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Effect of Magnetic Water on Semen Quality, Blood Constituents, Antioxidant Capacity and Immunity of Rabbit Bucks

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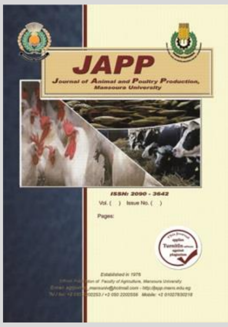

ABSTRACT

This study sought to evaluate the effects of receiving magnetized water on reproductive performance, blood constituents, antioxidant capacity and immunity of rabbit bucks. Sexually mature NZW bucks were (n=30) were allotted into 3 groups (10/group). Bucks in the first group received natural drinking water (NW, G1), while bucks in the second and third groups were received magnetic water (MW, 1500 and 3000 Gauss) for 30 days pre-semen collection, respectively. Semen was collected twice/week for 2 months. Reaction time (RT), and blood constituents, testosterone, antioxidants and immunity status were determined at the last collection week. Semen was evaluated and sperm outputs/ejaculate were calculated. Results showed the RT reduced ($P<0.05$) and testosterone increased ($P<0.05$) in MW groups. Red blood cells and packed cell volume, percentage of neutrophils and eosinophils, total proteins, albumin, globulin, high density lipoproteins, total antioxidant capacity and antibody titer increased, while white blood cells and percentages of lymphocytes, monocytes and acidophils, urea, creatinine, total lipids, triglycerides, total cholesterol, low density lipoproteins, malondialdehyde and lysozyme decreased ($P<0.05$) in MW groups. Treatment of MW improved ($P<0.05$) semen quality, litter size at birth and at weaning, bunny and litter weights at birth and at weaning. In conclusion, magnetizing water with 1500 Gauss for drinking rabbit bucks (30 days pre-semen collection) lead to significant improvement in water characteristics and antioxidant capacity, immunity, semen quality and fertility of rabbit bucks.

Keywords: Rabbit bucks, magnetized water, semen quality, immunity, fertility.

INTRODUCTION

Artificial insemination (AI) has a possibility for greatly improvement of the genetic structure of breeding animals (Januskauskas and Zilinskas, 2002). The AI can be defined as the deliberate action of introducing sperm into the female's reproductive tract to achieve pregnancy for animal breeding (Obasi *et al*., 2016). Successful outcome of AI is depends on a number of factors including animal management (Thomas, 2009) and improved the storage technique of domestic animal semen (Roca *et al*., 2006). This is high practical importance for breeding programs in domestic animals and the technique is also used to maintain the genetic diversity and establishment of gene-banks (Jalme *et al*., 2003). The mammalian sperm include high levels polyunsaturated fatty acids and is immensely weak to oxidative stress which is made of reactive oxygen species (ROS) (Cassani *et al*., 2005). Also, it has been speculated that ROS influence sperm physiology (Sanocka and Kurpisz, 2004).

Among the important factors of animal management, availability of potable water (Haugana *et al*., 2005; Chiba, 2009) is essential to fluid and nutrient transport into the blood vessels, maintaining the integrity of the cells and regulation of animal temperature (Attia *et al*., 2013). In some areas, underground water is used for drinking, whereas poor water quality is available, which presents main challenge in poultry production (Attia *et al*., 2015). There are several factors affecting the determination of the suitability of water sources in poultry production, including types of dissolved salts, salinity, and nitrate contents (Morsy *et al*., 2012). Furthermore, containing water inorganic ions of calcium, magnesium, sodium, chloride, sulfur, and carbonate may reflect poor quality of water (Kellems and Church, 2002).

