Physiological histological vision in diabetic-induced white rat treated with magnetized water, *Aloe vera* and metformin

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الرؤية النسيجية الفسيولوجية في الفئران البيضاء المصابة بمرض السكري والتي عولجت بالماء الممغنط والصبار والميتفورمين

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شملت الدراسة 60 جرذًا ذكرًا بالغًا، بواقع 6 جرذان لكل معاملة بمتوسط عمر 14 أسبوعًا، وأُعطيت كل مجموعة أوزانًا متساوية قدر الإمكان قبل بدء الدراسة بمتوسط 250 جرامًا. قُسِّمت الجرذان إلى مجموعتين رئيسيتين، الأولى مجموعة الضبط والتي ضمت مجموعتين ثانويتين وفقًا للماء المعتمد (العادي والممغنط)، والثانية مجموعة الجرذان المُستحثة بمرض السكري من النوع الثاني والتي ضمت أيضًا مجموعتين فرعيتين بواقع أربع مجموعات فرعية لكل منهما وفقًا للماء المعتمد (العادي والممغنط) وطريقة المعاملة، وقد خضعت الحيوانات للظروف المخبرية اللازمة وقُدِّمت لها العلف القياسي طوال مدة التجربة، وبعد انتهاء الفترة التحضيرية، تم تجويع الجرذان لمدة 24 ساعة وإحداث مرض السكري بالألوكسان. بعد تأكيد تحريض داء السكري، عولجت المجموعات الفرعية الثماني (للمجموعة الثانية) يوميًا لمدة 28 يومًا بالميتفورمين وعصير الصبار، مع مراعاة نوع الماء المُعتمد (طبيعي، ممغنط)، وقياس مستوى السكر أسبوعيًا لمدة أربعة أسابيع. جُوِّعت الفئران، ثم أُعطيت دواء الكلوروفورم، وأُخذت عينات دم من القلب مباشرةً عن طريق وخزة قلبية لإجراء فحوصات كيميائية حيوية، ثم تشريح الجثث واستئصال الكلية للفحص النسيجي. أظهرت نتائج الفحص المجهري حدوث عدة آفات نسيجية في الكلى، وضمور، وتفتت الكبيبات، وتنكس، ونخر في الأنابيب الحلزونية،

وتسلل خلايا التهابية، ونزيف. وتبين أن هذه الآفات كانت أكثر شدة لدى المجموعة المعالجة بالألوكسان، على عكس المجموعات التي تم اعتماد الماء الممغنط فيها، حيث أظهر نسج أعضائها شكلاً شبه طبيعي، مع تحسن كبير في نسج أعضاء المجموعات التي تم اعتماد الماء الممغنط فيها مع باقي المعالجات (ميتفورمين، عصير الصبار، ميتفورمين مع مستخلص الصبار التآزري)، كما ظهر تحسن طفيف للمجموعات التي تم اعتماد الماء الطبيعي فيها مع نفس المعالجات (ميتفورمين، عصير الصبار، ميتفورمين مع الصبار التآزري). أما من الناحية الفسيولوجية، فقد أظهر التحليل الإحصائي أن نسبة الإصابة بمرض السكري في دم الجرذان المُستحثة بالألوكسان، لوحظ وجود تأثيرات معنوية عند مستوى احتمالية $P> 0.05$ لأنواع ومدة العلاجات، وفي معدلات تأثير العلاجات خلال فترة الدراسة كاملة، وجد أن أعلى معدل معنوي لسكر الدم سُجل في المجموعة المُصابة التي اعتمدت على الماء الطبيعي، والذي بلغ 338.2 ملغم/ديسيلتر، بفارق معنوي عن باقي العلاجات.

الكلمات المفتاحية: مرضى السكري وماء السكري الممغنط، عصير الصبار السكري، ماء السكري الممغنط، حمض الكلى، الميتفورمين ومرض السكري.

Abstract

The study included 60 adult male rats, with 6 rats per treatment at an average age of 14 weeks, and each group was given equal weights as much as possible before the start of the study at an average of 250 grams. The rats were divided into two main groups, the first was the control group, which included two secondary groups according to the approved water (normal and magnetic), and the second was The group of rats induced with type II diabetes, which also included two subgroups with four subgroups each according to the approved water (normal, magnetized) and the method of treatment, the animals were subjected to the necessary laboratory conditions and were provided with the standard feed throughout the duration of the experiment, and after the end of the preparatory period, the rats were starved for 24 hours and inducted diabetes with alloxan. After confirming the induction of diabetes, the eight subgroups (for the second group) were treated daily for 28 days with Metformin, *Aloe vera* Juice, Metformin and *Aloe vera* Juice synergistically, taking into account the type of approved water (normal, magnetic) and with them the sugar

level was measured weekly for four weeks. The rats were starved, then drugged by chloroform, blood samples were taken by cardiac stab directly from the heart for chemobiological tests, and then autopsies and nephrectomy for histological examination. The results of microscopy showed the occurrence of several tissue lesions of the kidney, atrophy, fragmentation of the glomeruli, degeneration, necrosis of the coiled tubules, infiltration of inflammatory cells, and hemorrhage. These lesions were found to be more severe for the group treated with alloxan, in contrast to the groups in which the magnetized water was adopted, as the weaving of their organs showed a semi-normal shape, with a significant improvement in the weaving of the organs of the groups in which the magnetized water was adopted with the other treatments (Metformin, *Aloe vera* Juice, Metformin with Extract. Synergistic *Aloe vera*), and there appeared to be a slight improvement for the totals in which normal water was adopted with the same treatments (Metformin*, Aloe vera* Juice, Metformin with *Aloe vera* Synergy). As for the physiological aspect, the statistical analysis showed that the percentage of diabetes in the blood of rats induced by alloxan, the presence of significant effects was observed at the probability level of $P< 0.05$ for the types and duration of the treatments, in the rates of effect of the treatments during the entire study period, it was found that the highest significant rate of blood sugar was recorded in the affected group in which the normal water dependent, which reached 338.2 mg/dL, with a significant difference from the rest of the treatments.

Keywords: Diabetic and Diabetic Magnetized Water, Aloe Vera Diabetic Juice, Diabetic Magnetized Water, Kidney Acid, Metformin and Diabetes.

Introduction

Diabetes is a multifaceted and persistent metabolic disorder that has become a prominent global health concern, affecting a large population and posing significant

health risks, putting significant strain on healthcare systems [1] This disease is characterized by high blood glucose levels resulting from insufficient insulin production or impaired insulin function, and is of a complex nature that can lead to major complications affecting organs and causing deaths [2] .

