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EFFECT OF MAGNETIC WATER ON PRODUCTION AND PRESERVATION SEMEN OF RABBIT BUCKS

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ABSTRACT: This study aims to evaluate the effect of receiving magnetic water (3600 Gauss) on antioxidant, immunity status, semen production and preservation, and sperm fertilizing ability of APRI bucks. Twenty adult bucks were divided into two groups, 10 in each, receiving natural water (NW, control) or magnetic water (MW) for 90 days pre-semen collection. Semen was collected twice/week for 6 weeks using an artificial vagina. Reaction time (RT) was recorded during semen collection and serum testosterone, oxidative and immunity status were determined at the end of semen collection. Semen was evaluated for volume and pH value, progressive motility, livability, abnormality and acrosomal damage and outputs/ejaculate (TSO) of spermatozoa were determined. Semen was preserved for 48 h at 5 ^{o}C and evaluated for progressive motility, livability abnormality and acrosomal damage at 0, 24 and 48 h. At the end of semen collection, conception (CR) and kindling (KR) rates were recorded for does naturally mated with experimental bucks or artificially inseminate with preserved semen. Results showed that RT ($p<0.001$), malondialdehyde, thiobarbituric acid-reactive substances ($p<0.05$) and lysozyme content ($p<0.001$) decreased, while serum testosterone, total antioxidant capacity and antibody titer increased ($p<0.001$) in MW than in NW. All physical semen characteristics and total sperm output were higher, while semen pH was lower ($p<0.001$) in MW than in NW, but ejaculate volume was not affected by MW. The CR of does naturally mated by MW bucks were higher ($p<0.05$) than NW ones (70 vs. 90%). Sperm characteristics in preserved semen were better ($p<0.05$) for MW than NW, and had deleterious effects by advancing preservation time. Both CR and KR were higher ($p<0.05$) for preserved semen of MW (70 and 75.19%) than that of NW (56.67 and 67.46%), respectively, being the highest ($p<0.05$) for semen at 0 time.

In conclusion, magnetizing water with 3600 Gauss for effect of drinking rabbit bucks for breeding (natural mating) or semen collection for artificial insemination with preserved semen for 24 h at 5 ^{o}C resulted in improved natural water quality, antioxidant status, immune response, quality of fresh and preserved semen, and sperm fertilizing capacity of bucks.

Keywords: Rabbit – Semen-Magnetized water -Sperm function -Preservation -Fertility.

INTRODUCTION

In breeding programmes, reducing the number of genetically best rabbit bucks is one of the most immediate benefits of artificial insemination (Vasicek et al., 2014), which depends on some factors involving rabbit bucks management (Thomas, 2009). Among these managerial factors, potable water at all the time, clean, free from organic matter and used after adequate treatment to eliminate contaminants and biological materials, was reported for improving semen quality and sperm preservation, in resultant improving fertility after artificial insemination (Haugana et al., 2005).

Water quality is necessary for animal production (Chiba, 2009) for transporting fluids and nutrients into the blood, maintaining integrity of cellular structure, regulating body temperature (Attia et al., 2013). In poultry, Barton (1996) reported that drinking low quality water had negative effect on productivity. Many investigators found negative changes in natural water (NW) after sterilization (dead water) and magnetization of water (MW) transfers dead water to live water (Batmanghelidj, 2005; Al-Nuemi et al., 2015). The MW means passing water from magnetic tubes, by putting a magnet in water, so properties of water turn into very useful and active by increasing O_2 content, velocity of dissolved salts and amino acids in water (Shaban and Azab, 2017).

Exposure of water to the magnetic field caused marked changes in pH value, total dissolved O_2 and solids, total hardness, electric conductivity, salinity, temperature of evaporation, mineral contents, organic matter and bacteria count (Shaban and Azab, 2017). The pH value is about 7 for NW and can reach up to 9.2 in MW at 7000 Gauss strength magnet for a long period (Lam, 2001). Increasing pH value of MW may be related to more hydroxyl ions created to form alkaline molecules, and then reducing acidity. Increasing dissolved O_2 could be attributed to decreasing organic matter content, whereas physics showed marked changes in weight of water under the influence of magnetic fields (Yacout et al., 2015). However, increasing both the electric conductivity and the dielectric constant of water was documented in MW. In this respect, Ibrahim (2006) concluded that the applied magnetic field may effect on the hydrogen bonds formation of water molecule and this effect may lead to conformation changes, which may be responsible for the recorded variations in conductivity and dielectric contents. In MW, increasing salinity can be due to increasing soluble salts which concurred with the conductivity (Yacout et al., 2015). Also, water exhibited weight changes under the influence of magnetic field (Khudiar and Ali, 2012).

