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EFFECT OF MAGNETIC TREATED WATER ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF BALADY RABBIT DOES AND THEIR OFFSPRING

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SUMMARY

Thirty black balady rabbit does aged 7 to 8 months old with averaged live body weight (LBW) 3125±60.49 g were used in a complete randomized design and were randomly assigned into three homogeneous groups (10 does in each). The first group was drinking tap water and regarded as control group (G1), while the second (G2) and third (G3) groups were drinking a magnetic treated water with 1200 and 3600 gauss, respectively. Rabbits in all groups were fed the commercial rabbit diet. Results showed that magnetic treated water (MTW) had better quality than those for tap water (TW) in conductivity, salinity and total hardness. Does in G2 drink magnetic water (1200 gauss) showed significantly ($P<0.05$) the highest live body weight (LBW) at mating and kindling, 1st service conception rate and the lowest number of services per conception, followed by those in G3 drink magnetic water (3600 gauss), while those in G1 drink tap water had the poorest values. Moreover, does in G2 recorded significantly ($P<0.05$) the highest average daily milk yield (ADMY) at different suckling intervals, followed by those in G3, while those in G1 had the lowest yield. Also, does in G2 significantly ($P<0.05$) the highest percentages of fat, protein, TS and SNF in milk followed by those in G3, while those in G1 had the lowest percentages. While, lactose percentage in milk of does in G2 and G3 was higher significantly ($P<0.05$) than in milk of does in G1. Does in G3 showed significantly ($P<0.05$) the highest concentrations of total protein, globulin, total lipids, triglycerides and LDL, and those in G2 had the highest glucose concentration, while those in G1 recorded the highest albumin, urea-N, HDL concentrations and ALT activity. The concentrations of creatinine and total cholesterol and AST activity was not significantly affected by magnetic water. Concentrations of IgG and IgM in serum of does and their offspring were higher in G3, followed by G2, while they lower in G1, but the differences were not significant. Does in G2 showed significantly ($P<0.05$) the highest litter size during the different suckling intervals, followed by those in G3, while those in G1 had the lowest values. However, mortality rate revealed the opposite trend. Group G2 showed significantly ($P<0.05$) the highest weight and weight gain of litter and bunnies followed by G3, while G1 had the lowest values. Feed intake and feed cost was nearly similar for different groups. While, total cost (feed cost plus magnetic water cost) was higher significantly ($P<0.05$) for G3 followed by G2, while G1 had the lower cost. Group G2 showed significantly ($P<0.05$) the highest price of weaning weight and net revenue followed by G3, while G1 had the lowest values.

Keywords: *Rabbit does, magnetic water, reproductive, productive, offspring.*

INTRODUCTION

Although water is often overlooked and not considered as a nutrient when formulating rations, it is still extremely important to animal and composes about 71 to 73 % of the fat free animal body weight. Water is involved in numerous vital functions. It acts as a solvent for many different biological systems such as digestion, wastes excretion, temperature regulation and transport of nutrients, hormones and oxygen. Water makes up over 98 % of all molecules in the body and is necessary for production, growth, lactation, digestion, electrolytes balance, lubrication of joints, eyesight and as a cleaning agent (Lardy and Stolltenow, 1999).

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 approximately twice as much water 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, De Blas (2013) reported that the alteration in the gut compositional changes has been showed as a possible cause of gut disorder and retard growth and health problem in rabbits. Recent evidences indicated that magnetic treatment of water may offer a possible solution to improve water quality (Verma, 2011).