Magnetized water improves the tissue structure of the pancreas by repairing DNA damage, enhancing antioxidant status, reducing the inflammatory response, and regulating genes associated with glucose metabolism. Furthermore, treatment with magnetized water can reverse the adverse effects of pancreatic diabetes [3], in addition, aloe vera juice has been used to treat hyperglycemia [4,5]. *Aloe vera* has antibacterial as well as anti-inflammatory properties [6].

Metformin is an anti-diabetic drug in the Biguanides class, a widely used drug used by people with type 2 diabetes mellitus (T2DM), as the drug is taken orally and lowers cumulative sugar concentration values [7], as well as increases blood sugar absorption in skeletal muscle, and promotes fatty acid oxidation [8].

Materials and working methods

In this study, 60 male rats of the Albino Male Rats of *Rattus Norvegicus* were used with 6 rats at the age of 14 weeks for each treatment, with an average weight of 250 grams, which were bred in the Animal House Unit at the Faculty of Veterinary Medicine/Tikrit University, and were examined by the specialist doctor in the animal house and then placed in plastic cages with dimensions of (46 × 28 × 13) cm, and the animals were left in the laboratory for a period of time. Two weeks of acclimatization, subjected to appropriate laboratory conditions of 25ºC and a light period (12 hours of light and darkness) taking into account the ventilation factor, and fed with the standard custom forage.

1. The first group (control) includes two secondary groups:

- **Control group (plain water):** This group was given plain water and food daily for 28 days.

- **Control group (magnetized water):** This group (magnetized water) and food were given daily for 28 days.

2- The second group (in which diabetes is induced) includes two subgroups:

A- magnetized water group distributed into four subgroups:

- Infected group treated with 1 ml metformin.
- Infected group treated with aloe vera sap at a dose of 1 ml.
- Infected group and treated with metformin with aloe vera sap (synergistic) at a dose of 1 ml each.
- Infected and approved group with magnetized water: Magnetized water was prepared continuously by placing a piece of magnet in water for at least 12 hours, and then given to this group for the duration of the study.

B- The plain water group is divided into four subgroups:

- Infected group treated with 1 ml metformin.
- Infected group treated with aloe vera sap at a dose of 1 ml.
- Infected group and treated with metformin with aloe vera sap (synergistic) at a dose of 1 ml each.
- Infected and untreated group: Normal water was given only.

Preparation of *Aloe vera* juice extract

The leaves of the aloe vera were selected with a length ranging between (50-70) cm, then washed, cut from the top and bottom with 5 cm long slits and opened them, extracted the juice and weighed it with a sensitive scale. The average weight of the rats was about 250 grams, and since the experimental treatment included 24 animals for four groups, the total weight of the rats in the four groups was 6 kg, so the required amount of juice was weighed 6 grams per day and 42 grams per week, then distilled water was added to the juice in a ratio of (1:1) to obtain a concentration of 500 mg/kg of juice. Aloe vera and homogenizing it by means of an electric mixer,

then filtering it by cutting gauze, placing it in dark glass bottles, and then storing it in the refrigerator until use [9].

Preparation of Metformin Solution

The average human weight is 70 kg and the dose of Metformin is 1000 mg, and since the average weight of rats is about 250 grams, the dose was calculated in terms of the weight of the animal, so it reached 0.003571 g [10], i.e. 0.6 g per week (after taking into account the number of animals dosed daily, which is 24 animals for a week). After obtaining Metformin powder from Samarra Pharmaceutical Laboratory, the required amount of it per week for the four groups was weighed 0.6 g and dissolved in 168 ml of distilled water, then placed in tightly closed glass containers and kept in the refrigerator, and the animals were dosed at a rate of 1 ml per animal per day.

Blood sugar levels were measured for all groups after three days to confirm the occurrence of the disease, and blood sugar levels were measured weekly for four weeks for all treatments. After the experiment, the mice were anesthetized with chloroform, and the kidneys were collected and stored in plastic containers containing formalin solution, sealed tightly and prepared to prepare the tissue sections.

Preparation of Textile Sections

The textile sections were prepared according to the traditional method adopted: fixing, washing, draining, soaking, imbibing, burying, trimming and cutting, coloring [11].

Results and Discussion

1- Regarding the textile aspect:

Microscopic examination of the histological sections of the kidney in the control groups (normal water/magnetized water) showed the normal appearance of

glomerulus and renal/urinary tubules (renal/urinary tubules) as shown in Figures (1), (2), (3) and (4).

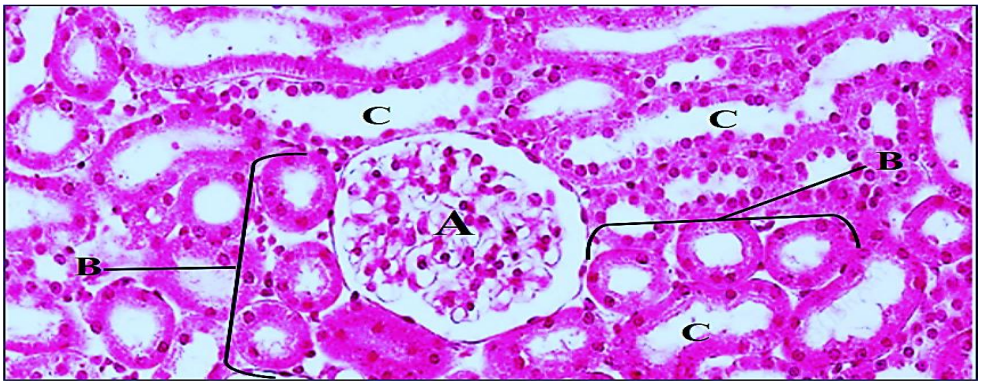

Figure 1: Microscopic image of a section of a rat kidney of a control group with normal water, in which the normal appearance of glomerulus (A) and renal/urinary tubules is observed. (H&E, X40).

