

The effect of the magnetic field on some physical and chemical characteristics of river water under laboratory conditions

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ABSTRACT

Magnetically treated water is used in many research, medical, industrial, agricultural and many other fields. Scientific research has proven amazing results for exposing various living organisms to magnetic fields, so the current study was conducted to identify the effect of water treated magnetically at different intensities, namely 500, 1000 and 1500 gauss, on some of the physical and chemical properties of river water under laboratory conditions, and the results obtained were compared with river water. Ordinary, (non-magnetically treated control). The results of the current study showed that significant changes occurred in some physical and chemical properties of the magnetically treated water under study after magnetic treatment of the water with the three aforementioned magnetic intensities, as the pH, dissolved oxygen concentration, electrical conductivity and total dissolved solids in the treatment water increased significantly with increasing magnetic intensity compared to the control water not magnetically treated. The study also indicated that there was no significant effect of the magnetic field and its three intensities on changing the water temperature. In addition, the study indicated with the intensity of 1500 Gauss achieved the best results in modifying some physical and chemical properties of the water.

Keywords: Magnetic treated water, Physical, Chemical properties, pH, DO, EC, TDS.

Introduction

The environment of water bodies is the natural resources for humans as well as plants and animals that humans exploit and the possibility of exploiting these resources economically without negatively affecting these resources (Al-Lami, 2000). Although fresh water constitutes a very small percentage, it plays a fundamental role in human life (Odum, 1971). The movement of water also helps distribute all forms of energy, including nutrients, dissolved gases, algae and zooplankton. It also helps reduce the concentrations of various types of essential elements and heavy metals present in it (Goldman & Horne, 1983). Dalali (1986) emphasized that water is

not an inert liquid, but on the contrary, it is a highly effective substance with unique and distinctive properties, and it has the ability to dissolve most materials because it can affect the bonds between molecules and work to break them down. Water has a relatively high melting point and boiling point. Also, the high specific heat capacity and the density of water is greater than the density of solid (Ibrahim, 2006). In recent years, the issue of polluted water has become one of the important topics in the world due to the pollution of river and sea waters. It is important to know the quality of water used in preparing humans and animals because it affects the productive performance and general health of the

living organism. Good water is necessary for growth and to increase the economic return of the product (Zimmerman *et al.*, 1991). The traditional methods of treating raw water in purification plants (agglomeration, sedimentation and filtration) in addition to adding chlorine, fluoride and ammonium salts, whose harmful effects on human health have been proven, lead to the formation of what is called dead water, i.e. water that has lost many of its vital properties, causing various health problems. Also, the chlorine used in sterilization reacts with organic materials, forming carcinogenic hydrocarbons (Pioneer, 2006). As a result of the great importance of water from the physiological and biological perspective that it provides to the human body, this water must be of a high degree of purity and free of pollutants that are harmful to human health, because through new research conducted in Colorado, 62 types of pollutants were diagnosed in drinking water, and other studies that tested blood taken from the umbilical cords of ten fetuses while they were growing in their mothers' amniotic fluid, it was found that it contained traces of pollutants from polluted water (McMahon, 2006). Therefore, it is necessary to use modern and advanced methods in water purification, such as the use of magnetic field techniques (Goldsworthy *et al.*, 1990). These methods have unique advantages as they are safe, do not affect the environment, are simple, and have low operating costs (Hammad, 2007). It is a modern technology with a scientific basis that has recently begun to invade the world, so much so that some describe it as a magic formula as it achieves many benefits at the same time. In addition to inhibiting bacteria, it treats many diseases and increases the capabilities of the immune system (Hilal, 2005). With this technology, some properties of water can be changed and those changes in water can be used in some applications related to industry, agriculture, health, and the environment (Fares *et al.*, 2010). Water is the medium through which life information is transmitted, and water absorbs magnetic resonance when it passes through a magnetic field, so it has an exceptional ability to prevent oxidation, raise the body's immune capacity, and increase its health (Higa, 2004). While Al-Shakli (2003), shows that the water ion system in the universe has been disrupted by the influence of various environmental factors and human intervention to restore the ionic system of water and change its properties to the correct image that enables the body to benefit from it in the best possible way; So a new technology was used, which is exposing water to a magnetic field to