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). An enhancement in the calves and sheep growth and a reduction in carcass fat in sheep were demonstrated due to magnetizing of water (Bergsrud and Linn, 1990). In addition, Lin and Yotvat (1989) cited that an increase in milk yield of dairy cattle consuming magnetic water. Verma (2011) reported that magnetized water stops 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 result was reported by Sargolzehi *et al.* (2009) who showed that magnetic water did not positively affect animal performance, carcass composition, blood glucose and urea and Na, K, Mg and P in blood and nutrient profiles in milk such as protein, fat, lactose, non-fat solid and total solid of lambs and goats. Contact of water with a permanent magnet for a considerable time produced magnetic charges and magnetic properties. Such magnetically treated water can decrease microbial load and improve the immune system (Lam, 2001). Exposing of water to a magnetic field may offer a solution to improve reproductive performance, function of liver, renal and ovary and antioxidant status of doe rabbits and their litters. This treatment may be useful management practice in the area where rabbit farms depends on well water as a source of drinking water (El-Hanoun *et al*., 2013). Thus, this study aims to evaluate the effects of magnetic treatment of tap and well water on productive and reproductive performance of balady rabbit does, milk yield and composition, blood parameters and immunity status and growth of their offspring's up to weaning.

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.

Thirty black balady rabbit does aged 7 to 8 months old with averaged live body weight (LBW) 3125±60.49 g were used in a complete randomized design and were randomly assigned into three homogeneous groups (10 does in each). The first group was drinking tap water and regarded as control group (G1), while the second (G2) and third (G3) groups were drinking a magnetic treated water with 1200 and 3600 gauss, respectively. All animals were subjected to tap and magnetic water as drinking water for 30 days before starting the experimental design. Magnetic treated water 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. Rabbits in all groups were fed the commercial rabbit diet to cover their requirements according to NRC (1977). Ingredients and chemical composition of the control diet are presented in Table (1). Chemical analysis of diet was determined according to AOAC (1995).

Rabbits were housed separately in individual wired cages (30 x 50 x 30 cm) and arranged in double tier batteries allocated in two rows till insemination. After insemination, rabbits were placed again in individual cages (50 x 60 x 35 cm) of galvanized wire net and arranged in double tier batteries allocated in two rows. Nest boxes (30 x 25 x 30 cm) were attached to the front sides of the cages five days prior to kindling and removed at 30 days of lactation (weaning age). The bucks were housed in individual cages as that of females, but without nest boxes. All cages were equipped with feeders (made of galvanized steel sheets) and nipples (automatic drinkers). The system provided animals with fresh water all over the experimental period. Rabbits in all treatment groups were kept under similar managerial system and environmental conditions.

Doe rabbits were individually weighed at the mating and kidding. Does were naturally inseminated using four balady bucks rabbit fed the control diet. Pregnancy diagnosis was done by palpation at 10-

12 days post-mating and does failed to conceive post 1st mating was reinseminated and number of services per conception was calculated. During the suckling period, milk yield was determined by the differences in LBW before and after suckling and milk composition was determined using milko-scan (Model 133B).

Table (1). Formulation and composition of commercial rabbit diet

Ingredient	%	Composition	%
Berseem hay	30	DM	88.06
Wheat bran	16	OM	90.57
Soybean meal	20	CP	16.54
Yellow corn	20	CF	12.33
Barley grain	10	EE	2.25
molasses	2	NFE	59.45
limestone	1	Ash	9.43
Common salt	0.5		
Premix*	0.5		
Total	100		

* *Each one kg of premix (minerals and vitamins mixture) contains vit. A, 20000 IU; vit. D3, 15000 IU; vit. E, 8.33 g; vit. K, 0.33 g; vit. B1, 0.33; vit. B2, 1.0 g; vit. B6, 0.33 g; vit. B5, 8.33 g; vit. B12, 1.7 mg; pantothenic acid, 3.33 g; biotine, 33 mg; folic acid, 0.83 g; choline chloride, 200 mg.*

Post-kindling, litter size and weight were recorded for each group at birth and at weekly intervals up to weaning at 30 days. Feed intake and weight gain during pregnancy and lactation and kindling rate of does as well as litter size and weights, stillbirths and mortality rate of bunnies were also recorded.