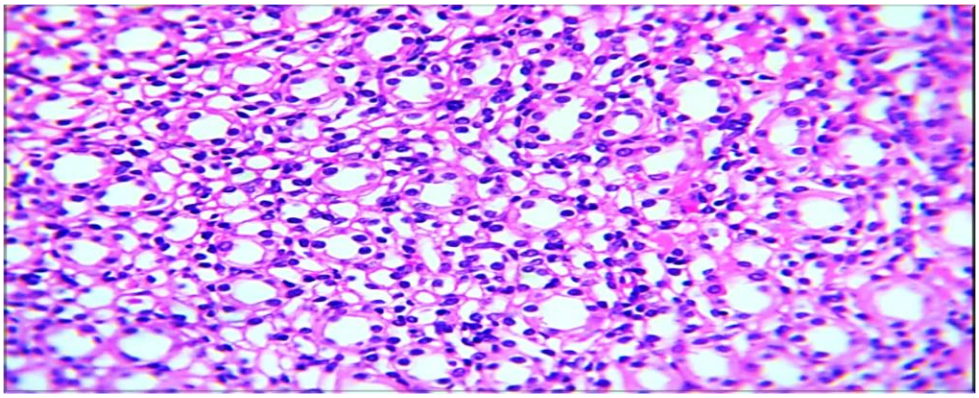

Figure 2: Microscopic image of a section in the kidney of a rat from the control group in which normal water is adopted, in which the normal appearance of renal/urinary tubules is observed throughout the tissue section. (H&E, X40).

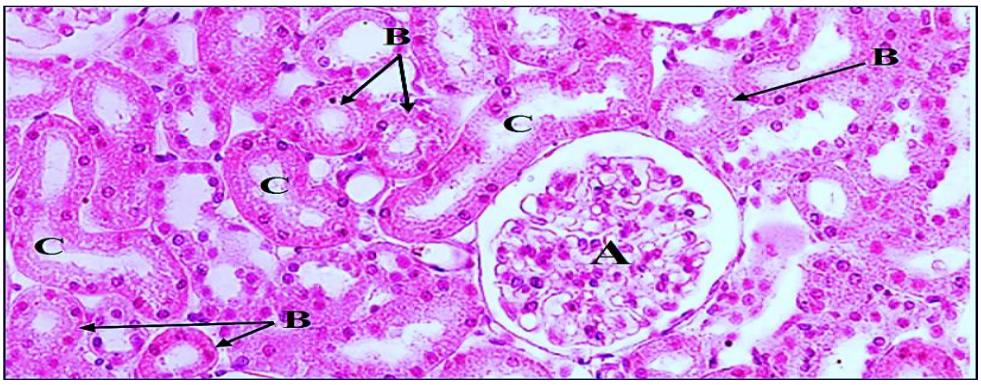

Figure 3: Microscopic image of a section of a rat kidney of the control group in which magnetic water is adopted, in which the normal appearance of glomeruli (A) and proximal (B) and distal (C) nephral/urinary tubules is observed. (H&E, X40).

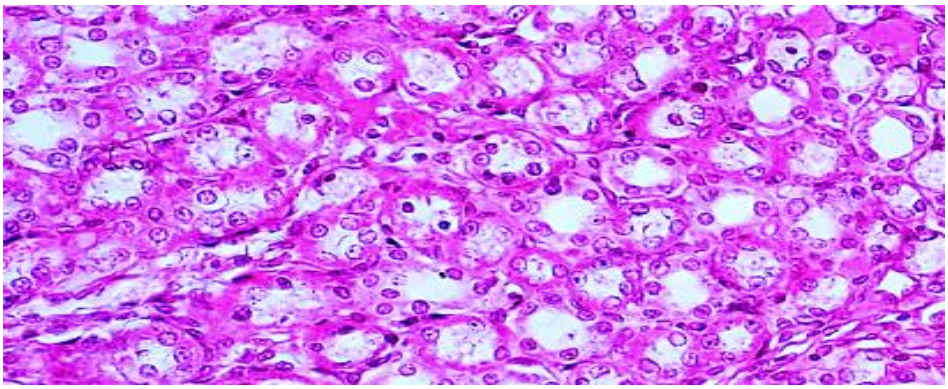

Figure 4: Microscopic image of a section in the kidney of a rat from the control group in which magnetic water is adopted, in which the normal appearance of the renal/urinary tubule is observed throughout the tissue section. (H&E, X40).

Microscopic examination of the tissue sections of the kidney in the affected group with normal water dependents showed atrophy, glomerular atrophy and fragmentation with cytoplasmic bursting of its cells and hemorrhage bleeding as well as inflammatory cellular infiltration in the interstitial tissue , and the occurrence of acute rupture in part of one of the tissue segments, in addition to the degeneration and necrosis of the epithelium lining the renal tubules, as shown in Figures (5) and (6).

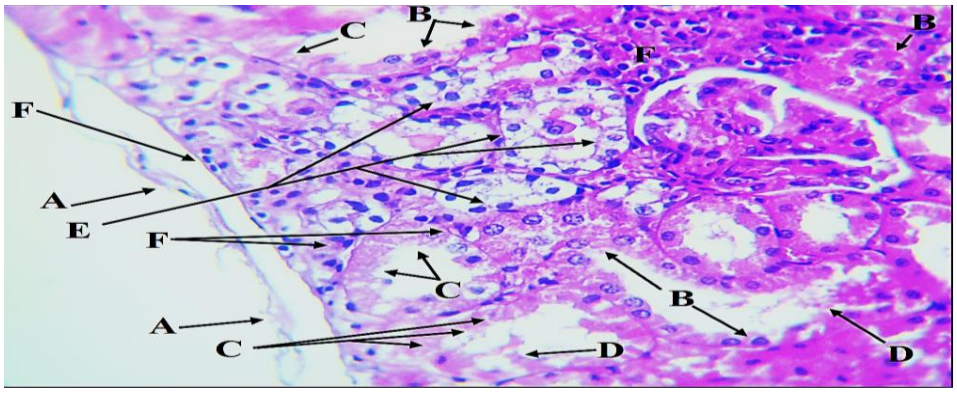

Figure 5: Microscopic image of a kidney section of a rat in the diabetic group in which normal water dependent, in which partial mollatation of the renal capsule (A) is observed, degeneration (B) and necrosis (C) necrosis of the epithelial cells lining a number of renal tubules, and their desquamation into the cavity of some tubules (D), with the vacuolation of cytoplasm epithelial cells of most other tubules (E), as well as inflammatory cellular infiltrate in a side of interstitial tissue (F). (H&E, X40).

These results are consistent with the findings of Sharma and Rana (2020) in their assertion that the populations of alloxan-induced diabetic mice led to diabetic nephropathy represented by pathological histological changes from tubular epithelial damage/damage, glomerular atrophy and urinary space dilation, to chemical abnormalities in the blood of these mice that led to glomerular filtration pressure It has contributed to the histological changes in it.

