EFFECTS OF MAGNETICALLY TREATED DRINKING WATER ON THE RABBITS PERFORMANCE

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SUMMARY

This study aimed to evaluate the influence of magnetic process of water such drinking tap water by exposed to magnetic field (at levels of 1200 and 3600 Gauss on growth performance of rabbits. Forty eight growing black Balady rabbits were randomly distributed into three similar groups of male and female (16 each), using complete randomized block design. Treatments of feeding trial included tap water without or with magnetic exposure (0 (control), 1200 and 3600 Gauss) for G, G1 and G2 treatments, respectively. Results showed that magnetic treatment induced greater effect on magnetic treated water in terms of pH, conductivity, salinity, and dissolved oxygen. Rabbits consumed low level magnetic water G1 had higher insignificantly final body weight and weight gain at (14 weeks) than those of control (G) and the higher level magnetic water (G2).Feed intake as DM was nearly similar in all groups. Feed conversion was improved ($P<0.05$) insignificantly for rabbits drank magnetic water (G1) than that of G groups and significantly than those of G2 group. Results showed that magnetic treatment did not affect nutrient digestibility coefficients and feeding values based on control. Group G1 had increased insignificantly in fasting, total edible parts and empty carcass weights than those of other groups. Dressing percentage was insignificant higher with G1 and significant higher with G2, than that of control G. While weights of edible giblets (heart, liver and kidney) did not affected significantly by experimental treatments. Concentrations of blood metabolites were nearly similar in all groups, except concentration of glucose which increased significantly due to both tested treatments. While ALT decreased ($P<0.05$) significantly by G2 than that of other groups. Counts of red blood cells and white blood cells were nearly similar in all groups. Also, no significant differences in respect of haemoglobin and haematocrit concentrations and PCV% as well among treatments. Rabbits received magnetic water at G1 were lower ($0<0.05$) significantly regarding total volatile fatty acids than other groups. Specifically, gram negative bacteria (*E.coli.*) and anaerobic bacteria numerically were decreased ($P<0.05$), while gram-positive germs (*Lactobacillus*) increased ($P<0.05$) significantly with magnetic treated water than those of control treatment. It could be concluded that magnetizing tap water by the two levels (1200 and 3600 Gauss) led to an improvement respecting growth performance of rabbits.

Keywords: *Rabbits, Magnetic drinking water, growth performance, digestibility, haematological parameters, carcass, bacteria.*

INTRODUCTION

Water and life are closely linked and has been recognized throughout the history by civilizations and religions and is still the case with scientists today. Water properties are found to be very affected by magnetic and electric fields. Water pollution is regarded as one of the most critical environmental problems, as it causes change in water color and increase the microscopic harmful living organisms count, which causes the spread of dangerous epidermal diseases. The water pollutants can be eliminated by physical methods like filtration, as well as chemical treatments like chlorination which is one of the most wide disinfectants (Vesilind *et al*., 1990). Tai *et al.* (2008) observed that when subjecting water to magnetic field, it leads to modification of its properties, as it becomes more energetic and more able to flow and potentially can be considered as a birth of new science called Magneto biology. Water and water solutions passed through the magnetic field acquire finer and more homogenous structures (Tkachenko and Semyonova, 1995). Magnetic wastewater treatment has been introduced to the chemical industry to remove heavy metals (Tsouris *et al.* 2001) and the magnetic wastewater treatment can also be applied to remove color, phosphates and oil at low concentration. Some researchers reported that magnetic treatment affects water properties, such as light absorbance, pH, zeta potential and surface tension (Holysz *et al., 2002*; Chibowski *et al., 2003*; Cho and Lee, 2005). Physics shows that water changes weight under the influence of magnetic fields. More hydroxyl (OH-) ions are created to form alkaline molecules, and reduce acidity. Increasing both the electric conductivity and the dielectric constant of water was documented (Ibrahim, 2006). In literature, the magnetic technology has been investigated in the agriculture with major emphasis on plant fields, but little attention has been given to the animal and poultry sector (Hozayn and Abdul Qados, 2010). Water is needed for every biological reaction and for transportation of every compound, cellular integrity and body temperature regulation, etc. Birds generally drink water approximately twice as much as the amount of feed consumed on a weight basis and low quality water has been shown to influence animal performance and to increase health threat (Marai *et al.*, 2005; Attia *et al.*, 2013). Moreover, recent evidences indicated that magnetic treatment of water may offer a possible solution to improve water quality (Verma, 2011). This increases the fluidity, dissolving capability for various constituents like minerals and vitamins (Mikesell, 1985) and consequently improves the biological activity of solutions affecting positively the performance of human, animal and plants (Goldsworthy *et al.*, 1999). It was observed that magnetized water helps in dissolving minerals and acids by a higher rate than unmagnetized water, in addition to dissolving oxygen and increasing the speed of chemical reactions (Moon and Chung, 2000). Moreover, Smirnov (2003) noticed that water can receive signals produced from magnetic forces that have a direct effect on living cells and their vital action. Hence, research is going on to use magnetic field in limiting microbial water pollution. A magnetic treatment changes mineral content of water, decreases lime deposition microbial load in the pipes and thus increases their permeability through biological membranes (Lam, 2001). Also, Verma (2011) reported that magnetized water stop the growth of bacteria and works as antibiotic, take care of pain, swelling and weakness and enhances overall general health. On the other hand, a contradictory results were reported by Sargolzehi *et al*. (2009) who showed that magnetic water did not positively affect animal performance, carcass composition, blood glucose, urea and Na, K, Mg and P in blood of lambs and goats. Abel (2002) pointed out that water pollution and its red color is caused by reproduction of microscopic living organisms in great rates. It was found that Ferro bacteria *(Clonothrix sp. and Creothrix sp.)* accumulates ferric hydroxide in their cells and their walls, causing some troubles in sewers including bad odor. It also forms adhesive substances which cause trouble in nutrient labs when water is used in production. Normal water has a pH level of about 7, whereas magnetized water can reach pH up to 9.2 following the exposure to 7000 (Gauss) strength magnet for a long period of time (Lam, 2001). It may be concluded that, the applied magnetic field may affect the formation of hydrogen bonds of water molecule and that may lead to conformation changes. These changes may be the reason for the observed variations in both conductivity and dielectric content (Ibrahim, 2006).

