Research Journal of
Pharmacology

Effect of Magnetic Drinking Water and Both of Feed Form and Feed Restriction on Sasso Broilers I. Productive Performance

M.S.H. Mahmoud, F.N.K. Soliman, M. Bahie EL Deen and Azza EL Sebai
Department of Poultry Production, Faculty of Agriculture, "EL-Shatby", Alexandria University, Alexandria, Egypt

Key words: DBWG, DWC, FCR, magnetic water, Sasso broiler

Corresponding Author:
M.S.H. Mahmoud
Department of Poultry Production, Faculty of Agriculture, "EL-Shatby", Alexandria University, Alexandria, Egypt

Page No.: 24-32
Volume: 14, Issue 3, 2020
ISSN: 1815-9362
Research Journal of Pharmacology

Abstract: The experiment was conducted to evaluate the effect of using the magnetic drinking water and both of the form and feed restriction on the broilers (Sasso strain) chick's performance: Body Weight (BW), Daily Body Weight Gain (DBWG), Daily Water Consumption (DWC), Daily Feed Consumption (DFC), Feed Conversion Ratio (FCR) and Mortality Percentages (MR) of the whole experimental period. A total number of 1600 chicks unsexed Sasso broiler was used, divided into eight Treatments with two replicates for each treatments, in factorial experimental design 2×2×2 by two replicates. The results of present study for the whole experimental period, showed highly significant differences ($p \leq 0.001$) between water treatments on BW at 8 weeks of age, since, the birds drank magnetic water has heavier BW than those drank ordinary water. Also, feed form and restricted diet had significant differences on Sasso broiler BW, since, those fed crumble diet or fed *ad libtum* has heavier weight than those fed pellet diet or fed 90% amount of feed. The results of DBWG showed significant difference between all treatment studied, since, magnetic water, crumble diet and *ad libitum* feeding has the superiority in that respect. Magnetic water and ad libtum feeding reduce significantly ($p \leq 0.001$) DWC values while the effect of feed form in that respect was insignificant. The only significant differences ($p \leq 0.001$) of DFC values was found between feeding treatments, since, those fed *ad libtum* has higher DFC (80.99 g) than those fed 90% amount of diet (70.63 g). The results of FCR indicated highly significant differences between water treatments, since, those drink magnetic water have better FCR values compared with those drink ordinary water. Feed form has insignificant differences in respect of FCR values, both forms has equal value (2.31), however, feed restriction has highly significant better FCR value (2.21) than those fed

ad libtium (2.41). In respect of MR, magnetic water treatment has significant ($p \leq 0.05$) higher MR than those drink ordinary water. Feed forms have insignificant effect on MR while the feed restriction has highly significant ($p \leq 0.01$) better MR value (2.06%) than *ad libitum* feeding (3.44%).

INTRODUCTION

Water is a major component of plants and animals and is the main medium for biochemical reactions. Using water magnetization has recently risen in different fields such as medical, engineering and agriculture, particularly in plant, animal and poultry production[1], lead to change the functions of organism[2]. Moreover, water magnetization changes water properties which becomes more energized, active, soft and high pH toward slight alkaline and free of germs[3]. Several reports are available on the application of water magnetization on broiler production[4]. Rona[5] 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[6].

On the other hand, different types of feed forms have been evolved in commercial broiler production at the present time. Broiler chicks can attain 2 kg body weight within 35 days, consuming only 3 kg feed[7]. The increase of feed intake is perhaps the single most important factor determining feed efficiency of broiler[8]. The physical form of feed is mash, pellet and crumble, for different age of birds, is a critical factor in meat yield of broiler. The feed consumption differed significantly among broiler fed different form diets[9]. However, the feed forms are important factor which directly influence the cost of production of broiler.

