

## The Effect of Furfural on the Histological Structure of the Kidneys in the Adult White Rabbit.

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### Abstract

This study was designed to investigate the effect of furfural on the tissue structure of the kidneys in the white rabbit (*Oryctolagus cuniculus*). The study included 12 white rabbits, ages ranged between 5-8 months and weights 1-1.99 kg. The animals were divided into four groups each group contained 3 rabbits: The first group included the control group, the second group injected with furfural at concentration of (50 mg), the third group (100mg) and the fourth groups (150mg). In groups (First, Second, Third and Fourth) animals of the three groups were injected with furfural substance under the skin at a concentration of (50mg, 100mg, 150mg) of furfural for 30 days, treatment with furfural led to the emergence of pathological conditions in the tissues of the kidneys, including necrosis and the occurrence of cell leaching as well as congestion in the blood vessels, enlargement of the vessel wall, and fibrosis around the blood vessels and the emergence of a state of edema. Other degenerative changes include the dissolution of some tubule cells and the detachment of others from the basement membrane and their collection inside the cavities of the renal tubules. The results showed that there was a shrinkage in the glomerulus and the expansion of Bowman's space by increasing the concentration of the treated substance, and there were clearly significant differences compared to the control group at a probability level of 0.05.

**Key words:** Bowman's space, furfural, glomerulus, kidney

### Introduction

Furfural is an important organic chemical substance that has a pungent aromatic odor that is produced from industrial agricultural waste and waste containing carbohydrates, known as pentosane, which is an essential chemical substance. It can be used in a variety of industries such as chemical industry, petroleum refining industry and agricultural industries. In its pure state, it is an oily liquid that is colorless or yellow with ascent like the smell of almonds, and when exposed to the air it turns yellow, then brown, then black. Furan 2-capaldehyde.<sup>(10)</sup> Furfural has the advantage of being more stable than furan with acidic reagents and the reason for the presence of a group of electron-withdrawing aldehydes, it has been shown from studies and research that it is a good organic tanning agent for leather due to the active aldehyde group present in its composition.<sup>(5)</sup>

The kidney in vertebrates plays a critical role in regulating the body's economies, and its failure means death, and the kidneys in this regard are of the same importance as the heart, lungs and liver.<sup>(3)</sup> A compact group of tubules located dorsally within the body cavity and on both sides of the spine.<sup>(7)</sup>

The kidneys are studied anatomically and functionally in different vertebrates<sup>(2)</sup> Attention may be drawn to the way the kidneys perform their functions. For example, these small organs that do not constitute more than 0.5% of the body weight in a person receive about 25% of the total pumping of the heart, which reaches approximately 2000 liters of blood per day, and this flow of blood passes through special tubular structures called renal units (nephrons), which number about two million renal units in a person, and each one represents a micro-excretory unit consisting of a filter operating with glomerular pressure (Glomerulus and urinary tubule).<sup>(8)</sup> The aims of this study are evaluation of the effect of furfural on the histological structure of the Kidneys in albino rabbits *Oryctolagus cuniculus*

## Materials and methods

In this study, 12 adult rabbits of *Oryctolagus cuniculus* were used. They were divided into four groups by 3 for each group. The first group was given 50 mg/kg furfural, the second group 100 mg/kg furfural, the third group 150 mg/kg and the fourth group a control group, which was obtained. White rabbits, *Oryctolagus cuniculus*, from the animal market in Baqubah / Diyala, aged 5-8 months. The animals were raised in the animal house of the College of Veterinary Medicine - University of Diyala, and all the experimental animals were placed under observation throughout the study period from 13/10/2020 - 14/11/2020. They were placed in cages of wood and wire mesh, their dimensions were (60 x 50 x 40) cm, and the cages' floors were made of wire mesh and were 25 cm high from the ground. The weights of the rabbits used in the experiments ranged from 1-1.99 kg. The most prominent macroscopic changes that appeared on the injected animals, such as fatigue, lethargy, and introversion were recorded after the end of the treatment period, and the animals were slaughtered. After dissection, the kidneys were removed and transferred to the fixation solution (formalin) for a period of 24 hours for the purpose of the study and making histological sections.