Thus, this study aims to evaluate the effects of magnetic treatment of tap water by two levels on productive performance of rabbits, digestibility, carcass characteristics, blood phyasiology, haematological parameters, liver and Kidney functions, antimicrobial activity and growth performance of growing rabbits.

MATERIALS AND METHODS

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture during the period from March to May 2015.

Experimental rabbits and diets:

Forty eight weaned black Balady rabbits (both sexes at 6 weeks of age and 725.00 to756.25 ±23.93 g LBW) were used in a randomized complete block design of three treatments during feeding period from 6 to 14 weeks of age. Rabbits in all groups were fed commercial pelleted diet and subjected to tap and magnetic water as drinking water for 30 days before starting the experiment. Rabbits were housed in separate cages, where they were divided into three groups (16rabbits each). Magnetic treated water (MTW) was prepared by passing water through a magnetic funnel 12 at relatively low speed. According to the product specification, water will keep its magnetic properties for the next 12 hour of exposure to the funnel. So, water was supplied to the animal's cages each 10 hours to ensure using magnetic treated drinking water. Funnel's magnetic field consists of seven pairs of successive magnets. Each magnet had a circle shape with a diameter and thickness of 7.22 and 4.96 mm, respectively. The strength of the magnet was between 1200 to 3600 (Gauss) as measured by a (Gauss) meter (Mega Dev, Inc). Sample preparation attention was paid to avoid contamination, therefore every item from the moment of sampling until analysis was regarded as potential source of contamination and was checked not to contain or leach detectable amount of any contaminant. The experimental feeding period lasted 6 weeks up to 14 weeks of age, where group (G) was drinking tap water (un-MTW) as control, while the second and third groups were drinking MTW at the strength of 1200 Gauss (G1) and 3600 Gauss (G2), respectively. The experimental diet was formulated to be iso-nitrogenous (~17% CP) and iso-caloric (~2500 kcal DE/kg diet). Diet is in pellets to satisfy the nutrients requirements of growing rabbits according to Agriculture Ministry Decree (1996). Ingredients and chemical composition of the experimental diet is presented in Table (1).

Table (1): Composition and calculated analysis of the experimental diet (as fed)

Item	experimental diet
Ingredients (%):	
Clover hay (12%CP)	30.00
Barley	17.00
Yellow corn	10.00
Soybean meal (44%CP)	17.00
Wheat bran	20.00
Molasses	3.50
DL-Methionine	0.10
Vitamins & minerals mixture[1]	0.50
Salt	0.50
Limestone	1.05
Di-Calcium phosphate	0.35
Total	100
Calculated analysis[2]:	
Dry matter (DM), %	87.10
Crude protein (CP), %	17.08
Ether extract (EE), %	2.41
Nitrogen free extract (NFE), %	48.27
Ash, %	5.82
Digestible energy (DE), kcal/kg)[3]	2513
Crude fiber (CF), %	13.52
NDF,%	37.81
ADF,%	21.76
Hemicellulose, %	16.05
Calcium, %	1. 01
Total phosphorus, %	0.519
Methionine, %	0.36
Lysine, %	0.82
DE:CP	147.11

1- Supplied per Kg. of diet: 12000 IU Vit. A; 2200 IU D3; 10mg Vit.E; 2.0 mg Vit.K3; 1.0 mg Vit.B1; 4.0 mg Vit.B2; 1.5 mg Vit.B6; 0.0010mg Vit.B12; 6.7 mg Vit. Pantothenic acid;6.67 mg Vit. B5; 1.07mg Biotin; 1.67 mg Folic acid; 400 mg Choline chloride; 22.3 mg Zn;10 mg Mn; 25 mg Fe; 1.67 mg Cu; 0.25mg I; 0.033 mg Se and 133.4 mg Mg.l. 2- According to MOA (2001). 3-Calculated according to Cheeke (1987): DE (Kcal/g) = 4.36 – 0.0491 (%NDF). %NDF = 28.924 + 0.657 (%CF). %ADF = 9.432 + 0.912 (%CF). Hemicellulose = %NDF - % ADF.