Dietary manipulation methods (feed restriction) play an important role in controlling the broiler growth. Plavnik and Hurwitz[10] defined the physical or quantitative feed restriction as provide a calculated quantity of feed per bird which is often just enough to meet maintenance requirements. In general, it can be defined as constrain due to the need to weight feed on a daily basis. There are many dietary methods for feed restriction physical (quantitative) feed restriction, skip-a-day feeding, reducing hours of illumination feeding[11] or the diet dilution, chemical and use of low protein or low energy and energy to protein ratio[12].

The current study was carried out to evaluate the effect of using the magnetic drinking water and both of the form and feed restriction on the broilers (Sasso strain) chick's performance.

MATERIALS AND METHODS

A total number of 1600 chicks one day old of unsexed Sasso broiler with an average initial weight was 40.0±2.0 g were used in this experiment. The study included eight groups of treatments with two replicates for each treatments (16 pens) in factorial experimental design 2×2×2 (two types of water treatments by two diet forms and two types of amount of feed) by two replicates. All birds were randomly divided in each pen. The birds were randomly allocated to eight treatments combinations: T1 birds drink magnetic water and fed *ad-libitum* crumble diet, T2 birds drink magnetic water and fed 90% amount of crumble diet, T3 birds drink magnetic drinking water and fed *ad-libitum* pellets diet, T4 birds drink magnetic water and fed 90% amount of pellets diet, T5 birds drink ordinary water and fed *ad libitum* crumble diet, T6 birds drink ordinary water and fed 90% amount of crumble diet, T7 birds drink ordinary water and fed *ad-libitum* pellets diet and T8 birds drink ordinary water and fed 90% amount of pellets diet. Birds in each replicate were kept in a partition (pens) of 5 m^2 space, 2.5 m long and 2 m width (20 birds/m^2) from one day up to 21 days of age, after that (10 birds/m^2) from 22 days up to the end of the experimental period, reared on the floor bedded with dry wood shavings provided with 6 cm height. Sasso broiler was provided with fresh Magnetic Water Treatment (MWT) every 12 h following the recommendations of the magnetic funnel manufacturer, produced by Delta water company (Web site: http://www.deltawater.net/). Also as reported by Khudiar and Ali[13]. The magnetized water can be kept in a reservoir for 0-12 h but over this range, its advantage may be lost[14]. Magnetic water treatment provided from 1-10 day-old via. inverse hand-fill drinkers (4 L) then the bigger capacity (8 L) were used tills the end of the experimental period (56 days of age). At 8 days of age until the end of the experimental period, the restricted birds (T2, T4, T6 and T8) received 90% of the quantity consumed by the broilers fed ad libitum (T1, T3, T5 and T7) on the previous day[15, 16]. The chicks were brooded on floor brooder at a starting temperature of 31.1°C for the first week and then decreased gradually 1-3°C every two days to reach 26:28°C until the end of the experimental period. The partitions without fans and has one window for each partition. The chicks were exposed to continuous lighting (24 h per day), one lamp 40 watt for each pen until the end of the fattening period. Two experimental commercial diets were used in this study, the first diet was starter diet used from 1-20 day of age, contained 23.37% crude protein and 3041.07 Kcal metabolizabale energy ME/kg and the second was fattening diet used from 21 day till the end of the experimental period (56 days of age), contained 21.28% crude protein and 3068.37 Kcal

ME/kg, water was available all the time; also all birds were kept under similar management conditions. The studied traits were: individual weekly Body Weight (BW), Daily Body Weight Gain (DBWG), Daily Water Consumption (DWC), Daily Feed Consumption (DFC), Feed Conversion Ratio (FCR) and Mortality Rate (MR). These traits calculated for the whole experimental period (1-56 days of age).

Data were analyzed using SAS[17] for statistical analysis program. Before analysis, all percentages data were transformed to their corresponding arcsin angles according to Snedecor and Cochran[18]. The significant tests for the differences between each two means for any studied trait were done according to Duncan[19].