Finer and more homogeneous structures occur during water solution passes via magnetic field, which increases the calcium salts solubility, and decreases lime scale deposits in pipes and cleans pipes from deposited lime scale (Verma, 2011). The fluidity, minerals and vitamins dissolving capability, production of general hormones, enzyme, sexual hormones, and semen production and fertility rate were reported to be improved in MW compared with NW (Khudiar and Ali, 2012). It was reported that sodium

deficiencies in NW adversely affect utilization of dietary protein and energy and interfere with reproductive performance, whereas excessive sodium intake (in term of excessive Na in MW) positively influences water consumption (Jacob et al., 2011; Attia et al., 2013). In addition, several studies indicated positive effect of MW on semen quality, blood parameters, immunity and antioxidant status of males (Attia et al., 2013; El-Hanoun et al., 2017).

The use of magnets to improve water quality is of significant interest due to low cost compared to chemical and physical treatments (Yacout et al., 2015), but the effects of MW is depending on magnetic field strength and/or exposure time (El-Hanoun et al., 2017). Little attention has been given to production and preservation of rabbit semen. Therefore, this study aims to evaluate the effects of exposing natural water to magnetic fields (3600 Gauss) for 90 days as a treatment period pre-semen collection, on antioxidant, immunity status, semen production and preservation, and sperm fertilizing ability of APRI bucks.

MATERIALS AND METHODS

Animal and management:

Twenty adult APRI rabbit bucks (an average of 6-6.5 months of age) were taken from a private rabbit farm (Mansoura City, Dakahlia Governorate) for semen collection. All bucks used in this study were individually housed in stainless steel cages supplied with feeders and nipples. Bucks in all groups were kept under the same conditions of management, health and environment, but differed in treatment of drinking water. Bucks were fed *ad. libitum* on a commercial complete feed diet in pelleted form 17.75% crude protein, 12.38% crude fiber and 2500 Kcal Digestible energy /kg diet.

Experimental design:

Rabbit bucks were divided homogeneously into two groups (10 bucks/each). The 1st group contained bucks receiving natural drinking water (control), while bucks were daily received magnetic water (drinking water exposed to the magnetic field of approximately 3600 Gauss) for a treatment period of 90 days pre-semen collection.

For conditioning water, one type of permanent magnets called Aqua Correct unit (Magnetic water softeners and Conditioners, Blue Goose Sales, 200S Duane Ct, Post Falls ID 83854, USA) with magnetic field strength of 3600 Gauss. At the beginning and end of the experiment termination, a Gauss meter was used to measure the strength of the magnet at Application Laboratory (City for Scientific Research and Biotechnology, Japanese University, Egypt).

Semen collection and evaluation:

After 90 days of treatment, semen was collected twice weekly for 6 weeks, as a collection semen period, from bucks in each group using an artificial vagina and a teaser doe. On day of semen collection, reaction time (RT) was estimated as an indication of sexual desire, in term of the time elapsed from introducing buck to complete ejaculation. Volume of each ejaculate (without gel mass) was recorded immediately after semen collection.

All ejaculates (120 ejaculates per group as replicates) were kept at 37 °C in water bath and transferred to the laboratory

(Physiology and biotechnology, Animal Production Department, Faculty of Agriculture, Mansoura University) for evaluation of semen. In the laboratory, semen pH value was determined using a pH paper (Spezial-Indikatorpapier, Germany). Percentage of progressive motility, livability, abnormality and acrosomal damage of spermatozoa, and sperm cell concentration were determined in each ejaculate. Sperm outputs, as total (TSO), motile (MSO), live (LSO) and normal (NSO) were calculated per ejaculate as the following:

TSO/ejaculate = Ejaculate volume (ml) x sperm cell concentration/ml.

MSO/ejaculate = TSO/ejaculate x progressive sperm motility (%).

LSO/ejaculate = TSO/ejaculate x live sperm (%).