obtain magnetically treated water. Experiments have proven that magnetically treating water changes the kinetic and electromagnetic properties of water. The process of magnetically treating water works to revive and strengthen the lost properties of water that occur due to desalination or environmental pollution, and magnetic treatment reorganizes the water charges correctly (Al-Mawsili, 2009). Note that magnetic energy is an ancient physical phenomenon that has been used in various fields since ancient times, and was used by Chinese and Indian civilizations, and magnetism was known at that time as a force and a field, and ancient Greece discovered the natural magnet for the first time in the form of magnetic stones called Idoestone (Koshak, 2004). Magnetic energy is the energy that controls many cosmic phenomena (Mahjoub, 2004). The earth is surrounded by a large magnetic field that affects everything to varying degrees and acts as a protective shield against destructive cosmic rays such as X-rays and gamma rays (Jain, 2000). Magnetically treated water is the water that is obtained after passing it through a specific magnetic field and placing that magnet inside or near the water for a period of time (Batmanghelidj, 2005). Since the physical and chemical properties in the aquatic environment are of great importance in the distribution and spread of organisms in that aquatic environment (Rashid, 1999), the abiotic factors in the aquatic environment determine the ability of living organisms to live and reproduce, and the physical factors are important in determining the type of organisms that can live in that environment, and then those physical factors have strong effects on biological and chemical measurements (Al-Kanani, 2010). These environmental factors include temperature, pH, dissolved oxygen in water, electrical conductivity, and total dissolved solids in water; therefore, this study aimed to identify some of the physical and chemical changes that occur in some properties of water during its magnetic treatment with the three aforementioned magnetic intensities, such as temperature, pH, dissolved oxygen in water, electrical conductivity, and total dissolved solids in it.

Materials and Methods

The magnets were prepared and prepared locally in the laboratory of the Water Treatment Department - Ministry of Science and Technology, where three devices were used to treat water magnetically of the type Dipolar Magnetized Water or what is called Magnetron and they were calibrated in the laboratory and the magnetic intensities of these

devices were given using a Gauss Meter device, type F.W.Bell/Gauss Model 5070, USA, as follows:

1. Magnetron device with an intensity of 500 Gauss.
2. Magnetron device with an intensity of 1000 Gauss.
3. Magnetron device with an intensity of 1500 Gauss.

As shown in figure 3. These magnets contain a positive north pole and a negative south pole, so that the direction of water flow during the magnetization process is from the positive North Pole towards the negative South Pole. After that, the three-strength magnetron devices were assembled locally to form an integrated device for magnetically treating water, as shown in figure 2.



Figure 1: Magnetrons with three magnetic intensities of 500, 1000 and 1500 Gauss.



Figure 2: Magnetic water treatment device with three intensities.

Magnetic treatment process of raw water:

Magnetically treated water was prepared by treating it with a magnetron with three different magnetic intensities, which are 500, 1000 and 1500 Gauss. This process was done by delivering raw water from the river (Tigris River) through the tap connected to the river water designated for irrigating crops by means of a plastic pipe and connecting it to the three taps of the magnetic water treatment device, and each tap of the device is connected to the magnetron with its own intensity. The water treatment device consists of the following parts:

1. The magnetron with an intensity of 500 Gauss with its own tap (fig.1).
2. The magnetron with an intensity of 1000 Gauss with its own tap (fig.1).
3. The magnetron with an intensity of 1500 Gauss with its own tap (fig.1). As in the figure 2.

Ecological Measurements: The water was exposed to the magnetic field with the three magnetic intensities 500, 1000 and 1500 Gauss every 24-48 hours throughout the experiment period weekly for 12 months (17 weeks) for the raw water (river water) treated magnetically with the three intensities, noting that the control water was not treated magnetically throughout the study period. Some physical and chemical properties of all waters present in all beakers were also measured, and these physical and chemical properties of the control water were compared with the water treated magnetically with the three magnetic intensities 500, 1000 and 1500 Gauss respectively. The study included the following properties:-

1. Measuring the water temperature in degrees Celsius. .
 2. Measurement of the pH of water.
 3. Measurement of the concentration of dissolved oxygen in water in units of (mg/L).
 4. Measurement of the electrical conductivity of water in units of (micro Siemens/cm).
 5. Measurement of the amount of total solids dissolved in water in units of (parts per million).
- The previous measurements were taken using the Yk-2001 PH device, Intelligent PH meter, UKAS, after calibrating it using calibration solutions with pH 4 and 7 at a temperature of 25 °C, as shown in figure (2).



Figure 3: Yk-2001 PH, Intelligent PH meter, UKAS.

Statistical analysis: The results were statistically analyzed using a set of statistical analyses in

analyzing the data and results obtained from those experiments by extracting the rates and standard deviations for all environmental variables of normal river water not magnetically treated (control) and those waters magnetically treated with the magnetic field of three intensities 500, 1000 and 1500 Gauss respectively; using the (SAS, 2001) program; in order to compare the different environmental factors, which are temperature, pH, dissolved oxygen in water DO, electrical conductivity of water EC and total dissolved solids TDS, for each of the control water not magnetically treated and the water treated with the magnetic field of the three magnetic intensities mentioned above; to know the significant differences in those physical and chemical properties between the control treatment and the treatments with the three magnetic intensities and to compare them throughout the study period (12 months).

