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Стаття надійшла до редакції 06.01.2025;
затверджена до публікації 06.02.2025

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UDC 616.61+616.68]-008.9-091.8-092.9:613.31:628.16:537.6/.8 https://doi.org/10.26641/2307-0404.2025.1.325457

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THE IMPACT OF VARYING INTENSITIES OF MAGNETICALLY TREATED WATER ON RENAL AND TESTICULAR TISSUE

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Цитування: Медичні перспективи. 2025. Т. 30, № 1. С. 173-186
Cited: Medicni perspektivi. 2025;30(1):173-186

Key words: *magnetic water, kidney, testes, rats*
Ключові слова: *магнітна вода, нирки, яєчки, щури*

Abstract. The impact of varying intensities of magnetically treated water on renal and testicular tissue. Sura Fouad Alsaffar, Lamyaa Abdulridha Fadhil, Ishraq Mohammed Baker. *This study aimed to investigate the effect of water treated with a magnetic field with different induction on the histological structure of the kidney and testicular tissue of albino rats. For this purpose, fifty albino rats were divided into five equal groups, the first of which was used as a control group, drank clean tap water for four weeks, the other groups were given daily water treated with a magnetic field with an induction of 500, 1000, 1500 and 2000 gauss. Then the animals were sacrificed and histological changes in the kidneys and testicles were examined. Histopathological examination of the kidneys of animals that were given water treated with a magnetic field with an induction of 500, 1000 and 1500 gauss revealed normal renal tubules and glomeruli. Histopathological examination of the kidneys of rats that consumed water treated with a magnetic field with an induction of 2000 gauss showed numerous focal hemorrhages and vacuolar degeneration of the epithelium lining the tubules. Histological sections at magnification revealed vacuolar degeneration of the epithelium of the tubules, mainly the collecting tubules, the formation of tubular casts and tubular necrosis. Examination of the testicular tissue of rats exposed to water treated with a magnetic field with an induction of 500 and 1000 gauss showed normal seminiferous structure and cytoarchitecture of the germinal epithelium areas, as well as normal interstitial tissue. In contrast, rats given water* *treated with a magnetic field with an induction of 1500 gauss showed marked narrowing of the seminiferous tubules, moderate vacuolar degeneration of the germinal epithelium, necrosis of a number of spermatogonia cells, and thickening of the testicular interstitium. Histopathological examination of the testes of rats exposed to water treated with a magnetic field with an induction of 2000 gauss showed significant vacuolar degeneration, necrosis of a number of spermatogonia cells, and thickening of the testicular interstitium, as well as significant damage to the seminiferous tubules and germinal epithelium. Thus, water treated with a magnetic field with an induction of 2000 gauss negatively affected both the kidneys and testicles, while water treated with a magnetic field with strength of 1000 gauss improved the function of the kidney and testicular tissue of rats and did not affect their structure.*

Реферат. Вплив води, обробленої магнітним полем з різною інтенсивністю, на тканини нирок і яєчок. Сура Фуад Аль-Саффар, Ламії Абдельреді Фаділ, Ішрак Мухаммад Бакр. *Це дослідження мало на меті дослідити вплив води, обробленої магнітним полем з різною індукцією, на гістологічну структуру тканини нирок та яєчок щурів-альбіносів. З цією метою п'ятдесят щурів-альбіносів розподілили на п'ять рівних груп, першу з яких використовували як контрольну групу, поїли чистою водопровідною водою протягом чотирьох тижнів, іншим групам давали щодня воду, оброблену магнітним полем з індукцією 500, 1000, 1500 і 2000 гаусів. Потім тварин умертвляли й досліджували гістологічні зміни в нирках і яєчках. Гістопатологічне дослідження нирок тварин, яким давали воду, оброблену магнітним полем з індукцією 500, 1000 і 1500 гаусів, виявило нормальні ниркові канальці та клубочки. Гістопатологічне дослідження нирок щурів, які вживали воду, оброблену магнітним полем з індукцією 2000 гаусів, показало численні фокальні крововиливи та вакуольну дегенерацію епітелію, що вистилає канальці. На гістологічних зрізах при збільшенні виявлено вакуольну дегенерацію епітелію канальців, переважно збірних канальців, утворення зліпків канальців і некроз канальців. Дослідження тканини яєчок щурів, які піддалися впливу води, обробленої магнітним полем з індукцією 500 і 1000 гаусів, показало нормальну сім'яну будову та цитоархітектуру ділянок зародкового епітелію, а також нормальну інтерстиціальну тканину. Навпаки, у щурів, яким давали воду, оброблену магнітним полем з індукцією 1500 гаусів, спостерігалося помітне звуження сім'яних канальців, помірна вакуолярна дегенерація зародкового епітелію, некроз ряду клітин сперматогонія та потовщення інтерстицію яєчка. Гістопатологічне дослідження яєчок щурів, які піддалися впливу води, обробленої магнітним полем з індукцією 2000 гаусів, показало значну вакуольну дегенерацію, некроз серії клітин сперматогонія та потовщення інтерстицію яєчок, а також значне пошкодження сім'яних канальців і зародкового епітелію. Таким чином, вода, оброблена магнітним полем з індукцією 2000 гаусів, негативно впливала як на нирки, так і на сім'яники, при цьому вода, оброблена магнітним полем з індукцією 1000 гаусів, покращувала функцію тканини нирок та яєчок щурів і не впливала на їхню структуру.*

Magnetic water is made by passing pure water (H_2O) through a specifically designed permanent magnet, which activates the water molecules and restructures it. When hydrogen and oxygen atoms are clumped together in clusters, ranging from two to hundreds of molecules of water, it is called structured water. Figure 1 shows how H_2O molecules combine into linear or nonlinear clusters. The impact of powerful magnetic fields on water mineral composition varied with both the magnetic field induction and the duration of exposure [1]. The magnetic field significantly altered the pH of the water, leading to an improvement in its quality [2]. Scientists have discovered that under the influence of a magnetic field, water can change its physicochemical properties, which is called the acquisition of magnetic characteristics [3]. Food and water intake, as well as digestion, nutrient absorption, cell development and function, circulatory function were significantly improved in male rabbits and goats given magnetic water (with field strength of 1200 and 3600 gauss) [4]. The increased release of the hormone prolactin may explain the increased milk production in females [5]. An increase in fertility rate, better semen quality, and an improvement in the reproductive system's overall hormone production are all possible outcomes of using magnetic water. There was a marked improvement in the sperm motility, concentration, and overall viability, when the levels of antioxidant enzymes, immunoglobulin A, and testosterone were high and the levels of the lipid peroxidation biomarkers such as malondialdehyde and thiobarbituric acid-reactive substances were low [6]. Researchers found that the scrotum and testicle circumferences of male animals who consumed magnetically treated water increased significantly [7, 8]. Study aimed to investigate the effect of water treated with a magnetic field with different induction on fertility and the histological structure of the kidney and testicular tissue.