NSO/ejaculate = TSO/ejaculate x sperm abnormality (%) –100.

Blood sampling:

Blood samples were collected from ear vein of 5 bucks in each group at the end of semen collection period. Serum was obtained by centrifugation of the whole blood at 3500 rpm for 15 minutes and carefully decanted into tubes and stored in a deep freezer at -20 ^{o}C until analyses.

Concentration of testosterone in blood serum was determined by immunoassay (Biosource-Europe S.A. 8, rue de L'Lndustrie.B-1400 Nivelles. Belgium). Antioxidant status, in terms of total antioxidant capacity (TAC), malondialdehyde (MDA) and thiobarbituric acid-reactive substances (TBARS) were determined in blood serum using commercial medical kits by commercial ELISA kits (Kamiya Biomedical Company, USA).

Humoral immune response was evaluated using haemagglutination (HA) test following the method according to Prescott et al. (1982). Five bucks from each group were intramuscularly injected with 50% sheep red blood cells (0.5 ml), as T-dependent antigen. The haemagglutination antibodies were assessed 7 days later by HA test. Titres were measured as $\log_2$ values. Lysozyme activity was determined according to Schultz (1987).

Semen preservation:

After the last week of semen collection (6 weeks), semen was collected for one week from each experimental group (20 ejaculates/group) for semen preservation. On each day of semen collection, ejaculates without gel mass were pooled, diluted at a rate of 1:2 with tris-buffer extender (Tris, 3.029 g; citric acid, 1.676 g; D-glucose 1.250 g; penicillin 10 mg; streptomycin, 100 mg; distilled water up to 100 ml).

During preserved period of 48 h at cool temperature (5 ^{o}C), the diluted semen was evaluated for progressive motility, livability abnormality and acrosomal damage of sperm cells at 0, 24 and 48 h.

Fertility trails:

At the end of semen collection period, total of 20 receptive APRI multiparous doe rabbits were used for fertility trail of does naturally mated with experimental bucks. Five bucks from each group were used for natural mating of does (2 does/buck).

On the other hand, 60 APRI multiparous rabbit does (30 does /group, 10 for each preserved time) were artificially inseminated with semen of each buck group preserved at 0, 24 and 48 h at cool temperature (5 ^{o}C). Conception rate (CR)

was determined by manual palpation of mated does on day 10-12 post-mating, while kindling rate (KR) was recorded at parturition.

Statistical analysis:

Data of sexual desire, all semen characteristics, antioxidant status and immunity titer were statistically analyzed using T-test to study effect of water treatment. However, data of sperm characteristics and rates of conception and kindling of preserved semen were statistically analyzed using ANOVA in factorial design (2 groups x 3 preserved times). Data were analyzed by SAS (2002). The significant differences of ANOVA were tested at $p<0.05$ using Duncan Multiple Range Test (1955).

RESULTS AND DISCUSSION

Magnetic water properties:

Analyses of magnetic water (MW) showed remarkable changes in its properties as compared to natural water (NW), in terms of increasing electrical conductivity, dissolved oxygen content, salinity, particularly sodium and calcium contents, and pH value. On the other hand, total hardness, surface tension, chloride, evaporating temperature and total bacterial count decreased in MW in comparing with NW (Table 1). Similar findings were reported on MW by several authors (Attia et al., 2015; Mahmoud et al., 2015; Yacout et al., 2015; El-Hanoun et al., 2017).

The pH value is about 7 for NW and can reach up to 9.2 in MW at 7000 Gauss strength magnet for a long period (Lam, 2001). Increasing electric conductivity of MW may be due to the effect of magnetic field on formation of hydrogen bonds of water molecule, leading to changes in water conformation, which may be responsible for variations in conductivity and dielectric contents (Ibrahim, 2006). Increasing content of dissolved oxygen may be related to the decrease of organic matter in MW (Yacout et al., 2015). Increasing the salinity could be attributed to increasing soluble salts (Na and Ca), which concurred with the conductivity. This increase still within the normal range of Na and Ca in water allowed for drinking animals (El-Hanoun et al., 2017). Meanwhile, more hydroxyl ions in MW created to form alkaline molecules, which reduce water acidity, and consequently increasing pH value (Yacout et al., 2015).

