

Evaluation the Effect Of Magnetized Water On The Bone Density And Osteoporosis In The Experimental Rats By DXA-Scan

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Abstract

Background: The electromagnetic field used with industrial, and also simultaneous action of those fields on the intensity of bone turnover process in rats was estimated by means of analysis of densitometry. The obtained effect was dependent on frequency and power density of used electromagnetic fields. There was improved in quality of the water when exposed to the electromagnetic field with significant changes in the minerals and organic matter. Therefore its penetration into cell wall would be facilitated, which can accelerate ordinary diffusion of water. That is vital for growth and development of different organs. Exposing the water to strong magnetic fields affect in the water's mineral content, and its effects depended on the "strength of the magnetic field and exposure time".

Objective: To study the effect of depreciation the magnetizing water on bone density and osteoporosis for rats.

Patients and Methods: In this study It was concluded (14) rat and divided to two groups, A and B "7 rats for each group". Group A feed normal water for 24 days, and group B feed magnetized water for 24 days. The magnetized system that used to magnetized the water consist of 4200 rolled silk around iron tube, and it is connected to the continuous power supply "220 V". and used Digital Gauss meter to measure the magnetic flux equal to 0.9mT. After 24 daily consumption of the magnetized water measure the bone density by DXA scan devise that use to measure the bone mineral density "BMD", bone mineral content "BMC", T-score and Z-score. Comparing the result of "T-score, Z-score, BMD and BMC" between group A and B of the animals after 24 days from consumption the magnetized water.

Results: The study shows enhancing in the biological activity in rats that consumption the magnetized, by repairing and turnover the bones in comparing to other group that use normal water.

Conclusion: The current study represented the consumptions of magnetized water increase the ability of bone repair and turnover.

Keywords: Electromagnetic field, Densitometry of the bone rats, Magnetized water, Osteoporosis, Bone regeneration.

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Introduction

During last. Decades there was increasing the interest in the bio effects of the electromagnetic fields interaction with living organisms. All living organisms are always expose to the electromagnetic fields ,from industrial and. domestic sources, induced by "ELF-MF" on cells function , and the interaction mechanisms of biological systems and electromagnetic fields are still partially understood [8].

Electromagnetic fields consist of waves that transport energy through space characterized by wavelength and frequency, the two of which are inversely correlated " The shorter the wavelength, the greater the frequency". Duration of exposure and strength of the field. ,gradient, rate of change, and orientation along or perpendicular to flow are variously cited as important to the results[5]. The shapes of solute molecules will be modified by physically powerful magnetic fields , leading to precipitated as spherical or round crystals, rather than deposit as sheets, or platelets of hard crystals [9].

The beneficial effects that investigate in the magnetized water for human and animals are improvement in quality of the water, that found when exposed to the magnetic field with extensive change in the "pH, total dissolved solids, total hardness, conductivity, salinity, dissolved oxygen, evaporating temperature, minerals, organic matter and total count of bacteria". Therefore it's cell wall penetration would be facilitate ,which can accelerate ordinary. diffusion of the magnetized water that is vital for growth of

different organs. "Magnetic water" means water passing from magnetic tubes ,and putting the magnet in water, so the properties of the water turned into very active and productive, causing high in a"oxygen ratio, velocity of dissolved salts and amino acids in water". after sterilization of the Natural water is called "dead water", so magnetic water convey water from dead to live [4] & [1]. Treatment water properties could be changed to become more energized, active, soft and high pH toward slight alkaline and free of germs [23].

"Magnetized water" was first used in Russia by 3 specialists: "Drs. G. Gerbenshchikow, I. Shetsov and K. Tovstoles, all specialists in urology at the Kirov Military Medical Academy in Leningrad". their patients drink a bi-polar magnetized water. This simple management was very efficient in breaking up (kidney and gall bladder stones) into small enough particles, and passed through urine without any pain or threat to the patient. "The magnetized water" also not permitted further formation of stones in the gallbladder and kidneys. Physicians of Soviet used "internally magnetized water" to patients for more than 30 years for treatment of (digestive, urinary and nervous problems, ailments like mastitis, pains and swellings, painful urination and many other disorders) [6] & [19].