Blood samples were taken from does and their offspring at the end of suckling period from ear vein into clean sterile tubes. Blood samples were let to coagulate and centrifuged at 3500 rpm for 15 minutes and serum was separated and stored at –20 ^{o}C till assay. Concentrations of total protein, albumin, globulin (by difference), creatinine, urea nitrogen, glucose, total cholesterol, HDL, LDL (by difference), triglycerides, total lipids and activity of aspartate (AST) and alanine (ALT) aminotransferases were determined in blood serum using spectrophotometer (Spectronic 21 DUSA) and commercial kits (Combination Pasteur Lap.). Also, concentration of immunoglobulins (IgG and IgM) was determined in serum of does and offspring using rabbit immunoglobulin M Elsa Kits.

Data were statistically analyzed using general linear models (GLM) procedures adapted by IBM SPSS statistics 22 (2013) for user's guide with one-way ANOVA. Duncan test within SPSS program was done to determine the degree of significance level among means.

RESULTS AND DISCUSSIONS

Water Quality:

Results in Table (2) indicated that magnetic treated water (MTW) had better quality than those for tap water (TW) in conductivity, salinity and total hardness, both water types were improved due to magnetic field exposure. The magnetic exposure resulted was in higher effect on MW than TW such as of pH (7.53 vs. 7.68 and 7.97), Viscosity (cst) (0.794 vs. 0.792 and0.790), salinity (360 vs. 390 and 400 Mg/L) and dissolved oxygen (51.5 vs. 72.5 (mg/L)). Total count of bacteria (2.86, 2.83 and 2.80). The tap water and there was an improvement in water quality when exposed to the magnetic field with considerable changes in the pH, conductivity, salinity, total hardness and dissolved oxygen. Physically, exposure water to magnetic field changes water properties which becomes more energized, active, soft and high pH toward slight alkaline and free of germs which fulfill water quality for poultry requirements (Mg-Therapy, 2000). Magnetized water causes the hydrogen-oxygen bond angle within the water molecule to be reduced from 104 to 103 degrees. This in turn causes the water molecule to cluster together in groups of 6-7 rather than 10-12. The smaller cluster leads to better absorption of water across cell walls (Verma, 2011). Normal water has a pH level of about 7, whereas magnetized water can reach pH of 7.8 while cancer cells do not survive well in an alkaline environment (Lam, 2001). 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). Chemical Analysis and total count of bacteria of ordinary and magnetically treated water used in the experiment.

Physical properties	Tap water	1200 (Gauss)	3600 (Gauss)
PH	7.53	7.68	7.79
Electrical conductivity (µs/cm)	498	503	507
Oxygen content (mg/l)	51.5	72.5	80.4
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)	0.75	0.72	0.70
Salinity Mg/L	360	390	400
Total bacterial count (CFU)	2.86	2.83	2.80

Reproductive performance of does:

Reproductive traits of does rabbit are shown in Table (3). Results showed that does in G2 drink magnetic water (1200 gauss) showed significantly (P<0.05) the highest live body weight (LBW) at mating and kindling, 1st service conception rate and the lowest number of services per conception, followed by those in G3 drink magnetic water (3600 gauss), while those in G1 drink tap water had the poorest values. However, gestation period length was nearly similar for all treatment groups, ranging from 30.3 to 31.4 days. The improved of reproductive traits of doe rabbits were concurred with increasing health status of rabbits. Similar effects were also shown in liver and renal functions and ovarian hormones. The present results are in line with those reported by Sunmonu and Oloyede (2007); Attia *et al.,* (2013). El-Hanoun *et al*. (2013) found that magnetic exposure resulted in lower (P≤0.05) number of service per conception and greater (P≤0.05) conception rate than those for the unexposed water.

Table (3). Reproductive traits of does rabbit in experimental groups.