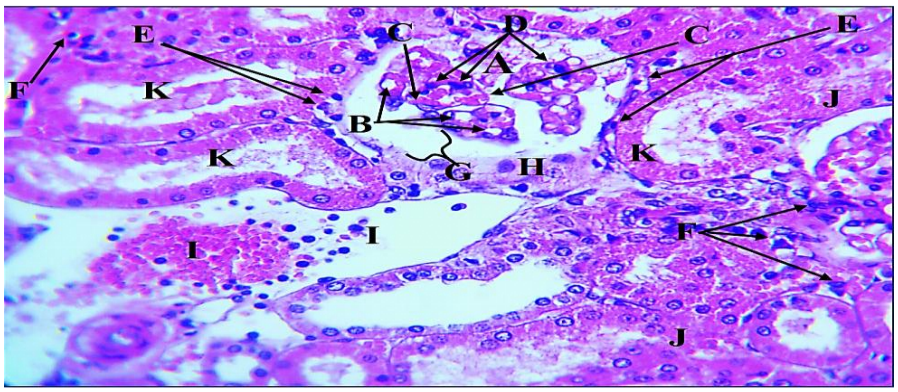

Figure (6): Microscopic image of a section in the kidney of a rat in the diabetic group in which normal water is induced, glomerular atrophy and fragmentation (A) with cytoplasmic bursting of its cells (B), hemorrhage bleeding (C) as well as inflammatory cellular infiltration on and around its surface (D) and around it (E)) and a number of renal tubules (F), an expansion of the capsular/urinary space (G), partial degeneration of the parietal layer of Bowman's capsule (H), an acute burst of a side of the interstitial tissue with hemorrhage and inflammatory cell infiltration (I), as well as degeneration (J) and necrosis (K).) the epithelium lining the renal tubules. (H&E, X40).

In microscopic examination of the tissue sections of the kidney in the affected group and in which magnetized water dependent, the normal appearance of the collecting tubules with their simple cuboidal epithelium was observed, as well as the simple squamous epithelium of the thin limbs of Henle's loop, with partial congestion of some of the Vasa rectal blood vessels. Tissue sections also showed partial scabies with hemorrhage and expansion of the capsular space, as well as degeneration and necrosis of the epithelium lining a number of renal tubules and the semi-normal appearance of other tubules, as shown in Figures (7) and (8).

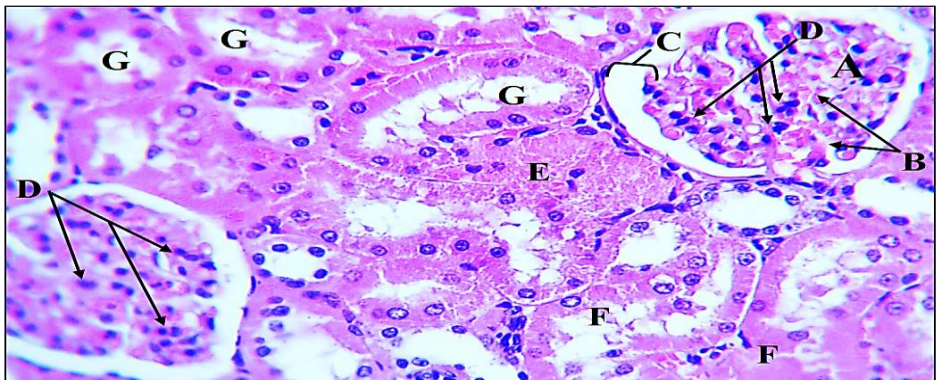

Figure 7: Microscopic image of a section in the kidney of a rat in the diabetic group in which magnetized water dependent, in which partial stenosis of one of the glomeruli (A) with hemorrhage (B) and expansion of the capsular space around it (C) and inflammatory cellular infiltration on the surface of the

glomeruli (D), as well as blood congestion in the interstitial tissue (E)), degenerate and necrosis in the epithelium lining a number of renal tubules (F) and the semi-normal appearance of other tubules (G). (H&E, X40).

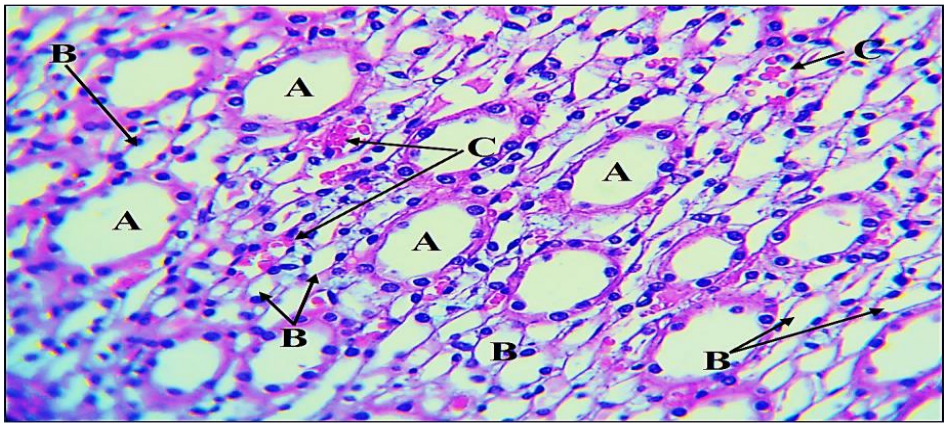

Figure 8: Microscopic image of a section in the kidney of a rat in the diabetic group in which magnetized water is adopted, in which the normal appearance of the collecting tubules with their simple cuboidal epithelium (A) is observed, as well as the simple squamous epithelium of the thin limbs of Henle's loop (B), with the exception of the vasa recta vascular with congestion (C). (H&E, X40).

In microscopic examination of the tissue sections of the kidney in the affected group treated with Metformin and approved with plain water, if limited blood congestion is observed in the tissue body, with degeneration and necrosis in the epithelial cells lining the renal tubules, and the appearance of other homomorphic tubules, as observed in other tissue segments that are glomerular and enlarged in the capsular space, with limited inflammatory cell infiltration between the renal tubules as in the two figures (9) and (10).