RESULTS AND DISCUSSION

Body Weight (BW): The BW results (Table 1) noted significant higher BW for those drink magnetic water, fed crumble diet or fed ad libitum (1914, 1900 and 1940 g, respectively) over those drink ordinary water, fed pellet diet or fed 90% amount of feed (1838, 1865 and 1826 g, respectively).

The improvements obtained with magnetic water in the present study for Sasso broiler BW are in line with the pervious findings by Rona[5] and Tyari *et al.*[20]. Al-Fadul[21] reported that magnetization of the water significantly increased Arbor Acres broiler BW especially in the late weeks. However, other researchers found that the use of magnetic water did not influence the performance of chickens[22, 4]. The differences results among studies in this field may be due to broiler strain, the magnetizer device type, power of magnetization, speed of the device, experimental procedures, etc.

The present results confirm the previous finding results, observed the superiority of weights for broiler chicks fed crumble diet[23, 24] or crumble-pellet diets[25, 26] over other forms studied. In contrast, Rierson[27] reported that Cobb 500 male broilers fed a pelleted diet had significantly better performance than those fed crumbles. These differences among studies may be due to strain of bird, the feed process procedures, the specifications of different forms (physically and their composition), particle size (degree of grinding), etc.

The present results showed that the feed intake of 90% feed reduce significantly 56-day Sasso broiler BW which are line with the findings of Omosebi *et al.*[28], Nassef *et al.*[29], Trocino *et al.*[16] and Adeyemi *et al.*[30] with different broiler strains, types and duration of feed restriction. Early feed restriction had insignificant or a low impact on broiler body weight as stated by Saber *et al.*[31] and Rahimi *et al.*[32]. However, Rokeshi and Jafari[15] found that early quantitative feed restriction improved the productive parameters which allow a complete recovery of broiler body weight. The inconsistent results and the variation in literature within this field may be partially due to differences in strain, management, method, timing, severity and duration of feed restriction applied.

Table 1: The effects of magnetic Water (W), Feed forms (F) and feed Restriction (R) treatments on Sasso broiler body weight, daily body weight gain, daily water consumption traits (M±SE) during the whole experimental period

Parameters Effects	56-d Body weight (g)	Daily Body weight gain (g/bird/day)	Daily water consumption (milliliter/bird/day)
Water treatments (W)			
Magnetic water	1914^{a}±11.58	33.5^{a}±0.21	211.50^{a}±1.77
ordinary water	1838^{b}±11.98	32.2^{b}±0.21	218.63^{b}±1.24
Feed forms (F)			
Crumbles	1900^{a}±11.40	33.2^{a}±0.20	215.63±1.67
Pellets	1865^{b}±12.55	32.6^{b}±0.22	214.50±1.88
Feed Restriction (R)			
ad-libitum	1940^{a}±12.01	33.1^{a}±0.21	211.88^{a}±1.14
90% amount of feed	1826^{b}±11.45	31.9^{b}±0.20	218.25^{b}±1.92
Significance			
W	***	***	***
F	*	*	NS
R	***	***	***
Interactions			
MW×C×ad	1951^{b}±18.60	34.2^{ab}±0.33	207.50^{a}±2.02
MW×C×R	1883^{d}±21.53	32.9^{b}±0.39	222.50^{c}±1.44
MW×P×ad	1980^{a}±26.88	34.7^{a}±0.49	209.50^{a}±0.29
MW×P×R	1817^{e}±25.42	31.8^{c}±0.45	206.50^{a}±0.87
OW×C×ad	1869^{d}±38.59	32.7^{b}±0.71	212.50^{ab}±0.87
OW×C×R	1840e±20.47	32.2c±0.36	220.00bc±1.15
OW×P×ad	1900c±20.38	33.3b±0.36	218.00b±0.58
OW×P×R	1767f±22.85	30.9d±0.41	224.00c±2.31
Significance			
W × F × R	*	*	***