Item	Experimental group			MSE
	G1	G2	G3	
No. of does	10	10	10	
LBW at mating (g)	2978b	3311a	3089ab	60.49
LBW at kindling (g)	3014b	3424a	3203ab	65.68
Conception rate %				
1st service	40ab	50a	30b	9.10
2nd service	20b	20b	30a	7.85
3rd service	20	20	20	7.43
4th service	20a	10b	20a	6.92
No. service/conception	2.2a	1.9b	2.3a	0.22
Gestation period (day)	30.9	30.5	31.4	0.21

a, b: Values in the same row with different superscripts differ significantly (P<0.05).

Milk yield and composition:

Results in Table (4) showed that does in G2 drink magnetic water (1200 gauss) recorded significantly (P<0.05) the highest average daily milk yield (ADMY) at different suckling intervals, followed by those in G3 drink magnetic water (3600 gauss), while those in G1 drink tap water had the lowest yield. Overall mean of daily milk yield during the suckling period significantly (P<0.05) increased by 37.25 and 15.69% for G2 and G3 compared with G1, respectively. These results agreed with those obtained by El-Hanoun *et al*. (2013) who found that exposure of water to the magnetic field increased (P≤0.05) milk yield compared to those of does drank un magnetized water.

Milk composition of does including the percentages of fat, protein, lactose, total solids (TS), solids not fat (SNF) and ash are presented in Table (4). Results showed that does in G2 drink magnetic water (1200 gauss) significantly ($P<0.05$) the highest percentages of fat, protein, TS and SNF in milk followed by those in G3 drink magnetic water (3600 gauss), while those in G1 drink tap water had the lowest percentages. Moreover, lactose percentage in milk of does in G2 and G3 was higher significantly ($P<0.05$) than in milk of does in G1. While, ash percentage was not affected by drinking magnetic water. These results agreed with those obtained by El-Hanoun *et al*. (2013) who found doe rabbits drank magnetic water yielded milk containing greater ($P\leq0.05$) values of fat, lactose, and energy than those drank untreated water.

Table (4). Milk yield and composition of doe rabbits at different suckling periods.

Suckling period (week)	Experimental group			MSE
	G1	G2	G3	
Milk yield (g/day)				
1	99b	109a	101b	9.88
2	94b	133a	130a	8.75
3	130b	181a	155ab	10.75
4	90b	140a	99b	9.57
Mean	102b	140a	118ab	5.61
Milk composition %:				
Fat				
1	8.70b	11.30a	10.16ab	1.17
2	11.52a	11.54a	8.76b	1.42
3	10.18b	11.40a	11.24a	1.46
4	8.08b	9.95a	10.08a	1.17
Mean	9.70b	11.11a	10.06ab	0.65
Protein				
1	16.12b	16.36b	18.18a	0.63
2	14.82b	15.48ab	16.22a	0.44
3	16.78ab	17.94a	16.14b	0.66
4	16.25ab	18.63a	15.36b	0.91
Mean	15.98b	17.02a	16.48ab	0.33
Lactose				
1	4.44	4.86	4.50	0.16
2	3.98b	4.58a	4.88a	0.24
3	3.42b	4.80a	4.34ab	0.25
4	3.70b	4.93a	4.68ab	0.23
Mean	3.89b	4.78a	4.60a	0.11
Total solids				
1	30.36b	33.93a	34.23a	1.31
2	31.72b	33.00a	31.27b	1.33
3	31.78c	35.54a	33.12b	1.92
4	29.44c	34.91a	31.53b	1.57
Mean	30.98c	34.31a	32.54b	0.76
Solids not fat				
1	21.96b	22.63ab	24.07a	0.72
2	20.20b	21.46ab	22.51a	0.51
3	21.60b	24.14a	21.88b	0.71
4	21.36b	24.96a	21.45b	1.00
Mean	21.27b	23.21a	22.48ab	0.37
Ash				
1	1.40	1.41	1.39	0.01
2	1.40	1.40	1.41	0.01
3	1.40	1.40	1.40	0.01
4	1.41	1.41	1.41	0.01
Mean	1.40	1.40	1.40	0.01

a, b, c: Values in the same row with different superscripts differ significantly ($P<0.05$).