"Osteoporosis" is an important systemic disorder, affecting mainly in Caucasian women, with a diverse and multifactorial etiology. wide variety of animal species ,including "rodents, rabbits, dogs, and

primates', have been used as animal models in the researchs of osteoporosis. "Osteogenesis" is a complex events ,by which "BMSCs" differentiate to produce new bone. "hBMSCs" possess characteristic Ca^{2+} waves ,that are involved in intracellular signaling. The waves work in short and long periods, the longer periods operating during "trans-cellular signaling"[18].

Bone density measured through "DXA" is an extremely accurate, and accurate method for quantifying bone mineral density "BMD", and mass body composition assessment. "DXA's" primary viable application use to measure the risk to assess fracture ,and diagnosing the osteoporosis.

The osteoporosis diagnosis in (the lumbar spine, proximal hip and, sometimes, the distal forearm are scanned). The whole body also can be scanned to measure whole bone mass and soft tissue of the body composition [13] &[12].

Patients and Methods

All procedure were standard by animal ethical committee .An observational non randomized cross-sectional study done from the 1st of December, 2017 to 30th of June 2018, in order to achieve the required objective of the present study and comparing the result with control group to estimate magnetic fields on the intensity of bone turnover process in rats, by means of analysis bone density . The investigations of current study were carried out in Diyala University- Collage of Medicine . The experiment was performed on rats, males and females adult Wistar rats (Rathus Norvegicus) and aged

about (6-8) weeks were used in this study. Weight of the animals was between (150-250gm) recorded by an electronic balance.. The data collection have been conducted during a period of 24days extending from 1 November 2017 – 1 may 2018. The animal procurement from Ministry of Health , Quality Measurement section , laboratory animal house.

Groups : study performed on 14 rats .The animal were non randomly divided in to two groups A(7 rats for experimental group) and B(7 rats for control group).

First group (A): use the magnetized water as a treatable material (according to the number of rolls using in magnetization 4200. The first group were take 7 rats.

Second group : 7 rats are use as a control group.

Magnetized System

The system of magnetization , an important part of current study in which create magnetic field makes the materials magnetize, is collected, designed, and manufactured manually by the researcher in order to meet the requirements in demand, materials, and specific ratios of the research which approved by supervisors of current study as shown in Figure (1).By using the following :

- 1-Iron tube (with length 45 cm) open from two end.
- 2-Iron wire (with diameter 0.3 mm).
- 3-Electric point >> 220 V .
- 4-Power supply>> regulated the voltage supply.
- 5-Gage for measure the current &voltage.

6-Magnetometer for measurement the flux meter (change field).

7-Wood box .

8-Water faucet.



Figure (1) :System of magnetization device for required magnetic field.

The 45cm iron tube is fixed horizontally inside the wooden box and wrapped up around it iron wire of 0.3 diameter about 4200 rolls.

The length of the wire has been measured in the tap by using the following special equation:

The length of the wire in single tap= $2\pi R$ *the number of roll sinthesame tap

Number of rolls controlled by the channel installed on the wooden box and the device is connected to the power supply. To install the voltage difference using 220 volts in my experience and the whole system is connected to the point of electricity chamber as the system current is direct current DC.

Digital Gauss Meter (china)

Technical Specifications

*measuring range: 0 ~ 200mT ~ 2000 mT

*Accuracy: 0 ~ 100mT 1%, 100mT more than 2% (uniform magnetic field measurement)

*Resolution: "DC \times 1: 0.00 ~ 200.00mT 0.01mT"

DC \times 10: 0.0 ~ 2000.0mT 0.1mT

AC \times 1: 0.00 ~ 200.00mT 0.01mT

AC \times 10: 0.0 ~ 2000.0mT 0.1mT

General principle of instrument

"Accurate flux density" measurement on magnetic and electromagnetic components such as : relays, DC motors, magnets, loudspeakers, etc. It is very relevant for online production testing. As shown in Figure (2).

Can be used to detect residual magnetism article after machining, detection pole distribution, the remaining product after demagnetization magnetic field, and the control electromagnetic tape, the magnetic detection of the motor, magnetic flux leakage detection of electromagnetic fields. The strength of a "magnetic field" is measured in units of (tesla) in the " SI" units, and in (gauss) in the "cgs "system of units. 10,000 gauss are equal to: one tesla [14].

