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Effect of Magnetized Water on Productive Performance and Digestive System of Japanese Quail

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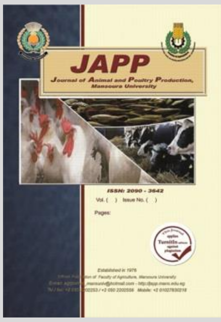

ABSTRACT

Four hundred and five unsexed Japanese quail were divided randomly to three treatments with three replicates for each treatment. In two-way analysis experimental design to compare between effect of sex and magnetized water (MW) and tap water on productive performance ,feed consumption (FC), feed conversion ratio (feed/gain) (FCR), relative weights of digestive tract, liver, gizzard, proventriculus, spleen and heart of Japanese quail. The first group drank normal tap water as a control group. The other groups drank the magnetized water which exposed to electric magnetic field with forces: 10000 gauss (1Tesla) (MW1) as second group or 20000 gauss (2 Tesla) MW2 as third group. (MW2). The most important results as follow: MW1 caused highly significant increase in LBW and LBWG and had better FCR compared to the other groups of Japanese quail. The birds that drank magnetized water were lower FC than those drank ordinary water. There was significant increase in LBW, LBWG and FC of female compared with male, and the females owned the best values of FCR during the all periods compared to males. Significant differences in rectal length at 35 days of age were found. Insignificant differences in lengths of the digestive system at all ages of study were found expect rectal length at 35 days of age was significant ($P \leq 0.05$) for treatments and the control group recorded highly length than magnetized water groups. It could be concluded that productive performance and digestive system of Japanese quail were improved due to offering MW1 was adequate to provide the beneficial effects.

Keywords: Digestive tract, Japanese quail, magnetized water, body weight, feed consumption, feed conversion ratio

INTRODUCTION

The water is the most important nutrient for growth and development. Furthermore in commercial production, water quality and consumption are generally not taken into consideration (Counotte, 2003). Low quality of water, presents one of major challenges to poultry farming (Attia *et al*., 2013; 2015), especially in arid areas. The magnetic field of the earth naturally charges the water in lakes, wells, and running streams. However, water loses its magnetic charge as it passed through treatment plants and pipes. The exposure of water to magnetic fields restores and balances its natural energy (Ovchinnikova and Pollack, 2009). Passing water through a magnetic field has been claimed to improve chemical, physical and bacteriological quality of water in many different applications.

The pH of water is a major factor effect on the amount of drinking water that birds consume (Marks, 1981). Contact of water with a permanent magnet for a long time produced magnetic charges and magnetic properties. Exposing of water to strong magnetic fields affected the mineral content of water and its effects depended upon the strength of the magnetic field and exposure time. Suggested that there is a change in mineral contents of water by magnetizing that causes them to pass the biological membranes more easily. Yi-Long et al., 1992 presented the possibility that magnetic water can prevent aging and fatigue by rising the cell membrane permeability. Also, Buyukuslu et al., (2006) indicated that the activity of superoxide dismutase was rise in magnetic field. Water magnetization changes water properties which become more energized, active, soft and high pH to slight alkaline and free of microorganism (Mg-Therapy., 1984). Physics shows that water changes weight under the influence of magnetic fields. More hydroxyl (OH-) ions are created to form alkaline molecules, and reduce acidity. Surface tension in magnetized water is reduced by 10-12% whilst its velocity is increased in compare with regular water. Therefore it's penetration into cell wall would be facilitated which can accelerate ordinary diffusion of water that is vital for growth of different organs (Cho and Lee, 2005, Hafizi et al., 2014). Rona (2004) found that using magnetic drinking water for chickens resulted in shortening of fattening period of broiler chickens, an increase in growth rate by 5-7%, improving meat quality, flavor and tenderness, as well as a decrease in feed intake and an improve in feed conversion ratio were detected (SagBaug, 2003).