Housing and management:

Rabbits were housed in galvanized wire cages (40 x 50 x 60 cm) and fresh and magnetized water was automatically available at all time. All rabbits were kept under the same managerial, hygienic and environmental conditions.

Experimental procedures:

Live body weight and feed intake were weekly recorded throughout the experimental feeding period. Then, daily weight gain, feed conversion ratio and economic efficiency were calculated.

Digestibility trials:

Digestibility trial was undertaken at the last week of the experimental period on three animals from each group. Rabbits were housed individually in metabolism cages. The experimental diet was offered daily and fresh un-MTW and MTW were provided all the time. Individual feed intake was accurately determined and feces were collected for 7 days as a collection period. Feces of each animal was mixed, dried at 60^{o}C for 24 hours, then representative samples were ground for chemical analysis. Chemical analysis of diets and feces were determined according to A.O.A.C. (1995).The feeding values as TDN, DCP and energy were calculated for the dietary treatments.

Caecum activity:

Cecal contents of slaughtered rabbits were taken for determing pH using Bechman pH meter, NH3-N concentration according to the method of A.O.A.C. (1995) and TVFAs concentration according to Warner (1964).

Blood sampling:

At the end of the experimental period, blood samples were collected from slaughtered rabbits (3 in each group) in two clean sterile tubes for each animal immediately after slaughtering. The 1st blood samples were let to coagulate and centrifuged at 3500 rpm for 15 minutes and then serum was separated and stored at -20°C till analysis, for concentrations of total proteins, albumin, glucose, total lipids, triglyceride, total cholesterol, high density lipoproteins (HDL). Concentration of globulin and low density lipoproteins (LDL) were obtained by difference. Also, activity of Aspartate (AST) and Alanine (ALT) aminotransferase were determined. All biochemical blood constituents were determined using spectrophotometer (Spectronic 21 DUSA) and commercial diagnostic kits (Combination, Pasteur Lap.). The 2nd blood samples were collected in heparinized tubes to obtain whole blood samples for determined haematological parameters including packed cell volume (PCV%) using microhaematocrit centrifuge at 4000 rpm for 15 min (Mitruka and Rawnsley, 1977), haemoglobin concentration using cyanomethemoglobin technique (Mitruka and Rawnsley, 1977). Red blood cells (RBCs) and white blood cells (WBCs) counts were immediately estimated per mm^3 from fresh blood using haematocytometer according to Mitruka and Rawnsley (1977).

Carcass traits:

At the end of the experiment, 3 rabbits were taken randomly from each group after they were fasted for18 hours before slaughtering, weighed and manually slaughtered. Weight of carcass plus head, kidneys, liver and heart was recorded according to Blasco *et al.* (1993).

Statistical analysis:

The experimental data were statistically analysis according to Sndecor and Cochran (1980) using SAS program (SAS, 1999). Difference among means between groups were determined using Duncan multiple range test (Duncan 1955).

RESULTS AND DISSCUSSION

Water Quality:

Data in Table (2) indicated that magnetic treated water (MTW) had better quality than those for tap water (TW) in conductivity, salinity, total hardness and both treated water types were improved due to magnetic field exposure. The magnetic exposure led to a higher effect on both MW levels than TW in respect of pH 7.68 and 7.97 vs. 7.53, respectively. The corresponding values for viscosity item were0.792 and 0.790 vs. 0.794 cst, with no marked differences among them. The respective values of salinity were 390 and 400 vs. 360Mg/L and for dissolved oxygen were 72.5 and 80.4 vs. 51.5 mg/L. Total count of bacteria was slightly decreased by magnetic treatment being 2.86, 2.83 and 2.80 CFU for G, G1 and G2 treatment respectively. These results are in harmony with those obtained by Yacout *et al.* (2015) who reported that there was an improvement in water quality when exposed to the magnetic field and the increase of salinity due to the magnetic exposure could be attributed to increasing soluble salts which concurred with the conductivity, while increasing dissolved oxygen could be due to the decrease in organic matter in magnetic water. Increasing both the electric conductivity and the dielectric constant of water was documented (Ibrahim, 2006). Some researchers reported that magnetic treatment affect water properties such as light absorbance, pH, surface tension Choand Lee (2005) and amount of oxygen dissolved in water (Harakawa *et al*., 2005). Normal water has a pH level of about 7, whereas magnetic water can reach pH to 9.2 following the exposure to 7000 (Gauss) strength magnet for a long period of time (Lam, 2001). Ibrahim, 2006concluded that the applied magnetic field may affect the formation of hydrogen bonds of water molecule and that may lead to conformation changes. These changes may be the reason for the observed variations in both conductivity and dielectric content. It was reported that water passed through the magnetic field acquires finer and more homogeneous structure (Tkachenko and Semyonova, 1995). This increasing fluidity, dissolving capacity of various constituents like minerals and vitamins (Kronenberg, 1985) and consequently improving the biological activity of solutions positively affecting the performance of human being, animal and plants (Al-Mufarrej *et al*., 2005).

Table (2): Physical properties and total count of bacteria of ordinary and magnetically treated water used in the experiment.