In some contexts, "magnetometer" is the term used for an instrument that measures the fields of less than 1 millitesla (mT) and "gaussmeter" is used for measuring the fields of greater than 1 mT b[14]. Measuring the magnetization, as a function of temperature and magnetic field .On the base of space,

measured the distribution of magnetic field parameters (e.g. amplitude or direction), the magnetovision images that may be generated. Such presentation of magnetic figures is very useful for further investigation and data

fusion. In current study, Digital Gauss Meter connected at electricity chamber has in order to calibrated magnetic flux measurement directly in magnetic field unit Figure(2).



Figure (2) :Digital Gauss Meter for Magnetic Flux Measurement.

Procedure /Intervention

Total of (14) The animals were housed in individual plastic cages measured (40 × 25 × 25 cm) with wood chip bedding in plastic cages .The animals had at 25°C, under a 12-12 light /dark cycle and free access to commercial rat pellets (Altromin 1324, Altromin GmbH, Lage, Iraq) and tap water. This was prepare to contain the nutrients that are needed for rapid growth in growing male rats and reproduction in adult female rats based on AIN-93G and AIN-93M, respectively [15].

Rats, are monitor daily for general health, changes in appearance or change in its behavior throughout the study. The rats were concern and maintained in observance, with the direct Care when Use of Laboratory Animals [16] and Massey University guidelines. Ethical approval for the study protocols of rats were gained from the Ethics Committee of Diyala University.

Pre-operatively, according to Institutional Animal Care, each rat (about 250 gm weighting)has anaesthetized with intentional anesthesia (Ketamine Hydride USP: ketamine 50 mg/ml for i.m./i.v. injection ;Batch NO. :70407 ; Germany), and a dose of general analgesia(0.01 mg/kg) was given intra muscularly. Once the rats reached the required depth of anesthesia, left-sided femur of each selected rat (selection due to highly response of magnetized water separately) exposure to DXA scan by researcher under supervision to ensure rats stability during procedure for testing BMD& BMC values affected under specific conditions with magnetized water.

Fertilization Process

All rats were fertilized before the duration of experiment in order to determine the effect of pregnancy duration and birth rates for rats

under treatment of exposed magnetized water.

Preparation of water extracts

Tap water was used also given to rats in the control group. Tap water was used in the study to obtain normally minerals pre- exist in water throughout the experimental period. water extracts were freshly prepared .Tap water were supplied in clean polyethylene water bottles, as the only source of drinking fluid during the study duration. Tap water

were replaced and served fresh once every day during the feed intake measurement. Polyethylene water bottles were cleaned weekly. Water bottles for tea drinks were cleaned thoroughly once every day during the fluid intake measurement to prevent spoilage from bacteria.

The animals were assigned from groups, the species of study by using the rats about 14 species and dividing it along 2 groups as show in Table (1).

Table (1): The treatment groups were exposed to magnetized nutrition's (water) for 24 days.

Groups	Tap(4200)	Control 2
	Magnetized water by use 4200 rolls(7 rats)	Use normal water (7 rats)

Magnetic Exposure

The water is placed in the iron pipe from the open side. Before that, making sure to close the water tap connected to the other side and open the power point and make sure that the voltage difference is set to the required value by the voltage regulator as well as fix the required number of rolls and open the device and measure the magnetization period Timing I used the time in my experiment 60 seconds and then we open the water faucet to collect the water in

the drip and measure the magnetic flux by gauss meter.

Magnetism happens by directing all the water molecules towards the field that is placed on the iron tube where the water is inside.The electromagnetic field is surrounded by all the water molecules where the electromagnetic field effect is stronger than magnetization by magnets where the magnetization is weaker because it only moves the molecules located on the boundary of the field as shown in Figure(3).

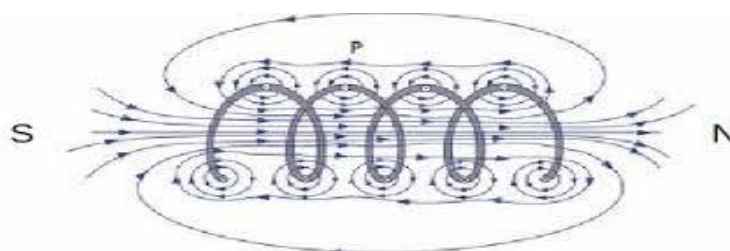


Figure (3) : Electromagnetic field effect.