Blood parameters:

Blood serum parameters of does shown in Table (5) revealed that drinking magnetic water resulted in significant differences (P<0.05) in the concentrations of total protein, albumin, globulin, urea-N, glucose, total lipids, triglycerides, HDL and LDL. While, the concentrations of creatinine and total cholesterol were nearly similar and not significantly affected by magnetic water. Does in G3 drink magnetic water 3600 gauss showed significantly (P<0.05) the highest concentrations of total protein, globulin, total lipids, triglycerides and LDL, and those in G2 drink magnetic water 1200 gauss had the highest glucose concentration, while those in G1 drink tap water recorded the highest albumin, urea-N and HDL concentrations.

Activity of AST was not significantly affected by magnetic water. While, ALT activity decreased with drinking magnetic water, which it was higher significantly (P<0.05) in G1 drinking tap water (Table 5). One could explain the enhanced biological performance, function of liver, kidney, ovary and antioxidants enzymes based on the effect of magnetic treatments to improving solubility of minerals of water, which facilities the transfer of the nutrients via improving membrane permeability to animal cells, thus nutrients uptakes and utilization as the water is the media for all biological and metabolic reactions. Furthermore, magnetic treatment was found to improve water quality, reduce lime deposition in pipes and bacterial load (Skeldon, 1990; Sargolzehi *et al.*, 2009). Khudiar and Ali (2012) revealed that drinking of magnetic water had beneficial effect on some physiological aspects manifested by a significant elevation in serum HDL and total serum proteins concentration. In addition to significant suppression in serums total cholesterol, triacylglycerol and LDL concentrations.

Table (5). Blood serum parameters of does in different groups.

Item	Experimental group			MSE
	G1	G2	G3	
Total protein (g/dl)	6.13b	6.15b	7.45a	0.27
Albumin (g/dl)	3.49a	2.79b	3.34a	0.12
Globulin (g/dl)	2.64b	3.36ab	4.11a	0.26
Creatinine (mg/dl)	0.76	0.80	0.76	0.08
Urea-N (mg/dl)	7.83a	5.86b	4.36c	0.73
Glucose (g/dl)	75.04b	98.06a	73.09b	5.65
Total lipids (mg/dl)	404.53b	336.57c	459.55a	57.59
Triglycerides (mg/dl)	44.90b	45.09b	50.15a	3.28
Total cholesterol (mg/dl)	157.25	156.47	154.51	2.64
HDL (mg/dl)	72.72a	69.53b	60.84c	9.89
LDL (mg/dl)	84.53c	86.94b	93.67a	8.17
Activity of AST (IU/L)	80.97	77.77	79.47	1.36
Activity of ALT (IU/L)	52.67a	34.53b	43.53ab	3.76

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Immune response of does and produced bunnies:

Immunoglobulin (IgG and IgM) concentration in blood serum of does and their offspring at the end of suckling period are presented in Table (6). Concentrations of IgG and IgM in serum of does and their offspring were higher in G3 drink magnetic water 3600 gauss, followed by G2 drink magnetic water 1200 gauss, while they lower in G1 drink tap water, but the differences were not significant. Concentrations of both IgG and IgM increased in serum of does than of offspring. Concentrations of both IgG and

IgM in serum of does was associated with globulin concentration in serum of does in all groups (Table 5). Contact of water with a permanent magnet for a considerable time produced magnetic charges and magnetic properties. Such magnetically treated water can decrease microbial load and improve the immune system (Lam, 2001).

