Effect of Magnetized Water on the Histological Structure of the Kidney of Albino Rats

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ABSTRACT

The present study investigates the possible histological effects of the magnetized water on the kidneys of Albino Rats. Tap water samples were collected from Faculty of Science, Zagazig University, Zagazig, Egypt. Twenty albino rats were divided into for 2 groups, the first group was considered as a control group (Pre-exposure, PE) and for group 2 drinking water was exposed to a weak static magnetic field (MF) generated from a stack of magnets (B = 18 Gs). After the treatment, albino rats (RatusNorvegicus) were kept for a month (30 days) and then the kidney tissue samples were prepared and analyzed using a transmission electron microscope (TEM). The physicochemical parameters of water samples and Blood Parameters were estimated. In addition the renal functional parameters were studied. The results of this study indicated that the magnetized water destroyed the renal functions and changed the water elements and Blood parameters. On the microscopic level; the histological examination of kidney showed abnormal configuration of renal tubules RT, congested blood vessel and degenerated renal tubules arrow, necrosis N, glomerular shrinkage GS, and increase in space between glomerulus and Bowman's capsule. Thus, it could be suggesting that.

Keywords: Magnetized water, Kidneys, Albino rats, TEM

INTRODUCTION

Water is the most important biological substance in solubilizing and modifying the properties of biomolecules such as; nucleic acids, proteins and carbohydrates by forming the hydrogen bonds with their polar functional groups (Jermanet al., 1996). Water is a diamagnetic material. However, its biophysical properties can be affected by a magnetic field (Raiet al., 1995). There are three natural conditions created in naturally magnetized water, which give the magnetized water its unique qualities: it contains a balance of essential minerals. Hence, water molecules would be more organized in structure and movement, forming smaller clusters and allows it to be more easily absorbed and utilized by cells. Also, it has a slightly higher alkaline pH (Ohno et al., 2005). It is known that the impact of the magnetic field on water bears a complex and multifactorial character, which influences the structure of water, hydrated ions, physico-chemical characteristics and the behavior of dissolved inorganic salts. Mosin and Ignatov, (2014) , (Liu et al., (2010) demonstrated that magnetic treatment causes water containing mineral to favor formation of more soluble calcium aragonite over calcium carbonate and resulting removal of calcium carbonate deposits from steel substrate.

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Magnetization is water exposure to a magnetic field, which causes changes in microscopic structure and macroscopic properties of water. These changes were determined by infrared, visible, ultraviolet and x-ray spectrum, which is described by displacements, polarization of molecules, atoms, and results in a change of the dipole moment in transition and vibrational state of molecule. Thus, the distribution of molecules, the transition probability of valance, bounded and molecules inner layer of electrons are varied. But the constitution of molecules and atoms do not alter in such case, while the macroscopic properties; such as surface tension force and water hydrophobicity of materials may be decreased after magnetization. The viscosity of the magnetized water increases with decreasing of the intensity of magnetic field and magnetization time (Xiaofeng et al., 2009).

Magnetized water is claimed to be energy-building, activating, cleansing and detoxifying. More recently, electromagnetic (low Hz to kHz frequencies) radiation was successfully applied in bone healing and osteoporosis treatment, with several FDA approved treatments, Tendons and muscles, after sports injuries, also seem to heal faster, with less pain and swelling. Magnetic methods attract a special attention due to their ecological purity, safety, simplicity and lessoperating costs. Alteration of physico chemical parameters of water by magnetic field implies a specific impact on the structure of aqueous solutions and water. Previous studies and several scientific societies have found that the magnetic field can improve water properties through increasing solubility of salts, accelerating coagulation of colloids and changing the kinetic movement of salt crystallization.

Magnetic field causes the asymmetry of hydrated shells due to its impact on water molecules, located around the charged particles. The magnetic field exposure causes higher electro-kinetic movement to the colloid. This will cloak the attracting particles with one another. The theory of magnetic field effects on technological processes for water purification is classified into two main categories; crystallization at magnetic water preparation and impurity coagulation in water systems (Fadil et al., 2001). Despite the restricted data and information concerning the magnetic preparation of waste water, one can state that magnetizers may be one of the simpler and more economically justified ecological investments, having measurable impacts (Krzemieniewskiet al., 2003). Turker and Yel (2014) found that the ultraviolet radiation can cause adverse effects on the living organisms for a long time and observed the detrimental effects of UVC radiation on kidney tissue cells in exposure periods that dependent on radiation dose and exposure time due to the limited information and data concerning the magnetic field effects on experimental animals.