MATERIALS AND METHODS

Four hundred and five unsexed quail chicks (ten days old) with an average weight of 49.23 g were assigned randomly to three equal treatments at batteries, each treatment containing 135 birds in three replicates of 45 birds each. The first group drank normal tap water

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as a control group. The second group drank the magnetized water which exposed to electric magnetic field with force 1 Tesla (MW1). The third group drank the magnetized water which exposed to electric magnetic field with force 2 Tesla (MW2). The steps of manufacturing an electromagnetic apparatus carried out according to Tantawy (2020). Chicks received the starter diet from 10 days of age containing 2900 kcal/kg metabolizable and 24% crude protein and the grower diet from three weeks of age containing 2800 kca/kg metabolizable energy and 20% crude protein. Both two diets were formulated according to NRC recommendation (1994). Productive performance; live body weight (LBW), live body weight gain (LBWG), feed consumption (FC), feed conversion ratio (feed/gain) (FCR), relative weights and lengths of digestive tract, in addition to relative weights of liver, gizzard, proventriculus, spleen and heart were measured. The number of 18 (6 birds/treatment) birds (9 male and 9 female) were chosen for slaughtering at (21 and 35 days of age) to determine previous characteristics of slaughtered birds. Data of productive performance and relative weight of organs, in addition to lengths of the digestive tract were computed using General Linear Model (GLM) procedure according to *SPSS*, 16.0 (2007), and analyzed two way analyses of variance with treatment and sex as main effects according to the following model:-

$$Y_{ijk}=\mu+T_i+S_j+TS_{ij}+e_{ijk}$$

Where: **Y_{ijk}: the observation on the ijk[th] the studied traits of Japanese quail µ: overall mean, T_i: treatment effect (i: 1 to 3), S_j: sex effect (j: 1 and 2), TS_{ij}: Interaction of treatment by sex, eijk: random error term. Significant differences (P≤0.05) among treatment means were evaluated using Duncan's multiple range test *(*Duncan, 1955*)*.**

RESULTS AND DISCUSSION

Effect magnetized water on productive performance.

Live body weight (LBW):

The results in Table (1) indicated that, magnetized water (MW) with level 1 Tesla caused highly significant increase in LBW of Japanese quail compared to those that drank magnetized water (MW) with level 2 Tesla or ordinary water at 21, 28 and 35 days of age. There was significant increase in LBW of female compared with male. However, no significant effect was observed by the interactions between water treatment and sex of birds on the LBW at all ages. This may be because magnetic water is able to increase the solubility of minerals, thus facilitating the better transfer of the nutrients to all parts of the body of quail via the membrane. The improvement obtained with magnetic water in the present study for Japanese quail is in agreement with Al-Fadul (2006) who reported that magnetization of the water significantly increased Arbor Acres broiler LBW especially in the late weeks. The ingestion of magnetized tap water improved body weight (El-Hanoun *et al.,* 2017).

Live body weight gain (LBWG):

The effects of MW on the LBWG of Japanese quail during the different periods are shown in Table (2). There are significant differences in LBWG of chicks by the effect of treatment during the periods from 10-21 and from 10-35 days of age or by sex during the all periods but not by the effect of the interactions among treatments and sex during the all periods. And the group of MW1 (1Tesla) owned elevation in LBWG compared to the other groups and the females had higher LBWG than males. Also, the improvements found in the present study for LBWG of chicks as a result of drinking magnetic water are in line with the pervious findings by Al-Fadul (2006); Nada *et al.* (2007); Gholizadeh *et al.* (2008); Mahmoud *et al.*, (2017). Water passing through a magnetic field acquires a finer and more homogeneous structure (Tkachenko and Semyonova, 1995), which increases its fluidity and ability to dissolve various constituents such as minerals and vitamins (Kronenberg, 1985). Consequently, it improves the biological activity of solutions, positively affecting performance of animals (Al-Mufarrej *et al.*, 2005). Verma (2011) found that magnetized water reduces the hydrogen-oxygen bond angle within the water molecule from 104 to 103 degrees, leading to better water absorption across cell membranes.

Feed consumption (FC)

The results of in Table (3) shown that, there are significant variation among treatment in FC during the three periods from 10-21, 21-35 and 10-35 days of age and the group of control consumed higher feed compared to the groups of MW1 and MW2. Not significant differences were observed on FC of Japanese quail by sex and the interaction effect between treatment and sex. This result agreement with SagBaug (2003); El-Katcha *et al.* (2016); Jassim and Aqeel (2017); Mahmoud *et al.* (2017); and Mustafa (2018).

Table 1. Effect magnetized water on body weight for Japanese quail at (10, 21, 28 and 35) days of age.