Effect of magnetic water on:

Libido of rabbit bucks:

Results regarding the libido of rabbit bucks indicated significant ($p<0.001$) reduction in reaction time (RT) and marked increase in serum testosterone concentration ($p<0.001$) in bucks received MW than in NW groups (Fig. 1). The present values of RT for are similar to that reported on adults, being between ≤ 0.5 and 1 min for good RT (Hultsch et al., 2002), indicating good sexual desire either in control or rabbit bucks drinking MW. Based on this finding, drinking MW showed more improvement in total sexual libido, in term of decreasing RT from 30.80 to 19.30 s, followed by increasing testosterone concentration (1.55 vs. 1.93) as reported by Attia et al. (2015) in rabbit bucks, Al-Nueimi and Al-Badry (2014) in Holstein bulls and El-Hanoun et al. (2017) in geese. It is well known that the increasing testosterone level was mainly associated with marked reduction in RT in rabbit bucks (Said et al., 2005). In this respect, improvement in libido may be due to increasing the body ability for

sexual hormone production (Al-Nuemi et al., 2015), especially testosterone level in rabbit bucks drinking MW (Kamel et al., 2009).

Oxidative and immunity status:

Bucks received MW significantly increased serum total antioxidant (TAC) concentration ($p<0.001$) and decreased serum malondialdehyde, MDA ($p<0.001$) and TBARS ($p<0.05$) concentrations as compared to NW groups. Also, MW resulted in significant ($p<0.001$) increase in antibody titer, and significant ($p<0.001$) decrease in lysozyme content in comparing with NW (Table 2).

The present results are in agreement with the results of improving antioxidant and immunity status of buck rabbits (Attia et al., 2015) and male geese (El-Hanoun et al., 2017). Also, MW showed a significant increase in antioxidants activity in rabbits (Khudiar and Ali, 2012) and goats (Yacout et al., 2015) as compared to NW groups.

Influence of drinking MW effectively on the antioxidant defense system by decreasing the MDA level, increase the superoxide dismutase activity in the heart, kidney and liver and also decreasing the amounts of nitric oxide (Shah and Nagarajan, 2013; Hafizi et al., 2014). Also, increased body immune response, by increasing lymph cells proportion, may be associated with increases in content of blood immune globulin and number of defensive white blood cells (Yacout et al., 2015). Moreover, decreased the microbial load in bucks received MW may improve the immune system (Kronenberg, 1985).

Fresh semen characteristics:

Bucks received MW significantly improved ($p<0.001$) all physical semen characteristics, in terms of increasing percentages of progressive motility and livability of spermatozoa, sperm cell concentration and sperm outputs (TSO) as total, motile and live spermatozoa as compared to NW. However, semen pH value, sperm abnormality and acrosomal damage of spermatozoa were significantly ($p<0.001$) lower in bucks received MW than in NW groups, but ejaculate volume without gel mass was not affected significantly by MW (Table 3).

The positive impact of MW on semen quality was established in rabbit bucks (Attia et al., 2015), Holstein bulls (Al-Nueimi and Al-Badry, 2014), male geese (El-Hanoun et al., 2017) and human (Shaban and Azab, 2017).

Increased testosterone level due to MW was found to increase semen quality (Said et al., 2005). It is of interest to observe that improvements of semen physical characteristics of rabbit bucks drinker MW are in relation with remarkable increase in testosterone level, antioxidant enzymes and immune response. Also, this improvement was associated with reduction of lipid peroxidation biomarkers (MDA and TBARS), leading to enhancing body tolerance to pollutants and body protection from the free radicals (Attia et al., 2015). Moreover, increasing the testosterone level and improved semen quality are consistent with improving in the immune response and antioxidant status of rabbit bucks drinking MW (Attia et al., 2015).

In general, the penetration of MW via cellular wall would be facilitated which can accelerate ordinary diffusion of water that is vital for growth of different organs (Shaban and Azab, 2017). This leads to

increasing fluidity and dissolving capacity of some constituents (minerals and vitamins), and consequently improving the biological activity of solutions positively affecting the performance animal (Al-Mufarrej et al., 2005).