Evaluation of Bone Densitometry By Using DXA (BMD & BMC)

DXA is the best method of measuring bone density and, thus, the best available indicator of fracture risk. Plain radiographs of supplement to DXA when there is a specific reason for the use. A number of methods for measuring BMD have been developed. Radiographic absorptiometry has not found widespread use, although the recent development of sophisticated computer analyses has renewed interest in this technique and may lead to its re-evaluation [22] & [7]. Measurement of "bone mineral density (BMD)" by central dual-energy. "X-ray absorptiometry (DXA) Central DXA" actually measures "bone mineral content (BMC)" and an area of bone, and it uses these numbers to calculate "BMD" [20] different types of "BMD" tests, all are non-invasive. Most tests vary according to which bones are measured, to establish the "BMD" and "BMC" results which varies by age, race and gender.

Z-score: Is serious for the interpretation of "BMD" measurements in clinical research and practice. That can be recognized in part to generalization of the relevance of "BMD" values to risk of fracture and involvement threshold, and parallel to risk gradients factors in other widespread clinical diseases such as "heart attacks and stroke". the

diagnosis of "low bone mass for age" is the categorization of choice, if the Z-scores is (-2.0) in these groups, in the suitable clinical context [20].

Determining how the individual evaluate to their peers. The density measured according to "Z-score", the number of standard deviations (SD) below or above the mean for rats under treatment of exposed magnetized nutrition (water) as well as controlled group.

T-scores: The T-score is the relevant measure when screening for osteoporosis. The criteria of the World Health Organization are [21]. Normal: Is a T-score of (-1.0) or higher. "Osteopenia" is defined as between (-1.0 and -2.5).

Also "T-score", the number of standard deviations (SD) below or above the mean for rats under treatment of exposed magnetized nutrition. The "T score" is used to analyze osteoporosis in older adults rats take (magnetized water) in Tap (4200), as well as controlled grope.

Results: Are generally achieve by two measures, the "T-score and the Z-score". Scores be a sign of the amount one's "bone mineral density" varies from the mean. Negative scores: indicate (lower bone density), and positive scores: indicate (higher bone density), in addition to Pelvis BMD and Pelvis BMC score.



Figure (4) : DXA ;X ray imaging technique measures Bone Densitometry.

Protective measures

Protective measures and personal hygiene to find if protective equipment, hygiene and knowledge of pollution risks have an impact on magnetic exposure in this study.

Statistical analysis

Results are presented as means with their standard error of the mean (mean \pm Stander error MSE).Statistically analysis of data was carried out using the available statistical package of SPSS-02 (Statistical Package for Social Sciences version 2) .All data were tested for normality using the PROC UNIVARIATE, a procedure used mainly for examining the distribution of data. Homogeneity of group variances was estimated using Levine's test.

The variety of group means were compared using one-way analysis of variance (ANOVA), followed by post-hoc Tukey's test for pair-wise multiple comparisons of the group means. The Welch's variance-weighted ANOVA was used in place of the simple one-way ANOVA when the assumption of homogeneity of variances was not met and groups were unequal in size, which was followed by post hoc Tukey's test for pair-wise multiple comparisons. A

difference was considered to be statistically significant when $p < 0.05$.

Results

Presented Results utilized from the experimental part of the study includes, impact of electromagnetic field experiment, and simultaneous action of intensity of bone turnover in rats , compares the efficiencies in each case as well as the spectral measurements. The gain achieved from the magnetization system has been analyzed in accordance with effectiveness of magnetized water . The information collected in this section was further put to a statistical analysis. The results obtained are based on SPSS Statistics generates tables in one-way ANOVA analysis and Tukey post hoc test .

The sample for the study was divided into four categories according to The ANOVA statistical evaluation of the mean values of group (control, water) and number of rolls (4200) as shown in Table (2).

Pelvis (BMD, BMC, T-score, Z-score)

Table(2) shows distribution of Pelvis(BMD, BMC, T-score, Z-score) among study sample (water, Tea and pellet) according to Mean, as appears below the Control Group (BMD = 0.04, BMC= 0.50, T-score = 4.81, Z-score = 5.00) , the highest

mean value in BMD Water(mean = 0.19 ,Str. Error \pm 0.005). According to BMC the highest mean value exists in Water (mean=17.57 Str. Error \pm 0.655) . While in T-score the highest mean value exists in Water (mean= 19.09,

Str. Error \pm 0.534).According to the Analysis of ANOVA, in water group highest statistically significant difference appears in pelvis – BMC & pelvis – T-score $p < 0.05$.