Age (day) Treatments	10	21	28	35
Treatments effect				
Control	48.889	108.84[b]	152.09[b]	197.96[b]
MW(1Tesla)	49.258	119.42[a]	159.36[a]	208.98[a]
MW(2 Tesla)	49.379	113.27[b]	154.55[ab]	200.60[b]
SEM	0.363	0.985	1.368	1.625
SIG	NS	***	NS	*
Sex effect				
F	49.358	115.233	156.707	208.206
M	48.965	111.409	152.847	192.385
SEM	0.527	1.460	2.004	2.322
SIG	NS	NS	NS	***
Interaction				
T X S	49.233	113.544	154.250	200.483
Control F	50.271	110.506	152.390	201.778
M	47.860	106.860	151.979	189.851
MW(1Tesla) F	48.920	121.455	158.612	215.827
M	49.596	116.085	154.068	197.136
MW(2Tesla) F	49.318	114.141	155.988	206.963
M	49.440	112.220	152.196	191.348
SEM	0.915	2.483	3.466	3.999
SIG	NS	NS	NS	NS

[a,b] Means having different superscripts within each effect in the same column are significantly different at accompanied probability. NS= insignificant; *=significant at P≤0.05 *=significant at P≤0.001 MW = water magnetized; F = female; M =Male; SEM = Standard Error Means.**

Table 2. Effect of magnetized water on live body weight gain (LBWG; g) Japanese quail at different periods.

Age (day) Treatments		10-21	21-28	28-35	10-35
Treatment effect					
Control		59.774[c]	44.278[a]	46.614	148.543[b]
MW (1Tesla)		70.154[a]	40.287[b]	46.220	156.794[a]
MW(2Tesla)		64.044[b]	40.763[b]	46.095	150.375[b]
SEM		0.000	0.010	0.958	0.043
SIG		***	*	NS	*
Sex effect					
Female(F)		66.78[a]	42.79	51.14[a]	159.40[a]
Male (M)		62.54[b]	40.76	41.46[b]	144.41[b]
SEM		0.003	0.085	0.000	0.000
SIG		**	NS	***	***
Interaction					
T X S					
Control	F	60.988	44.429	52.455	155.937
	M	58.580	44.128	40.773	141.149
MW(1Tesla)	F	73.860	42.688	49.848	165.543
	M	66.447	37.886	42.591	148.045
MW(2Tesla)	F	65.488	41.259	51.190	156.728
	M	62.600	40.267	41.000	144.022
SEM		0.293	0.246	0.476	0.784
SIG		NS	NS	NS	NS

a,b,c; Means having different superscripts within each effect in the same column are significantly different at accompanied probability. NS= insignificant; *=significant at P≤0.05 **=significant at P≤0.01 *=significant at P≤0.001; MW = water magnetized; F = female; M=Male; SEM = Standard Error Means.**

Table 3. Effect of magnetized water on feed consumption (FC) for Japanese quail.

Age (day) Treatments		10-21	21-28	28-35	10-35
Control		190.895[a]	158.601[a]	198.503	547.9720[a]
MW(1Tesla)		178.050[b]	137.3520[c]	197.711	513.111[b]
MW(2Tesla)		175.338[c]	142.9750[b]	196.562	514.874[b]
SEM		0.223	0.228	0.385	2.364
SIG		***	***	NS	***
Sex effect					
F		181.45	148.765	206.02	536.22
M		181.38	146.831	205.59	533.80
SEM		1.39	1.35	1.41	3.44
SIG		NS	NS	NS	NS
Interaction					
T X S					
Control	F	180.82	137.19	250.46	568.10
M		181.01	136.61	249.77	567.39
MW(1Tesla)	F	178.41	138.05	249.85	566.21
M		177.40	135.11	247.59	560.16
MW(2Tesla)	F	175.11	136.80	251.19	563.17
M		175.27	134.05	248.00	557.33
SEM		1.56	2.44	2.476	5.96
SIG		NS	NS	NS	NS

a,b,c: means in the same raw having different superscripts are significantly at p≤0.05. MW = water magnetized F = female M =Male FC= feed consumption *=significant at P≤0.001; **=significant at P≤0.01 NS= insignificant**

Feed conversion ratio (FCR):