Results and Discussion

Measurements of environmental factors of water:

Water Temperature: There were no significant differences in the values of the temperature rates recorded during the experiment period for all experimental waters, whether the control water or the water treated magnetically with the three magnetic intensities, as is clearly shown in table 1, as the temperature of the experimental basins was close because they are located in the laboratory, and the temperature rates ranged between 32.62 m for the month of August in summer and 18.10 m for the month of December in winter. These temperature rates were constant throughout the experiment periods, whether the control water or the

magnetically treated water, and no significant differences appeared for all months of the study. It was seen through the results of the current experiment that the temperature ranges of the experimental basins' water ranged between 32.62-18.10°C and within the normal and optimal limits, as the highest temperature values were reached in summer and the lowest in winter, because the water temperature follows the air temperature (Al-Kenzawi, 2009).

The magnetic field applied to the water of the experimental basins with its three previously mentioned intensities did not cause any change in the water temperature. This opinion contradicts the opinion of the researcher Bellokossy (2000). When he used a magnetic field with an intensity of 160,000 Gauss to identify the functional and structural effectiveness of minerals and compounds dissolved in water, significant differences were recorded in increasing the water temperature with increasing the intensity of the magnetic field applied to it. This may be due to his use of a magnetic field with a high intensity compared to the magnetic intensities used in this experiment, which are low in relation to the intensity mentioned above (Govindasamy & Dhandapani 2007). The temperature factor is one of the environmental factors that play an important role in increasing and decreasing the concentration of dissolved oxygen in water, as the increase in temperature leads to a decrease in the concentration of dissolved oxygen in addition to its use by the organisms analyzing in the water surface (Anber, 1984).

Table (1): Temperature measurements of magnetically treated water and control water with the least significant difference value for comparison at the probability level ($P < 0.05$) during the study period.

| LSD | 1500 gauss | 1000 gauss | 500 gauss | control | Months of study |
|--------|-------------|-------------|-------------|-------------|-----------------|
| 4.72NS | 3.49 ±19.70 | 3.36 ±19.48 | 3.58 ±19.44 | 3.64 ±19.22 | January |
| 2.06NS | 1.55 ±23.26 | 1.83 ±22.86 | 1.34 ±23.28 | 1.38 ±23.00 | February |
| 2.04NS | 1.35 ±21.12 | 1.28 ±21.14 | 1.59 ±21.30 | 1.81 ±20.80 | March |
| 0.83NS | 0.65 ±22.70 | 0.69 ±23.02 | 0.62 ±23.32 | 0.48 ±23.40 | April |
| 2.56NS | 1.87 ±26.62 | 1.96 ±26.58 | 2.03 ±26.68 | 1.75 ±26.30 | May |
| 3.23NS | 2.31 ±30.18 | 2.38 ±29.92 | 2.27 ±29.90 | 2.63 ±29.84 | June |
| 1.71NS | 1.23 ±32.22 | 1.38 ±31.98 | 1.33 ±31.94 | 1.14 ±32.04 | July |
| 0.86NS | 0.62 ±32.62 | 0.73 ±32.38 | 0.76 ±32.56 | 0.37 ±32.40 | August |
| 2.46NS | 1.68 ±29.92 | 1.92 ±29.92 | 2.02 ±29.78 | 1.68 ±29.78 | September |
| 1.55NS | 1.13 ±28.00 | 1.01 ±28.10 | 1.05 ±27.90 | 1.40 ±28.02 | October |
| 1.13NS | 0.69 ±23.90 | 0.69 ±23.60 | 0.89 ±23.66 | 0.92 ±23.72 | November |
| 0.89NS | 0.65 ±18.44 | 0.68 ±18.22 | 0.63 ±18.10 | 0.69 ±18.12 | December |

NS = no significant differences.

PH of Water: The pH values of the magnetically treated water were taken, where the slight increase in the pH rates with the increase in the magnetic intensity imposed on the exposed water compared to the non-magnetically treated water, as in table no. 2; which indicates the slight increase in the pH rates, as its rates for the control water ranged between 8.04-7.65 and an average of 7.82, while the rates for the water exposed to the intensity of 500 Gauss ranged between 8.18-7.81 and an average of 7.99, and ranged between 8.18-7.82 and an average of 8.00 in the water exposed to the magnetic intensity of 1000 Gauss, while the water exposed to the magnetic intensity of 1500 Gauss ranged between 8.17-7.84 and an average of 8.00. From all of this, it is clear that there are significant differences in the pH values for some of the study months, namely April, July, August, November and December. As for the rest of the study months, no significant differences appeared in the pH values for the control and treatment waters. The highest water temperature was 32.36°C and 32.62°C in summer for the months of July and August, and the lowest temperature was 18.32°C and 18.10°C in winter for the month of December, respectively.