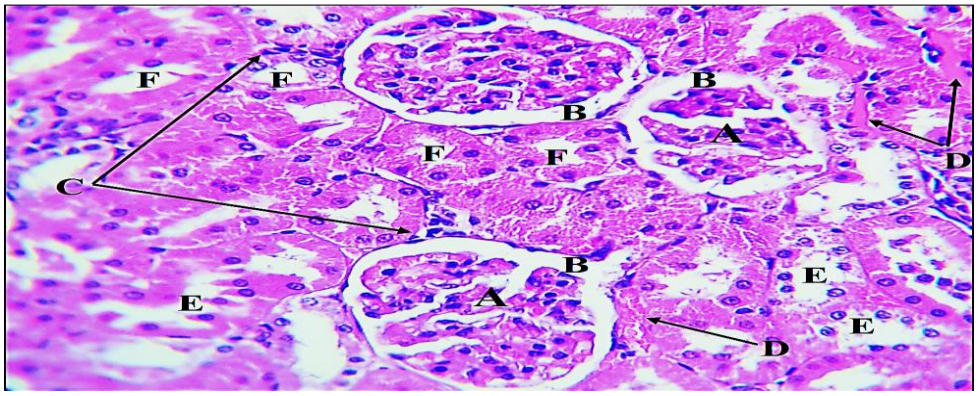

Figure 9: Microscopic image of a kidney section of a diabetic-induced rat treated with metformin and approved with regular water, in which glomerular stenosis (A) and capsular space dilation (B) are observed, with limited inflammatory cell infiltration between renal tubules (C), and slight blood congestion in the tissue body (D), as well as the degeneration of the epithelium lining a number of renal tubules (E), and the appearance of other homologous tubules (F). (H&E, X40).

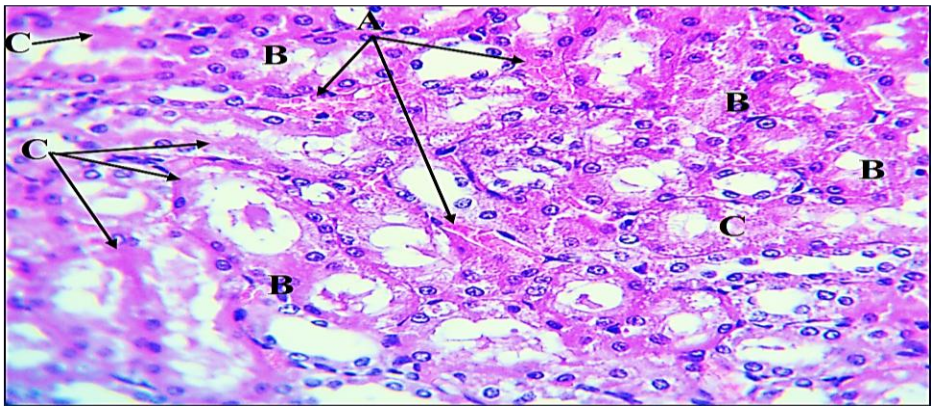

Figure 10: Microscopic image of a section of a kidney of a rat in the diabetic-induced group treated with Metformin, in which normal water dependent, limited blood congestion is observed in the tissue body (A), with degeneration (B) and necrosis (C) of the epithelial cells lining the renal tubules. (H&E, X40).

The results of this study did not agree with the findings of a study that indicated that the use of Metformin in rats induced diabetes with aloxane led to an improvement in the renal tubules and blood vessels, and indicated signs of rapid

recovery of kidney tissue cells, and the results indicated that the use of aloe vera juice with Metformin To treat diabetic patients would help with kidney integrity and prevent kidney failure (Atanu *et al*., 2018). Microscopic examination of the tissue sections of the kidney in the affected group treated with Metformin and dependent on magnetic water, the normal structure of the glomeruli in the tissue segments was observed, with the exception of a slight stiffening of some of them in other tissue segments, with necrosis and degeneration of the epithelial cells lining a number of renal tubules, and vacuolar degeneration of their cells, as well as a slight blood congestion in the interstitial tissue as shown in Figures (11) and (12).

Figure 11: Microscopic image of a section of a kidney of a rat in the diabetic group treated with Metformin and dependent on magnetized water, in which limited glomerular stenosis (A) is observed with vacuolar degeneration (B) and expansion of the capsular space (C), as well as slight blood congestion in the interstitial tissue (D)), with necrosis and degeneration of epithelial cells lining a number of renal tubules (E). (H&E, X40).

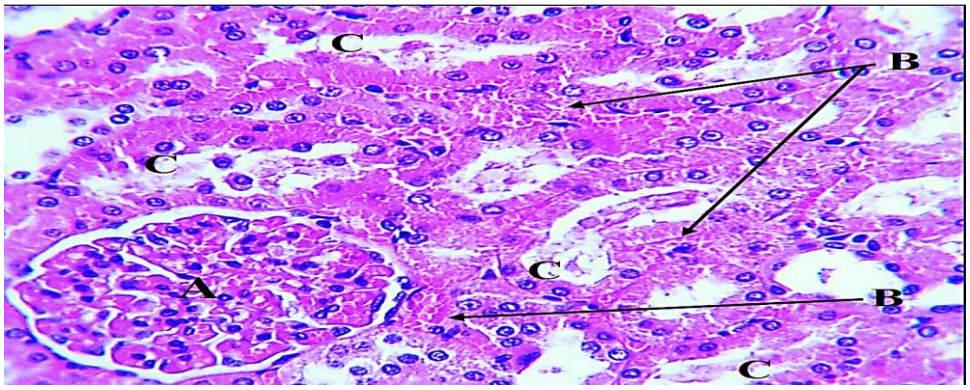

Figure 12: Microscopic image of a section in the kidney of a rat in the diabetic group treated with Metformin and approved with magnetic water, in which a nephromerulomic glomerulus of Figure A is observed, hematological congestion in the body of tissue (B), with necrosis and deterioration of the epithelial cells lining a number of renal tubules (C). (H&E, X40).

By using magnetized water with alloxan-induced rat populations, and adopting Metformin as a treatment, our results were consistent with the results of the aforementioned study of Atanu *et al* (2018), which indicated the positive effect of Metformin, which was adopted as a treatment for diabetic rats with alloxan, and its role in significantly healing the renal tissue. Here we can We attribute the reason to the effective effect of the physical and chemical properties of the approved water type, which had a synergistic effect with Metformin**.** In microscopic examination of the tissue sections of the kidney in the affected group treated with aloe vera juices and dependent on plain water, it was observed that glomerular stenosis and expansion of the capsular space were observed, as well as a noticeable expansion of the cavities of a number of renal tubules and their appearance with simple cube lined cells that are very low, with the bursting and degeneration of the epithelium lining a number of other tubules, and the expansion of the cavities of a number of others, and some of them contain a leachate of crystalline protein material in the form of glass

molds Hyaline casts as well as inflammatory cell infiltration in the interstitial tissue as shown in Figures 13 and 14.