Magnetized water (MW) is water that has been passed through a magnetic field. It shows increased permeability into cells and electron-donating characteristics (El-Speiy *et al*., 2017). Water exposed to magnetic field resulted in remarkable change in water properties, in term of increasing pH value, total dissolved O_2 and solids, total hardness, electric conductivity, salinity, evaporation temperature, elements, organic matter and bacterial count (Shaban and Azab, 2017). Natural water (NW) is characterized by pH value of 7. Exposing NW to seven thousands Gauss for a long time increased pH value up to 9.2, and water is characterized as magnetized water (MW) (Lam, 2001). The increase in water acidity may be attributed to creation of more hydroxyl ions from alkaline molecules. Increased dissolved O_2 may be in relation with reducing content of organic matter (Yacout *et al*., 2015). These properties of MW can protect the cellular membrane damage and removing ROS in mammalian cells (Lee and Park, 2015). Several reports indicated improvement of fluidity, minerals and vitamins dissolving capability, hormonal production, enzymes, semen quality, fertility rate (Al-Sabeea, 2008; Khudiar and Ali, 2012), blood parameters, immune response and antioxidant capacity of

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bucks (El-Ratel and Fouda, 2017) by consumption of MW as compared to NW. In comparing with other chemical and physical treatments, usage of MW is of significant interest to improve water quality with low cost (Yacout *et al*., 2015). Impact of MW is limited by strength of magnetic field (Gauss) or/and exposure time (El-Hanoun *et al*., 2017). Hence, this paper sought to study the effects of drinking MW for 30 days before semen collection, on reproductive performance, blood constituents, antioxidant status and immunity response of rabbit bucks.

MATERIALS AND METHODS

Animal and management:

Total of 30 sexually mature NZW rabbit bucks weighing 2556.20± 1.59 g and 5 months of age were taken from Rabbit Research Unit, Agricultural Researches and Experiments Station of Department of Poultry Production, Faculty of Agriculture, Mansoura University, for semen collection. Throughout the experimental period, bucks were housed in individually steel cages supplied with feeders and nipples. The managerial, healthy and environmental conditions were similar for all experimental bucks, but differed in type of drinking water (NW vs. MW). Feeding system was also similar for all bucks, being *ad. libitum* on the same basal pelleted diet (17.5% CP, 14.2% CF and 2700 Kcal/kg diet, as a digestible energy).

Experimental design:

Experimental bucks (n=30) were allotted into 3 groups (10 bucks in each group). Bucks in the first group (G1, control) were received NW. Bucks in the second and third groups were drinking MW following exposure to 1500 (G2) and 3000 (G3) Gauss for 30 days pre-semen collection, respectively.

Magnetic field with strength of 1500 or 3000 Gauss (Aqua Correct unit) was used for conditioning water (Magnetic water softeners and conditioners, Blue Goose Sales, 200S Duane Ct, Post Falls ID 83854, USA). The strength of the magnet at Application Laboratory was measured during the experimental period by a Gauss meter.

Semen collection and evaluation:

At the end of treatment period (30 d), semen was ejaculated (160 ejaculates) twice/week for eight weeks (semen collection period) by an artificial vagina. Semen ejaculated was transport to the laboratory in water bath (37°C), then semen was evaluated. Reaction time (RT) was recorded during semen collection (libido), defined as the time elapsed from introducing buck to complete ejaculation. Volume of each ejaculate (EV) was recorded after removing the gel mass, pH value was recorded by a pH paper. Mass (MSM, score 0-5, and percentages of progressive motility, live, abnormal and acrosome status, and concentration of sperm cells (SCC) were evaluated per ejaculate. Index of motility (MI), total sperm counts (TSC), motile sperm output (MSO) and normal sperm output (NSO), and total functional sperm output (TFSF) were calculated per ejaculate as the following:

MI = MSM (score) x progressive motility (%)

TSC/ejac. = EV (ml) x SCC (ml).

MSO/ejac. = TSC/ejac. x progressive motility (%).

NSO/ejac. = TSC/ejac. x abnormal sperm (%) – 100.

TFSF/ejac. = TSC/ ejac. x progressive motility x normality x livability.

Blood sampling:

At the last week of semen collection, samples of blood from ear vein of 5 buck in each group were taken into two test tubes of each buck. the first tube contained heparin as anticoagulant for estimating the hematological parameters including, hemoglobin (Hb) concentration, packed cell volume (PCV), number of red and white blood cells, and platelets, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) in the whole blood (Wintrobe, 1967). Leukocyte fraction, in terms of lymphocytes, monocytes, eosinophils and neutrophils percentages were estimated (Lucky, 1977). In the second test tube, blood was left to clot (2-3 h) without anticoagulant, then blood serum was isolated using centrifuge (3500 rpm for 15 min), then stored at -20 °C for until analyses. Concentrations of total proteins, albumin, glucose, urea, creatinine, total lipids, triglycerides, total cholesterol, high (HDL) and low (LDL) density lipoproteins were determined in blood serum using colorimetric enzymatic methods by commercial kits (Egyptian company for biotechnology, Obour City, industrial area, Cairo, Egypt). Total antioxidants capacity (Erel, 2004) and malondialdehyde (MDA, Conti *et al*., 1991) were assayed in the serum using commercially available kits (Bio-Diagnostic Research, Giza, Egypt). Serum testosterone level was assayed by radioimmunoassay using commercial kits (Immunotech, A Coulter Co., France) based on the information of manufacturer. However, globulin level was computed by subtracting albumin from total proteins levels. Haemagglutination (HA) test (Prescott *et al*., 1982) was used to measure the immuno-response. Rabbit bucks (5/group) were i.m. injected with 0.5 ml sheep red blood cells (T-dependent antigen), then the HA antibodies were investigated seven days later using HA test. Titers were measured as $\log_2$ values. Lysozyme activity was also determined (Schultz, 1987).

Fertility study

Twenty NZW nulliparous doe rabbits were naturally mated by bucks (5/group). On day 10-12 post-mating, pregnancy diagnosis was performed abdominally to calculate pregnancy rate (Number of pregnant does/number of mated does x 100). Two days pre-expected date of parturition, doe cages were provided with nest boxes. After parturition, kindling rate (KR) was calculated as the following: KR = (Number of kindled does/number of pregnant does) x 100. Total litter size at birth and live litter size after 12 h of kindling as well as litter size at weaning were recorded, and then viability rate of bunnies at birth and weaning was calculated. Bunnies were left with their dams during the suckling period and weaned on day 28 of age. Average bunny and litter weights at birth and at weaning were recorded.

Statistical analysis

Data were analyzed as a randomized design using the General Linear Model procedure of SAS (2000), according to the present model:

$$Y_{ij} = \mu + A_i + e_{ij}.$$

Where: Y_{ij} = observed values, μ = overall mean, A_i = effect of treatment (1….3) and e_{ij} = random error.

Before data analysis, all sperm characteristics percentages were transformed to arcsine values, then pre-transformed percentages were tabulated. Chi-Square test was used for analyzing the rates of pregnancy, kindling and viability. The treatment differences were set at P<0.05 using Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Water quality:

Data in Table (1) showed that following the physical analysis of MW properties**,** there was an increase in electrical conductivity, contents of dissolved O_2, salinity, contents of Na, K and Ca, and pH value as compared to NW. However, total hardness (TH), surface tension (ST), chloride, evaporating temperature and total bacterial count (TBC) were decreased in MW compared with NW.

Table 1. Characteristics of magnetic water.

Parameter	Tap water	Magnetic water 1500_Gauss	Magnetic water 3000 Gauss
Electrical conductivity (µs/cm)	510	560	572
Oxygen content (mg/l)	51.10	63.50	65.21
TH(mg/l)	420	418	412
ST (dyn/cm)	50.13	44.20	30.18
Salinity (mg/l)	380	391	399
Chloride (ppm)	3.52	3.32	2.90
Sodium (ppm)	6.32	7.10	7.50
Calcium (ppm)	110.00	124.10	125.14
Potassium (ppm)	1.3	1.60	1.75
Evaporating temperature (ppm)	0.70	0.65	0.61
Organic Matter (ppm)	50	42	40
TBC (cfu)	2.70	2.68	2.65
pH value	7.10	7.20	7.35

Recently, El-Hanoun *et al*. (2017) and El-Ratel and Fouda (2017) reported similar results to those obtained in our study. They indicated the obtained trend of change in MW as compared with NW. The salinity of MW may increase due to increased soluble salts which concurred with the conductivity, while level of dissolved O2 may increase by decreasing the organic matter (Yacout *et al*., 2015). During magnification, formation of hydrogen bonds was affected by magnetic field leading to increasing electric conductivity of MW (Ibrahim, 2006). Natural water (NW) is characterized by pH value of 7. The MW was characterized by finer and more homogeneous structure compared with NW (Tkachenko and Semyonova, 1995), leading to increase in fluidity, mineral and vitamin dissolving capacity (Kronenberg, 1985), and improve in solution biological activity (Al-Mufarrej *et al*., 2005). In case of drinking MW, flow of blood and O_2 and nutrient supply to the cells increased (Hussen, 2002). Further, water magnetization can eliminate the negative role of ROS and reducing DNA damage.