The results of this study proved that when water was exposed to a magnetic field with three different intensities, the pH values of the magnetically treated water increased with those intensities with the increase in magnetic intensity and the pH values of the water exposed to the intensity of 1500 Gauss increased compared to the rest of the intensities and the control water; This is because the magnetically treated water tends towards basicity instead of acidity due to the increase in hydroxyl ions at the expense of hydrogen ions in the water (Fathi *et al.* 2006); this appears to be a physical change, but the water changes in weight under the influence of magnetic fields due to the increase in hydroxyl ions resulting from calcium bicarbonate compounds and other basic molecules that help reduce acidity in the water (Lam, 2001). The results of the current study agree with Babiker (2002), when he noticed an increase in the pH of the water passing through a magnetic field with an intensity of 2000 Gauss by 2.857%. Therefore, the acidity of water increases with the increase in the intensity of the magnetic field directed at the water and the exposure time (Mousa & Hamed, 2008).

Table (2): pH levels of control and treatment waters with the least significant difference value for comparison at the probability level ($P<0.05$) during the study period.

| LSD | 1500 gauss | 1000 gauss | 500 gauss | control | Months of study |
|--------|------------|------------|------------|------------|-----------------|
| 0.35NS | 0.26 ±7.95 | 0.27 ±7.91 | 0.26 ±7.91 | 0.24 ±7.80 | January |
| 0.42NS | 0.31 ±7.84 | 0.31 ±7.82 | 0.30 ±7.81 | 0.32 ±7.65 | February |
| 0.37NS | 0.26 ±8.17 | 0.26 ±8.14 | 0.27 ±8.14 | 0.29 ±7.98 | March |
| 0.12* | 0.07 ±8.17 | 0.09 ±8.13 | 0.10 ±8.12 | 0.09 ±8.00 | April |
| 0.11NS | 0.08 ±8.14 | 0.07 ±8.13 | 0.08 ±8.14 | 0.08 ±8.04 | May |
| 0.39NS | 0.09 ±8.01 | 0.41 ±8.18 | 0.40 ±8.18 | 0.08 ±7.80 | June |
| 0.15* | 0.12 ±7.94 | 0.11 ±7.94 | 0.12 ±7.93 | 0.11 ±7.75 | July |
| 0.17* | 0.12 ±8.00 | 0.13 ±7.98 | 0.13 ±7.97 | 0.13 ±7.76 | August |
| 0.23NS | 0.17 ±7.87 | 0.18 ±7.85 | 0.18 ±7.84 | 0.14 ±7.72 | September |
| 0.18NS | 0.14 ±7.84 | 0.13 ±7.83 | 0.14 ±7.83 | 0.10 ±7.68 | October |
| 0.17* | 0.13 ±7.94 | 0.13 ±7.92 | 0.14 ±7.90 | 0.10 ±7.71 | November |
| 0.12* | 0.11 ±8.16 | 0.10 ±8.15 | 0.10 ±8.14 | 0.05 ±8.03 | December |

NS= There is no significant difference. , *= There is a significant difference.

Dissolved Oxygen: It is known that magnetically treating water turns it into living water or clean water, as it becomes more vital and active and has the property of dissolving oxygen to a high degree; as happened in that experiment, as the solubility of oxygen in water increased with the increase in the intensity of the magnetic field imposed on the water, as shown in table 3, as the highest value of dissolved oxygen concentration in water exposed to a

magnetic intensity of 1500 Gauss for the month of January was 11.08 mg/L, while the highest value of oxygen concentration was 11.04 mg/L for water exposed to an intensity of 1000 Gauss, as for water exposed to an intensity of 500 Gauss, the highest concentration was 11.00 mg/L, while the average value reached 7.56 mg/L for the concentration of dissolved oxygen in the control water for the month of May. From observing the data recorded in Table

(3), it is clear that there are clear significant differences for all study months in the concentration of dissolved oxygen in the magnetically treated water at the three magnetic intensities of 500, 1000 and 1500 Gauss, respectively, compared to the concentration of dissolved oxygen in the control water, as the solubility of oxygen increases with the increase in the intensity imposed on the water. When calculating the value of the least significant difference, the significant differences were shown for all study months, starting from January until December. Dissolved oxygen in water plays a major role in the life of aquatic organisms. It has been found that in the absence of oxygen, a state occurs; Anoxia, i.e. there are no oxygen molecules dissolved in the water, or a state of low oxygen called Hypoxia; estimated at less than 2 mg/L (Cloern, 1996). The temperature affects the oxygen content of water, which is considered one of the important factors that affect raw water sources and thus affect the biological and chemical processes that occur in any body of water (World Health Organization, 2004).