MW = Magnetic Water; C = Crumbles; ad = ad-libitum; OW = Ordinary Water; P = Pellets; R = 90% amount of feed; *= Significant at p≤0.05; ***= Significant at p≤0.00; NS = Not Significant; $^{a-c}$Means having different letters in the same column and effect indicating significant differences (p≤ 0.05)

Considering the second order interactions (Table 1), the birds drink magnetic water and fed *ad libitum* pellet diet has significant ($p \leq 0.05$) highest 56-day BW (1980 g) while the birds drink ordinary water and fed 90% amount of pellet feed has the lowest (1767 g) ones.

Generally, the feed restriction method applied in the current study (continuous 90% of feed during 8-56 days of age) obviously affected the final BW of Sasso broilers and this effect was negatively higher with those drink ordinary water than those drink magnetic water.

Daily Body Weight Gain (DBWG): The DBWG results (Table 1) noted obviously significant higher DBWG for those drink magnetic water, fed crumble diet or fed *ad libitum* (33.5, 33.2 and 33.1 g, respectively) over those drink ordinary water, fed pellet diet or fed 90% amount of feed (32.2, 32.6 and 31.9 g, respectively).

The improvements found in the present study for DBWG of Sasso broiler as a result of drinking magnetic water are in line with the pervious findings by Al-Fadul[21], Nada *et al.*[33], Gholizadeh *et al.*[34] and Tyari *et al.*[20]. Magnetic water did not influence the performance of broiler chickens as found by Al-Mufarrej *et al.*[22] and Alhassani and Amin[4].

The diet form played an important role on the broiler growth performance, the present results support the previous results observed the superiority of weights for broiler chicks fed crumble diets[23, 24] or crumble-pellet diet[25, 26] over other forms studied. However, the studies of Maertens *et al.*[35] observed the superiority of final weights for broiler chicks fed pellet diets during different stage of fattening period over those fed mash form. Rierson[27] with Cobb 500 male broilers and Amer[36] with Sasso broiler, reported that pellet diet feed had significantly better performance than those fed crumbles.

The present results showed that the 90% of *ad libitum* feed intake in the present study reduce significantly 1-56-day DBWG which are line with the findings of Jalal and Hana Zakaria[37], Nassef *et al.*[29] and Trocino *et al.*[16] with different types and duration of feed restriction. Feed restriction had insignificant or a low impact on broiler body weight as stated by Saber *et al.*[31] (2011) and Rahimi *et al.*[32].

Considering the second order interaction, the birds drink magnetic water and fed *ad libitum* whatever crumble or pellet diet has higher DBWG during 1-56 days of age (34.2 and 34.7 g, respectively) while those drinks ordinary water and fed 90% amount of pellet diet has the significant lower (30.9 g) ones.

These results recommends that pellet or crumble diet fed *ad libitum* can use with magnetic water to obtain higher Sasso broilers DBWG values throughout the grow-out period.

Daily Water Consumption (DWC): The birds drink magnetic during 1-56 days of age had highly significant ($p \leq 0.001$) lower DWC value (211.50 mL) than those drink ordinary water (218.63 mL). The birds fed crumble diet had higher insignificant DWC value (215.63 mL) than those fed pellet diet (214.50 mL). The birds fed 90% amount of feed consumed highly significant ($p \leq 0.001$) more DWC (218.25 mL) than those fed *ad libitum* (211.88 mL).

The present results showed that magnetization of water reduced significantly water consumption of Sasso broiler chickens which confirms the pervious results of Al-Mufarrej *et al.*[22] and Al-Fadul[21]. The reduction of water intake for the birds consumed magnetized water could be explained by the interpretations of Al-Mufarrej *et al.*[22] and McMahon[38], since, they attributed the decrease in water intake to the changes in water properties such as surface tension, fluidity, absorbency, pH level and dissolving capabilities.