Litter size and mortality rate:

Results in Table (7) showed significant differences (P<0.05) in litter size and mortality rate of bunnies among groups during different suckling intervals. Does in G2 drink magnetic water 1200 gauss showed significantly (P<0.05) the highest litter size during the different suckling intervals, followed by those in G3 drink magnetic water 3600 gauss, while those in G1 drink tap water had the lowest values. The litter size of G2 and G3 increased by 6.67 and 3.33% compared to G1, respectively. However, mortality rate revealed the opposite trend, which G1 showed significantly (P<0.05) the highest mortality rate, followed by G3, while G2 had the lowest rate. Mortality rate of young rabbit during suckling period decreased with advancing age as well as with increasing milk yield (Table 4). Mortality rate of G2 and G3 decreased by 5.46 and 2.80% compared with G1, respectively. These results agreed with those obtained by El-Hanoun *et al*. (2013) who found that exposure of water to the magnetic field increased (P≤0.05) litter size and number of kits born alive compared to those of does drank un magnetized water.

Table (6). Immunoglobulin concentration in blood serum of does and their offspring for the different groups.

Item	Experimental group		
	G1	G2	G3
Does:			
IgG (ng/ml)	3.44	3.92	4.26
IgM (ng/ml)	0.93	1.07	1.15
Offspring:			
IgG (ng/ml)	2.62	3.67	4.12
IgM (ng/ml)	0.75	0.88	1.18

Table (7). Litter size / doe and mortality rate (%) in different groups during suckling period.

Age (day)	Experimental group			MSE
	G1	G2	G3	
Litter size:				
1	7.0b	7.4a	7.2ab	0.19
7	6.6b	7.0a	6.8ab	0.13
14	6.3b	6.7a	6.5ab	0.16
21	6.1b	6.5a	6.3ab	0.14
30	6.0b	6.4a	6.2ab	0.12
Mortality rate (%):				
1-7	5.71a	5.41b	5.56ab	0.09
8-14	4.55a	4.29b	4.41ab	0.08
15-21	3.17a	2.99b	3.08ab	0.07
22-30	1.64a	1.54b	1.59ab	0.06
1-30	14.29a	13.51b	13.89ab	0.12

a, b: Values in the same row with different superscripts differ significantly (P<0.05).

Litter weight and gain:

Litter weight (LW) and their gain in different groups are shown in Table (8). The second group (G2) drink magnetic water 1200 gauss showed significantly (P<0.05) the highest litter weight and litter weight gain followed by G3 drink magnetic water 3600 gauss, while G1 had the lowest values. These results may be due to the higher milk yield for G2 compared to G1 as shown in Table (4). The litter weight of G2 and G3 at the weaning increased by 373 and 201 g or 15.32 and 8.26% compared to G1, respectively. The corresponding values for litter weight gain were 289 and 57 g or 14.01 and 2.76%, respectively. The improved litter performance was concurred with increased milk yield and its contents of fat, lactose and consequently energy. These results agreed with those obtained by El-Hanoun *et al*. (2013) who found that exposure of water to the magnetic field increased (P≤0.05) litter weight at birth and at day 28 of age compared to those of does drank un magnetized water.

Growth performance of bunnies:

Data in Table (9) showed similar trends to litter weight and gain, which bunnies of G2 drink magnetic water 1200 gauss were significantly (P<0.05) the heaviest weights and gains at different times of the suckling period followed by those of G3 drink magnetic water 3600 gauss, while those of G1 drink tap water had the lightest weight and gain. These results may be due to the higher milk yield for G2 compared to G1 as shown in Table (4). The bunnies weight of G2 and G3 at the weaning increased by 32.79 and 19.34 g or 8.08 and 4.77% compared to G1, respectively. The corresponding values for litter weight gain were 0.84 and 0.51 g/day or 7.16 and 4.34%, respectively. The improved performance for growing rabbits, before and after weaning coming from does consumed magnetic water, showing the carry over effect of water type and magnetic treatments on their progeny performance. This could be explained by the improvements in health and immunity of the does as mentioned previously. Similar results were reported by Attia *et al.*, (2011a, b, 2013). These improvements in progeny performance are in general agreement with those reported by Kronenberg (1993) and Lin (1995) who mentioned that magnetic water improved the performance of farm animals (chickens, turkeys, pigs, cows, calves and sheep).