The mean values of feed conversion ratio (FCR) for the three treatment s during the periods (10-21, 21-35 and 10-35 days of age) are shown in Table (4). Which observed that magnetic water with levels of 1 and 2 Tesla caused improving in FCR during the period from 10-21 compared to the control. But the group of MW1 (1Tesla) had the best value for FCR during the period from 10-35 days of age. And the females owned the best values of FCR during the all periods compared to males. While the interactions among the treatment s and sex did not affect. The present results confirm the pervious findings of Al-Fadul (2006); Nada *et al.* (2007); El-Katcha *et al.* (2016); Jassim and Aqeel (2017); Mahmoud *et al.* (2017) and Mustafa (2018) who found that FCR of broiler chickens was improved by magnetization of water.

Table 4. Effect of magnetized water on feed conversion ratio (FCR) for Japanese quail.

Age(day) Treatments		10-21	21-28	28-35	10-35
Treatment effect					
Control		3.19[a]	3.58[a]	4.26	3.69[a]
MW1 (1Tesla)		2.58[b]	3.41[b]	4.28	3.27[c]
MW2 (2 Tesla)		2.74[b]	3.51[ab]	4.26	3.42[b]
SEM		0.02	0.05	0.14	0.03
Sig		***	*	NS	***
Sex effect					
F		2.70[b]	3.48	4.03[b]	3.36[b]
M		2.90[a]	3.60	4.96[a]	3.69[a]
SEM		0.05	0.11	0.18	0.04
SIG		*	NS	***	*
Interaction					
T X S					
Control	F	2.96	3.09	4.77	3.64
	M	3.08	3.10	6.13	4.02
MW(1Tesla)	F	2.42	3.23	5.01	3.42
	M	2.67	3.57	5.81	3.78
MW(2Tesla)	F	2.67	3.32	4.91	3.59
	M	2.80	3.33	6.05	3.87
SEM		0.08	0.20	0.01	0.05
SIG		NS	NS	NS	NS

a,ab,c: means in the same row having different superscripts are significantly at p≤0.05.

a,b Means having different superscripts within each effect in the same column are significantly different at accompanied probability. NS= insignificant; *=significant at P≤0.05; *=significant at P≤0.001; MW = Magnetized water; SEM = Standard Error Means; F= Female; M= Male.**

Relative weight of organs at 21day

The mean values for relative weight of organs (liver, gizzard, proventriculus, heart and spleen) of Japanese quail at 21day of age for the three treatments of magnetic water and tap water are shown in Table (5). There are insignificant differences (P>0.05) among treatments, sex and interaction between treatment by sex in the relative weight of organs digestive tract, liver, gizzard, proventriculus, heart and spleen of Japanese quail at 21 days of age. Also, not effect on relative weight organ neither numerically nor.

Relative weight of organs at 35 day

The influence of treatment, sex and interaction between treatment by sex were insignificant (P>0.05) on relative weight of organs (digestive tract, liver, gizzard, proventriculus, heart and spleen) of Japanese quail at 35 days of age Table (6).

Table 5. Effect of magnetized water on relative weight of organs (digestive tract (DT), liver (Liv), gizzard (Giz), proventriculus (Prov), heart (H) and spleen (Sp)) of Japanese quail at 21 days of age.

Items	Relative weight of organs					
	DT	Liv	Giz	Prov	H	Sp
Treatment effect						
Control	7.37	3.42	2.54	0.71	0.88	0.08
MW1 (1Tesla)	8.75	3.73	2.33	0.76	0.89	0.09
MW2 (2 Tesla)	6.90	3.93	2.47	0.70	0.94	0.12
SEM	0.374	0.174	0.134	0.047	0.051	0.06
Sig	NS	NS	NS	NS	NS	NS
Sex effect						
Female (F)	7.888	3.65	2.49	0.72	0.94	0.09
Male (M)	7.462	3.74	2.40	0.72	0.87	0.21
SEM	0.648	0.17	0.110	0.038	0.042	0.022
Sig	NS	NS	NS	NS	NS	NS
Interaction						
Control F	7.970	3.55	2.35	0.71	0.89	0.09
M	6.971	3.30	2.73	0.71	0.87	0.08
MW1(1Tesla) F	7.71	3.73	2.38	0.74	0.94	0.11
M	9.59	3.74	2.28	0.77	0.84	0.07
MW2 (2Tesla) F	7.99	3.68	2.75	0.75	0.97	0.07
M	5.82	4.17	2.20	0.69	0.91	0.17
SEM	0.07	0.246	0.190	0.067	0.071	0.088
Sig	NS	NS	NS	NS	NS	NS

Means having different superscripts within each effect in the same column are significantly different at accompanied probability. NS= insignificant; MW = magnetized water; SEM = Standard Error Means.