Lal and Atapattu[39] reported that broiler water intake was not significantly affected by the dietary physical form, it being 478 and 502 mL per day during 28-42 days old for mash and pellets, respectively. However, Huang *et al.*[40] found that the broilers feed intake on fines and mash was much lower than pellets, resulting in lower water intake.

The present results of DWC values were in line with the findings of Mench[41] and D'Eath *et al.*[42], whom reported that overdrinking has been reported in feed-restricted chickens. Although, Morrissey *et al.*[43] found that birds fed on a skip-a-day regime drank more than control birds only around feeding time and much less on off-feed days and so did not seem to replace feed with water. In contrast, Huang *et al.*[40] noted that the average daily water intake for 0-42 days was significantly higher on *ad libitum* than on restricted feeding, an observation which could be related to higher feed intake.

The second order interaction among treatments studied showed highly significant ($p \leq 0.001$) effect on DWC values during 1-56 days of age. Generally, the birds drink magnetic water and fed pellet diet whatever ad libitum or restricted feed has the lowest DWC (209.50 and 206.50 mL, respectively). Also, the lowest DWC value were observed for those drink magnetic water and fed *ad libitum* crumble diet (207.50 mL). The differences among the later three types of interaction groups were insignificant. The birds drink magnetic water and fed restricted crumble diet or those drink ordinary water and fed restricted pellet diet has the highest DWC values (222.50 and 224.00 mL, respectively).

These results indicate that magnetic water was more effective with pellet form more than with crumble form in decreasing DWC. The results of DWC increased in feed restriction groups, except for those drink magnetic water and fed pellet diet.

Table 2: The effects of magnetic Water (W), Feed forms (F) and feed Restriction (R) treatments on Sasso broiler daily feed consumption, feed conversion ratio, mortality rate traits (M±SE) during the whole experimental period

Parameters Effects	Daily feed consumption (g/bird/day)	Feed conversion ratio 1-56 days	Mortality rate (%)
Water treatments (W)			
Magnetic water	74.60±2.03	2.23^{a}±0.04	3.27^{b}±0.51
ordinary water	77.01±2.27	2.38^{b}±0.06	2.22^{a}±0.37
Feed forms (F)			
Crumbles	76.05±2.24	2.31±0.06	2.98±0.56
Pellets	75.56±2.16	2.31±0.04	2.51±0.34
Feed Restriction (R)			
ad-libitum	80.99^{b}±1.06	2.41^{b}±0.04	3.44^{b}±0.45
90% amount of feed	70.63^{a}±0.95	2.21^{a}±0.04	2.06^{a}±0.41
Significance			
W	NS	**	*
F	NS	NS	NS
R	***	**	**
Interactions			
MW×C×ad	79.65^{c}±1.05	2.34^{d}±0.04	5.52^{f}±0.78
MW×C×R	69.55^{a}±0.35	2.11^{a}±0.01	2.53^{c}±1.46
MW×P×ad	79.95^{c}±2.25	2.31^{d}±0.07	2.01^{b}±0.01
MW×P×R	69.25^{a} ±0.55	2.18^{b}±0.02	3.02^{d}±0.01
OW×C×ad	82.95^{e}±2.85	2.54^{f}±0.09	2.52^{c}±0.01
OW×C×R	72.05^{b}±3.55	2.24^{c}±0.11	1.34^{a}±0.48
OW×P×ad	81.40^{d}±3.20	2.45^{e}±0.10	3.69^{e}±0.97
OW×P×R	71.65^{b}±2.45	2.31^{d}±0.08	1.34^{a}±0.48
Significance			
W×F×R	*	*	**

MW = Magnetic water; C = Crumbles; ad = ad-libitum; OW = Ordinary Water; P = Pellets; R = 90% amount of feed; *= Significant at p≤0.05; **= Significant at p≤0.01; ***= Significant at p≤0.001; NS = Not Significant; $^{a-c}$Means having different letters in the same column and effect indicating significant differences (p≤0.05)