There are many factors that work to increase the concentration of dissolved oxygen in water, and among those factors are the magnetic fields directed at the water with different intensities. We notice that, through the results of this study, the rates of dissolved oxygen concentrations in water increased with the increase in the magnetic intensity directed at the water; therefore, the magnetic intensity of 1500 Gauss is the best magnetic intensity in this study, which significantly affected the increase in the solubility of oxygen in water. It is clear from this that the concentration of dissolved oxygen in water increases with the increase in the magnetic intensity to which the water is exposed. The results of this study agreed with Nasser (2006), when using a magnetic field with an intensity of 500 Gauss, as there was a noticeable increase in the concentration rate of dissolved oxygen in water from 5.43 mg/L to 10.62 mg/L; this is because magnetically treated water is used to solve many different problems and helps improve the quality of water (Pioneer, 2006). The electrical and magnetic properties of magnetically treated water change the physical and chemical properties of water, as it increases the solubility of oxygen by about 6-4 mg/L (Gold – Aqua, 2005). Water is bipolar and its molecules are partially arranged in an electric field, and magnetically treating water increases the concentration of dissolved oxygen in water, as the

low magnetic field with an intensity of 200 Gauss increases the water groups, which leads to an increase in its surface area, and then an increase in the concentration of dissolved oxygen in water occurs (Chaplin, 2004). This is what the results of that study showed, as the lowest value of dissolved oxygen concentration was in May for the control water, while the highest values were in December and January when the weather was cold in winter, so the dissolved oxygen concentrations in the water increased, in addition to the presence of another factor, which is the magnetic field factor. There are other factors in the water that control the reduction of dissolved oxygen concentration in the water, which is the number of living organisms in the water, as they consume oxygen through respiration and bacterial decomposition of dead materials in the sediments (Kemp, *et al.* 1992). This is consistent with Hassan's study (Hassan, 2004), as he confirmed that the decrease in the value of dissolved oxygen in the summer may be due to the rise in temperature, which leads to an increase in the decomposition of organic materials due to the increased activity of organisms.

Electrical Conductivity of Water: The results shown in table 4 indicated an increase in electrical conductivity rates with increasing magnetic field intensity, as the electrical conductivity rates of water treated with magnetic intensity of 1500 Gauss were higher than their rates in water exposed to intensity of 500 Gauss and 1000 Gauss. The highest value of the electrical conductivity rate of water exposed to magnetic intensity of 1500 Gauss for the month of March was 865.20 micro Siemens/cm, while the highest value of conductivity in water exposed to intensity of 1000 Gauss was 864.80 micro Siemens/cm for the month of March as well, and it reached 864.60 micro Siemens/cm, as the highest value for water treated magnetically with intensity of 500 Gauss and for the month of March, respectively, but the average value reached 633.00 micro Siemens/cm for control water in the month of February. From calculating the value of the least significant difference, it is clear that there were significant differences for some months of the study, such as February, April, and December. As for the rest of the months of the study, no significant differences were shown in the electrical conductivity rates of magnetically treated water compared to the control water.

Table (3): Dissolved oxygen levels (mg/L) for control and treatment waters with the least significant difference value for comparison at the probability level ($P < 0.05$) during the study period.

| LSD | 1500 gauss | 1000 gauss | 500 gauss | control | Months of study |
|-------|------------------|------------------|------------------|-----------------|-----------------|
| 1.08* | 0.94 \pm 11.08 | 0.91 \pm 11.04 | 0.91 \pm 11.00 | 0.23 \pm 8.04 | January |
| 1.60* | 1.37 \pm 10.44 | 1.40 \pm 10.48 | 1.36 \pm 10.48 | 0.15 \pm 8.06 | February |
| 1.22* | 1.04 \pm 10.16 | 1.10 \pm 10.04 | 0.99 \pm 10.04 | 0.20 \pm 7.76 | March |
| 0.48* | 0.36 \pm 9.24 | 0.41 \pm 9.18 | 0.44 \pm 9.14 | 0.13 \pm 7.92 | April |
| 0.59* | 0.48 \pm 9.26 | 0.39 \pm 9.32 | 0.48 \pm 9.06 | 0.40 \pm 7.56 | May |
| 0.25* | 0.24 \pm 9.20 | 0.11 \pm 8.86 | 0.10 \pm 8.88 | 0.24 \pm 7.92 | June |
| 0.53* | 0.25 \pm 9.08 | 0.40 \pm 9.00 | 0.53 \pm 9.08 | 0.35 \pm 7.84 | July |
| 0.40* | 0.24 \pm 9.60 | 0.31 \pm 9.58 | 0.43 \pm 9.52 | 0.10 \pm 7.98 | August |
| 0.49* | 0.43 \pm 9.34 | 0.40 \pm 9.28 | 0.29 \pm 9.16 | 0.32 \pm 7.68 | September |
| 0.43* | 0.38 \pm 9.32 | 0.33 \pm 9.44 | 0.35 \pm 9.38 | 0.19 \pm 7.92 | October |
| 0.92* | 0.77 \pm 9.86 | 0.80 \pm 9.78 | 0.77 \pm 9.74 | 0.23 \pm 7.74 | November |
| 1.11* | 1.10 \pm 10.12 | 0.72 \pm 9.80 | 0.98 \pm 9.82 | 0.23 \pm 7.68 | December |