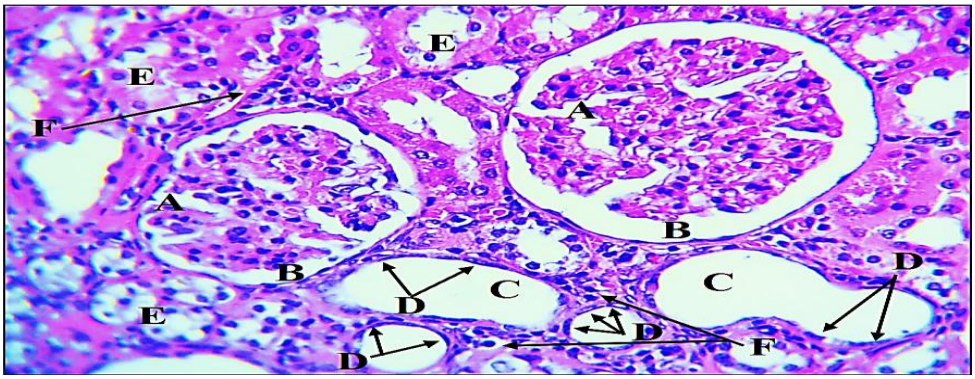

Figure 13: Microscopic image of a kidney section of a diabetic rat treated with *Aloe vera* sap and adopted with plain water, in which glomerular stenosis (A) and capsular space dilation (B) are observed, as well as a marked dilation of the cavities of a number of renal tubules (C) and their appearance in simple, very low (semi-squamous) cuboidal lined cells (D), with bursting and degeneration of the epithelium lining a number of other tubules (E), and inflammatory cytoplasm in the interstitial tissue (F). (H&E, X40).

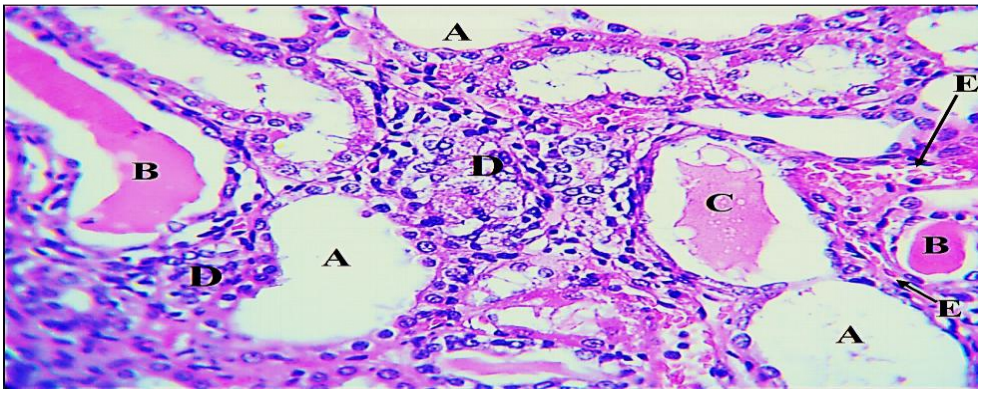

Figure 14: Microscopic image of a section in the kidney of a rat in the diabetic-induced group treated with *Aloe vera* juice, in which plain water is observed, in which the cavities of a number of renal tubules (A) are dilated and some of them contain hyaline casts (a crystalline protein material) (B), as well as a homogeneous glomerular leachate in one of them (C), with fibrosis Fibrosis

and extensive inflammatory cell infiltration of the interstitial tissue (D), and hematocongestion on one side of the tissue (E). (H&E, X40).

The results of this study did not agree with the findings of Atanu and his group (2018) in their study, which confirmed that the use of *Aloe vera* juice in diabetic rat populations induced with alloxan led to an improvement in the renal tubules and blood vessels, and the results of their study indicated that the use of aloe vera for the treatment of diabetic patients would help prevent kidney failure. Microscopic examination of the tissue sections of the kidney in the affected group treated with *Aloe vera* juice and dependent on magnetized water showed an expansion of the capsular space and glomerular stenosis, as well as degeneration of the epithelium lining a number of renal tubules, and a semi-normal appearance of the collecting ducts, as well as the thin ends of the Henley loop, as shown in Fig. (15) and (16).

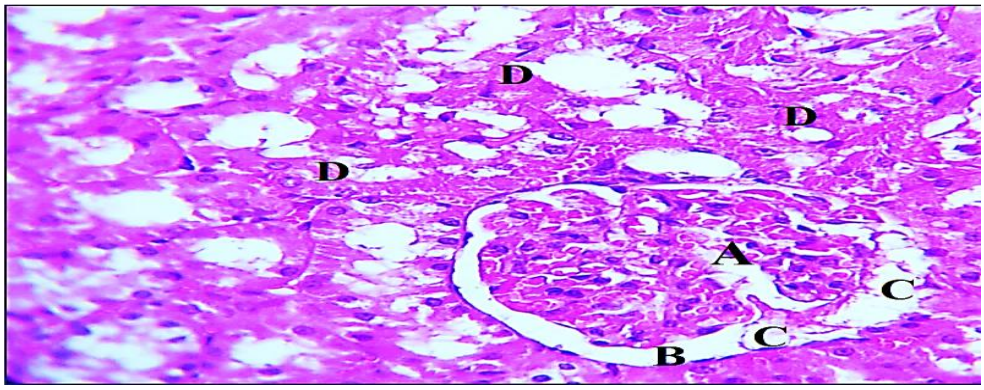

Figure 15: Microscopic image of a kidney section of a rat in the diabetic induced group treated with *Aloe vera* juice, in which magnetic water dependents glomerular stenosis (A) and capsular space dilation (B) are observed, with partial degeneration of the epithelium lining the parietal layer of the Bowman capsule (C), as well as degeneration of the epithelium lining a number of renal tubules (D). (H&E, X40).