Item	Treatments		
	Tap water	1200 (Gauss)	3600 (Gauss)
Physical properties:			
pH	7.53	7.68	7.79
Electrical conductivity (µs/cm)	498	503	507
Oxygen content (mg/L)	51.50	72.50	80.40
Surface tension (Dyn/cm)	66.56	58.89	51.11
Chloride concentration (ppm)	61.24	52.12	41.22
Viscosity (cst)	0.794	0.792	0.790
Evaporating temperature (ppm)	0.750	0.720	0.700
Salinity Mg/L	360	390	400
Total count of bacteria (CFU)	2.86	2.83	2.80

Body weight changes for Rabbits:

Data of growing rabbits exposed to magnetic treated water are presented in Table (3). Average final live body weight and average daily weight gain of rabbits were increased insignificantly in G1 than those received G and G2.Similar results were reported by Al-Mufarrej *et al*. (2005) who concluded that the exposure of tap water to a magnetic field of approximately 500 (Gauss) reduced broiler water consumption, but did not significantly influence the performance of broiler chickens. In contrary these results are in disagreement with those obtained by (El-Hanoun *et al.*, 2013) who showed that rabbits drank tap and well water which exposed to magnetic treatment at 4000 Gauss was increased (P≤0.05) significantly body weight gain during 6-12 weeks of age. Also, Gholizadeh *et al.*, (2008) emphasized that chickens consuming magnetically treated water having heavier growth than nonmagnetic by 200g and also higher meat fat ratio, livability and production efficiency. An enhancement in the growth for calves and sheep and a reduction in carcass fat in sheep were demonstrated due to magnetizing of water (Bergsrud and Linn, 1990).

Table (3): Growth performance as affected by magnetic water for growing rabbits.

Item	G(Control)	G1	G2	±SE
Live body weight (g/h):				
Initial LBW	725.00	710.00	756.25	±23.93
Final LBW	1632.19	1659.38	1624.06	±40.28
Average daily gain (g/h):	907.19	949.38	867.81	±32.56
Average feed intake (g):	4032.19	4019.69	4044.38	±13.17
Feed conversion ratio (g feed/g gain):	4.44^{ab}	4.23^{b}	4.66^{a}	±0.153

a and b : means in the same row with different superscripts are significantly (P ≤ 0.05) different.

G =group fed the basal diet (control), G1 = group fed the basal diet with magnetic water (1200 gauss) and G2 = group fed the basal diet with magnetic water (3600 gauss).

***Feed intake and feed conversion*:**

Feed intake and feed conversion ratio data of rabbits of control and two drank magnetic treated water levels are presented in Table (3). No significant differences among treatments in average feed intake as DM. These results are in disagreement with those obtained by Yacout *et al.* (2015) who showed that higher feed intake was recorded for bucks consumed magnetic water at 3600 Gauss, while insignificantly different (P> 0.05) between the control and 1200 Gauss. Feed conversion of G1 was improved (0<0.05) significantly compared with that obtained by G2 group, but insignificantly compared with G (control) one. While, (El-Hanoun *et al*., 2013) showed that rabbits drank both types of water (tap and well water) exposed to magnetic treatment at 4000 Gauss increased (P≤0.05) significantly body weight gain for growing rabbits during 6-12 week of age, but feed intake decreased, and feed conversion ratio was significantly improved. Also, Patterson and Walker (1979) showed that magnetic treatment of water tended to reduce food intake, However, Rodriguez *et al*. (2003) showed positive impact of magnetic exposure on weight gain and feed utilization of rabbit bucks.

***Digestibility and Feeding Values*:**

Results in Table (4) indicated that no significant effect due to experimental treatments was noticed for digestion coefficients and nutritive values of all nutrients. These results are different with those reported by levy *et al*. (1992) who reported that digestibility of dry matter tended to increase and metabolizable energy

Table (4): Digestion coefficients and feeding values as affected by magnetic water for growing rabbits

Treatment	Digestibility %						Feeding values^{K} %	
	DM	OM	CP	CF	EE	NFE	TDN	DCP
G	66.07	69.56	62.73	29.27	78.50	82.00	64.65	11.80
G1	67.28	69.77	63.70	31.52	79.35	81.37	64.86	11.98
G2	66.86	68.79	62.44	31.70	77.95	80.21	63.94	11.74

Differences among treatments were not significant.

G =group fed the basal diet (control), G1 = group fed the basal diet with magnetic water (1200 gauss) and G2 = group fed the basal diet with magnetic water (3600 gauss) was converting more efficiently to gain with magnetic drinking water. Also, these results are disagreed with the results of the study done by Yacout *et al.* (2015) who showed that the highest values of digestibility coefficients were recorded with the two groups used magnetic water (1200 and 3600 Gauss) than that of control one, and the magnetic water increased (0<0.05) significantly the feeding values in group received 3600 Gauss than the other groups for zaraibi bucks. Moreover, Qiu-jiang *et al.* (2008) found that sheep consumed magnetic water significantly increased DM intake and the apparent digestibility of OM, CP and cellulose by 17.3%, 4.4%, 5.0% and 4.8%, respectively.