*= There is a significant difference.

There was an increase in the electrical conductivity rates in the magnetically treated water, especially the higher intensity (1500 Gauss) compared to the control water throughout the study period. The results of this study agreed with Ibrahim (Ibrahim, 2006), in his study on the effect of using the magnetic field in distilled water, as he proved that with increasing the intensity of the magnetic field, the speed of water flow increases and with it the electrical conductivity and dielectric constant of the water. The results of that study agreed with Babiker (2002), when there was an increase in electrical conductivity by 13.333% for water passing through a magnetic field with an intensity of 2000 Gauss; The reason for the increase in electrical conductivity of magnetically treated water is that magnetic water treatment changes the molecular structure of water from large molecules to small molecules and changes normal water from the pentagonal structure to the effective hexagonal structure that has high permeability to the cells and tissues of the body, and thus an increase in electrical conductivity occurs (Babaker, 2002). The mineral ion content of water has a significant effect on the molecular structure of water. For example, iron, copper, zinc, calcium and sodium ions have large electrical charges and small densities that lead to strengthening healthy ionized water (hexagonal water), while other mineral ions such as aluminum, magnesium, chloride and potassium ions have much smaller electrical charges and large densities that then lead to a weak water structure and lead to the formation of pentagonal water that is not suitable for drinking. When the water was treated magnetically, its molecular structure changes from

large molecules to small or fine molecules, and normal water changes from the pentagonal structure to the effective hexagonal structure that has high electrical conductivity, and thus has high permeability to the body's cells (Babaker, 2002). The results of this study agreed with the researchers Joshi & Kamat (1966), who indicated that the passage of water in a magnetic field leads to a change in more than 14 properties of water, including electrical conductivity, reduction of surface tension, change in the speed of chemical reactions, evaporation property, refractive index, electrical insulation, density, viscosity, and increased permeability, in addition to increasing the percentage of dissolved oxygen and hydroxyl ions in water and increasing the ability to dissolve acids, salts, minerals and vitamins. These results also agreed with the researchers Mousa & Hmed (2008), when they confirmed that the surface tension of water decreases with increasing magnetic field intensity and exposure time, while electrical conductivity and acidity function increase with increasing magnetic field intensity and exposure time. There are several factors that affect the values of electrical conductivity, including temperature and the rate of dissolved oxygen in water (Al-Hassani, 2010). The current results agree with the researchers Adam *et al.* (2007), the highest values of electrical conductivity and salinity were obtained during the summer and fall, which coincided with a decrease in the concentration of dissolved oxygen in the water, while the lowest values of salinity and electrical conductivity were obtained in the winter and spring; this was due to the rise in water levels due to rainfall. The results of this study are

consistent with the study of Al-Taie (2010), when the values of salinity and electrical conductivity increased with the decrease in water levels and the increase in the evaporation rate resulting from the

rise in temperature in his experiment; the reason for this study is that the laboratory temperature was constant for all experimental basins from the beginning of the experiment to its end.

Table (4): Electrical conductivity rates (micro Siemens/cm) for control and treatment water with the least significant difference value for comparison at the probability level ($P < 0.05$) during the study period.