Libido:

Drinking MW by rabbit bucks significantly (P<0.05) decreased the reaction time (RT), while increased (P<0.05) testosterone concentration in serum of bucks in treated groups compared with those in control group (Fig. 1). The obtained RT values are within a range reported by some authors on rabbit bucks, (≤0.5 and 1 min, Hultsch *et al*., 2002) for good RT, which may indicate good libido either in G1 or G2 and G3. Accordingly, drinking MW may cause improvement in the sexual desire, as reported by Attia *et al*. (2015), who found marked reduction in RT to 19.30 s compared to 30.80 s in controls in association with elevating serum testosterone from 1.55 to 1.93) in rabbit bucks. Similar trend was reported in geese by El-Hanoun *et al*. (2017). Generally, the rise of testosterone concentration was reported to associate with decreased RT in rabbit bucks (Said *et al*., 2005). In this line, it was reported that MW improved sexual desire was attributed to parallel increase in the release of the reproductive hormones (Al-Nuemi *et al*., 2015), in particularly, testosterone (Kamel *et al*., 2009).

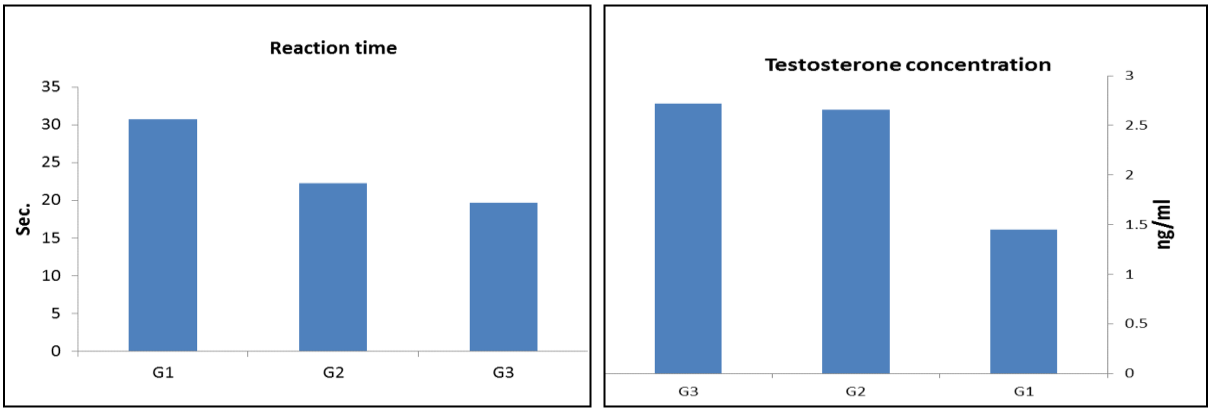

Fig. 1. libido parameters of NZW rabbit bucks as effected by magnetic water.

Hematological parameters:

Bucks drinking with MW increased (P<0.05) RBCs, PCV, neutrophils and acidophils. Both WBCs count and lymphocytes, monocytes and eosinophils percentages were lower (P<0.05) in MW than in NW group. The Hb concentration, platelets count, percentages erthrocytic values of MCV, MCH and MCHC were not affected significantly by MW (Table 2). The obtained increase (P<0.05) in RBCs in G2 and G3 is in relation with the rise (P≥0.05) in Hb and PCV value (P<0.05) of bucks both treatment groups compared with the control. Also, the observed WBCs (P<0.05) reduces was in consistent with reducing (P<0.05) lymphocytes, acidophils and increasing neutrophils percentages (Table 2). Similar results were reported for improved RBCs as affected by MW in rabbit bucks by Attia *et al*. (2015), in goats by Yacout *et al*. (2015) and in bulls by Al-Nuemi *et al*. (2015). The obtained elevation of RBCs via MW treatment may be in relation with increasing the production and transferring great number of RBCs, increased releasing RBCs within the blood vessels (Kulish, 2004; Shamsaldain and Al-Rawee, 2012).