MATERIALS AND METHODS OF RESEARCH

Experimental animals: 50 adult male albino rats, 3-4 months old, with a body weight of 200-210 g. The rats lived in sterile settings in the Animal House of the Department of Biology, College of Science, University of Baghdad, in cages and were maintained under laboratory control of temperature (25±2˚C), humidity at 45±5%, and the day/night cycle was kept at 12 hours. The mice could eat and drink as much as they wanted.

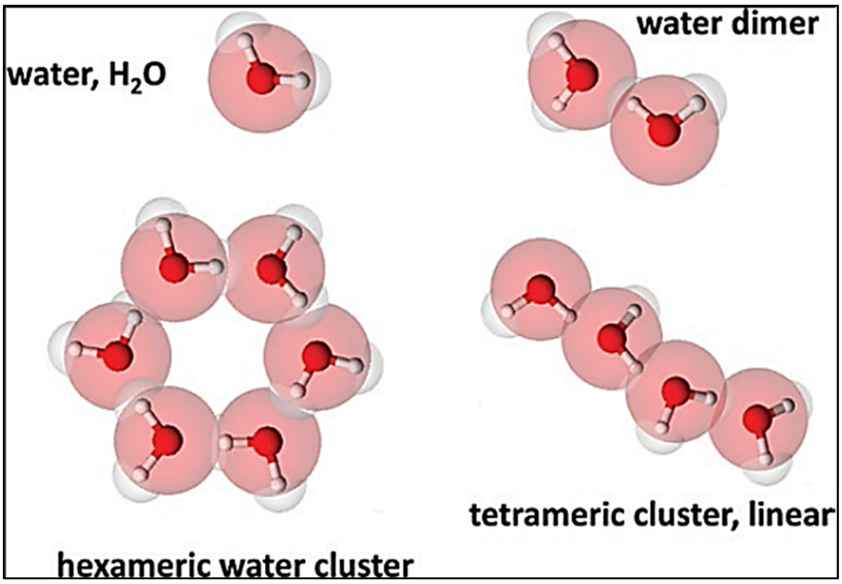

Fig. 1. Water molecules are connected by hydrogen bonds [8]. Hydrogen and oxygen atoms clumped together in clusters ranging from two to hundreds of molecules of water, it is called structured water

The study was approved in August 2023, by the Animal welfare and experimental ethical committee of the Department of Biology, College of Science, University of Baghdad, under reference number CSEC/1023/0117.

For a duration of four weeks, the rats were randomly assigned to five groups, with ten male rats in each combination. There was a control group of rats that drank tap water. Each of the five groups were given daily water treated with a magnetic field with a strengths of: 500 gauss – the second group, 1000 gauss – the third, 1500 gauss – the fourth, and 2000 gauss – the fifth (Fig. 2).

Water treatment: the water was treated using a device developed by the Ministry of Science and Technology. It consisted of a plastic pipe connected to water source, encircled by an annular magnet with varying strengths of 500, 1000, 1500, and 2000 gauss. After treatment, the water was collected, and intensity was measured using a WT10A tesla meter. The animals used in the experiment were then given this water [9].

The histological analysis: animals were scarified, and small sections of kidney and testes tissues were prepared by fixing them in 10% neutral formalin, then dehydrated in alcohol and embedded them in paraffin. The sections were subsequently sliced to a mean thickness of 4 μm. Hematoxylin and eosin stains were used to evaluate the histological investigation by analyzing the morphological alterations [10] the diameter of seminiferous tubules was measured under microscope magnification 100X by image J software Version 1.5.

Statistical analysis: GraphPad prism software version 10 was used in research, the data are presented in mean and standard deviation to compare the difference between different groups by using One way ANOVA. The probability level was below $p<0.05$.

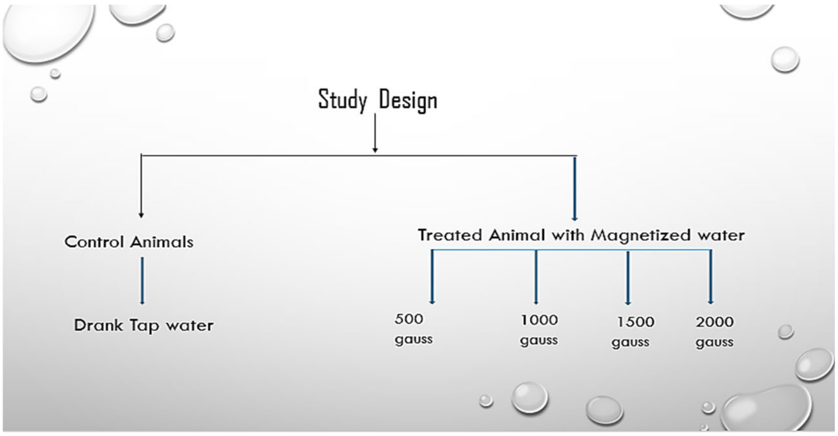

Fig. 2. The study design shows the study groups

RESULTS AND DISCUSSION

The kidney tissue of rats, consuming water treated with a magnetic field with strength of 500, 1000 and 1500 gauss showed normal appearance as illustrated in Figure 4, 5, 6 and 7 respectively, like normal control kidney (Fig. 3). Histopathological examination of the kidneys of rats, given water treated with a magnetic field with strengths 2000 gauss showed multiple focal hemorrhages, and vacuolar degeneration of tubular lining epithelium (Fig. 8). The magnified figure revealed vacuolar degeneration of tubular lining epithelium mostly of collecting tubules, tubular cast formation and tubular necrosis (Fig. 9).