Fertility trail of fresh semen:

The CR of APRI does naturally mated by bucks received MW group were significantly ($p<0.05$) higher than those in NW group (70 vs. 90%), while KR was 100% in both groups (Table 4). These findings indicated beneficial effects of MW treatment on fertility of rabbit bucks, in term of improving the semen quality. The observed decrease in serum TBARS and MDA concentrations of bucks in MW group can provide further evidences for improving semen quality and fertility in rabbits (Attia et al., 2015; Attia and Kamel, 2012) and in lambs (Al-Sabeea, 2008).

Semen preservation at 5 ºC for 48 hours:

Results in Table (5) revealed significant effect of MW or preservation time, while the effect of their interaction was not significant on all sperm characteristics studied. Overall mean of sperm characteristics in semen preserved at 5 ^{o}C for 48 h, including percentages of sperm progressive motility and livability were significantly ($p<0.05$) higher, while abnormality and acrosomal damage percentages were significantly ($p<0.05$) lower for bucks drinking MW than for those drinking NW (Table 5).

These results are in agreement with Tamer et al. (2005 and 2006), who reported that the attracted to magnetic field lead to improve significantly quality of semen and Al-Daraji and Aziz (2003), who revealed more better quality and quantity of semen for roosters drinking MW than controls. These findings were proved for several studies on different species, such as rabbit bucks (Atteyh, 2008), bulls (Al-Nueimi and Al-Badry, 2014), rams (Mahdi, 2012) and human (Gorpinchenko, 1995). Therefore, improving sperm characteristics in fresh semen produced by bucks in MW group exhibited better sperm characteristics post-preservation. In this line, Zhau (1991) observed that the transaction magnetic rabbits had positive results and it is important to improve semen quality by increasing the collective and individual movement, beside increasing susceptibility storage of rabbit semen for 12-24 h as compared to control rabbits. Hafizi et al. (2014) reported that the intake of MW results in reduced damage of DNA.

Overall mean of all sperm characteristics studied in semen preserved at 5 ^{o}C was affected significantly ($p<0.05$) by preservation period, while the effect of interaction between type of water and preservation time was not significant (Table 5), indicating better semen quality for bucks drinking MW than NW at all preservation times with similar trend of changes in sperm characteristics by advancing preservation time.

By advancing preservation period, percentages of sperm progressive motility and livability significantly ($p<0.05$) decreased, while abnormality and acrosomal damage percentages significantly ($p<0.05$) increased, regardless drinking MW or NW (Table 5).

In agreement with the present results, rabbit sperm cells showed significant

decrease in progressive motility and livability percentages and significant increase in abnormality and acrosomal damage percentages with progressive preservation time at 4-6 ^{o}C up to 72 h (Ali and Ghazal, 2013) or 24 h (Mangiagalli et al., 2012) and even in pot-thawed semen (Castellini et al., 2003).

Oxidative damage of sperm cells during semen preservation produces reactive oxygen species (ROS) from sperm components, causing marked reduction in sperm motility (Shamiah et al., 2017). Also, reducing content of adenosine tri-phosphate (Zeidan et al., 2008) and increasing lactic acid accumulation (anaerobic sperm metabolism) leads to changes in osmotic pressure and pH value in semen (Seleem et al., 2007) during preservation, resulting in inactivation of spermatozoa and exerting deleterious effects on sperm cells. The MW increase efficiency in the reactions biological biochemical sperm cells (Wang et al., 1998). The positive effect of MW as antioxidant on lipid peroxidation could be hypothesized, because peroxidation and sperm viability are strictly linked (Shaban and Azab, 2017). The MW is very effective, as antioxidant, to protect body cells and tissues from the harmful effects of various acids and oxygen ions, as well as a positive effect on body absorption and metabolism, leading to increases in cellular viability (Remedy, 2006).

Fertility trail of preserved semen:

Overall mean of CR and KR rates were significantly ($p<0.05$) higher for preserved semen from MW (70 and 75.19%) than that from NW (56.67 and 67.46%) group, respectively. However, overall mean of CR and KR was significantly ($p<0.05$) the highest for semen preserved at 0 time, followed by semen preserved for 24 h, while that preserved for 48 h showed the poorest CR and KR. It is of interest to note that, MW had no interaction with preservation period on CR or KR, reflecting the highest values of CR and KR in MW than in NW group, being the highest for semen at 0 time (Table 6).