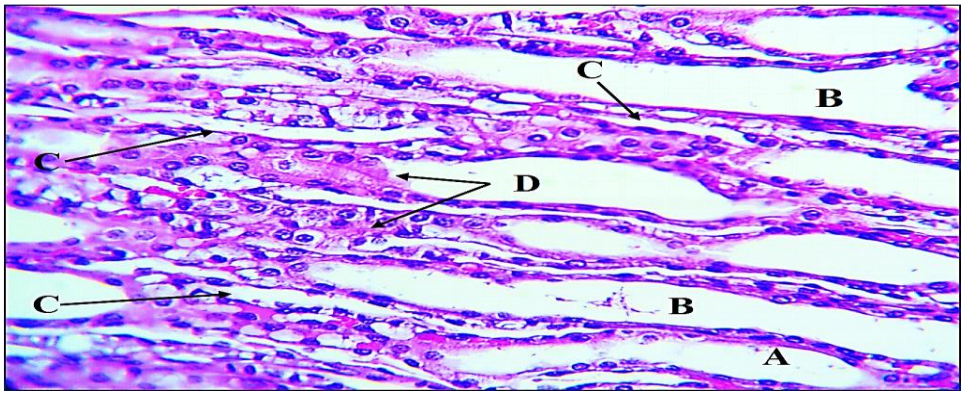

Figure 16: Microscopic image of a section of a rat kidney of *a diabetic group* treated with Aloe vera juice, in which magnetized water dependent, the near-normal appearance of the collecting ducts (B) is observed, as well as the thin ends of the Henley loop (C), with the exception of hyperplasia. In the lining of some of the ducts the collector resulted in partial closure in their cavities (D). (H&E, X40).

In microscopic examination of the tissue sections of the kidney in the affected group treated with Metformin + *Aloe vera sap* and approved with plain water, glomerular stenosis and expansion of the capsular space with slight thickening in the parietal layer of the Bowman capsule was observed, as well as limited blood congestion in the interstitial tissue body, degeneration and necrosis of the epithelium of a number of renal tubules. With focal infiltration of some inflammatory cells as shown in Figures (17) and (18).

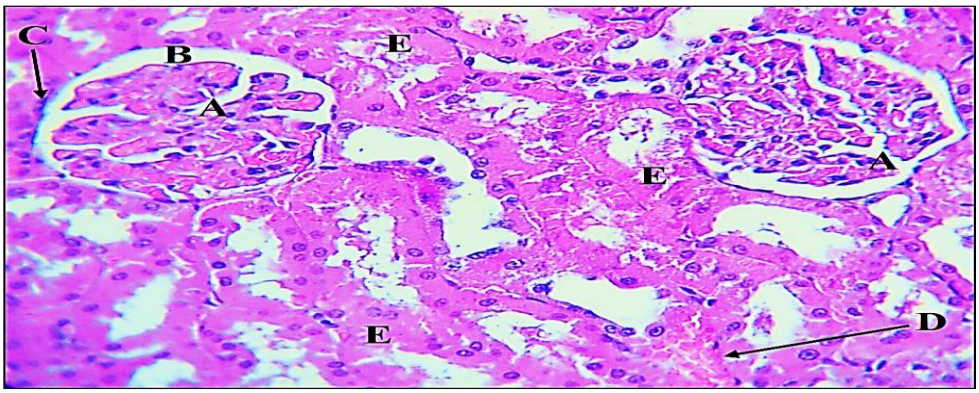

Figure 17: Microscopic image of a section in the kidney of a rat in the diabetic group treated with metformin + *Aloe vera* sap and approved with plain water, glomerular stenosis (A) and expansion of the capsular space (B) with slight thickening of the parietal layer of the Bowman capsule (C), limited blood congestion in the interstitial tissue (D), degeneration and necrosis of the epithelium of a number of renal tubules (E). (H&E, X40).

Figure 18: Microscopic image of a kidney of a rat in the diabetic group treated with metformin + Aloe vera sap and approved with plain water, glomerular stenosis (A) and expansion of the capsular space (B) with thickening of the parietal layer of the Bowman capsule (C), acute hematological congestion in the interstitial tissue (D)) with focal infiltration of inflammatory cells (E) in it. (H&E, X40).

The results of this study are consistent with the findings of a study that confirmed that the use of aloe vera juice and metformin synergistically in diabetic rat populations induced with alloxan led to an improvement in the overall renal tissue, and the study indicated that the synergistic adoption of aloe vera with metformin for the treatment of diabetic patients would help prevent kidney failure [12]. In microscopic examination of the tissue sections of the kidney in the group of patients treated with Metformin + aloe *vera juice*, in which magnetized water is adopted, glomerular atrophy and cytoplasmic atmospheric degeneration of its cells with

expansion of the capsular space were observed, as well as the degeneration of the epithelium lining the renal tubules, with reference to the semi-normal appearance of the renal tubules in all other tissue segments as shown in the two figures (19) and (20).

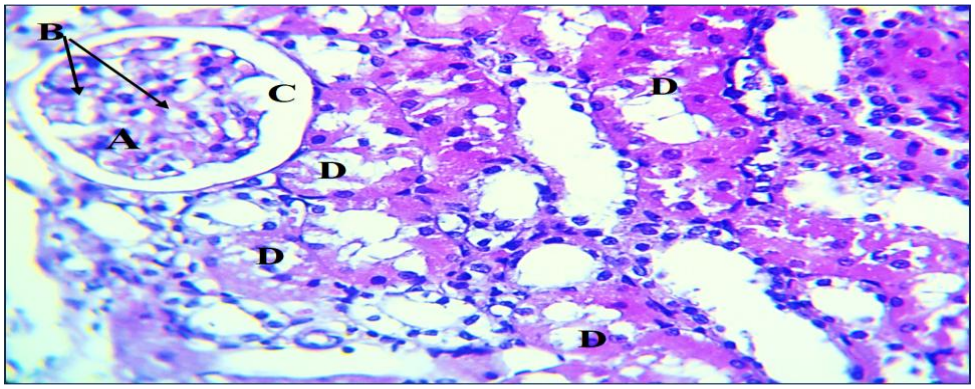

Figure 19: Microscopic image of a kidney section of a diabetic rat treated with metformin + Aloe vera *sap* with magnetized water, in which glomerular atrophy (A) and cytoplasmic atmospheric degeneration of its cells (B) with expansion of the capsular space (C) are observed, as well as degeneration of the epithelium lining the renal tubule (D). (H&E, X40).