| LSD | 1500 gauss | 1000 gauss | 500 gauss | control | Months of study |
|----------|---------------|---------------|---------------|---------------|-----------------|
| 57.9 ns | 43.74 ±739.40 | 43.18 ±738.60 | 42.73 ±737.80 | 43.06 ±709.00 | January |
| 39.62* | 24.11 ±695.00 | 24.39 ±692.40 | 21.73 ±690.20 | 42.94 ±633.00 | February |
| 85.26 NS | 66.90 ±865.20 | 68.08 ±864.80 | 66.13 ±864.60 | 51.87 ±795.60 | March |
| 40.20* | 33.28 ±861.00 | 33.36 ±860.80 | 24.08 ±857.60 | 28.20 ±817.60 | April |
| 97.47 NS | 74.25 ±755.00 | 75.62 ±753.40 | 73.95 ±752.40 | 66.62 ±691.40 | May |
| 30.13 NS | 18.51 ±664.60 | 17.65 ±663.80 | 18.61 ±662.20 | 31.92 ±660.60 | June |
| 66.63 NS | 47.84 ±748.60 | 46.52 ±746.80 | 46.80 ±746.80 | 56.89 ±709.40 | July |
| 48.29 NS | 38.26 ±733.40 | 38.20 ±732.00 | 37.19 ±730.40 | 29.69 ±698.40 | August |
| 78.31 NS | 49.96 ±762.80 | 61.41 ±760.20 | 63.07 ±759.00 | 58.31 ±724.20 | September |
| 56.01 NS | 43.41 ±759.80 | 40.62 ±759.40 | 43.76 ±758.20 | 39.11 ±705.40 | October |
| 67.38 NS | 53.36 ±815.00 | 54.04 ±814.00 | 54.15 ±813.80 | 37.43 ±748.20 | November |
| 11.47* | 8.29 ±778.40 | 8.79 ±777.40 | 7.94 ±777.20 | 9.14 ±728.80 | December |

NS= There is no significant difference. , *= there is a significant difference.

Total Dissolved Solids in the Water: Table 5 shows the measurement of total dissolved solids in each of the magnetically treated water at different intensities, which are 500, 1000 and 1500 Gauss, respectively, and water not magnetically treated. From observing the data recorded in the previous table (table no. 5), it is clear that there are effects of the magnetic field and the three intensities imposed on it in causing physical changes in the properties of the water, namely that the magnetically treated water increases the solubility of the elements, i.e. increases the ability to disintegrate and break down salts, and with increasing the intensity of the magnetic field, the solubility of those salts increases; The highest value of the total dissolved solids in water was 577.60 ppm for the magnetically treated water with intensity of 1500 Gauss for the month of March, while the highest value of those materials was 577.20 ppm for the month of March as well, and the highest value of those materials reached 577.00 ppm also for the month of March dissolved in the magnetically treated water with intensity of 500 Gauss, while the average value reached 419.80 ppm for the control water in the month of February, and significant differences were obtained for some months of the study when calculating the value of the least significant difference, which are the months of February, April, October, November and December, while for the rest of the study months,

no significant differences were obtained for the total dissolved solids in magnetically treated water compared to the control water.

The results show that the values of the rates of total dissolved solids in water increase significantly with the increase in the magnetic intensity imposed on the water, which is 1500 Gauss. The more the intensity of the magnetic field imposed on the water and the longer the exposure time, the percentage of total dissolved salts in the water and electrical conductivity increase (Mousa & Hamed, 2008).

The magnetic field works to precipitate minerals, salts, vitamins and other substances dissolved in water by increasing the intensity of the magnetic field. The results of this study agreed with the researchers Fathi *et al.* (2006), when they used the magnetic field to precipitate calcium carbonate compounds from hard water, as the precipitation process increased with the increase in the strength of the magnetic field exposed to the water. The results of this study also agreed with Nasser (2006), when he noticed a decrease in the chloride ion dissolved in water by 7.8 parts per million and the solubility of water increased from 3.01 g to 3.17 g per 10 ml of water when the water was passed through a magnetic field with an intensity of 500 gauss. The reason for the increased solubility of these solids with the increase in magnetic intensity is that magnetically treated water works to modify

some of the properties of the water and makes it retain its magnetic properties through its ability to dissolve various components such as minerals and vitamins (Kronenberg, 2006). There are many properties of water that change when it passes through a magnetic field, including an increased ability to dissolve acids, salts, minerals and vitamins (Kronenberg, 1985). Since the water molecule consists of an oxygen atom linked to two hydrogen atoms at an angle of 105 degrees, and as a result of the strong tendency shown by the oxygen atom to withdraw electrons, this leads to charging it with a local negative charge $-\delta$ and charging the hydrogen nuclei with a local positive charge $+\delta$. Although the water molecule is neutral in charge, meaning that the number of positive charges is equal to the number of negative charges, but its negative and positive charges are far apart from each other, which makes the water molecule bipolar and the molecule in this position is similar to a magnet. This condition is largely responsible for the attractive forces between water molecules. Water molecules tend to gather around polar materials dissolved in water and do not return to attract each other because the dielectric constant of water is somewhat high. Therefore, water molecules work to weaken the bonds between charged ions and thus increase their destruction (Boyd, 1999). The results of this study are consistent with what was found by researcher Cranfield (2002), when he proved that magnetically treated water leads to a reduction in the formation of calcium carbonate calcifications by 70%, and this depends on physical and chemical conditions such as temperature, pH, and alkalinity. When researcher Bikul'chuyus *et al.* (2003), when they used a magnetic field with an intensity of 0.05 Tesla to remove rust from drinking water pipes by using the magnetic field permanently, and the exposure period was 2 hours at a temperature of 70-40 °C. When the water was passed through the pipe containing the magnetic field, the percentage of rust decreased by 14%, because the magnetic field interacts with the positive and negative ions associated with the elements of water containing salts, minerals, and other total solids dissolved in water; Therefore, these materials and salts disintegrate or break down and calcium carbonate compounds precipitate, after which minerals, compounds and various molecules such as calcium and magnesium dissolve, and then the rest of the other elements are absorbed (L. L. C., 2001). The results of this study agreed with both researchers Godio & Naldi (2009), when they used magnetic field technology to get rid of household