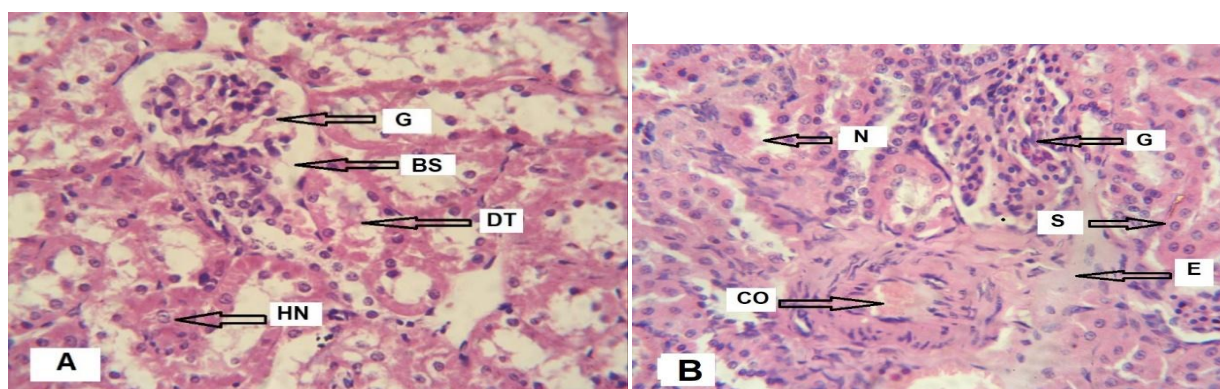
The tissue sections of the kidneys were prepared following the steps described (Bancroft and Stevens,<sup>(13)</sup>) Then the samples were examined using an HDCE-20C optical microscope camera.

## Results and Discussion

### - Histological changes of the kidneys

#### The treated group at a concentration of 50 mg / kg

The results of the histological examination showed tissue changes in the kidney, represented by clear vascular congestion in some blood vessels in the cortex area and enlargement of the vascular wall inside the kidney. The explanation for this is that furfural has affected the permeability of blood vessels in the kidney by increasing the osmotic pressure of its walls due to slow blood flow in it, the cause of the damage represented by congestion of these infected vessels and damage to the blood vessels lining them, leading to this to filter red blood cells and increase their flow through the renal tissue and this result is consistent with the findings of the researcher Izzedine H et al.<sup>(6)</sup> It was caused by the effect of furfural on the membranous organization of cells such as Llama P et al.<sup>(9)</sup> indicated a reversal of the effect of voltarin in kidney cells on the membrane organization, which leads to the accumulation of edematous fluids in the intercellular space. As for the degenerative changes represented by the swelling of the cells lining the renal tubules, the researchers indicated that the toxic substances lead to the swelling of the cells of the urinary tubules and this leads to the blockage of the lumen of the urinary tubules and consequently the necrosis of the cells due to the deposition of calcium and this results from the lack of oxygen that impedes the work of the mitochondria to produce energy which is similar to the findings of Morrissey S.E et al.<sup>(11)</sup> Also, slight necrosis and enlargement of the glomerulus was observed with a significant difference, which led to a small area of Bowman's space, as is evident in Figure (1).



**Figure (1)** Cross section in the kidneys of the treated group rabbits at a concentration of 50 mg / kg of furfural (A), **HN** nucleation, **DT** cell breakdown of the renal tubules, **G** glomerulus, **BS** Bowman spacing (B), **CO** congestion, **S** swollen cells Epithelial lining of some tubules, **N** necrosis of tubule cells, **E** edema. Colorful (H&E 40X).

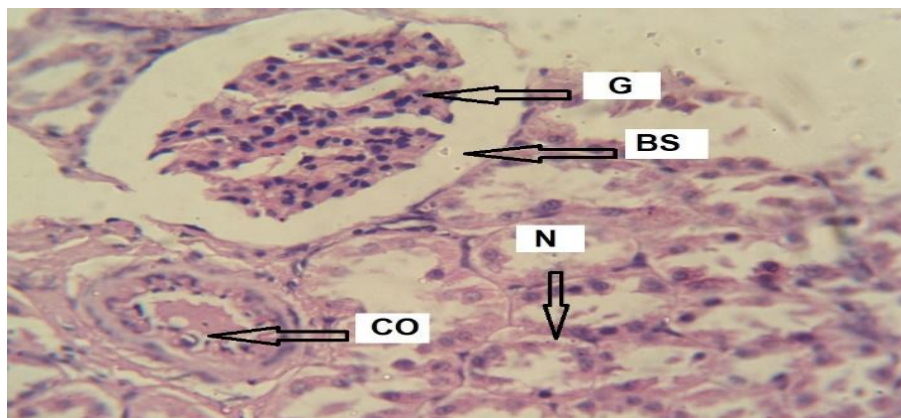
**Table (1):** Effect of furfural on average Bowman space/ $\mu\text{m}$