Table (8). Litter weight and weight gain in different groups during suckling period.

Age (day)	Experimental group			MSE
	G1	G2	G3	
Litter weight (g):				
1	371c	455a	415b	26
7	715c	877a	815b	49
14	1139c	1345a	1263b	70
21	1621c	1895a	1773b	82
30	2434c	2807a	2635b	104
Litter weight gain (g):				
1-7	344b	422a	400ab	40
8-14	424b	477a	448ab	53
15-21	482b	541a	510ab	34
22-30	813b	912a	862ab	123
1-30	2063c	2352a	2220b	109

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Table (9). Average live body weight and gain of bunnies produced by does in different groups during suckling period.

Age (day)	Experimental group			MSE
	G1	G2	G3	
Bunnies weight (g):				
1	53.05b	61.25a	57.64ab	1.12
7	108.28b	125.28a	119.87ab	1.43
14	180.80	202.14a	194.28ab	1.76
21	265.78b	291.46a	281.43ab	1.95
30	405.73b	438.52a	425.07ab	2.24
Bunnies weight gain (g):				
1-7	8.69b	9.14a	9.89ab	0.19
8-14	10.36b	10.98a	10.63ab	0.22
15-21	12.14b	12.76a	12.45ab	0.26
22-30	15.55b	16.34a	15.96ab	0.29
1-30	11.74b	12.58a	12.25ab	0.33

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Economic efficiency:

Results in Table (10) showed that feed intake and feed cost was nearly similar for different groups. While, total cost (feed cost plus magnetic water cost) was higher significantly (P<0.05) for G3 drink magnetic water 3600 gauss followed by G2 drink magnetic water 1200 gauss, while G1 had the lower cost. The second group (G2) drink magnetic water 1200 gauss showed significantly (P<0.05) the highest price of weaning weight and net revenue followed by G3 drink magnetic water 3600 gauss, while G1 had the lowest values. Net revenue improved by 38.18% for G2, however decreased by 6.94% for G3 compared with G1, respectively.

Table (10). Economic efficiency for the different groups.

Item	Experimental group			MSE
	G1	G2	G3	
Feed intake (kg)	13.07	13.12	12.97	0.19
Feed cost (LE)	39.20	39.35	38.91	0.57
Cost of magnetic water (LE)	0	2	6	
Total cost (LE)	39.20b	41.35ab	44.91a	0.89
Weaning weight (g)	2434.38c	2806.53a	2635.43b	103.57
Price of weaning weight (LE)	55.99c	64.55a	60.61b	2.38
Net revenue (LE)	16.79b	23.20a	15.70b	2.42
Net revenue improvement %	00.00b	38.18a	-6.49c	0.53

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

CONCLUSION

Based on the foregoing results, it could be concluded that doe rabbits drink magnetic water at 1200 gauss showed the best results concerning reproductive performance, milk yield and composition, blood parameters and immune response of balady rabbit does as well as the best results regarding litter size and weight, mortality rate and growth performance of their offspring and economic efficiency.

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تأثير الماء المعامل بالمغناطيسية على الأداء الانتاجى والتناسلى لأمهات الأرانب البلدى ونتاجها

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استخدم فى هذه الدراسة 30 أم أرنب بلدى عمر 7-8 شهور ومتوسط وزنها الحى 3125±60.49 جم فى التصميم الكامل العشوائية ووزعت عشوائيا الى ثلاثة مجموعات متماثلة (10 أمهات بكل منها). استخدم ماء الصنبور فى شرب المجموعة الأولى (ج1) واعتبرت كمجموعة مقارنة، بينما استخدم الماء المعامل بالمغناطيسية 1200، 3600 جاوس فى شرب المجموعتين الثانية (ج2) والثالثة (ج3)، على التوالى. عذيت الأرانب فى كل المجموعات على عليقة الأرانب التجارية.