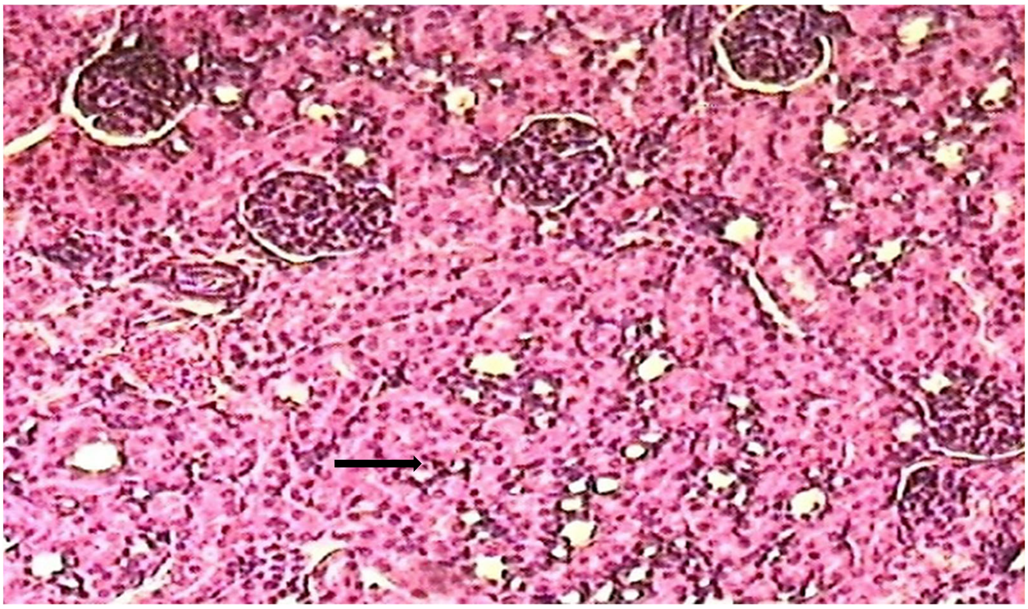

Fig. 3. Kidney section of control rats shows glomeruli, Bowman space (⟶) kidney tubules

Fig. 4. A section of the renal cortex (500 gauss) shows normal glomeruli (black arrow) and renal tubules (red arrows). H&E stain. 100x

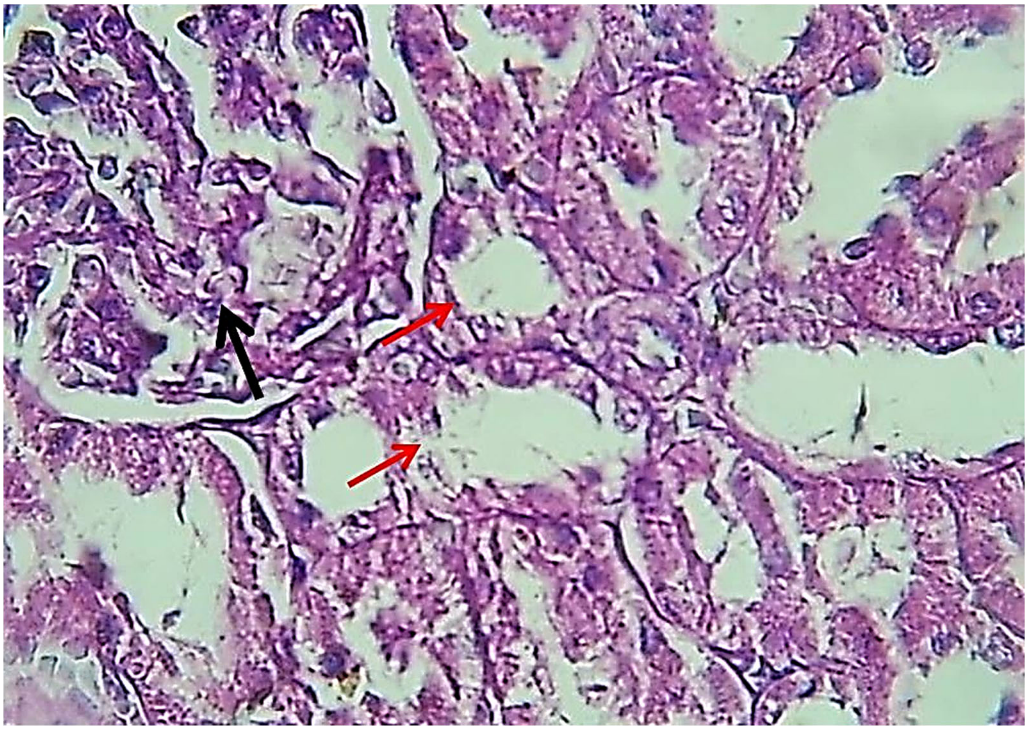

Fig. 5. A section of the renal cortex (500 gauss) shows normal glomeruli (black arrow) and renal tubules (red arrows). H&E stain. 400x