Treatment	No	Mean $\pm$ Std.error
Control	8	1.89 $\pm$ 0.08
50 mg	8	1.53 $\pm$ 0.12*
100 mg	8	2.39 $\pm$ 0.16*
150 mg	8	2.64 $\pm$ 0.11*
Total	32	2.11 $\pm$ 0.09

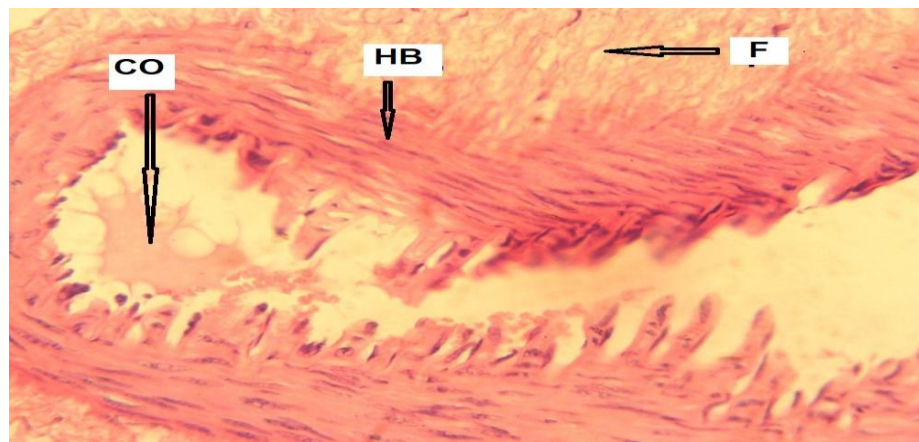
\*Significant differences at 0.05 likelihood

### The treated group was at a concentration of 100 mg/kg

The results showed the presence of tissue changes in the kidneys when compared with the control group, and they were more severe, represented by an increase in the shrinkage of the glomerulus, which led to the expansion of the Bowman's space, and this leads to a significant decrease in the diameter of the glomerulus (89.69) micrometers and a significant increase in the Bowman's space (2.39) micrometer. Also, necrosis was observed In the glomerulus figure (2), the current study showed that congestion of blood vessels, enlargement of the vessel wall, and fibrosis around the blood vessels Fig. (3) and the occurrence of necrosis of the renal tubules and the cause of this renal degeneration can be attributed to the fact that furfural is the substance that disrupts the manufacture of Some cytochrome enzymes due to removing mitochondrial proteins and participating in the action of many other enzymes in the cells that line the urinary tubes, and this is in agreement with the results of the researcher's study Cibulka J.Z et al.<sup>(1)</sup>.



**Fig. (2)** Cross section in kidneys of the group treated rabbits at a concentration of 100 mg/kg of furfural for 30 days. **BS** Bowman's expanse, **N** necrosis of renal tubule cells, **G** glomerulus, **CO** vascular congestion. (H&E 40X)

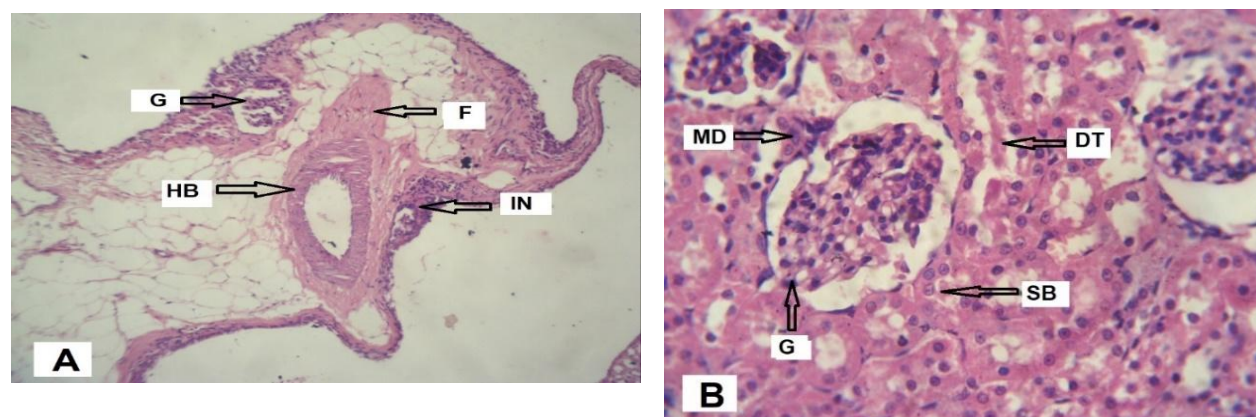


**Fig. (3)** Cross section in the kidneys of rabbits of the treated group at a concentration of 100 mg/kg of furfural, **F**, perivascular fibrosis, **CO** vascular congestion, **HB**, vascular wall hypertrophy, stained (H&E 40X).