The results of different studies on animals and humans dealing with the biological effects of exposure to ELF-EMFs have consistently been both positive and negative. In literature, various theories described the effect of EMF on living organisms through induction, resonance, and radical mechanisms (Sieroń, 2000; Bachanek et al., 2010), which affecting the cell signal transmission, structure of biological membranes, ion transport, processes of replication, transcription of nucleic acids and synthesis of proteins, and cell proliferation processes. Creatinine is a chemical waste molecule that is generated from muscle metabolism. Creatinine is produced from creatine, a molecule of major importance for energy production in muscles. Approximately 2% of the body's creatine is converted to creatinine every day. Creatinine is transported through the bloodstream to the kidneys. The kidneys filter out most of the creatinine and dispose of it in the urine. Although it is a waste, creatinine serves a vital diagnostic function. Creatinine has been found to be a fairly reliable indicator of kidney function. As the kidneys become impaired, the creatinine will rise. Thus, abnormally high levels of creatinine warn of possible malfunction or failure of the kidneys.

The aim of this study was to investigate the physiological and histopathological effects of drinking magnetized water on kidneys of rats.
MATERIALS AND METHODS

1- Sampling site

Tap water samples were collected from the laboratory of Zoology Department, Faculty of Science, Zagazig University, Egypt.

2- Analytical methods

Tap water samples were taken from the study site before and after subjection to the magnetic field. The magnetic apparatus (magnetic liquid modifier of Professor Yuri Tkachencho, R. Sian Technology) was put in the water tap letting the water to pass through it (Figure 1). All samples were analyzed for water quality (chemical and physical properties), heavy metals, Manganese (Mn), zinc (Zn), cobalt (Co) and lead (Pb) were also analyzed. About twenty albino rats were used, half as exposed rats and the others as a control. The kidneys (twenty samples) and the blood samples (twenty samples) were taken and prepared for physiological and histopathological studies.

2.1- Water examinations

I- Physico-chemical parameters of water

Samples of water were taken and then placed in a clean sampling glass bottle.

* Temperature: The water temperature was measured by a mercury thermometer of 0 to 50°C range.
* Conductivity: The conductivity was measured by a conductivity meter HI 98302 DIST 2.
* pH-value: It was measured by glass electrode pH-meter (Digital Mini-pH-Meter model 55).
* Total dissolved solids (TDS): Dissolved oxygen has been measured according to Ibraheim and Khater (2013).
* Alkalinity: It has been determined according to Gupta (2000).
* Chlorinity: Chlorinity has been measured by a digital chlorimeter (model HI 93711).
* Salinity: Salinity has been measured by a digitalsalinometer (model Atago Hand Refractometer).

II- Trace elements in water

The water samples were collected from a tap water for heavy metal analysis, half of which were exposed to the magnetic field, and the others as control, put in cleaned bottles and stored until analysis was carried out. Heavy metal concentrations were determined by atomic absorption spectrophotometer (Perkin Elmer, 2280). The water samples were prepared and analyzed in sequential for manganese, aluminum, cobalt and lead.
2.2- Histo-pathological studies

2.2.1- Blood parameters estimation

Blood samples (n = 20) were collected from the experimental rats after thirty days in non-heparinized tubes (Weatherman tubes) for determination of serum creatinine and serum blood urea (Murry, 1984 and Tietz et al., 1987 and Reddy et al., 2012). The serum was separated from the blood cells by centrifugation for 10 minutes at 3000rpm at room temperature. The serum was stored at -20°C in stoppered metal-free polypropylene tubes (Eppendorf tubes) until used (Hegazy, 2011).

2.2.2 - Histopathological examination for kidney

Specimens of kidney tissues were taken from all groups and prepared for the histological and histopathological sections following Bancroft and Stevens techniques (2006). Kidney tissue was fixed in 10% buffered formalin (10 ml formalin in 30 ml normal saline or sterilized distilled water) embedded in paraffin blocks and sectioned. The tissues were subsequently dehydrated in upgraded concentrations of alcohol (70% alcohol) cleansed in xylene. Several sections of 3 to 6 μm thickness were cut, dried with blotting paper, using microtome then embedded in paraffin and sections are stained with Hematoxylin and Eosin (H&E) (Al-Nakeeb, 2011; Al-Qudah, 2012). The slides were then evaluated for pathological changes under the light microscope (100x).