Carcass characteristics:

Fasting weight and carcass characteristics data of growing black balady rabbits of experimental treatments are presented in Table (5). Dressing% and spleen weight were (0<0.05) significantly higher with G2 than those of G (control), but G1 was not significantly different with both G or G2 treatments. It was noticed that rabbits drank MTW byG1 had significantly higher weights of head and fats than those received unexposed magnetic water, but no significant with those on G2. Similar results were reported by Patterson and Walker (1979) who reported that magnetic treatment of water increase both the depth of subcutaneous fat and the concentration of chemical lipid in the carcass. Weight of lungs were significantly (0<0.05) higher with G1 drank magnetic water than the other treatments. There were not significant differences among treatments respecting weights of Heart, Liver and kidneys. Also there were no significant differences among treatments regarding weights of fur, stomach, small intestine, large intestine. These results are similar to those reported by Al-Mufarrej *et al.* (2005) who concluded that the exposure of tap water to a magnetic field of approximately 500 Gauss did not significantly influence carcass composition of broiler chickens. These results are disagreed with the results of the study done by (Bergsrud and Linn, 1990) who revealed an enhancement in the calves and sheep growth and a reduction in carcass fat in sheep due to magnetizing water. Patterson and Walker (1979) showed that magnetic treatment of water tended to reduce food intake, depress the rate of carcass gain and give less efficient conversion of food to carcass gain. In addition, magnetic treatment increase both the depth of subcutaneous fat and the concentration of chemical lipid in the carcass.

Table (5): Carcass traits as affected by magnetic water for growing black baldy rabbits.

Item	G (control)	G1	G2	±SE
Fasting wt. (g)	1748.3	2000.0	1780.0	±108.1
Empty carcass wt. (g)	843.3	1001.7	906.7	±54.3
Head wt. (g)	110.00^{b}	128.33^{a}	126.67^{ab}	±4.90
Heart wt. (g)	5.07	7.27	8.13	±0.862
Liver wt. (g)	68.70	83.60	65.00	±9.40
kidneys wt. (g)	11.57	12.67	11.83	±0.628
Total edible parts wt. (g)	1038.67	1233.53	1118.30	±60.73
(Dressing %)	59.41^{b}	61.79^{ab}	62.82^{a}	±0.707
Fats wt. (g)	9.60^{b}	15.57^{a}	13.90^{ab}	±1.64
Lungs wt. (g)	9.67^{b}	14.43^{a}	10.43^{b}	±1.02
Spleen wt. (g)	1.00^{b}	1.53^{ab}	2.20^{a}	±0.216
Fur wt. (g)	316.67	345.00	283.33	±25.03
Stomach wt. (g)	109.17	120.07	100.63	±16.61
Small intestine wt. (g)	48.00	51.63	45.70	±4.69
Large intestine wt. (g)	27.73	31.70	30.57	±2.74

a and b: means on the same row with different superscripts are significantly ($P \leq 0.05$) different.
Edible giblets wt. = Liver wt. + Kidneys wt. + Heart wt.
Total edible parts wt. = Empty carcass wt. (with head) + Edible giblets wt.
*Dressing % = Total edible parts wt. / Fasting wt. *100*
G =group fed the basal diet (control), G1 = group fed the basal diet with magnetic water (1200 gauss) and G2 = group fed the basal diet with magnetic water (3600 gauss).

Blood Parameters:

Blood serum parameters could be used as an indicators for nutritional and physiological status of experimental dietary treatments with normal or magnetic tap water as shown by data which are presented in (Table 6). The differences in concentrations of total protein, albumin and globulin among groups were not significant. These results are disagreed with those obtained by Khalisa and Ali (2012) who showed that total serum protein concentration was higher significantly in magnetized water comparing to control.

Also, (Araibi and Dagher, 2014) found that using magnetic water at the levels of 1500 Gauss with broiler caused an increase ($P<0.05$) significantly total protein and albumin, but significant ($P<0.05$) decrease in globulin compared with those on unmagnetic water (control), well water and 750 Gauss-treated water.

Blood glucose concentration in rabbits received MTW (G1) was increased ($0<0.05$) significantly compared with those received G or G2 ones, despite all values are in the normal range. These results are in agreement with those obtained by Yacout *et al.* (2015) who found that using magnetic water at the levels of 1200 and 3600 Gauss caused a significant ($P<0.05$) increase in blood glucose concentration compared with does that drank unmagnetic water. On the other hand, the present results are disagreed with those done by Sargolzehi *et al*. (2009) who showed that when lactating Saanen goats consuming magnetic water at 1200 and 3600 Gauss did not affect blood glucose concentration significantly.

Concerning transaminase enzymes, the differences in activity of AST was not significant among the experimental treatments. Mean while, the activity of ALT was decreased ($0<0.05$) significantly for rabbits received G2 than that received G one, while no significant difference was observed with those received G1. These results are in agreement with those obtained by Yacout *et al*. (2015) who showed that magnetic water had a significant ($P<0.05$) decrease in ALT than unmagnetic water. So, these parameters showing improved liver function due to magnetic treatment. Also, Araibi and Dagher (2014) found that using magnetic water for broilers chickens at 1500 Gauss caused significant decrease ($P<0.05$) in GPT compared with those drank unmagnetic water (control), well water and 750 Gauss-treated water. While, El-Hanoun *et al*. (2013) mentioned that magnetized tap and well water at 4000 Gauss was decreased ($P\leq0.05$) significantly liver enzyme (ALT) compared to those for unexposed water.