#### The treated group at a concentration of 150 mg/kg

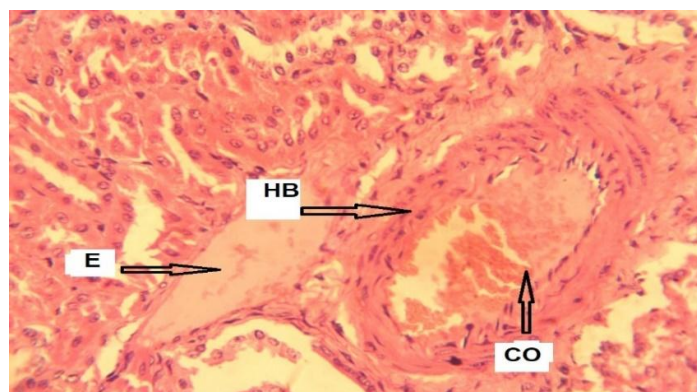
The results of the present study showed that the effects of furfural increased with the increase in the dose administered to rabbits. The histopathological sections of the group of rabbits treated at a concentration of 150 mg/kg for 30 days showed more severe tissue changes than in the two groups treated with concentrations of 50 and 100 mg/kg.

These changes were represented by an increase in glomerular shrinkage and atrophy in many glomeruli, increased glomerular necrosis, enlargement capsule space expansion, and a significant decrease in mean glomerular diameter (85.11 micrometer compared to the control group (90.07) micrometer, which may be attributed to furfural toxicity, which led to overgrowth. Pressure and decreased blood flow in the kidney due to damage to the renal blood vessels or due to damage to the tubules or both together, and the average height of Bowman's space (2.64) micrometers when compared to the control group Figure (4) This is due to the shrinking of glomerular due to the death of glomerular cells as a result of the occurrence of inflammation in the epithelial cells of the glomerulus, which resulted in the death of the glomerular cells. This result is consistent with the findings of the researcher Howie<sup>(4)</sup> who mentioned that the cause of the expansion of Bowman's space is the result of contraction or disappearance of some glomeruli. The results of the study showed blood vessel wall thickening, vascular fibrosis, edema between kidney tubules and macrophage cell leaching. Other degenerative changes include the dissolution of some tubule cells and the detachment of others from the basement membrane and their collection inside the cavities of the renal tubules (Figure 4-B). Expansion, and that this inhibition leads to the occurrence of constriction of these arterioles, which reduces the supply of necessary blood, which in turn affects the nutrition of cells, and this study was in agreement with the findings YasmineenT et al.<sup>(12)</sup>.



**Figure (4)** Cross section in the kidneys of rabbits of the treated group at a concentration of 150 mg / kg of furfural for 30 days. (A), Glomerulus **G**, **F** fibrosis, **IN** Infiltration, **HB**, stained blood vessel wall thickening (H&E 10X) B)) **DT** cell

breakdown, **SB** Some tubule cells detachment from the basement membrane, **MD** Dense macula **BS** Bowman Headroom Color (H&E 40X)



**Figure (5)** Cross section in the kidneys of rabbits of the treated group at a concentration of 150 mg/kg of furfural for 30 days, showing changes within the kidney, **E**, edema, **HB**, hypertrophy of the blood vessel wall (H&E 40X)

**Table (2):** Effect of furfural on mean glomerular diameter/ $\mu\text{m}$

Treatment	No	Mean $\pm$ Std. error
Control	8	90.07 $\pm$ 1.08
50 mg	8	111.87 $\pm$ 3.93*
100 mg	8	89.69 $\pm$ 6.33*
150 mg	8	85.11 $\pm$ 8.08*
Total	32	94.19 $\pm$ 3.22

\*Significant differences at 0.05 likelihood

## Conclusions

- 1- The treatment with Furfural caused significant damage, represented by degenerative changes in the glomerulus, bleeding, congestion of blood vessels, and infiltration of inflammatory cells.
- 2- Furfural has an effect on the rate of glomeruli diameter in an adult white rabbit.

**Conflict of Interest:** Nil.

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**Ethical Clearance:** Ethical clearance has been taken from Institutional Ethical Committee.

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