أظهرت النتائج أن المياه المعاملة بالمغناطيسية كانت ذات جودة أفضل من مياه الصنبور في التوصيل الكهربائى والملوحة والعسر الكلي. أظهرت أمهات المجموعة الثانية (ج2) التى تشرب الماء المعامل بالمغناطيسية 1200 جاوس معنويا (عند مستوى 0.05) أعلى وزن للجسم الحى عند التلقيح وعند الولادة، معدل الخصوبة من التلقيحة الأولى وأقل عدد من التلقيحات اللازمة لحدوث الاخصاب تلتها أمهات المجموعة الثالثة (ج3) التى تشرب الماء المعامل بالمغناطيسية 3600 جاوس، بينما كانت أقل القيم مع أمهات المجموعة الأولى (ج1) التى تشرب ماء الصنبور. علاوة على ذلك، سجلت أمهات ج2 معنويا (عند مستوى 0.05) أعلى متوسط لانتاج اللبن اليومى عند فترات الرضاعة المختلفة تلتها ج3، بينما كان أقل انتاج فى ج1 كذلك حققت ج2 معنويا (عند مستوى 0.05) أعلى نسب مئوية لكل من الدهن والبروتين والجوامد الصلبة الكلية والجوامد الصلبة اللادهنية فى اللبن عند فترات الرضاعة المختلفة تلتها ج3، بينما كان أقل انتاج فى ج01 بينما ارتفعت النسبة المئوية للاكتوز معنويا (عند مستوى 0.05) فى لبن ج2 و ج3 عن لبن ج01

أظهرت أمهات ج3 معنويا (عند مستوى 0.05) أعلى تركيزات لكل من البروتينات الكلية والجلوبيولين والليبيدات الكلية والجليسريدات الثلاثية والكوليسترول المنخفض الكثافة وكان أعلى تركيز للجلوكوز فى ج2، بينما حققت ج1أعلى تركيزات لكل من الألبيومين ونيتروجين اليوريا والكوليسترول المرتفع الكثافة ونشاط أنزيم الألانين فى الكبد (ALT)0 بينما تركيز الكرياتينين والكوليسترول الكلى ونشاط أنزيم الأسبرتيات (AST) لم تتأثر بمعاملة الماء بالمغناطيسية0 ارتفاع تركيزات المناعة (IgG & IgM) فى سيرم الأمهات ونتاجها فى ج3 تلتها ج2، بينما كانت أقل تركيزات فى ج1 مع عدم ظهور أى اختلافات معنوية0

أظهرت أمهات ج2 معنويا (عند مستوى 0.05) أعلى عدد للخلفات أثناء فترات الرضاعة المختلفة تلتها ج3، بينما كان أقل عدد فى ج01 على العكس من ذلك أظهر معدل النفوق اتجاه مضاد.

حققت ج2 معنويا (عند مستوى 0.05) أعلى وزن وزيادة فى وزن الخلفات خلال فترة الرضاعة تلتها ج3، بينما أظهرت ج1 أقل القيم0 كانت كميات الغذاء المأكول وتكلفة التغذية متماثلة تقريبا للمجموعات المختلفة0 بينما ارتغعت التكلفة الكلية (تكلفة التغذية وتكلفة المعاملة المغناطيسية للماء) معنويا (عند مستوى 0.05) فى ج3 تلتها ج2، بينما كانت أقل تكلفة فى ج01 حققت ج2 معنويا (عند مستوى 0.05) أعلى ثمن لوزن الفطام والعائد الصافى تلتها ج3، بينما كانت أقل القيم فى ج1

نستخلص من هذه الدراسة أن المعاملة المغناطيسية لماء الشرب بمعدل 1200 جاوس حققت أفضل النتائج من حيث أداء التناسل وانتاج اللبن وتركيبه وصفات الدم والاستجابة المناعية لأمهات الأرانب البلدى وكذلك عدد الخلفات و وزنها وأداء النمو للنتاج خلال فترة الرضاعة والكفاءة الاقتصادية.