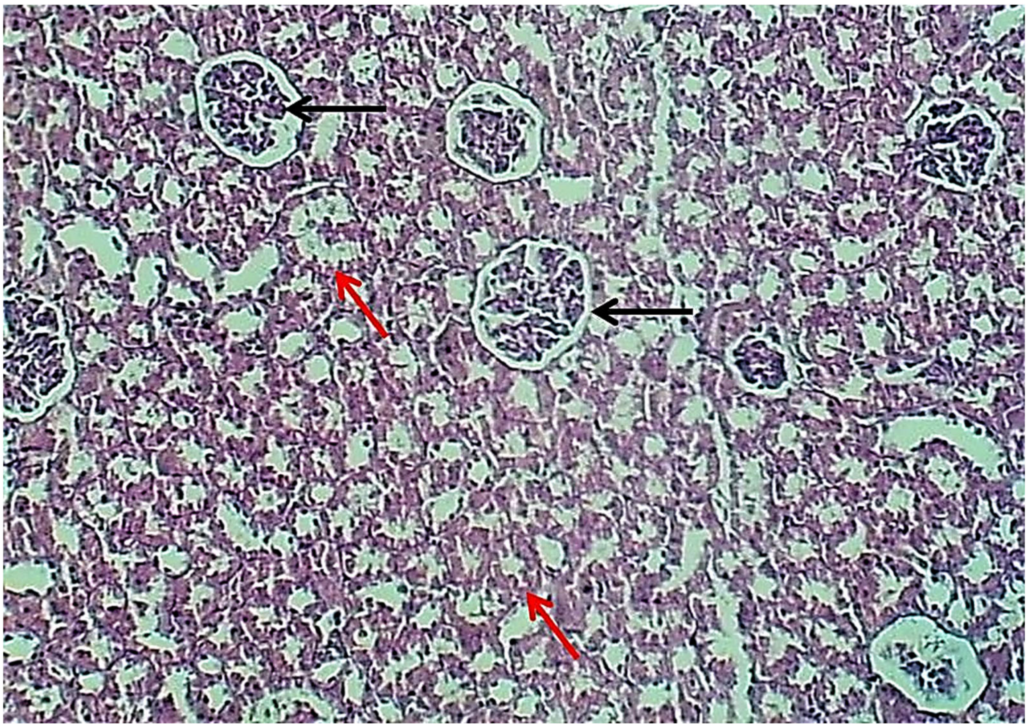

Fig. 6. A section of renal cortex (1000 gauss) shows normal glomeruli (black arrow) and renal tubules (red arrows). H&E stain. 100x

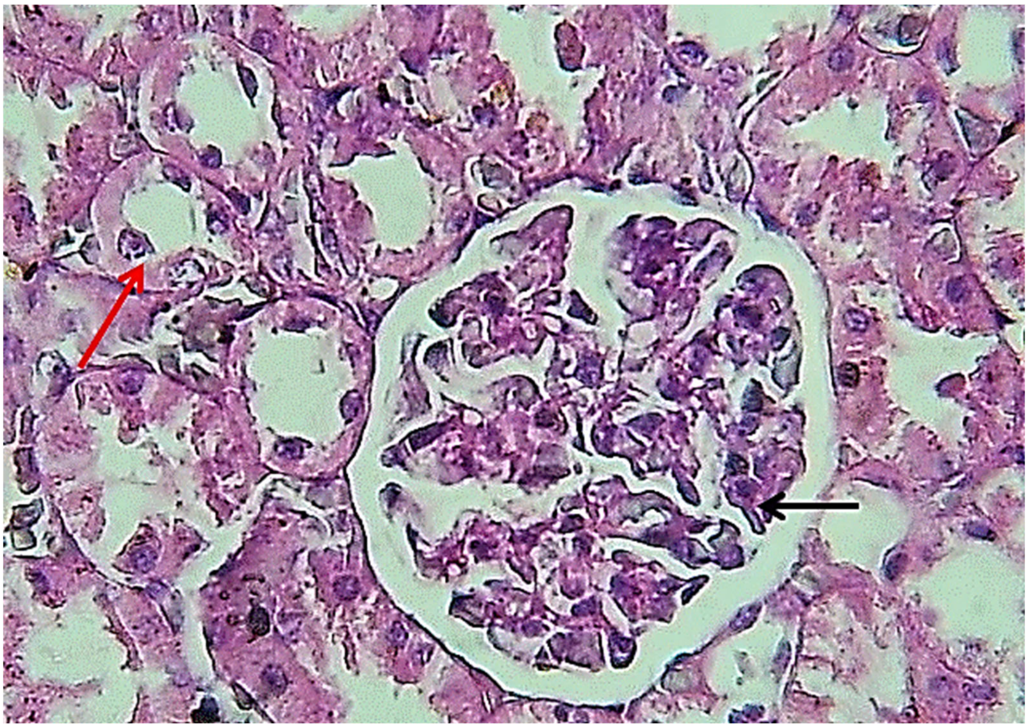

**Fig. 7. A section of the renal cortex (1500 gauss)
shows normal glomeruli (black arrow) and renal tubules (red arrow).
H&E stain. 400x**

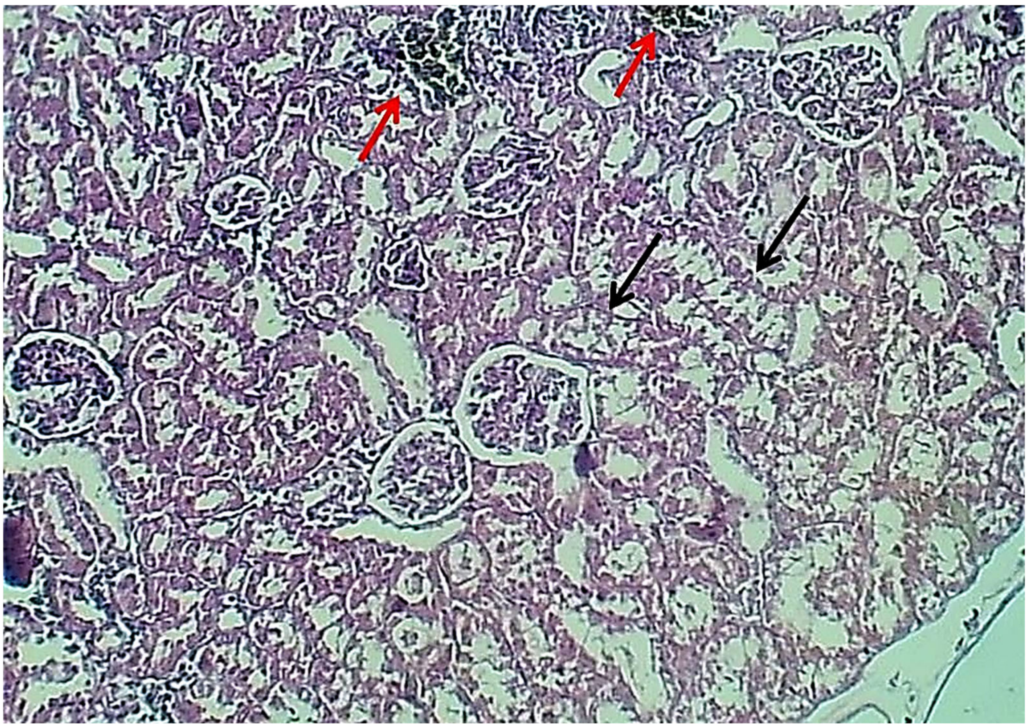

**Fig. 8. Section of renal cortex (2000 gauss) shows multiple focal hemorrhages (red arrow)
and vacuolar degeneration of tubular lining epithelium (black arrows).
H&E stain. 100x**