It was reported that KR of does was significantly impacted by quality of semen (Lavaraa et al., 2005). Regardless preservation period, improving semen quality of bucks treated with MW, as antioxidant is linking to improve reproductive efficiency of rabbit does. These improvements may indicate a decrease of the oxidative stress, and subsequently oxidative damage, which enhances the normal fertilizing ability of spermatozoa (Calogero et al., 2017).

As expected, fertility rate was higher in fresh than in preserved semen. This was proved in stored semen of rabbits (Ali and Ghazal, 2013), cockerel (Shamiah et al., 2017) and rams (Maxwell and Watson, 1996). The observed increase in fertility rate in rabbit does inseminated artificially by diluted semen ejaculated by MW treated bucks, can be attributed mainly to improvement of semen quality before preservation. However, the obtained reduction in fertility of semen as affected by advancing preservation period was attributed to remarkable deleterious effects on preserved spermatozoa (Zeidan et al., 2008; Seleem et al., 2007) by progressing preserved time.

CONCLUSION

Magnetizing water with 3600 Gauss for drinking rabbit bucks for breeding (natural mating) or semen collection for artificial insemination with preserved semen for 24 h at 5 ^{o}C resulted in improved water quality, antioxidant status, immune response, quality of fresh and preserved semen, and sperm fertilizing capacity of bucks. Further studies are needed for studying the effect of magnetic water regarding level of Gauss in reference with amount of treated water, kidney function and water consumption.

Table (1): Properties of magnetic water used in the experiment in comparing with natural water

Parameter	Natural water	Magnetic water
Electrical conductivity (µs/cm)	480	530
Oxygen content (mg/l)	57.10	82.60
Total hardness (mg/l)	450	440
Surface tension (dyn/cm)	61.24	50.41
Salinity (mg/l)	350	405
Chloride (ppm)	58.10	40.50
Sodium (ppm)	6.50	8.30
Calcium (ppm)	122.10	135.20
Evaporating temperature (ppm)	0.640	0.600
Total count of bacteria (cfu)	2.90	2.85
pH value	7.20	7.70

Table (2): Effect of magnetic water on oxidative and immunity status in serum of APRI bucks

Parameter	Natural water	Magnetic water	T-Value	P-Value$^{(sig.)}$
Oxidative status:				
Total antioxidants (mmol/l)	143.60±1.21	161.20±0.58	13.12	0.0001***
Malondialdehyde (nmol/ml)	1.13±0.02	0.892±0.01	12.51	0.0001***
TBARS (nmol/ml)	0.98±0.02	0.90±0.01	3.28	0.0112*
Immunity status:				
Antibody titer(SRBCs)	4.89±0.02	6.35±0.20	7.08	0.0001***
Lysozyme ((mmol/ml)	82.60±0.93	71.40±0.68	9.75	0.0001***

TBARS: thiobarbituric acid-reactive substances.

* Significant at $p<0.05$. *** Significant at $p<0.001$.

Table (3): Effect of magnetic water on semen characteristics and sperm output of APRI bucks

Parameter	Natural water	Magnetic water	T-Value	P-Value(Sig.)
Semen characteristics:				
Ejaculate volume (ml)	0.710±0.53	0.730±0.41	1.94	0.0685^{NS}
Progressive sperm motility (%)	65.50±1.38	78.50±1.07	7.44	0.0001***
Sperm livability (%)	77.90±0.61	90.40±0.40	17.24	0.0001***
Sperm abnormality (%)	15.70±0.47	11.30±0.42	6.94	0.0001***
Acrosomal damage (%)	16.80±0.63	12.60±0.48	5.32	0.0001***
Sperm cell concentration (x10^6/ml)	461.80±2.09	506.1±1.51	17.18	0.0001***
Semen pH value	7.12±0.01	7.19±0.01	5.39	0.0001***
Sperm output (x10^6/ejaculate):				
Total	336.26±3.54	375.05±2.59	8.84	0.0001***
Motile	220.15±4.74	305.05±4.69	11.13	0.0001***
Live	261.94±3.31	339.03±2.79	17.81	0.0001***

^{NS}: Not significant. *** Significant at p<0.001.

Table (4): Fertility rate of rabbit does naturally mated by APRI bucks drinking magnetic water (Fresh semen)

Item	Natural water	Magnetic water
Conception rate (%)	70^b	90^a
Kindling rate (%)	100	100

Conception rate were analyzed by Chi-square student test.