waste and factory waste in areas polluted with these pollutants by using magnetic fields with intensities between 2000 - 40000 Gauss; to dissolve the various salts and minerals and then get rid of them. The values of the rates of total solids dissolved in water are affected by many factors such as temperature and dissolved oxygen rate, as the increase in water temperature increases the dissolution of total solids in water due to the increase in evaporation rates that occur with high temperatures and low water levels, while the decrease in their value coincides with the decrease in temperature due to the increase in water levels, which leads to dilution processes (Waziri & Ougbuaja, 2010).

Conclusions

This study reached a number of conclusions that can be summarized as follows:

- 1- It was noted from the results of this study that there was a gradual significant improvement and modification in some of the physical and chemical properties of water, reaching the magnetic intensity of 1500 Gauss, which achieved the best results.
- 2- With increasing the magnetic intensity, the pH of the water, dissolved oxygen in the water, electrical conductivity of the water, and total solids dissolved in the water increase, thus improving the properties and quality of the water; thus, it becomes.
- 3- Magnetized water becomes clean, more vital and active, and has the property of dissolving oxygen in the water to a high degree; due to the increase in the surface area of the magnetically treated water.
- 4- The ability of magnetically treated water to dissolve elements increases, i.e. the ability to break down and break down salts increases by increasing the intensity of the magnetic field.
- 5- The alkalinity of the water increases instead of its acidity; due to the increase in hydroxyl ions, by increasing the intensity of the magnetic field applied to the water and the exposure time.
- 6- The magnetic field converts large water molecules into small molecules; Normal dead water turns into effective functional water; because the magnetic field transforms the water from the pentagonal structure to the effective hexagonal structure that has high permeability to the cells and various body tissues, then the electrical conductivity of the magnetized water increases.
- 7- With the increase in the intensity of the magnetic field, the fragmentation of minerals, salts, vitamins and other substances dissolved in the water increases; therefore, magnetized water works to fragment salts and stones in the kidneys.

Table (5): Total dissolved solids (ppm) levels for control and treatment waters with the least significant difference value for comparison at the probability level (P<0.05) during the study period.

| LSD | 1500 gauss | 1000 gauss | 500 gauss | control | Months of study |
|----------|---------------|---------------|---------------|---------------|-----------------|
| 43.86NS | 33.83 ±499.80 | 34.00 ±499.00 | 33.58 ±498.20 | 29.20 ±472.00 | January |
| 28.16* | 16.34 ±468.80 | 17.79 ±465.80 | 14.66 ±464.00 | 31.07 ±419.80 | February |
| 57.53 NS | 45.09 ±577.60 | 46.26 ±577.20 | 44.36 ±577.00 | 34.99 ±530.40 | March |
| 26.39* | 22.33 ±574.00 | 22.42 ±573.80 | 15.83 ±571.40 | 17.24 ±538.40 | April |
| 64.92 NS | 48.97 ±504.00 | 48.81 ±502.20 | 50.44 ±502.20 | 45.32 ±453.80 | May |
| 34.71 NS | 25.98 ±456.60 | 27.85 ±456.00 | 27.18 ±454.80 | 22.16 ±439.00 | June |
| 45.78 NS | 31.66 ±499.00 | 30.92 ±497.80 | 30.80 ±497.80 | 41.91 ±468.00 | July |
| 38.15 NS | 30.46 ±492.00 | 30.26 ±490.80 | 29.81 ±489.80 | 22.52 ±461.00 | August |
| 53.61 NS | 33.39 ±508.60 | 43.28 ±507.00 | 41.32 ±507.00 | 41.21 ±476.60 | September |
| 39.52* | 32.34 ±510.00 | 30.33 ±509.00 | 32.40 ±508.00 | 21.47 ±467.20 | October |
| 42.75* | 32.34 ±545.40 | 30.33 ±544.40 | 32.40 ±544.20 | 14.23 ±492.20 | November |
| 10.13* | 7.33 ±521.40 | 7.92 ±520.40 | 7.12 ±520.20 | 7.82 ±483.60 | December |

NS=There is no significant difference, *= there is a significant difference

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