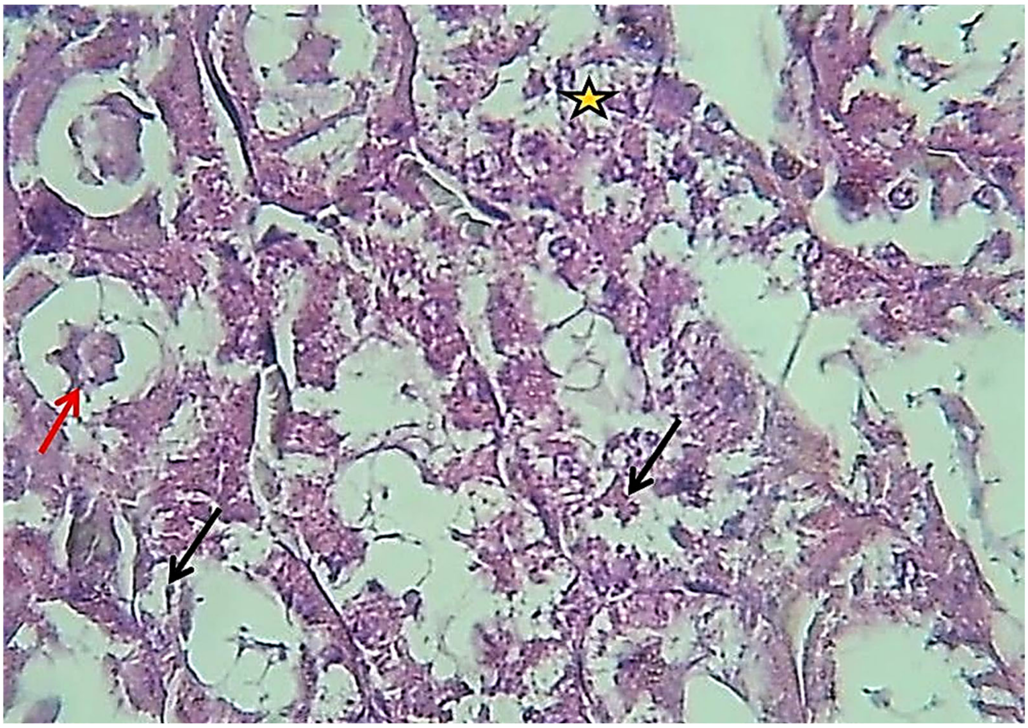

Fig. 9. A section of the renal cortex (2000 gauss) shows vacuolar degeneration of the tubular lining epithelium (black arrows), tubular cast formation (red arrow), and tubular necrosis (asterisk). H&E stain. 400x

The testicular tissue of rats, consuming water treated with a magnetic field with induction 500 and 1000 gauss showed normal section of seminiferous and cytoarchetecture of the germinal epithelium and normal interstitial tissue (Fig. 11, 12, 13 respectively) with increase in seminiferous tubules diameter (Table), which is resemble to normal control testes section in Figure 10. The testicular tissue sections of the those subjected to strengths 1500 gauss revealed marked decreased diameter of seminiferous tubules as shown in Figure 1, and the germinal epithelium revealed moderate vacuolar degeneration with necrosis of the series of spermatogonium cells and there was marked thickening of testicular interstitum (Fig. 14). The histopathological sections of the testes of rats, given water treated with a magnetic field with strengths 2000 gauss intensity revealed marked damage to seminiferous tubules and the germinal epithelium revealed severe vacuolar degeneration with necrosis of the series of spermatogonium cells and there was marked thickening of testicular interstitum (Fig. 15, 16) also there was a decrease in seminiferous tubules as shown in Figure 17, Table.

Difference of the mean of diameter of seminiferous tubules of each group vs control group

	Control	500 gauss	1000 gauss	1500 gauss	2000 gauss
Mean ± SD µm	**185.6±5.2**	**302.3±9.3**	**514.0±7.21***	**212.8±5.34**	**166.3±4.53**
P value	**Ns**	**Ns**	**0.0186 ***	**NS**	**NS**

Notes: SD – standard deviation; NS – non-Significant; * – significant difference p<0.05.

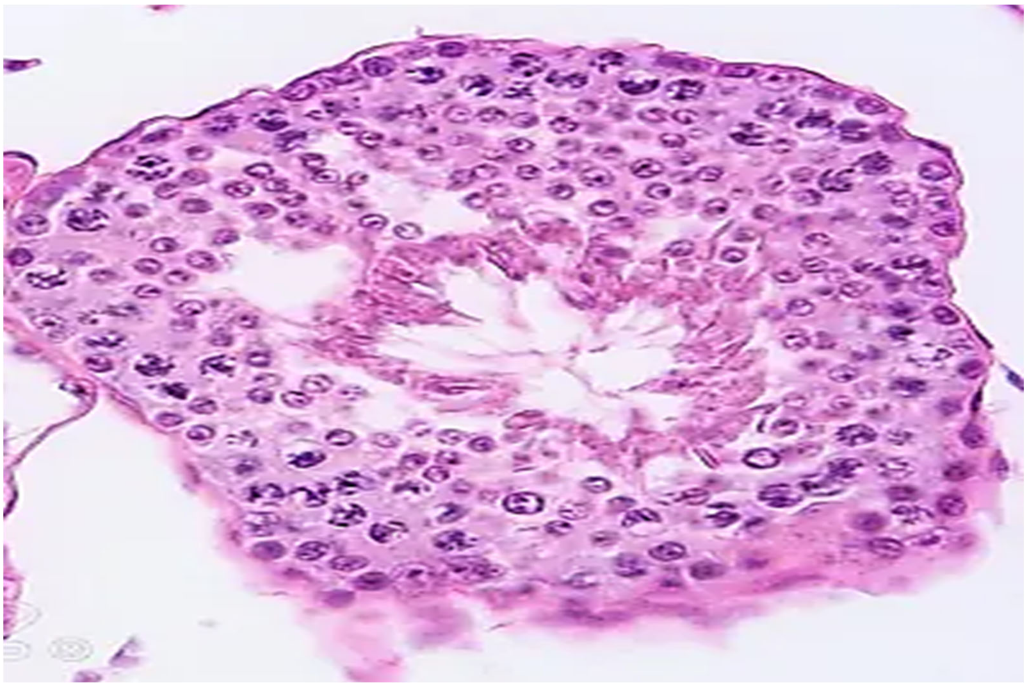

Fig. 10. A section of normal testes of control group shows normal seminiferous and germinal epithelium and interstitial tissue. H&E stain. 400x