2.2.3- Transmission electron microscopic (TEM) studies on the kidney of albino rats

Twenty specimens of the kidneys were taken from the control and also from rats that have been exposed for thirty days, these specimens have undergone histological techniques and then microtome slicing and prepared for electron microscopic studies (grids were examined and photographed on a Jeol-Jem1010 transmission electron microscope belonging to Al-Azhar University, Cairo, Egypt) according to Ali (2013).

2.3- Statistical analysis

The statistical analysis is performed with independent t-test at the significant level of 0.05 (p < 0.05) using SPSS program.

RESULTS AND DISCUSSION

1-Water analysis

1.1- Physico-chemical parameters of water

A comparison was made between the average means of the same physicochemical parameters of water samples in the different pre and post- exposed levels and the data recorded in the Table (1) shows remarkable variations in alkalinity and conductivity only.

Table(1): The physico-chemical parameters (Mean ± SD) of water before and after magnetic exposure

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Magnetic exposure</th>
<th>Pre-exposure</th>
<th>Post-exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>23 ± 0</td>
<td>23 ± 0</td>
<td></td>
</tr>
<tr>
<td>Conductivity (ppm)</td>
<td>0.190 ± 0</td>
<td>0.180 ± 0</td>
<td></td>
</tr>
<tr>
<td>pH value</td>
<td>7.000 ± 0</td>
<td>6.900 ± 0</td>
<td></td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>0.280 ± 0</td>
<td>0.280 ± 0</td>
<td></td>
</tr>
<tr>
<td>Chlornity (%)</td>
<td>0.150 ± 0</td>
<td>0.150 ± 0</td>
<td></td>
</tr>
<tr>
<td>Total dissolved solids (ppt)</td>
<td>1.100 ± 0</td>
<td>1.100 ± 0</td>
<td></td>
</tr>
<tr>
<td>[Alkalinity] (ppm)</td>
<td>99.020 ± 0.707a</td>
<td>91 ± 0.707a</td>
<td></td>
</tr>
</tbody>
</table>

* Data are represented as mean ± SD, (n = 12).

** Means with the same letters in the same row are significantly different (p<0.05), using Independent t-test.
1.2-Heavy metals in water

The average concentrations of the heavy metals for the control and exposed animals are recorded in Table (2) which shows remarkable variations in the heavy metal concentrations in water samples. The concentrations had the order: Mn > Al > Pb > Co.

Table (2): The trace element concentrations (Mean ± SD) of water before and after magnetic exposure

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-exposure</th>
<th>Post-exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese (Mn) ppm</td>
<td>1.900 ± 0.707</td>
<td>1.660 ± 0.446</td>
</tr>
<tr>
<td>Cobalt (Co) ppm</td>
<td>0.003±4.122E-4</td>
<td>0.001±4.000</td>
</tr>
<tr>
<td>Aluminium (Al) ppm</td>
<td>0.770±0.010</td>
<td>0.705±0.020</td>
</tr>
<tr>
<td>Lead (Pb) ppm</td>
<td>0.005 ± 4.126E4</td>
<td>0.003 ± 4.550E-4</td>
</tr>
</tbody>
</table>

* Data are represented as mean ± SD, (n = 12 ).
** Means with the same letters in the same row are significantly different (p<0.05).

2.1- Blood parameters estimation

The changes in the blood parameters such as creatinine and urea were measured for the control and exposed animals. The results indicated changes in all the blood parameters (Table 3&4). There were significantly differences (p < 0.05) values of urea and creatinine of water only is exposed not the rats compared to control.