Table 2. Hematological parameters and leucocyte fraction in blood of experimental rabbit bucks drinking magnetic water.

Parameter	G1 (Control)	Magnetic Water		P-Value
		G2 (1500 Gauss)	G3 (3000 Gauss)	
Haematological parameters				
Haemoglobin (mg/dl)	10.51±0.19	11.04± 0.31	11.11±0.30	0.2751
RBCs (x 10^6/mm^3)	5.28±0.07^b	5.72±0.06^a	5.78±0.05^a	0.0001
White blood cells (x 10^3/mm^3)	7.32±0.05^a	6.95±0.02^b	6.87±0.04^b	0.0001
Platelets (x 10^3/mm^3)	199.00±3.32	206.20±4.18	208.80±3.89	0.2113
Hematocrit (%)	40.20±1.77^b	47.40±1.60^a	46.80±1.28^a	0.0121
MCV (µ3)	73.80±1.53	72.80±2.78	72.40±2.50	0.9096
MCH (pg)	22.80±1.50	23.00±2.17	23.60±2.04	0.9544
MCHC (g/dL)	31.60±1.21	32.10±1.50	32.40±1.50	0.9218
Leucocyte fraction (%)				
Lymphocytes	44.80±2.08^a	38.40±0.93^b	39.80±0.80^b	0.0172
Monocytes	4.40±0.51^a	2.17±0.33^b	2.45±0.15^b	0.0018
Neutrophils	1.59± 0.03^b	2.02±0.02^a	1.99± 0.04^a	0.0001
Acidophils	47.02±2.19^b	55.66±0.75^a	53.99± 0.79^a	0.0023
Eosinophils	2.19±0.32^a	1.74±0.10^b	1.77±0.12^b	0.01518

Means denoted with different superscripts within the same row are significantly different at P<0.05.

Biochemical parameters:

Levels of total proteins and its fractions, and HDL increased (P<0.05) increase by MW treatment. However, levels of urea, creatinine, total lipids, triglycerides, total cholesterol and LDL decreased (P<0.05) by MW compared with NW. Meanwhile, the effect of MW on glucose concentration was not significant.

Rabbit bucks treated with MW (60 days) showed a significant increased total proteins and HDL, while a significant decrease in total cholesterol, triacylglycerol, LDL concentrations in blood serum (Atteyh, 2008; Khudiar and Ali, 2012). In goats, total protein, albumin and globulin increased (P<0.05), while cholesterol level decreased (P<0.05) by drinking MW compared with NW (Yacout *et al*., 2015). The observed rise in total proteins in blood as affected by MW may indicate maintaining the functions of body cells (Goodman and Blank, 2002; Schmidt *et al*., 2009).

The observed in blood metabolites as affected by MW may be due to enhancement of buck metabolism, solubility of minerals (Fe and/or Cu) reflecting increased RBCs and proper transport of nutrients to different body tissues, movement of blood within the arteries facilitating the transport of oxygen-bearing blood and nutrients to various body tissues (El-Kholy *et al*., 2008; Al-Daraji and Aziz, 2008).

Table 3. Serum biochemical concentration of experimental rabbit bucks drinking magnetic water.

Biochemical	G1 (Control)	Magnetic Water		P-Value
		G2 (1500 Gauss)	G3 (3000 Gauss)	
Total proteins (g/dl)	6.18± 0.03^b	6.80±0.02^a	6.81±0.03^a	0.0001
Albumin (g/dl)	3.39±0.01^b	3.52±0.03^a	3.53±0.02^a	0.0011
Globulin (g/dl)	2.79±0.03^b	3.28±0.04^a	3.28±0.04^a	0.0001
Glucose (mg/dl)	105.60±2.46	103.80±2.20	103.40±1.87	0.7570
Urea (mg/dl)	35.80±1.20^a	29.40±0.81^b	31.20±1.28^b	0.0046
Creatinine (mg/dl)	1.13± 0.02^a	0.94±0.03^b	0.97±0.02^b	0.0006
Total lipids (mg/dl)	238.20±1.28^a	196.40 ±2.73^b	196.20±1.88^b	0.0001
Triglycerides (mg/dl)	79.80±1.77^a	57.40±1.78^b	54.40±2.16^b	0.0001
Total cholesterol (mg/dl)	90.00±1.70^a	70.20±1.66^b	69.60±1.44^b	0.0001
Low density lipoproteins (mg/dl)	112.20±2.13^a	92.20±2.35^b	90.40± 3.56^b	0.0002
High density lipoproteins (mg/dl)	67.40±1.78^b	80.20±1.71^a	79.40 ±1.91^a	0.0004