Fig. 11. A section of the testes (500 gauss) shows normal seminiferous and germinal epithelium (asterisk) and interstitial tissue (arrow). H&E stain. 100x

Fig. 12. A section of the testes (500 gauss) shows normal germinal epithelium (asterisk) and interstitial tissue (tissue with blood vessels) (arrow). H&E stain. 400x

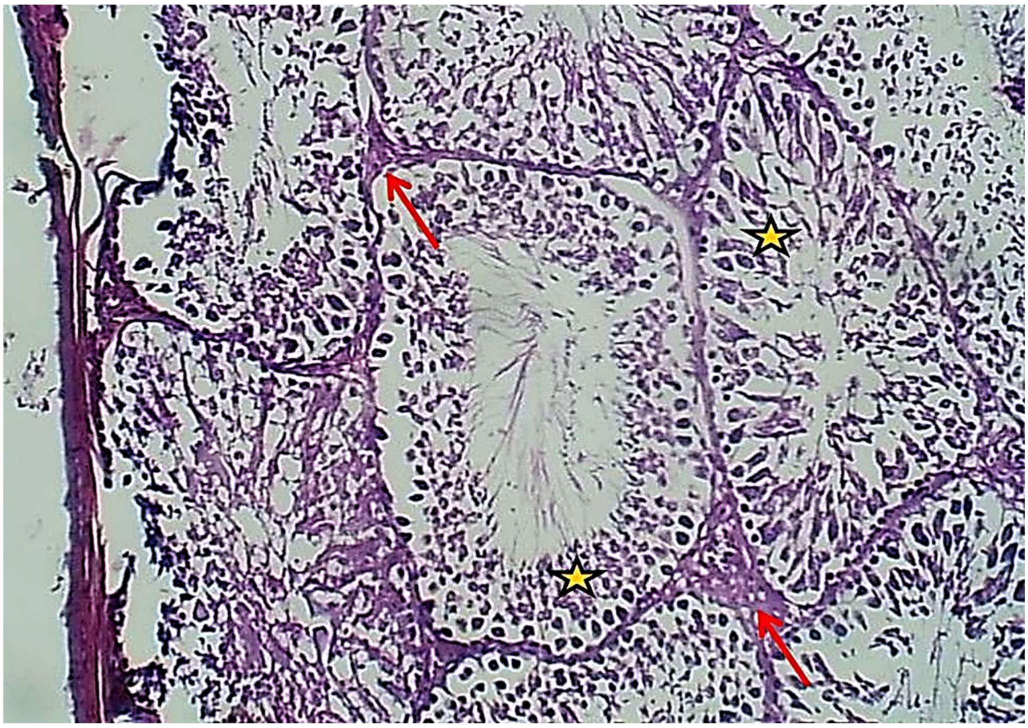

Fig. 13. A section of the testes (1000 gauss) shows normal seminiferous and germinal epithelium (asterisk) and interstitial tissue (arrows). H&E stain. 100x

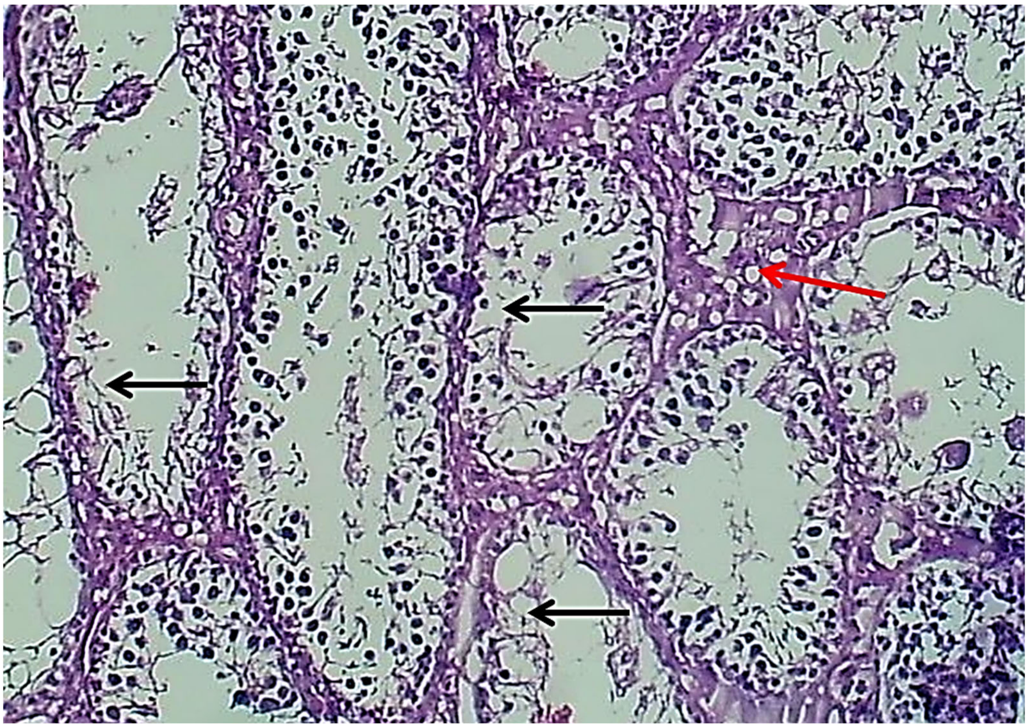

Fig. 14. A section of the testes (1500 gauss) shows a marked decrease in the diameter of seminiferous tubules, and the germinal epithelium revealed vacuolar degeneration with necrosis of a series of spermatogonium cells (black arrows) and marked thickening of the testicular interstitum (red arrow). H&E stain. 100x