Table (6): Blood parameters as affected by magnetic water for growing black baldy rabbits.

Item	G (control)	G1	G2	±SE
Total protein (g/dl)	8.77	8.27	8.32	±0.181
Albumin (g/dl)	3.72	3.97	3.77	±0.143
Globulin (g/dl)	5.05	4.30	4.55	±0.247
A/G ratio (g/dl)	0.745	0.934	0.833	±0.067
Glucose (g/dl)	51.12^{c}	88.49^{a}	71.45^{b}	±4.01
AST	0.840	0.845	0.746	±0.034
ALT	0.352^{a}	0.232^{ab}	0.202^{b}	±0.041
Createnine	0.713	0.867	0.820	±0.071
Urea	3.04	2.85	2.98	±0.276
Total lipids	187.70	193.60	155.34	±56.85
Cholesterol (mg/dl)	154.90	151.37	153.33	±4.95
Triglyceride	113.12	112.90	110.40	±23.66
HDL	104.84	88.68	90.72	±6.12
LDL	50.06	62.69	62.62	±6.81

a, b and c: means on the same row with different superscripts are significantly ($P \leq 0.05$) different.

G =group fed the basal diet (control), G1 = group fed the basal diet with magnetic water (1200 gauss) and G2 = group fed the basal diet with magnetic water (3600 gauss)

Also, the present results revealed that concentrations of createnine and urea were not significant influenced by magnetic water exposure. These results are in agreement with those obtained by Sargolzehi *et al*. (2009) who showed that when lactating Saanen goats consuming magnetic water at 1200 and 3600 Gauss did not affect blood urea concentration and blood ions (Na, K, Mg) significantly. Otherwise, (El-Hanoun *et al.,* 2013) showed that the magnetized tap and well water at 4000 Gauss was decreased ($P \leq 0.05$) significantly plasma urea concentration, but increased plasma creatinine compared to those for unmagnetized water. The results of present study showed that the other blood metabolites like cholesterol and LDL concentrations didn't influenced by the two levels of magnetic water. In accordance with the present results Khalisa and Ali (2012) reported that no significant differences of adult male rabbits ($P>0.05$) respecting serums total cholesterol (TC) and low density lipoprotein-cholesterol (LDL-c) concentrations were observed among control and magnetized group along the experimental period. Similarly, the present results of triglyceride, high density lipoprotein (HDL) and total lipids concentrations didn't influenced by magnetic water. While, Khalisa and Ali (2012) reported that the values of serum triglyceride concentrations tended to decrease significantly ($P<0.05$) and serum high density lipoprotein–cholesterol (HDL-C) concentration tended to increase significantly following exposure to magnetic water for 60 days of the experiment based on control group. The mechanisms of the effect of electromagnetic field which affect water quality after exposure to magnetic funnel on lipid metabolism have not been well understand yet. However, the antioxidant activity of magnetic water was claimed to be responsible for its hypolipidemic effect. Single exposure to electromagnetic field (EMF) increase the serum values of HDL-c and decreased total cholesterol concentration of rat liver (Torres-Duran *et al*. 2007). On the other hand, a beneficial effect of EMF was also reported in diet induced hypercholesterolemic rabbit, where pulse of EMF lowered total cholesterol and triglyceride level (Luo *et al*., 2004). It can be concluded that intensity and duration of exposure water to magnetic field had an effective role in the formation of free radicals (FRs) and behavior of its antioxidant activity (Canseven *et al*., 2008).

Haematological Parameters:

Hematological parameters data (Table 7) revealed no significant differences ($P>0.05$) among experimental treatments in concentrations of red blood cells count (RBC's), hemoglobin (Hb), haematocrit (Hct), packed cell volume (PCV) and white blood cells count (WBC's). These findings are in agreement with those reported by (Aziz *et al*., 2013) at some different periods of their study. While these result are opposite to those recorded by (Araibi and Dagher, 2014) who showed that there are significantly increases in physiological traits (RBC, WBC, Hb, P.C.V) for broilers which consumed magnetic treated water with 1500 Gauss compared with those of unmagnetic water (control) and 750 Gauss-treated water. Also, data in present study revealed that, there was no significant differences among experimental treatments in concentrations of Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC). These findings are in agreement with those reported by (Aziz *et al.*, 2013) who showed that there were no significant differences ($P>0.05$) for (MCV), (MCH) and (MCHC) among groups received magnetic water with intensity 500, 1000 and 2000 Gauss compared with those received control one in most periods. Regarding the types of white blood cells (Leukocytes), results of rabbits exposure to MTW at the level of G1 showed that Neurtophils value was increased ($0<0.05$) significantly compared with those of unexposed one, while, the value of G2 was not different significantly with G group. Lymphocyte value was lower ($P<0.05$) significantly with G1than control, while the value of G2 was insignificant lower than control (G). While mesophils percent was significant higher with G2 and insignificant higher with G1, in comparison with that of control (G). While (Aziz *et al.*, 2013) observed that heterophil to lymphocyte ratio was decreased ($P<0.05$) significantly in group received magnetic water with intensity (2000 G) in first period of the experiment. Finally eosinophil value did not affected by experimental treatments. Hussen (2002) reported that magnetic water lead to an increase of blood flow and supply of oxygen and nutrients to the cells.