Means denoted with different superscripts within the same row are significantly different at P<0.05.

Antioxidants capacity and immunity:

Serum TAC level and antibody titer were increased (P<0.05), while serum MDA and lysozyme content were decreased (P<0.05) in treated groups compared with control, reflecting higher antioxidants capacity and immunity for bucks drinking MW than control bucks (Table 4). Similarly, Attia *et al*. (2015) and El-Ratel and Fouda (2017) reported the beneficial effects of MW on capacity of antioxidant and immuno response of buck in treatment group. Also, Khudiar and Ali (2012) and Yacout *et al.* (2015) found that MW had significantly positive impact on antioxidants status of rabbits and goats, respectively.

Table 4. Oxidative capacity and immunity in blood serum of rabbit bucks drinking magnetic water.

Parameter	G1 (Control)	Magnetic Water		P-Value
		G2 (1500 Gauss)	G3 (3000 Gauss)	
Total antioxidants capacity (mmol/l)	0.56±0.01^b	0.70 ±0.01^a	0.68±0.02^a	0.0001
Malondialdehyde (nmol/ml)	16.40±1.21^a	11.40±1.08^b	13.80±0.73^b	0.0161
Antibody	5.14±0.08^b	6.33±0.05^a	6.28±0.05^a	0.0001
Lysozyme	84.80±1.98^a	69.80±1.28^b	70.20±1.74^b	0.0001

Means denoted with different superscripts within the same row are significantly different at P<0.05.

The effective role of MW on the antioxidant status was by decreased level of MDA, increased activity of superoxide dismutase in the heart, kidney and liver (Shah and Nagarajan., 2013; Hafizi *et al*., 2014), increased immunity (Yacout *et al*., 2015), and decreased the microbial capacity (Kronenberg, 1985).

Semen quality:

All semen parameters (ejaculate volume, mass sperm motility, individual motility, livability, motility index, concentration and TSC of spermatozoa) were significantly (P<0.05) higher in G2 and G3 than in G1. On the other hand, sperm abnormality and acrosomal damage of spermatozoa significantly (P<0.05) decreased. However, drinking MW groups increased total functional sperm fraction (TFSF) significantly (P<0.05) as compared to NW group. The effect of MW on semen pH value was not significantly (Table 5). Similar results were reported by El-Ratel and Fouda (2017) and Attia *et al*. (2015) in rabbit bucks, El-Hanoun *et al*. (2017) in male geese, and Shaban and Azab (2017) in human. In this study, MW treatment significantly (P<0.05) improved most characteristics of semen, being the best for bucks in G2, which may indicate beneficial effects of MW at 1500 than at 3000 Gauss.

In accordance with the present results, Attia *et al*. (2015) reported that drinking MW resulted in marked increase in testosterone level, enzymes of antioxidant, and immunity in addition to decreasing level of MDA and subsequently elimination of the harmful effects of pollutants and ROS. Also, increasing the testosterone concentration and enhanced semen characteristics are conjunction with enhancing in the immunity and antioxidant capacity of bucks drinking MW.

Generally, magnetization of water, that is vital for growth of different organs, facilitate its penetration through the cellular wall (Shaban and Azab, 2017), resulting in increase of mineral and vitamin dissolving capacity (Al-Mufarrej *et al*., 2005).

Table 5. Effect of magnetic water on semen quality parameters and sperm count in semen of rabbit bucks.