Table (2): The distribution of pelvis (BMD, BMC, T-score, Z-score& Control) among study sample (water, Tea and pellet) according to Mean and stander error.

	Pelvis BMD	Pelvis BMC	Pelvis T-score	Pelvis Z-score
Water	0.19 \pm 0.005	17.57 \pm 0.655	15.28 \pm 0.594	19.09 \pm 0.534
Control	0.04 \pm 0.001	0.50 \pm 0.021	4.81 \pm 0.208	5.00 \pm 0.204
Total	0.21 \pm 0.003	9.035 \pm 0.338	17.545 \pm 0.401	12.045 \pm 0.369
Sig.	0.019	0.000	0.002	0.092

*The mean difference (MD):is significant at the(0.05) level.

*test treat between Media groups

Table(3) shows distribution of Pelvis (BMD, BMC, T-score, Z-score) among magnetic fields 4200 according to Mean, as appears below the Control Group (BMD = 0.04, BMC= 0.50, T-score = 4.81, Z-score = 5.00) , the highest mean value in BMD exists 4200 roll (mean =0.22,Str. Error \pm 0.016) the less value in the Control Group (mean = 0.04 ,Str. Error \pm 0.001). According to BMC the highest mean value exists in 4200 roll (mean= 26.67 ,Str. Error \pm 2.162) less value in the Control Group (mean=0.5

Str. Error \pm 0.021) . While in T-score the highest mean value exists in 4200 roll (mean= 15.61, Str. Error \pm 0.558) less value in the Control Group (mean = 4.81,Str. Error \pm 0.208).While in Z-score the highest mean value exists in 4200 roll (mean= 19.00, Str. Error \pm 0.676) less value in the Control Group (mean = 5, Str. Error \pm 0.204). Magnetic field group highest statistically significant difference appears in pelvis – BMD, pelvis – BMC, & pelvis – Z-score $p < 0.05$.

Table (3): The distribution of pelvis (BMD, BMC, T-score, Z-score,& control) among magnetic fields (4200) and control according to Mean and stander error.

	Pelvis BMD	Pelvis BMC	Pelvis T-score	Pelvis Z-score
4200 roll	0.22 \pm 0.016	26.67 \pm 2.162	15.61 \pm 0.558	19.00 \pm 0.676
Control	0.04 \pm 0.001	0.50 \pm 0.021	4.81 \pm 0.208	5.00 \pm 0.204
Total	0.13 \pm 0.0085	13.585 \pm 1.091	10.21 \pm 0.383	12 \pm 0.44
Sig.	0.000	0.000	0.178	0.000

*The mean difference is significant at the 0.05 level.

*test treat between Magnetic field groups

Discussion

Exposing the water to strong magnetic fields, affected the content of mineral and its effects depended on : the strength of the magnetic field in addition to exposure time.

Nowadays, the using of magnets to improve quality of the water is a significant importance, due to low cost when compared to chemical and physical treatments [23]. The

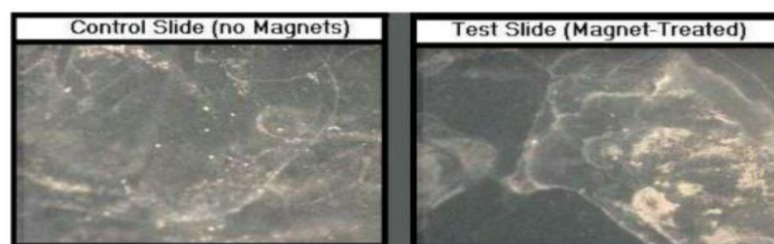
pH level of Normal water has a about [7], whereas pH of the magnetized water can reach to[9.2]. following the exposure to(7000) gauss strength magnet and for a long period of time[11]. Attia et al., "reported that rabbit bucks drank magnetized water showed a significant increase in body weight, feed intake" [3].

On the other .hand, Feed consumption .showed there was non- significant changes, while increased the metabolic factor and decreased the body weight only among water group animals that magnetically treated, the highest enhancement was evidence in consumption of the water in magnetically treated water groups. water that magnetically treated makes animals thirsty, could be used as a plan to enhance hygiene of the body and immune system [2].