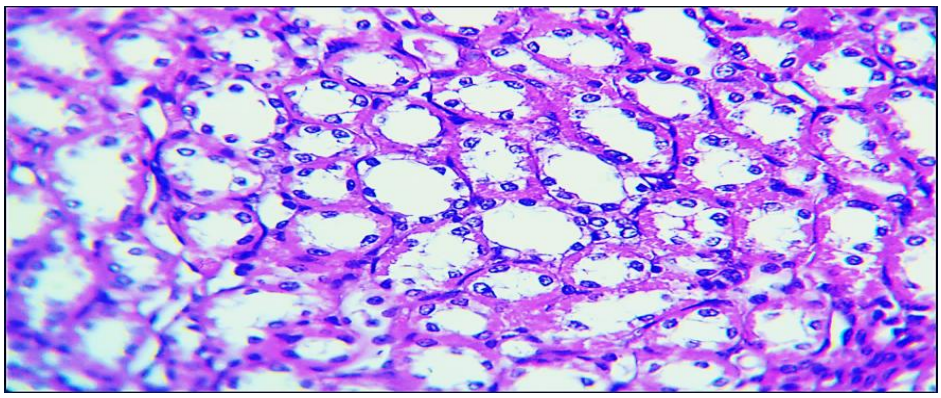

Figure (20): Microscopic image of a kidney of a rat in the diabetic group treated with metformin + *Aloe vera* juice and approved magnetic water, in which the appearance of the renal tubule is observed in the entire tissue section. (H&E, X40)

2- Regarding the physiological aspect:

The Effect of Transactions and Their Duration on the Diabetes Ratio

Table (1) shows the results of the effect of the treatments and their duration on the diabetes percentage, as it is observed that there are significant effects at the probability level of $P<0.05$ for the types of treatments, in the rates of effect of the treatments throughout the study period, it was found that the highest significant rate of blood sugar was recorded in the affected group without treatment and in which normal water was adopted, which reached 338.2 mg/dL, while the control group in which the approved water was recorded The lowest blood glucose was 79.3 mg/dL, a significant difference from the rest of the treatments. Significant differences were found during the third day after induction of diabetes with alloxan, the highest significant pre-treatment glycemic rate was recorded in all groups, reaching 277.4 mg/dL, while the fourth week of treatment recorded the lowest blood sugar rate of rats at 100.82 mg/dl, with no significant difference from the third week's rate of 106.4 mg/dl.

The combined effect of the overlap between the type and duration of the treatment is also shown in the table, from which it is noted that the highest average percentage of diabetes during the treatments and its different durations was 388.8 mg/dL when the affected group was interfered with and the third day after induction of diabetes with alloxan, with a significant difference from the averages of the rest of the interactions, while the overlap between the affected group (magnetized water, aloe vera juice and Metformin) and the fourth week recorded the lowest average of the Blood sugar was 61.33 mg/dL. The important role of magnetized water in all transactions and its contribution to reducing and regulating blood sugar is observed, and this is due to the pharmacokinetics of magnetized water, as some reports have already recorded faster decomposition in the presence of magnetized water [13]. Given the critical importance of absorption rates of diabetes medications, the effect of magnetized water is very important and may indicate a marked advance in the

methodologies adopted for the treatment of diabetes [14]. In addition to its hydrogen bonding structure, which leads to the formation of groups of water molecules of different sizes and configurations connected to hydrogen bonds, this process of magnetization leads to many changes in the physical and chemical properties of water, such as an increase in pH, electrical conductivity, and dissolved oxygen content. Surface tension, density, and evaporation temperature compared to ordinary water, as it has a well-established history of applications, and its potential for direct applications in the medical field [15]. These findings are consistent with a study that confirmed that magnetized water can contribute to lowering and regulating blood glucose, enhancing antioxidant status, reducing the inflammatory response, and regulating genes associated with glucose metabolism [3].

Although diabetics use several classes of drugs with a chemical composition, however, they may have serious long-term side effects, therefore, stronger alternatives with fewer side effects are needed to reduce diabetes-related complications, and many secondary plant extracts have been shown to improve glucose balance and lower lipid levels. Biological activities, including the effects of lowering blood sugar **[16].** Aloe vera *contains* many important chemical components that are widely used in the pharmaceutical industry and in the treatment of many diseases such as diabetes, and most of these chemicals are found in the leaf of this plant [17].

These results are consistent with studies showing that *Aloe vera* juice is used to treat diabetes by lowering blood glucose level [5,18]. Metformin has a role in lowering serum triglyceride concentrations, as well as low-density lipoprotein (LDL), and in turn increases the concentration of HDL-C and HDL-C to LDL-C in blood serum, and is also used as a blood glucose regulator [19], as well as these effects depend on improving insulin resistance, and it has also been found that metformin inhibits the increase of blood glucose in the liver, in turn inhibiting the absorption of sugar in

the intestines [20,21], and that the incidence of lactic acidosis associated with metformin use is low by 2-7 cases per 100,000 patients [22], Metformin increases blood glucose uptake and promotes fatty acid oxidation [8]. Despite the reliability of Metformin as a blood glucose regulator, the results of the study indicate that it is more effective in lowering glucose when magnetized water is adopted synergistically, as there are results that show the significantly enhanced solubility of the compound, which usually shows very low water solubility when used in conjunction with magnetized water. This characteristic phenomenon is particularly noteworthy, as the benefits of these compounds are realized only when they are properly absorbed and used effectively within the body[23], thus, the use of magnetized water has the potential to significantly increase and enhance the therapeutic benefits associated with these substances [24].

These findings are consistent with the findings of [25] in demonstrating the efficacy of metformin in reducing glucose induced by alloxan-induced diabetes.It also agreed with a study that confirmed that the use of metformin with magnetized water on diabetic rats induced with alloxan contributed to the reduction and regulation of blood glucose [3].

Table 1: Effect of Treatments and Processing Time on Glucose

Drug period / Treatments	Day 3	Week 1	Week 2	Week 3	Week 4	Treat. Average
MW control	85 m-p	81 m-p	78.67 nop	77 nop	74.67 op	79.3 e

PW control	84.5 m-p	92 k-o	87.83 l-p	81.67 m-p	81.67 m-p	85.5 e
MW. Met. Diabetes	328.2 cd	116.6 ijk	97.17 j-o	76.67 nop	71.33 op	138 c
MW. AV. Diabetes	336.7 bc	121 ghi	112.2 i-l	78.33 nop	75.33 op	144.7 bc
MW. Met. AV. Diabetes	295.7 ef	108.7 i-m	84.83 m-p	69.83 op	61.33 p	124.1 d
MW. Diabetes	281.5 f	124.7 ghi	117.7 ijk	79.33 nop	69.5 op	134.5 c
PW. Met. Diabetes	308.2 de	145.8 gh	104 i-n	81.5 m-p	80.83 m-p	144.1 bc
PW. AV. Diabetes	324.7 cd	149.3 g	108 i-m	83.17 m-p	82.17 m-p	149.5 b
PW. Met. AV. Diabetes	388.8 a	128.7 ghi	74.33 op	82.17 m-p	73.33 op	149.5 b
PW. Diabetes	341.2 bc	332 bcd	325.2 cd	354.7 b	338 bc	338.2 a
Drug period average	277.4 a	139.98 b	118.98 c	106.4 d	100.82	

The values followed by similar letters do not differ significantly from each other $P<0.05$

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