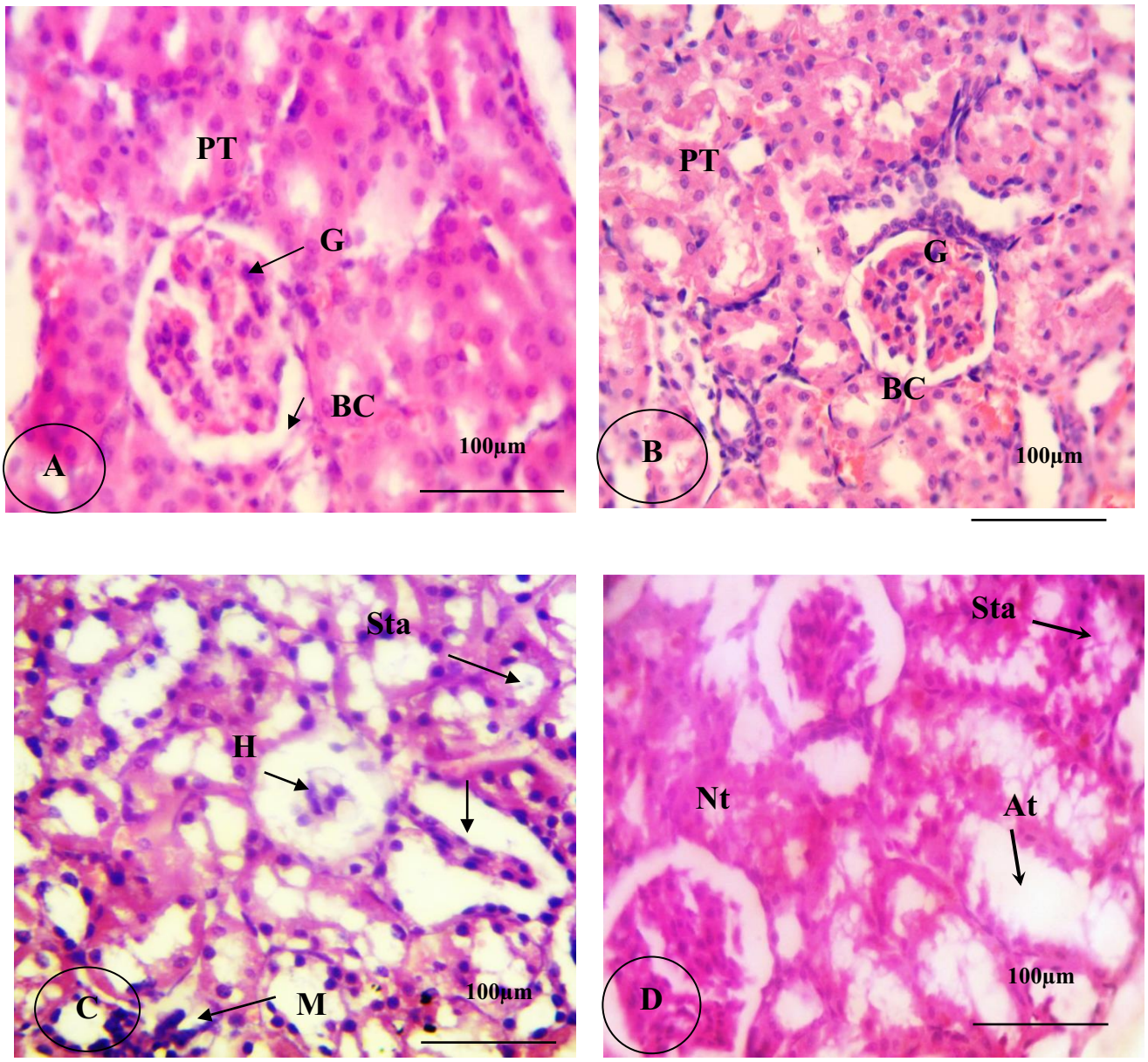

Figure 2.
A: The normal kidney structure of control specimen, showing normal Bowman's capsule (BC), glomeruli (G) and renal proximal tubules (PT).
B: The kidney of G2 rats showing no histopathological effect and the liver structure as control group.
C: The kidney of G3 rats days showing complete atrophy of renal tubules, stagnation fluid (Sta) of renal tubules, hypertrophy of glomeruli (H) and sloughing of a tubular epithelial cells in tubular lumen and some macrophages cells (M) also observed.
D: The kidney of G4 rats showing necrotic renal tubules (Nt) complete atrophy and degeneration of renal tubules (At), and stagnation fluid (Sta) of renal tubules.