Daily Feed Consumption (DFC): The Sasso broiler chicks drink magnetic water or fed pellet diet (Table 2) consumed insignificant lower daily feed (74.60 and 75.56 g, respectively) during 1-56 days of age than those drink ordinary water (77.01 g) or fed crumble diet (76.05 g). The Sasso broiler chicks fed restricted amount of feed during 1-56 days of age consumed highly significant (p≤0.001) lower daily feed amount (70.63 g) than those fed *ad libitum* (80.99 g). Normally, the applied continuous and severe feed restriction throughout the experimental period in the present study affected DFC trait.

The insignificant differences results of DFC between Sasso broiler drink magnetic or ordinary water confirms the previous findings with broiler chickens by Al-Fadul[21], Nada *et al.*[33], Gholizadeh *et al.*[34] and Alhassani and Amin[4].

The results confirm the previous finding results, observed the superiority of weights for Sasso broiler chicks fed crumble diet (Table 1). Chehraghi *et al.*[24] and Amer[36] showed that birds consumed pellet form diet had highest values in that respect over those fed either crumble or mash diets. Lv *et al.*[26] observed that Ross 308 fed the crumble-pellet diets had higher average daily feed intake (p≤0.01) than those fed the mash diet. Pelleted diets had higher significant feed intake than those fed mash diets[44-46].

The results showed that the feed intake of 90% feed in the present study reduce significantly 56-day Sasso broiler BW which are line with the findings of Adeyemi *et al.*[30] with different broiler strains, types and duration of feed restriction.

The second order interactions among the three treatments in that respect showed significant (p≤0.05). The birds drink ordinary water and fed *ad libitum* crumble feed consumed highest significant amount of feed (82.95 g) during the whole experimental period while the birds drink magnetic water and fed 90% pellet or crumble diet consumed significant lower feed (69.25 g).

The results of Table 2 indicated that magnetic water decrease significantly DFC of Sasso broilers over those drink ordinary water whatever they fed crumble or pellet feed. Also, feed restriction results obtained reveals a highly significant decrease in DFC throughout the experimental period which caused highly significant (p≤0.001) reduction in BW, DBWG of Sasso broiler chickens (Table 1). Therefore, it is suggested to reduce the applied quantity feed restriction method, for its benefits and to increase DFC which give the opportunity for compensatory growth.

Feed Conversion Ratio (FCR): The FCR values of water treatment showed highly significant (p≤0.01) better values for those birds drink magnetic water or those fed restricted feed (2.23 and 2.21, respectively) than those drink ordinary water or fed *ad libitum* (2.38 and 2.41, respectively), the feed form effect being insignificant in that respect (Table 2).

The present results confirm the pervious findings by Al-Fadul[21] and Nada *et al.*[33] whom found that FCR of broiler chickens was improved by magnetization of water. However, the water magnetic treatment exhibited no significant differences for FCR trait as showed by Al-Mufarrej *et al.*[22] and Alhassani and Amin[4].

The crumble or pellet diets showed better FCR than mash diet as found by Zohair *et al.*[47], Amer[36] and Shabani *et al.*[46]. Feed restriction improved FCR in the present study and has been well documented by Mehmood *et al.*[48], Adeyemi *et al.*[30] and Rokeshi and Jafari[15]. However, feed restriction seemed to be insufficient to markedly improve the FCR[46].