Table 6. Effect of magnetized water on relative weight of organs (digestive tract (DT), liver (Liv), gizzard (Giz), proventriculus (Prov), heart (H) and spleen (Sp)) of Japanese quail at 35 days of age.

Items	Relative weight of organs					
	DT	Liv	Giz	Prov	H	Sp
Treatment effect						
Control	4.492	2.75	2.05	0.55	1.16	0.05
MW1 (1Tesla)	4.505	2.15	2.24	0.49	1.04	0.07
MW2 (2 Tesla)	4.190	2.70	2.32	0.51	1.03	0.09
SEM	0.837	0.14	0.08	0.02	0.03	0.013
Sig	NS	NS	NS	NS	NS	NS
Sex effect						
Female (F)	4.483	2.52	2.29	0.50	1.08	0.07
Male (M)	4.308	2.54	2.12	0.54	1.08	0.061
SEM	0.716	0.25	0.14	0.03	0.05	0.010
Sig	NS	NS	NS	NS	NS	NS
Interaction						
Control F	4.97	2.78	2.09	0.56	1.12	0.05
M	4.01	2.73	2.01	0.54	1.19	0.05
MW1(1Tesla) F	4.11	2.08	2.12	0.43	1.06	0.05
M	4.90	2.22	2.36	0.54	1.02	0.08
MW2(2Tesla) F	4.37	2.7	2.65	0.50	1.05	0.08
M	4.01	2.67	1.98	0.52	1.02	0.09
SEM	0.38	0.38	0.16	0.04	0.07	0.02
Sig	NS	NS	NS	NS	NS	NS

Means having different superscripts within each effect in the same column are significantly different at accompanied probability. NS= insignificant; MW= magnetized water SEM = Standard Error Means.

Effect magnetized water on some lengths of the digestive tract of Japanese quail

Some lengths of the digestive tract (duodenum, small intestine, cecum and rectal) of Japanese quail at 21 days of age were found in Table (7). Not significant differences in lengths of the digestive system at 21 days of age were found for all studied effects.

Some lengths of the digestive tract (duodenum, small intestine, cecum and rectal) of Japanese quail at 35 days of age were found in Table (8). Not significant differences in lengths of the digestive system at 35 days of age were found for all studied effects expect rectal length was significant ($P \leq 0.05$) for treatments and the control group recorded highly length than magnetized water groups.

Table 7. Effect of magnetized water on some lengths of the digestive tract (duodenum, small intestine, cecum and rectal) of Japanese quail at 21 days of age.

Items	Lengths of the digestive tract			
	Du	SI	Ce	Re
Treatment effect				
Control	9.83	42.17	12.00	4.67
MW1 (1Tesla)	10.67	43.67	14.67	4.83
MW2 (2 Tesla)	10.33	43.00	13.50	4.83
SEM	0.17	0.70	0.55	0.20
Sig	NS	NS	NS	NS
Sex effect				
Female (F)	10.44	43.00	12.56	4.78
Male (M)	10.11	42.89	14.22	4.78
SEM	0.29	1.21	0.95	0.35
Sig	NS	NS	NS	NS
Interaction				
Control F	9.67	43.00	11.00	4.78
M	10.00	41.33	13.00	4.67
MW1 (1Tesla) F	11.00	43.00	13.67	5.00
M	10.33	44.33	15.67	4.67
MW2 (2Tesla) F	10.67	43.00	13.00	4.67
M	10.00	43.00	14.00	5.00
SEM	0.41	1.87	1.37	0.54
Sig	NS	NS	NS	NS

Means having different superscripts within each effect in the same column are significantly different at accompanied probability.
NS= insignificant; MW = magnetized water SEM = Standard Error Means; Du= Duodenum; SI= Small Intestine; Ce= Cecum and Re= rectal.