Parameter	G1 (Control)	Magnetic Water		P-Value
		G2 (1500 Gauss)	G3 (3000 Gauss)	
Semen characteristics:				
Ejaculate volume (ml)	0.69±0.01^{c}	0.80±0.01^{a}	0.77±0.01^{b}	0.0001
Mass motility (Score 1-5)	2.90±0.23^{b}	3.70± 0.15^{a}	3.30±0.15^{a}	0.0171
Individual sperm motility (%)	71.0±1.80^{b}	83.50±1.30^{a}	81.00±1.24^{a}	0.0001
Sperm livability (%)	74.50±1.57^{b}	85.00±1.83^{a}	82.00±1.58^{a}	0.0004
Sperm abnormality (%)	21.60±0.81^{a}	13.10±0.60^{b}	15.10 ±0.96^{b}	0.0001
Sperm normality (%)	78.40± 0.81^{b}	86.90± 0.60^{a}	84.90±0.69^{a}	0.0001
Motility index	205.0±16.16^{b}	308.00±11.30^{a}	268.00±14.70^{a}	0.0001
Acrosomal damage (%)	18.10±0.79^{a}	11.10± 0.50^{b}	13.40±0.56^{c}	0.0001
Sperm cell concentration (x10^{6}/ml)	353.40±2.67^{c}	401.00±2.87^{a}	389.60±1.85^{b}	0.0001
Semen pH value	7.17±0.02	7.09±0.05	7.13±0.02	0.2256
Sperm output (x10^{6}/ejaculate):				
Total	242.78±2.99^{c}	321.31±5.70^{a}	300.41±4.50^{b}	0.0001
Motile	172.60±5.68^{c}	268.62±7.49^{a}	243.30±4.94^{b}	0.0001
Normal	190.42±3.60^{c}	279.15±5.01^{a}	255.10±4.66^{b}	0.0001
TFSF	100.44±2.94^{c}	198.52± 7.60^{a}	169.28±4.53^{b}	0.0001

Means denoted with different superscripts within the same row are significantly different at P<0.05.

Fertility trail:

Reproductive performance of NZW does as affected by natural mating by bucks treated with MW (conception rate, total and live litter size at birth and at weaning, and bunny and litter weights at birth and at weaning) was significantly (P<0.05) increased compared with NW group (G1), but rate of kindling and viability (at birth and weaning) was not affected significantly (P ≥0.05) by MW (Table 6). These results indicated that enhancing semen characteristics of rabbit bucks administrated with MW as antioxidants are linking to increase reproductive performance of doe rabbits.

Table 6. Reproductive traits of doe rabbits after mating with experimental bucks.

Item	G1(Control)	Magnetic Water		P-Value
		G2 (1500 Gauss)	G3 (3000 Gauss)	
No. of mated does	20	20	20	-
Conception rate(%)	13/20 (65)	18/20 (90)	16/20(80)	-
Kindling rate (%)	10/13 (76.92)	16/18 (88.89)	13/16 (81.25)	-
Total litter size at birth/doe (n)	6.33± 0.50^{b}	8.25±0.35^{a}	7.70±0.40^{a}	0.0089
Live borns at birth/doe	5.11± 0.35^{b}	7.42± 0.40^{a}	6.70±0.39^{a}	0.0010
Viability rate at birth (%)	82.10	89.94	87.66	-
Litter size at weaning (n)	4.33± 0.29^{b}	6.83± 0.44^{a}	5.80± 0.53^{a}	0.0020
Viability rate at weaning (%)	86.30	91.80	85.46	-
Average bunny weight at birth (g)	55.33± 1.17^{b}	59.16±0.99^{a}	59.10±0.95^{a}	0.0261
Average bunny weight at weaning (g)	423.33±1.42^{b}	442.75±0.99^{a}	442.70± 1.56^{a}	0.0001
Litter weight at birth (g)	282.67±20.08^{b}	436.42±20.06^{a}	396.90±26.09^{a}	0.0001
Litter weight at weaning (g)	1833.56±120.41^{b}	3025.67±196.55^{a}	2572.00±242.40^{a}	0.0010

Means denoted with different superscripts within the same row are significantly different at P<0.05.