The second order interactions among treatments for Sasso broiler FCR was significant ($p \leq 0.05$), the chicks drink magnetic water and fed 90% amount of crumble diet has significant better FCR value (2.11) while the chicks drink ordinary water and fed *ad libitum* crumble diet has significant highest FCR value (2.54, worst value). The differences in FCR between those drink magnetic water and fed *ad libitum* pellet diet and those of corresponding group drink the ordinary water were 2.31 and 2.45, respectively with significant differences between them (Table 2). These results indicated that magnetic water improved FCR of Sasso broilers and this positive effect was for both forms studied. Also, the results showed, in general, the superiority for the birds fed restricted feed over those fed *ad libitum* in that respect, except for those fed restricted pellet diet. With support of the previous conclusion, the restricted pellet diet associated with drinking magnetic water obtained significant better FCR value (2.18) than those of corresponding group drink ordinary water (2.31). The same trend was observed with those fed crumble diet (2.11 and 2.24, respectively). On the other wards, the improvement in FCR of Sasso broilers fed 90% of pellet or crumble diet was due to drinking magnetic water and of course with their low feed consumption.

Mortality Rate (MR): The MR values showed significant better values for those Sasso broiler ordinary water ($p \leq 0.05$) or those fed restricted ($p \leq 0.01$) diet (2.22 and 2.06%, respectively) than those drink magnetic water or fed *ad libitum* (3.27 and 3.44%, respectively) the feed form effect being insignificant in that respect (Table 2).

Gholizadeh *et al.*[34] stated that magnetic water increase livability of broiler chickens. However, the result of Alhassani and Amin[4] showed that it has being insignificant effect. Despite the present result of water treatment for MR values, the both values are within the normal level for commercial broiler production. Generally, broiler mortality usually peaks at approximately 3 to 4 days after placement, declines until approximately day 9 or 10 then stabilizes until approximately day 30 and after day 30 a gradually increase is observed until approximately day 40-45. After day 45, mortality rates increased until harvest[49]. According to Heier *et al.*[50], the average weekly cumulative mortality during the first week was 1.54 and 0.48% a week during the remainder of the grow-out period.

The feed form results of MR support the pervious findings pointed out by Attia *et al.*[51], Chehraghi *et al.*[24] and El-Hammady *et al.*[52] that no significant effect of feed form on mortality rate. On the other hand, some drawbacks of pelleted diets have been pointed out[53,47]. Also, Broiler chickens fed mash diet had a significantly lower mortality rate than birds fed pellet[47]. Also, Amer *et al.*[45] found that Sasso broilers fed mash diet has significantly lowest mortality rate (5.10%) during 1-8 weeks of age than those fed crumble (9.80%) or pellet (8.09%) diet.

The feed restriction results of MR are in agreement with the pervious findings by Mehmood *et al.*[48], that feed restriction has positive effect on mortality rate. The *ad libitum* feeding affected broiler chickens; they become obese and suffer thermal discomfort, a high incidence of lameness and high mortality due to skeletal disorders and heart failure[54]. Moreover, feed restriction has a positive effect on a significant protective effect against necrotic enteritis[55].

The second order interaction among treatments studied showed highly significant ($p \leq 0.01$) effect on MR values. Generally, the birds drink ordinary water and fed 90% amount of crumble or pellet feed has significant lowest equal MR values (1.34%, for both) during the whole experimental period.

Whereas, the birds drink magnetic water and fed *ad libitum* crumble diet and those drink ordinary water and fed *ad libitum* pellet diet has significant highest MR value (5.52, 3.69%, respectively). These results indicate that feed restriction method applied in the present study affected positively MR trait (lower values) especially with those drinking ordinary water. However, the feed form has fluctuated manner of effect with water and feed restriction treatments.

CONCLUSION

The results of current study indicate a remarkable performance of magnetized water and might be suggested to use it as drinking water for Sasso broiler chicks while both of studied feed forms produced nearly the same performance. However, although the feed restriction applied in the present study had a slightly lower performance than *ad libitum* feeding but the continuity and severity should be alleviated. Further studies needed with magnetic water on other commercial broilers strains.