In current study rats have daily treated for 24 days with" magnetic water", at these time many defects in the bone will be repaired, and showed a significant increase in the density of bone (BMD, BMC, T – score, & Z – score) and given magnetized water with intensity of 4200 every day . Howeve , differs in treatment period with the study conducted by Neto et al., who reported that

"the consumption of water treated by magnetic field for 45 d provided an effective way to improve the bone mineral density, bone mineral content, and bone resistance in Wistar rats"[17].

The results showing components of Pelvis (BMD, BMC, T-score, Z-score) due to magnetic fields (4200 rolls). According to 4200 roll the highest mean value in exists in BMC (26.67,Str. Error \pm 2.162) in which $p < 0.05$. Each day for 24 days the animals had histological change on bone density . Bone mineral density has be measured only to assist in making a clinical management choice. Water, component consists of Hydrogen and Oxygen atoms and water molecule in simplest shape . water molecules bond with each other with hydrogen bonds with bilateral or multiple bonds. When water molecules have been put through magnetic field, the hydrogen bonds among molecules either change or disintegrate and that disintegration absorbs the energy, reduses water molecules union, increases susceptibility electrolysis, affects on crystals decomposition as well. As shown in Figure (5).



Figure(5): Electrolysis of water molecule and crystal decomposition.

After passing through the magnetic field (6).
water molecules rearrange as shows in Figure

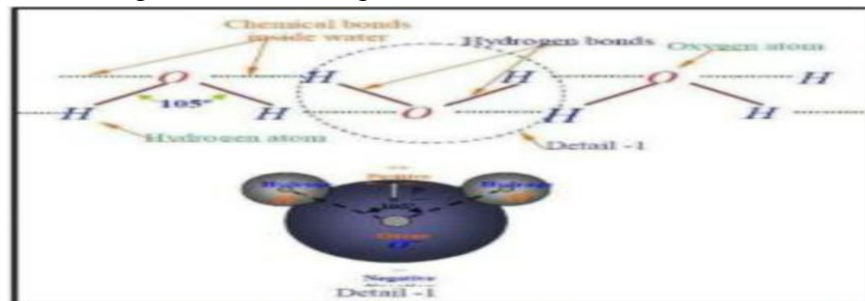


Figure (6) :Shows water molecules.

This kind of oriented arrangement causes drag and break of hydrogen bond and align water molecules to certain direction as passing through magnetic field as well as reduces bond angle to less than 105° . as shows in figure (7) that leading to reduction of molecules union level. On other hand, decreasing in molecules volume resulted from break of hydrogen bond so that some

turn to solo- molecules. For that the magnetized water viscosity less than regular water. Also water molecule groups changes accompanied with osmotic pressure, superficial tighten, hydrogenous figure, and water electric connect changes. All these changes occur in different degree may be solo .

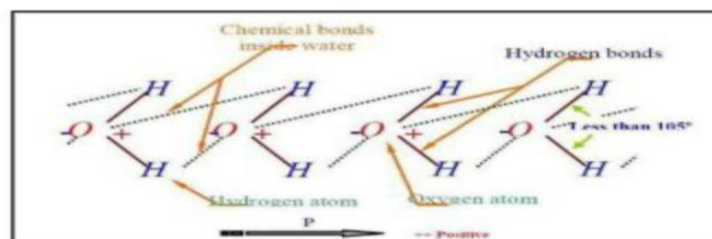


Figure (7) :Shows water molecules arrangement after passing through magnetic field.

Conclusion

In conclusion, the current study that represented our findings of the impact of electromagnetic field and also simultaneous action of those fields, on the intensity of bone turnover process in rats exhibited that magnetized water by using system of magnetization, stimulation partially preserves bone mass, .osteoporosis, and bone structure

by promoting skeletal activities in experimental rats, which are revealed by reducing the bone-building duration to two weeks compared to the control group, which was in 24 days. the results of this study can be used for future clinical trial.