Table (3): Red Blood Cell (RBC) count, blood haemoglobin (Hb), Mean Corpuscular Haemoglobin (MCH), White Blood Cell (WBC) count, Packed Cell Volume (PCV) and plasma haemoglobin (Hb) ( mean ± SD) of blood samples of control and exposed rats to 18G magnetic field.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-exposure</th>
<th>post-exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC count (x10⁶/µl)</td>
<td>6.1±0.09</td>
<td>6.5 ±0.10</td>
</tr>
<tr>
<td>WBCs (x10³/µl)</td>
<td>5.32 ± 0.22</td>
<td>5.47 ±0.12</td>
</tr>
<tr>
<td>Plateletes</td>
<td>445.00 ±133</td>
<td>453.00 ±144</td>
</tr>
<tr>
<td>HB (g/dl)</td>
<td>11.6 ±1.2</td>
<td>12.0 ±0.9</td>
</tr>
<tr>
<td>MCH (Pg)</td>
<td>18.92 ±2.1</td>
<td>18.12 ±1.3</td>
</tr>
<tr>
<td>MCV (Fl)</td>
<td>54.87 ±4.5</td>
<td>54.00 ±5.6</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>34.00 ±5.67</td>
<td>33.12 ±26.3</td>
</tr>
</tbody>
</table>
Table (4): The serum creatinine and urea concentrations (mean ± SD) of blood samples of Pre-exposure and post-exposure

<table>
<thead>
<tr>
<th>Magnetic field</th>
<th>Pre-exposure</th>
<th>post-exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood urea nitrogen (mg/dl)</td>
<td>24.20 ± 0.01b</td>
<td>17.00 ± 0.01b</td>
</tr>
<tr>
<td>Serum creatinine(mg/dl)</td>
<td>0.52 ± 0.05a</td>
<td>0.78 ± 0.02a</td>
</tr>
<tr>
<td>Uric acid (mg/dl)</td>
<td>3.25 ±0.90</td>
<td>3.15 ±1.00</td>
</tr>
<tr>
<td>Sodium (mEq/l)</td>
<td>151.90 ±9.30</td>
<td>150.88 ±8.70</td>
</tr>
<tr>
<td>Potassium (mEq/l)</td>
<td>7.20 ±1.00</td>
<td>7.39 ±0.85</td>
</tr>
</tbody>
</table>

II-Transmission electron microscopic (TEM) Studies on the Kidney of Albino Rats

The electron microscopic studies indicated the dangerous effects of the magnetized water on kidneys of the studied rats drinking it. (Figures 2-6). The frequency and severity of histopathological alterations in the cortical area of the kidney was increased in magnetic exposed rats compared to the control.

![TEM photomicrograph](image)

**Fig. (2):** TEM photomicrograph of the kidney proximal convoluted tubule of a control rat showing the general morphology of proximal convoluted tubule cells. The proximal convoluted tubule cell has long microvilli (Mv) and a round nucleus (N) with peripherally located nucleolus (Ne) and condensed chromatine (Ch), peripherally placed in a cytoplasm packed with various organelles and inclusions. These organelles comprise thromboplastin reticulum (RER) and Golgi apparatus (G). Mitochondria (M) are numerous exhibiting round or elongated shapes. Lysosomes (Ly) appear as small rounded vesicles bounded by a single membrane. Abundant glycogen particles (Gl) in the form of rosette shaped particle (X 10000).
Fig. (3): TEM photomicrograph of kidney Malpighian corpuscle from a control rat showing the general morphology of podocyte and glomerular capillary. The podocyte cell body (Pc) has an irregular-shaped nucleus (N) with peripheral nucleolus (Ne) and batches of chromatine materials (Ch), centrally placed in a cytoplasm packed with various organelles and inclusions. Glomerular capillary has blood capillary, filtration slit (FS), primary process (PP) and secondary foot processes (SP) (X 6000).

Fig. (4): TEM photomicrograph of the kidney tubules of cortex from a rat treated with magnetized water for a month (30 days) showing necrosis of cytoplasmic organelles, necrotic nuclei (NN) with condensed chromatin (CC), dilation of tubule lumen (DL) and invasion of the tubule lumen with nuclei (N) (X 6000).
Fig. (5): TEM photomicrograph of the kidney tubules from a rat treated with magnetized water for a month (30 days) showing degeneration of the cytoplasmic organelles (DO), swollen mitochondria (M), marked dilation with inflammatory cells (IC) and necrotic nuclei (NN) (X6000).

Fig. (6): TEM photomicrograph of the kidney tubules of cortex of a treated rat with magnetized water for a month (30 days) showing necrotic elongated nuclei (NN) with condensed chromatin (CC) and large nucleoli (Ne), degeneration of the cytoplasmic organelles (DO), dilated inflammatory cell (IC) and vacuolation of the cytoplasm (V) (X10000).