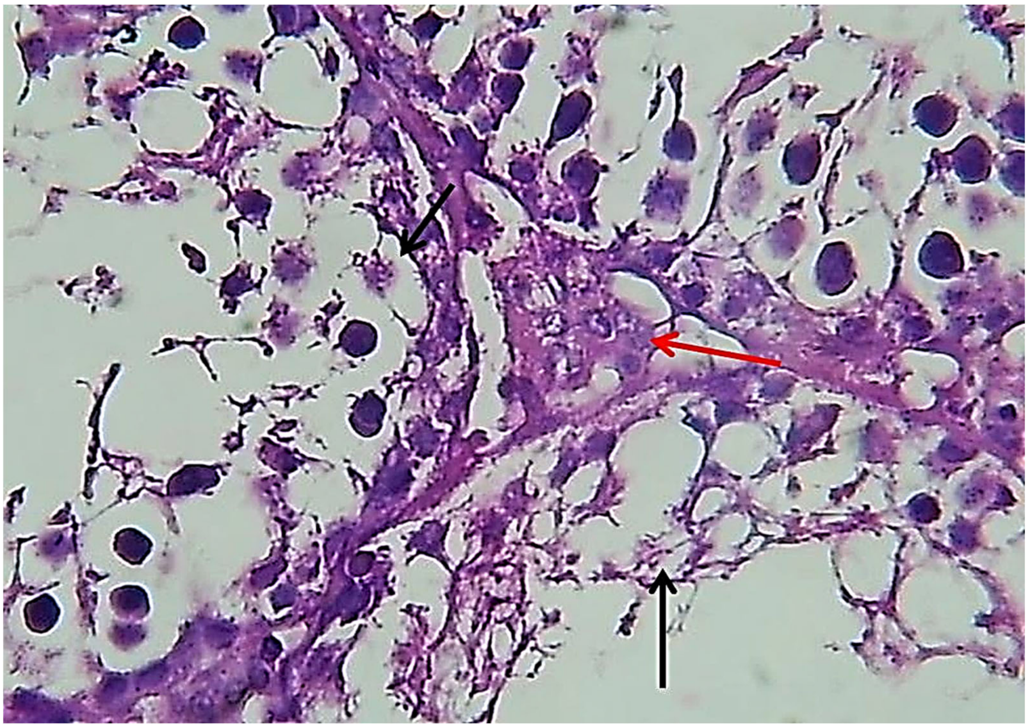

Fig. 15. A section of the testes (2000 gauss) shows vacuolar degeneration with necrosis of a series of spermatogonium cells (black arrows) and marked thickening of the testicular interstitum (red arrow). H&E stain. 400x

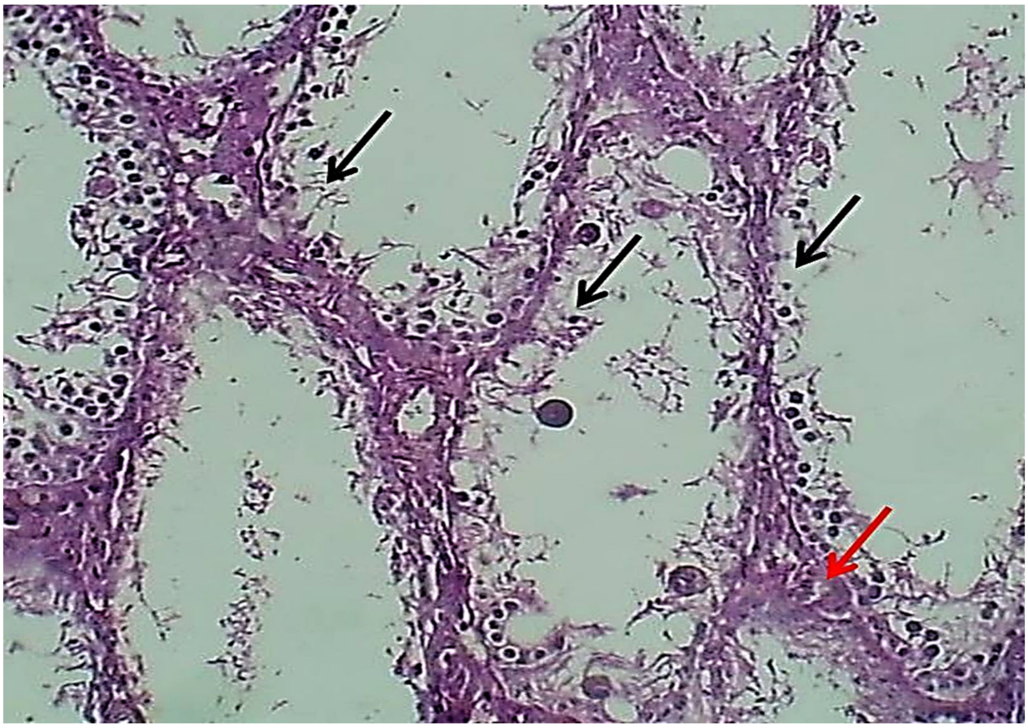

Fig. 16. A section of the testes (2000 gauss) shows marked damage to seminiferous tubules and the germinal epithelium, degeneration with necrosis of a series of spermatogonium cells (black arrows) and marked thickening of the testicular interstitum (red arrow). H&E stain. 100x