References

- [1] Al-Nuemi SH, Al-Badry KI, Atteyh AJ, Al-Sabeea WS, Ibrahim FF, and Rajab BA (2015). Effect of magnetic water drinking on testis dimension, scrotal circumference and blood parameters of holstein bulls born in Iraq. *Adv Anim Vet Sci* 3(7): 413-417.
- [2] Alhammer AH, Sadiq GT, and Yousif S. (2013). Effect of magnetized water on several biochemical and physical properties in mice. *J Babylon Univ Pure Appl Sci*, 21(3):910-916.
- [3] Attia YA, El-Hamid AE, El-Hanoun AM, Al-Harathi MA, Abdel-Rahman GM, and Abdella MM. (2015). Responses of the fertility, semen quality, blood constituents, immunity and antioxidant status of rabbit bucks to type and magnetizing of water. *Annals Animal Sci*, 15(2): 387-407.
- [4] Batmanghelidj F. (2005). *Diamagnetic water. Is it just water* Biomagnetizer biophysics institute. Canada.
- [5] Chaplin, M. (26 July 2011). "Descaling of Water" . *Water Structure and Science*. London South Bank University. Retrieved 2012-03-26.
- [6] Ekong EB, Jaar BG, and Weaver VM. (2006). Lead-related nephrotoxicity: a review of the epidemiologic evidence. *Kidney inter*, 70 (12): 2074–2084.
- [7] Genant HK, Engelke K, Fuerst T., 1996. Noninvasive assessment of boneminerals and structure: state of the art. *IBone Miner Res* :11;707-30.
- [8] Ikezoe, N.; Hirota, J.; Nakagawa, S. and Kitazawa, K. (1998). Making water levitate. *Natural*, 393: 749-750.
- [9] "Interview of Klaus Kronenberg, Ph. D" .GMX International. Retrieved 2012-03-26.
- [10] International Society for Clinical Densitometry. 2014 Facility Accreditation. Available at: <http://www.iscd.org/accreditation/>. Accessed March 15, 2016.
- [11] Khudiar K, and Ali AM (2012). Effect of magnetic water on some physiological aspects of adult male rabbits. In *Proceeding of the Eleventh Veterinary Scientific Conference* Pp.120-126.
- [12] Kelly, T.L., SLOVIK, D.M., NEER, R.M., (1989) . Calibration and standardization of boneminerals densitometers, *J. Bone Miner. Res.* 4 5 663–669.
- [13] Laskey, M., PHIL, D., (1996) Dual-energy X ray absorptiometry and body composition, *Nutrition* 12 1 -45–51.
- [14] Macintyre, Steven A. 2014. "Magnetic field measurement" (PDF). *ENG Net Base References* (2000). CRC Press LLC. Retrieved 29 March 2014.
- [15] National Research Council . *Nutrient requirements of laboratory animals* (4th revised ed.) Washington ,DC:National Academy Press, pp3-79, 1995.
- [16] National Research Council. *Guide for the care and use of laboratory animal* . Washington ,DC:National Academy Press, pp1-79, 1996.
- [17] Neto GB, Engracia Filho JR, de Oliveira BRSM, Coelho CMM, de Souza LFA, and Louzada MJQ. (2017). Water treatment by magnetic field increases bone mineral density of rats. *J Clin Densit.* DOI:

- <http://dx.doi.org/10.1016/j.jocd.2017.06.002>.
- . Kanis JA, Melton L III, Christiansen C, et al. The diagnosis of osteoporosis. *Bone Miner Res* 1994;9:1137-41.
- [18]Parekh A. Decoding cytosolic Ca²⁺ oscillations. *Trends Biochem. Sci.* 2011;36:78–87.
- [19]Raafat BM, and Nabil GM., (2016). Hemoglobin different derivatives concentration enhancement after usage of magnetic treated water as drinking water. *Inter J AdvanSci Tech Res*,6(1): 415-424.
- [20](The International Society for Clinical Densitometry,2016).
- [21]WHO Scientific Group on the Prevention and Management of Osteoporosis (2000 : Geneva, Switzerland) (2003). "Prevention and management of osteoporosis : report of a WHO scientific group" (pdf). Retrieved 2007-05-31.
- [22]Yates AJ, Ross PD, Lydick E, Epstein RS. Radiographic absorptiometry in the diagnosis of osteoporosis [review]. *Am J Med* 1995;98(2A):S41-7.
- [23] Yacout M. H., Hassan A. A., Khalel M. S., Shwerab A. M. and Abdel-Gawad. E. I., 2015. Effect of Magnetic Water on the Performance of Lactating Goats. *J. Dairy Vet. Anim. Res.*, 2(5): 00048.