These impacts may be in association with oxidative stress reduction, which subsequently decreased oxidative damage, increased the fertilizing ability of sperm cells (Calogero *et al*., 2017), and improving sperm cell parameters

(Lavaraa *et al*., 2005). In this respect, many authors (Attia and Kamel, 2012; Attia *et al*., 2015; El-Ratel and Fouda, 2017) mentioned that the decreased MDA level can provide additional evidences for enhancing semen quality and fertility in rabbit bucks. Therefore, drinking MW has promising impact on improving fertility of rabbit bucks, in term of lipid peroxidation reduction, and DNA damage.

CONCLUSION

Magnetization of drinking water at 1500 Gauss, 30 days before collection of semen or natural mating by bucks, lead to significant improvement in water characteristics, antioxidant capacity, immunity, semen production and fertility of rabbit bucks.

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تأثير الماء الممغنط على جودة السائل المنوى، مكونات الدم، حالة مضادات الأكسدة والمناعة لذكور الأرانب

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تهدف هذه الدراسة الى تقييم تأثير الماء الممغنط على الاداء التناسلى، مكونات الدم، نشاط مضادات الاكسدة والاستجابة المناعية لذكور الارانب النيوزيلاندى البيضاء. استخدم فى هذه الدراسة ٣٠ ذكر نيوزيلاندى ابيض، تم تقسيمهم الى ٣ مجاميع متجانسة (١٠ذكور/ مجموعة) . استقبلت ذكور المجموعة الاولى على ماء شرب طبيعى ، بينما ذكور المجموعة الثانية والثالثة استقبلت على ماء شرب ممغنط بقوة ١٥٠٠ و ٣٠٠٠ جاوس على التوالى لمدة ٣٠ يوم كمدة معاملة، قبل جمع السائل المنوى. تم جمع السائل المنوى مرتين/اسبوعيا لمدة ٨ اسابيع باستخدام المهبل الصناعى. تم تسجيل وقت رد الفعل اثناء جمع السائل المنوى، بينما فى نهاية فترة جمع السائل المنوى تم تقدير مكونات الدم البيوكيمائية،التستوستيرون، مضادات الاكسدة والمناعة. تم تقييم خواص السائل المنوى من حيث حجم القذفة ، قيمة ايون الهيدروجين ، الحركة الكلية، والنسبة المئوية للحركة التقدمية، الحيوية، الشواذ، شواذ الاكروسوم وتركيز الحيوانات المنوية . فى نهاية فترة جمع السائل المنوى، تم دراسة الخصوبة للامهات الارانب الملقحة بالذكور المستخدمة فى التجربة. وقد اظهرت النتائج تحسن معنوى فى الرغبة الجنسية لذكور الارانب المعاملة بالماء الممغنط، وذلك عن طريق انخفاض معنوى (P<0.05) فى وقت رد الفعل، مع زيادة معنوية (P<0.05) فى تركيز هرمون التستوستيرون مقارنة بالماء العادى. ادت المعاملة بالماء الممغنط الى تحسن معنوى (P<0.05) فى خصائص الدم الهيماتولوجية، وكذلك زيادة معنوية (P<0.05) فى الخصائص البيوكيمائية (البروتين الكلى،الالبيومين، الجلوبيولين، والليبوبروتينات مرتفعة الكثافة) و مضادات الاكسدة الكلية والاستجابة المناعية، بينما لوحظ انخفاض معنوى (P<0.05) فى تركيز اليوريا ، الكرياتين،والدهون الكلية، الجليسريدات الثلاثية ، الكوليستيرول الكلى، الليبوبروتينات منخفضة الكثافة، والمانوالدهيد، ومكونات الليسوزوم مقارنة بمجموعة الماء العادى. ادى الماء الممغنط الى تحسن معنوى (P<0.05) فى جميع خصائص السائل المنوى للذكور المعاملة مقارنة بالكنترول. لوحظ تحسن معنوى (P<0.05) فى معدل الحمل و حجم البطن (الكلى و الحى) عند الميلاد وعند الفطام للامهات الملقحة بالذكور المعاملة بالماء الممغنط. نستخلص من هذه الدراسة ان : معاملة ذكور الارانب بالماء الممغنط عند قوة ١٥٠٠ جاوس لمدة ٣٠ يوم ادى الى تحسن معنوى فى جودة الماء وحالة مضادات الاكسدة، الاستجابة المناعية، جودة السائل المنوى والمقدرة الاخصابية للذكور الارانب.