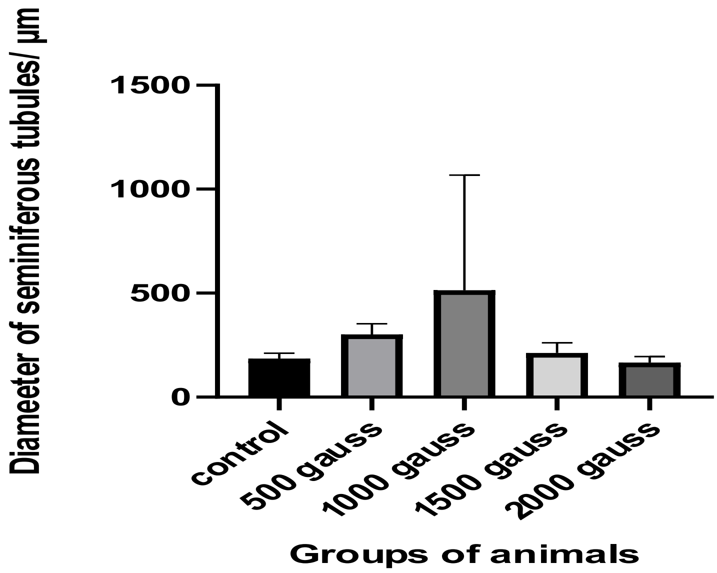

Fig. 17. Difference of the mean of diameter of seminiferous tubules of each group vs control group

Water treatment with magnetic fields is the trend of water purification. The current result relies on tap water exposure to magnetic fields with different intensities 500, 1000, 1500 and 2000 gauss. The renal tissue of rats, given water treated with a magnetic field with induction of 500, 1000, 1500 gauss showed no adverse effect. This was consistent with previous studies which indicated that magnetic field could improve water quality and enhance kinetic movement of salt crystals, increase salt solubility [7]. Other studies mentioned that magnetic water has anti-oxidant properties and high ability to diffuse into the cells and also it possess antiapoptotic effect on kidney cells [11, 12], reduces the nephrotoxicity [13], whereas Mansoor et al. mention that the histological section of the kidney of *Cyprinus carpio L.* fish under the impact of magnetic field with strengths of 1000 gauss showed melanomacrophages, slight cellular swelling, hypercellularity of glomerular bundle and collecting tubules and hyperplastic epithelium [14, 15]. The water, treated with a magnetic field with strengths of 2000 gauss showed harmful effect on renal tissue which included vacuolar degeneration on lining of tubules that finally led to tubular necrosis, cast formation. These changes may be related to hydropic changes due to osmotic nephrosis that is characterized by fine vacuoles formation in tubular cytoplasm, which is obvious in collecting tubules, these vacuoles increase in size and unite gradually till they fill the cytoplasm which leads to cell swelling and narrowing in tubular lumen [16], this was mentioned by Ibrahim and Khater [17]. This may be related to an increase in water permeability. Abnormal vacuole formation may be found in renal tubular parts, especially in collecting tubules and epithelial lining of proximal convoluted tubules. Vacuoles might be small, they are called (microvesicles) or they unite to form large vacuoles (macrovesicles) [18]. This affects the permeability coefficient via the enhancement of water transport through membranes of renal tubules and vascular cells through water channels, which is observed in basolateral and apical membranes, permeability coefficient is decreased five-fold with increasing transepithelial osmotic gradients [19]. Recent results indicate that apical water channels are retrieved by endocytosis so the magnetic water affects the tubular osmosis, resulting in "osmotic nephrosis" this may be the cause of vacuolar degradation of renal tubules. The tubular necrosis may be related to focal vascular hemorrhages that was seen in renal section in rats, given water treated with a magnetic field with induction of 2000 gauss, that may be related to magnetic water effect through osmotic changes that lead to ischemic-induced acute tubular necrosis that interpretated by Kindall [20].

The testes of rats, given water treated with a magnetic field with strengths of 500 and 1000 gauss showed normal histological appearance. This was consistent with Sabry et al. who mentioned that the magnetic water improves semen quality [6] due to it enhance blood circulation, antioxidant enzyme and testosterone level. Tarasewicz et al. mentioned that magnetic water has a high PH by forming calcium carbonate, Ca^{++} ion easily absorbed by cell, which acts as a cofactor for many enzyme and hormones, especially reproductive hormones [21] and increases the dissolved salts and improves electrical conductivity [22], so it boost sperm quality, its count and its capability for fertilization and reduction of abnormal spermatozoa, acrosomal abnormalities [21]. The testicular tissue under the impact of 1500 and 2000 gauss showed germinal epithelium degeneration that can be explained by osmotic effect of magnetic water on blood capillary which leads to ischemic seminiferous tubular necrosis that is characterized by cell death of spermatogonia and others cells like Sertoli cells, as a consequence of cellular vacuolization and protein coagulation and secondary injury lead to ischemia [23]. The cell death consists in vacuolization or formation of larger areas of pale eosinophilic regions of protein coagulation due to ischemia or infarction [2, 24]. The most common cause of seminiferous tubule necrosis is ischemic injury. Seminiferous necrosis is irreversible, due to loss of testicular structure, and the affected area is replaced by scar tissue [25, 26]. Testicular tubule decrease is related to a degradation of germinal epithelium and increase the accumulation of seminal fluid in the lumen that secreted by Sertoli cell [27].

The present study continues previous study [9] on heart, spleen and lung, but with very little reference to histological effect of magnetic water on testes and kidneys that was the novelty of the study. But it needs to confirm the impact of magnetic water on other animals to prove its effect and study its effect in the treatment of renal diseases.

CONCLUSION

1. Water treated with a magnetic field improves its quality, so the renal and testicular tissue was intact in rats, given water treated with a magnetic field with an induction of 500 and 1000 gauss.
2. Water treated with a magnetic field with an induction of 2000 gauss affected testicular and renal tissue, which manifested as vacuolar degeneration and necrosis in both renal tubular and spermatogonium cells in testes of rats.
3. Water treated with a magnetic field with an induction of 1000 gauss best of all preserves rat renal and testicular tissue and improves their function.

Acknowledgement: The authors would like to thank the Ministry of Science and Technology, Directorate of water and Environment for water magnetization device designing.

Contributors:

Sura Fouad Alsaffar – conceptualization, methodology, supervision, writing – review & editing, project administration;

Lamyaa Abdulridha Fadhil – validation, resources, writing – original draft;

Ishraq Mohammed Baker – investigation, resources, supervision.

Funding. This research received no external funding.

Conflict of interests. The authors declare no conflict of interest.

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Стаття надійшла до редакції 16.10.2024;
затверджена до публікації 13.12.2024