Table 8. Effect of magnetized water on some lengths of the digestive tract (duodenum, small intestine, cecum and rectal) of Japanese quail at 35 days of age.

Items	Lengths of the digestive tract			
	Du	SI	Ce	Re
Treatment effect				
Control	10.67	44.33	9.67	6.00[a]
MW1 (1Tesla)	10.67	41.17	9.67	5.50[ab]
MW2 (2 Tesla)	10.67	42.33	11.00	4.33[b]
SEM	0.24	1.16	0.68	0.26
Sig	NS	NS	NS	*
Sex effect				
Female (F)	10.22	42.67	10.22	5.33
Male (M)	11.11	42.65	10.00	5.22
SEM	0.42	2.02	1.18	0.46
Sig	NS	NS	NS	NS
Interaction				
Control F	10.00	43.33	8.00	6.33
M	11.33	45.33	11.33	5.67
MW1 (1Tesla) F	10.67	41.00	11.33	5.33
M	10.67	41.33	8.00	5.67
MW2 (2Tesla) F	10.00	43.89	11.33	4.33
M	11.33	41.00	10.67	4.33
SEM	0.54	3.11	1.59	0.71
Sig	NS	NS	NS	NS

Means having different superscripts within each effect in the same column are significantly different at accompanied probability.
NS= insignificant; *=significant at $P \leq 0.05$; MW = magnetized water; SEM = Standard Error Means; Du= Duodenum; SI= Small Intestine; Ce= Cecum and Re= rectal

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تأثير الماء الممغنط علي الأداء الإنتاجي والجهاز الهضمي للسمان الياباني

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تم تقسيم أربعمائة وخمسة سمان ياباني غير مجنس بشكل عشوائي إلى ثلاث معاملات بثلاث مكررات لكل معامله. تصميم التجربة بالتحليل ثنائي الاتجاه للمقارنة بين تأثير الجنس والمياه الممغنطة (MW) ومياه الصنبور على الأداء الإنتاجي مثل؛ وزن الجسم الحي (LBW)، زيادة وزن الجسم الحي (LBWG)، العلف المستهلك (المأكول) (FC)، معامل التحويل الغذائي (العلف المأكول / الزيادة الوزنية) (FCR) ، الأوزان النسبية وأطوال الجهاز الهضمي، بالإضافة إلى الأوزان النسبية للكبد، والمعدة الغدية والقانصة والطحال والقلب بالسمان الياباني. المجموعة الأولى شربت ماء الصنبور العادي كمجموعة كنترول. المجموعة الثانية شربت الماء الممغنط الذي تعرض لمجال مغناطيسي كهربائي بقوة 10000 غاوس (1 تسلا) (MW1). المجموعة الثالثة شربت الماء الممغنط الذي تعرض لمجال مغناطيسي كهربائي بقوة 20000 غاوس (2 تسلا) (MW2). أهم النتائج على النحو التالي: تسبب الماء الممغنط بقوة ا تسلا MW1 في زيادة معنوية في LBW و LBWG وكان أفضل FCR مقارنة بالمجموعات الأخرى من السمان الياباني. كانت الطيور التي شربت الماء الممغنط أقل من تلك التي شربت الماء العادي في كمية الاعلاف المستهلكة. كانت هناك زيادة معنوية فيLBW، LBWG و FC للإناث مقارنة بالذكور، وكانت الإناث تمتلك أفضل قيم FCR خلال جميع الفترات مقارنة بالذكور. عدم وجود اختلافات معنوية في أطوال الجهاز الهضمي في جميع الأعمار المدروسة باستثناء طول المستقيم عند عمر 35 يوما من العمر كان معنويا ($P \leq 0.05$) وسجلت المجموعة الضابطة طولا اكبر من مجموعات المياه الممغنطة. يمكن استنتاج أن الأداء الإنتاجي والجهاز الهضمي للسمان الياباني قد تحسن بسبب التعرض لمجال مغناطيسي كهربائي بقوة 10000 غاوس (1 تسلا) MW1 و كان كافياً لتوفير تأثيرات مفيدة.

الكلمات الدالة: الجهاز الهضمي، السمان الياباني، المياه الممغنطة، وزن الجسم، العلف المستهلك ، معامل التحويل الغذائي.