Table (5): Sperm characteristics in semen preserved at 5 ^{o}C for 48 hours as affected by type of drinking water, preserved period and their interaction

Treatment	Sperm characteristics (%)			
	Progressive motility	**Livability**	**Abnormality**	**Acrosomal damage**
Effect of Type of water (T):				
Natural water	42.22	53.44	15.23	17.22
Magnetic water	52.22	65.89	11.00	12.11
±SEM	1.290	1.083	0.444	0.609
Significance	*	*	*	*
Effect of preserved period (S):				
0	60.50^{a}	72.33^{a}	9.83^{c}	10.50^{c}
24	48.50^{b}	60.33^{b}	13.50^{b}	14.67^{b}
48	32.67^{c}	46.33^{c}	16.00^{a}	18.83^{a}
±SEM	1.581	1.326	0.544	0.745
Effect of interaction between (T x S):				
Significance	NS	NS	NS	NS

^{NS}: Not significant. * Significant at p<0.05.

$^{a,b\ and\ c}$: Means denoted within the same column with different superscripts are significantly different at p<0.05.

Table (6): Conception and kindling rates of rabbit does artificially inseminated by semen as affected by type of drinking water, preserved period of semen and their interaction. (Preserved semen)

Type water	Conception rate (%)			Overall mean	Kindling rate (%)			Overall mean
	0 h	**24 h**	**48 h**		**0 h**	**24 h**	**48 h**	
Natural water	70	60	40	56.67^{b}	85.71	66.66	50.00	67.46^{b}
Magnetic water	80	70	60	70.00^{a}	87.50	71.43	66.67	75.19^{a}
Overall mean	75^{a}	65^{b}	50^{c}	-	86.61^{a}	69.05^{b}	58.33^{c}	-

$^{a\ and\ c}$: Means denoted within the same column with different superscripts are significantly different at p<0.05.

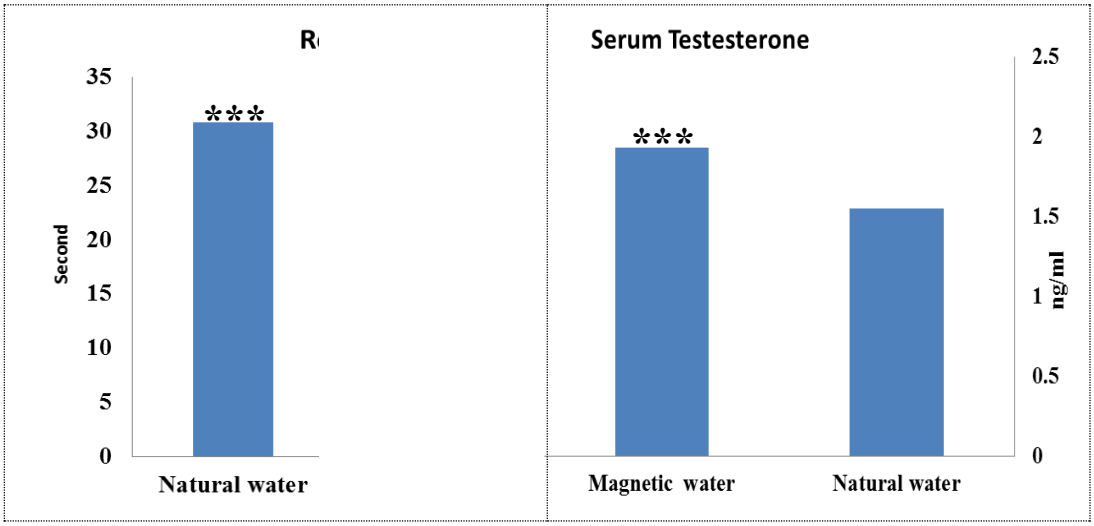

Fig. (1): Effect of magnetic water (3600 Gauss) on reaction time and serum testosterone concentration of APRI rabbit bucks. (*** Significant difference at p<0.001)