4. Discussion

Liver and kidney are important organs of metabolism, detoxification, storage and excretion of xenobiotic and their metabolites, and are especially vulnerable to damage [18]. The liver tissue consists of hepatocytes that aggregate in masses, separated from each other by blood sinusoids, and arranged in anastomosing lamina and in rings around a central vein, and is light brown in herbivores animals [19].

The present results clarified that, oral exposure of adult albino rat to BPA and 2-Butoxyethanol showed different signs of histopathological deformations, which varies in intensity according to the dose of exposure. It represented by swollen and vacuolated hepatocytes with nuclear degenerations, congestion in the central vein and blood sinusoids with increased number of Von Kupffer. Similar

observations were recorded by previous studies [20-22]. In addition, periportal infiltration of inflammatory cells, mild necrotic and macrophages cells were detected. These findings agreed with the results recorded by Daniela-Saveta et al and Ahmed, et al. [23 and 3].

Liver damage is the most frequently reported histopathological response to organic compounds, the importance of the liver as a marker for pathological change reflects the central role of mammalian hepatic tissue in nutrition, lipid and carbohydrate storage, synthesis of protein and enzymes, fatty acid metabolism, and biotransformation and elimination of wastes [24].

Vacuolar degeneration and necrosis of liver cells were illustrated in many investigations. According to [25], vacuolar degeneration may be due to a direct effect of toxic materials on the cell membranes, or may be due to generation of reactive oxygen species in the liver [26]. Or may attribute to contain lipids and glycogen, which are related to the normal metabolic function of the liver [27]. Or might indicate an imbalance between the rate of synthesis of substances in the parenchymal cells and the rate of their release into the systemic circulation [28]. Or duo to metabolic damage, possibly related to exposure to contaminated food. Also, may due to cellular defense mechanism against injurious substances to hepatocytes [29]. The presence of definite necrosis indicated capability of the toxic metabolites causing cell death [30]. Several authors have suggested that, the involvement of melano-macrophage centers in various disease processes and the changes brought about in them by chemical exposure [31, 32].

Kidney is highly susceptible to toxicants for two reasons: a high volume of blood flows through it and it filtrates large amounts of toxins which can concentrate in the kidney tubules. Nephrotoxicity is toxic to the kidneys. It can result in systemic toxicity causing decreased ability to excrete body wastes, inability to maintain body fluid and electrolyte balance, and decreased synthesis of essential hormones [33]. Regards to the kidney, this study observed that, kidney of rats group treated to BPA and 2-Butoxyethanol showed different signs of histopathological deformations, which varies in intensity according to the duration of exposure. It represented by shrinkage of glomeruli, glomerular distortion, necrotic renal tubules, and atrophy of renal tubules. The interpretation of the stagnation fluid in renal tubules may be duo to Bisphenol has a nephrotoxic effect due to accumulation of BPA toxic metabolites and inability of the kidney to eliminate them and these results are agreed with [34-35].

The initial stage in the degeneration process can progress to hyaline degeneration, characterized by the presence of large eosinophilic granules inside the cells. These granules may be formed inside the cells or by the reabsorption of plasma proteins lost in the urine, indicating damage in the corpuscle [36]. In more severe cases, the degenerative process can lead to tissue necrosis [36]. The atrophy of renal tubule interpreted according to Saenphet, et al [37]; they stated that, because of water reabsorption taking place in the distal tubules, relatively high concentrations of toxins may have an effect on renal cells

5. Conclusions

This study proves that oral exposure of adult albino rat to BPA and 2-Butoxyethanol showed, liver and kidney have different signs of histopathological deformations, which varies in intensity according to the dose of exposure.

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