Table (7): Haematologicalparametes as affected by magnetic water for growing rabbits.

Item	G (control)	G1	G2	±SE
Red blood cells (RBCs) × 10^6 /ul	5.87	5.82	5.79	±0.051
Haemoglobin (Hb), mg/dl	11.57	11.60	11.25	±0.097
Haematocrit (Hct), %	34.25	34.10	33.50	±0.539
Packed cells volum (PCV),%	34.07	34.03	33.50	±0.551
Mean Corpuscular Volume (MCV), %	58.25	58.60	58.00	±0.937
Mean Corpuscular Hemoglobin (MCH),%	19.70	19.90	19.45	±0.186
Mean Corpuscular Hemoglobin Concentration (MCHC),%	33.90	33.95	33.55	±0.347
White blood cells (WBCs) × 10^6 /ul	13.07	10.97	11.60	±2.10
Nutrophil (N), %	29.67^b	36.50^a	35.00^{ab}	±1.75
Lymphocytes (L), %	65.33^a	47.50^b	58.00^{ab}	±3.56
Mesophils (M), %	2.33^b	4.00^{ab}	4.50^a	±0.535
Eosinophils(E), %	2.67	2.00	2.50	±0.630

a and b: means on the same row with different superscripts are significantly (P ≤ 0. 05) different.

G =group fed the basal diet (control), G1 = group fed the basal diet with magnetic water (1200 gauss) and G2 = group fed the basal diet with magnetic water (3600 gauss)

Antimicrobial activity:

Cecaum activity:

Cecal activity in terms of pH value, concentration of TVFAs and NH_3-N of rabbits in the different groups is presented in Table (8). Cecal pH value and Ammonia (NH3-N) were not significantly different among rabbits groups. While the concentration of TVFAs was lower (P<0.05) significantly with G1 and insignificantly with G2 than that of control one. These results are disagreed with those recorded by Yacout *et al.* (2015) who found that goats consumed ordinary tap water was significant higher in NH3-N value and lower in TVFA's concentrations than those consumed magnetic water. While, Al-Hafez *et al.* (2013) illustrated that sheep consumed magnetic water at the level of 1400 Gauss significantly decreases ruminal pH with non significant effect in ammonia concentration due to such treatment.

Table (8): Caecum activity and cecum microbial counts as affected by magnetic water for growing rabbits.

Item	G (control)	G1	G2	±SE
Cecum activity:				
Cecum pH value	6.53	6.67	6.43	±0.152
Ammonia (mq/dl)	189.00	218.40	208.60	±13.60
TVFAs (mq/dl)	2.80^a	2.20^b	2.60^a	±0.115
Cecum wt. (g)	88.07	87.20	80.40	±9.94
Cecum length	44.67	72.67	41.67	±10.19
Caecum microbes:				
Anaerobic count	$1.3^b \times 10^5$	$8.0^c \times 10^3$	$1.8^a \times 10^6$	±0.335
E. Coli	$1.8^a \times 10^2$	$1.7^b \times 10$	$1.4^b \times 10$	±3.36
Lactobacillus	$7.5^c \times 10$	$1.5^b \times 10^2$	$2.1^a \times 10^2$	±5.77

a and b: means on the same row with different superscripts are significantly (P ≤ 0. 05) different.
G =group fed the basal diet (control), G1 = group fed the basal diet with magnetic water (1200 gauss) and G2 = group fed the basal diet with magnetic water (3600 gauss)

The results of this study (Table 8) showed strong antimicrobial activity due to water exposure to magnetic field (MF) on Gram-negative germs (*E.coli*) and Gram- positive germs (*Lactobacillus*). It well known that *E. coli* is a type of bacteria that lives in intestine of human and animals. Although most types of *E. coli* are harmless, some types can make health problems and among many strains of *E. coli*, only a few have induce diarrhea. One group of *E. coli* produces a powerful toxin that damages the lining of the small intestine which can cause bloody diarrhea.

Groups of both magnetic water levels (G1 and G2) had significant lower (P<0.05) *E. Coli* count and higher (P<0.05*) Lactobacillus* count than those consumed tap water. While, the lowest (P<0.05) anaerobic count was observed in group drank G1 than the other groups. While, Yacout *et al.* (2015) found that the highest number (P<0.01) of total bacteria was recorded with 3600 G followed by 1200 G compared with control group. El-Sayed *et al*. (2006) discovered that, when *E. coli* is subjected to a magnetic field (50 hertz) and electromagnetic waves (2 µT) for different times, it caused a great inhibition in the growth of bacteria after 6 h and became more sensitive to antibiotics with an effects on their morphological characters which are represented in the decrease in the length of bacterial cell. However, the results were being the opposite after 16 h, accompanied by a decrease in cellular thickening and disappearance in most elements from the cytoplasm. Additionally, Pengfei *et al*. (2007) found that inhibition in the growth and concentration of *Pseudomonas aeruginosa* bacteria by using wireless magneto-elastic, which facilities the sterilization process specially in canned food. Verma (2011) reported that magnetized water stop the growth of bacteria and works as an antibiotic, take care of pain, swelling and weakness and enhances overall general health. The highest numbers of heterotrophic bacteria were recorded with the least magnetic intensity (130µT), while, the bacterial numbers were decreased proportionally by the increase in the magnetic force intensity (390 µT) for both static and shaking cases. This is due to the effect of a magnet on the metals in treated water, especially organic substances, nitrogen and phosphorus which are essential in the reactions of bacterial metabolism. Furthermore, water forms 80% of bacterial cells, so when its physical and chemical properties were changed by magnetic force, the growth of bacterial cells was inhibited as their composition changed Molouk and Saddiq (2010). This is in accordance with Strasak *et al.* (2002) who revealed that the ability of bacteria to form colonies decrease with increasing magnetic field intensity and with increasing time of exposure. The decrease in oxidoreductive activity and ability to form colonies were compared with the assumption that, the effect of magnetic field is probably bactericidal.