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الملخص العربى

تأثير الماء الممغنط على إنتاج وحفظ السائل المنوى لذكور الأرانب

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تهدف هذه الدراسة إلى تقييم تأثيرتعريض الماء العادى لمجال مغناطيسى شدته (3600 جاوس) على نشاط مضادات الأكسدة، الإستجابة المناعية، إنتاج وحفظ السائل المنوى والقدرة الإخصابية لذكور الأرانب الأبرى.
استخدم فى هذه الدراسة 20 ذكر أبرى ناضج جنسياً تم تقسيمهم إلى مجموعتين (10 ذكور فى كل مجموعة). حيث استقبلت الذكور مياه شرب عادية (كنترول) أو مياة شرب عادية تم تعريضها لمجال مغناطيسى بشدة قدرها (3600جاوس) لمدة 90 يوم قبل البدء فى جمع السائل المنوى. تم جمع السائل المنوى مرتين اسبوعياً لمدة 6 اسابيع بإستخدام المهبل الصناعى. تم حساب الرغبة الجنسية خلال فترة جمع السائل المنوى وتقدير تركيز هرمون التستوستيرون، نشاط مضادات الأكسدة والإستجابة المناعية فى سيرم الدم فى نهاية فترة جمع السائل المنوى.
تم تقييم خصائص السائل المنوى لتقديرحجم القذفة ودرجة الحموضة، النسبة المئوية للحركة التقدمية، الحيوية، الشواذ، شواذ الأكروسوم والتركيز الكلى لكل قذفة. تم حفظ السائل المنوى لمدة 48 ساعة على 5°م وتقييم النسبة المئوية للحركة التقدمية، الحيوية، الشواذ، وشواذ الأكروسوم بعد صفر، 24 و 48 ساعة من الحفظ. فى نهاية فترة جمع السائل المنوى، تم تسجيل معدلات الحمل والولادة لأمهات الأرانب الأبرى الملقحة طبيعياً من ذكور التجربة أو الملقحة صناعياً بالسائل المنوى المحفوظ على 5°م عند صفر، 24 و 48 ساعة.
وقد أظهرت النتائج :- تحسن معنوي فى الرغبة الجنسية ($p<0.001$)، حالة مضادة الأكسدة ($p<0.001$) ومكونات الليسوزيم ($p<0.001$)، مع زيادة معنوية فى تركيز هرمون التستوستيرون ($p<0.001$)، نشاط مضادات الأكسدة والإستجابة المناعية ($p<0.001$) فى سيرم دم الذكور المعاملة بالماء الممغنط مقارنة بالكنترول.
وجد تحسن معنوى ($p<0.001$) فى جميع خصائص السائل المنوى والتركيز الكلى للقذفة للذكور المعاملة بالماء الممغنط مقارنة بالكنترول، مع إنخفاض معنوى فى درجة حموضة السائل المنوى ($p<0.001$) للذكور المعاملة بالماء الممغنط مقارنة بالكنترول، وعدم تأثر حجم القذفة بدون جل بالمعاملة بالماء الممغنط. وجد أن معدل الحمل للأمهات الملقحة طبيعياً بالذكورالمعاملة بالماء الممغنط أعلى معنوياً ($p<0.05$) مقارنة بالكنترول (70 مقابل 90%) ، بينما كان معدل الولادة 100% فى كلا المجموعتين. لوحظ تحسن معنوى ($p<0.05$) لخصائص الحيوان المنوى فى السائل المنوى المحفوظ على 5°م لمدة 48 ساعة عند المعاملة بالماء الممغنط مقارنة بالكنترول، مع تأثره الضار بطول مدة الحفظ، ولم يكن هناك تأثير معنوى بين نوع الماء ووقت الحفظ. سجل المتوسط العام لمعدلات الحمل والولادة أعلى معنوية ($p<0.05$) للسائل المنوى المحفوظ للذكور المعاملة بالماء الممغنط (70,00 و 75,19 %) مقارنة بالكنترول (56,67 و 67,46%) على التوالى وقد سجلت أعلى نسبة للسائل المنوى عند صفر ساعة. ونستخلص من هذه الدراسة أن مغنطة الماء بشدة 3600 جاوس لشرب ذكور أرانب التربية (تلقيح طبيعى) أو جمع السائل المنوى للتلقيح الصناعى بسائل منوى محفوظ لمدة 24 ساعة على5°م أدت الى تحسن جودة الماء العادى، نشاط مضادات الأكسدة، الإستجابة المناعية، جودة السائل المنوى الطازج والمحفوظ وكذلك القدرة الإخصابية للذكور.