* Physico-chemical parameters

The present study indicated that there is no change in the values of water temperature in the various examined samples due to the magnetic exposure and this range of water temperature was favorable for all living organisms according to results obtained by Owei and Ologhadien (2009); Rahim et al. (2009); Sithik et al. (2009).
In the present study, the conductivity of all the examined water samples decreased and this agreed with Alkhazan and Saddiq (2010) who found that conductivity decreases after the magnetic exposure.

The present investigations revealed that the pH values of all the examined samples were always on the neutral side and there was no effect of the magnetic field on it. This disagrees with that of Alkhazan and Saddiq (2010) who observed that the pH-value increased with the magnetic field who indicated a decrease in pH values with magnetic exposure. The data obtained in this study indicate that the pH values of all the study samples lie within the favorable limits (6.2-8.3) needed for the growth and survival of living organisms and comply with results of Korai et al. (2008).

From the present data, it is clear that the salinity and TDS contents were not changed in the examined samples and this disagreed with Alkhazan and Saddiq (2010), and may be related to the short period of the magnetic exposure and weak intensity of the magnetic field. Although, the range of salinity in the study (<3 mg/l) was suitable for survival of the living organisms and man. The data reported in this study reported that the values of alkalinity decrease after the exposure to the magnetic field.

* Trace elements in water

The mean levels of the detected Mn concentration were higher than the permissible limits (0.4 mg/l) recommended by WHO (2008) in the water samples. Comparable Mn levels were recorded by Akoto and Adiyiah (2007); Obasohan (2007). However, high concentrations of Mn were also recorded by İncekara (2009); Abdul Ghaﬀar et al. (2009) and Khater (2010). The magnetic exposure decreased the mean concentrations of Mn. The mean Co concentrations in this investigation were higher than the permissible levels (0.0014 mg/l) recommended by Abdul Ghaﬀar et al. (2009). Also, as in Mn, the magnetic exposure decreased the mean concentrations of Co. The mean levels of Pb obtained here were higher than legal limits (0.01 mg/l) reported by WHO (2008) in water samples collected from all the study sites. The magnetic exposure decreased the mean concentrations of Pb.

The present study observed that the mean Al concentrations are lower than the permissible levels (0.2 mg/l) recommended by WHO (2008) at all the examined samples. The concentrations of Al in the present study were lower than those recorded by Awofolu (2006); and Abdul Ghaﬀar et al. (2009).

Moreover, the concentrations of all heavy metals decreased in all water samples after the exposure to the magnetic field and this may be related to the direct effect of the magnetic field on chemical characteristics of water and attraction of macromolecules. This is in agreement with those of Alkhazan and Saddiq (2010). Also, the decrease may be attributed to the effect of magnetic force in breaking hydrogen bonds between water molecules, so the ions become separated and combine with elements and precipitate. In addition, Changand Weng (2008) found that the enhanced mobility of the ions under a magnetic field causes serious damage to the hydrogen bond network in the high Na concentration solution. Conversely, in the low concentration solution, the structural behavior is dominated by the properties of the water molecules and hence the hydrogen bonding ability is enhanced, as the magnetic field is increased.

* Histo-pathological studies

This data of the present study can lead to important conclusions which may be of great importance for evaluating the benefits and hazards of the exposures to low frequency or low-level magnetic field. The present data indicates the very dangerous effect of magnetized water on experimental animals since it damaged the cortical areas of kidneys of the experimental rats (Table 4 and Figures 2-6). The present results showed that the magnetized water has risk impacts on the examined rats’ kidneys as it harms the cortex tissues prompting putrefaction and kidney disappointment. This may be attributed to the role of magnetic field on hydration of ions of the exposed
water which effect on molecules arrangement around charged ions inexperimental animal cells causing disruption and deformation of animal tissue cells. This concurred with Hummadi (2012), Reddy et al., (2012), Abdelhalim and Moussa (2013), Peters and Chike (2013), Türker and Yel (2014).

CONCLUSION

The pathophysiological effect of the kidney due to magnetized water administration is relying on the magnetic field intensity and frequency. The magnetized water has harmful effects on blood and kidney tissue cells of the exposed rats. So, using the magnetic field with an intensity of 18G for water pollution treatment is not a safe method for the living creatures. However, it can be used for treating many diseases such as kidney stones by subjecting it directly to the target foreign bodies.

Further research should be conducted to prove the safety of the magnetic field utilization before it is applied.

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