CONCLUSION

In conclusion, exposing drinking water to a magnetic field could be considerable a good practice for improve productive performance, function of liver, renal function of rabbits. This treatment may be used as a useful management practice in the area where rabbit farms depends on well water as a source of drinking water.

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تأثير استخدام الماء المعالج مغناطيسياً على أداء الأرانب

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أجريت هذه التجربة بهدف دراسة تأثير استخدام ماء الشرب المعالج بالمجال المغناطيسى بقوة 1200جاوس و 3600 جاوس مع الأرانب على معاملات الهضم و القيمة الغذائية وكذلك تأثير ذلك على نمو الأرانب وتأثيره على خصائص الدم والذبيحة وكذلك التأثيرعلى النشاط الميكروبى من خلال الفحص الميكروبى لأعور الأرانب.

تم توزيع عدد 48 ارنب نامى بلدى أسود عمر 6 أسابيع على ثلاثة مجاميع عشوائيا متماثلة بكل منها (16 أرنب) فى تجربة اشتملت على تقديم ماء الصنبور غير معرض (كنترول) أو معرض لمجال مغناطيسي بقوة 1200 و 3600 جاوس و غذيت المجموعات كلها على عليقة أساسية موحدة تفى بالاحتياجات الغذائية.

أوضحت النتائج أن معاملات مياه الشرب بالمجال المغناطيسى بقوة 1200 و 3600 جاوس بالمقارنة مع ماء الصنبور (الكنترول), بانها أحدثت تأثيرا واضحا على مياه الصنبور من حيث درجة الحموضة, القدرة على التوصيل, الملوحة, العسر الكلى والاكسجين المذاب.

وسجلت نتائج أوزان الارانب انه يميل للزيادة مع المعاملة التجريبية 1200جاوس مقارنة مع مجموعات الكنترول و 3600 جاوس مع عدم وجود فروق معنوية بين المعاملات التجريبية عند 14 أسبوع.

كما أوضحت النتائج وجود فروق معنوية في التحويل الغذائي بين المعاملات التجريبية و الكنترول وأن أفضل (0.05>0)الكفاءات التحويلية كانت مع المجموعة التجريبية 1200جاوس مقارنة بمعاملة الكنترول أو المعاملة المختبرة الأخرى (3600 جاوس).

أوضحت النتائج أنه لم يكن هناك اختلافات (0.05>0) معنوية فى قيم معاملات هضم المواد الغذائية والقيمة الغذائية بادخال المعاملات التجريبية المختبرة.

أظهرت النتائج أن هناك زيادة (0.05>0) معنوية لل(Dressing %) فى المعاملة التجريبية 3600 جاوس بالمقارنة مع الكنترول, لكن لاتوجد فروق معنوية مع ال 1200 جاوس. كما سجلت النتائج أنه لاتوجد فروق معنوية لأوزان القلب والكبد و الكليتين بين الكنترول والمعاملات المختبرة.

سجلت النتائج أنه لاتوجد فروق معنوية فى معظم الخصائص الفسيولوجية للدم بين المعاملات التجريبية المختلفة. وأوضحت النتائج أيضا أن هناك زيادة (0.05>0) معنوية فى تركيز جلوكوز الدم مع قوة 1200جاوس مقارنة بالكنترول وفى نفس الوقت وجد هناك انخفاض (0.05>0) معنوى لل ALT مع قوة 3600جاوس مقارنة مع المجموعتين الأخريين.

أوضحت النتائج انه لاتوجد هناك فروق معنوية فى قيم كرات الدم الحمراء و الهيموجلوبين (Hb) و الهيماتوكريت (Hct) وال%PCVوكرات الدم البيضاء بين المعاملات التجريبية.

أوضحت النتائج أن ادخال المعاملات التجريبية المختبرة بقوة 1200 و 3600جاوس أدى الى انخفاض بكتيريا *E.coli*وزيادة بكتيريا اللاكتوباسيلاس مقارنة بالكنترول.

نخلص من هذه النتائج أنه يمكن استنتاج أنه يمكن استخدام المجال المغناطيسى بقوة 1200جاوس فى مياه الشرب لتحقيقها افضل النتائج على أداءالأرانب النامية.