REFERENCES

01. Helal, M.H., 2002. Magnetism, developments, technique and benefits in agriculture, irrigation and environment. National Center for Research-Advisor on Magnetic Researches Project in Egypt.
02. Alhassani, D.H., 2000. Physiology of Domestic Fowl. 1st Edn., Dar Alkutub, Baghdad.
03. Yacout, M.H., A.A. Hassan, M.S. Khalel, A.M. Shwerab and E.I. Abdel-Gawad, 2015. Effect of magnetic water on the performance of lactating goats. J. Dairy Vet. Anim. Res., Vol. 2. 10.15406/jdvar.2015.02.00048
04. Alhassani, D.H. and G.S. Amin, 2012. Response of some productive traits of broiler chickens to magnetic water. Int. J. Poult. Sci., 11: 158-160.
05. Rona, Z., 2004. Magnetized water is not mystery. Encyclopedia of Natural Healing, pp: 405.
06. Sagbaug, M., 2003. Heavy duty magnetic watercondition. http://www.space.age.com.
07. Choct, M., 2009. Managing gut health through nutrition. Br. Poult. Sci., 50: 9-15.
08. Bao, Y.M. and M. Choct, 2010. Dietary NSP nutrition and intestinal immune system for broiler chickens. World's Poult. Sci. J., 66: 511-517.
09. Mirghelenj, S.A. and A. Golian, 2009. Effects of feed form on development of digestive tract, performance and carcass traits of broiler chickens. J. Anim. Vet. Adv., 8: 1911-1915.
10. Plavnik, I. and S. Hurwitz, 1989. Effect of dietary protein, energy and feed pelletting on the response of chicks to early feed restriction. Poult. Sci., 68: 1184-1185.
11. Religious, K.B., S. Tesseraud and O.A. Piccady, 2001. Food neonatale and early development of table fowl. Prod. Anim., 14: 219-230.
12. Zubair, A.K. and S. Leeson, 1996. Compensatory growth in the broiler chicken: A review. World's Poult. Sci. J., 52: 189-201.
13. Khudiar, K.K. and A.M. Ali, 2012. Effect of magnetic water on some physiological aspects of adult male rabbits. Proceedings of the 11th Veterinary Scientific Conference, November 2012, College of Veterinary Medicine, Baghdad, Iraq, pp: 120-126.
14. Fu, W. and Z. Wang, 1994. The New Technology of Concrete Engineering. The Publishing House of Chinese Architectural Industry, Beijing, China, pp: 56-59.
15. Rokeshi, M. and M. Jafari, 2015. The effect of quantitative feed restriction in different ages on performance and carcass traits of broilers chicks. Adv. Biores., 6: 90-95.
16. Trocino, A., A. Piccirillo, M. Birolo, G. Radaelli and D. Bertotto *et al*., 2015. Effect of genotype, gender and feed restriction on growth, meat quality and the occurrence of white striping and wooden breast in broiler chickens. Poult. Sci., 94: 2996-3004.
17. SAS., 2004. SAS User's Guide Statistics. Version 9.1, SAS Institute Inc., Cary, NC., USA.
18. Snedecor, G.W. and W.G. Cochran, 1982. Statistical Methods. 7th Edn., Iowa State University Press, Ames, Iowa, USA.
19. Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.
20. Tyari, E., A.R. Jamshidi and A. Neisy, 2014. Magnetic water and its benefit in cattle breeding, pisciculture and poultry. Adv. Environ. Biol., 8: 1031-1037.
21. Al-Fadul, M.F.M., 2006. The effect of magnetic treated water and diet on the performance of the broiler chicks. M.Sc. Thesis, Department of Poultry Production, Faculty of Animal Production, University of Khartoum, Sudan.
22. Al-Mufarrej, S., H.A. Al-Batshan, M.I. Shalaby and T.M. Shafey, 2005. The effects of magnetically treated water on the performance and immune system of broiler chickens. Int. J. Poult. Sci., 4: 96-102.
23. Jahan, M.S., M. Asaduzzaman and A.K. Sarkar, 2006. Performance of broiler fed on mash, pellet and crumble. Int. J. Poult. Sci., 5: 265-270.
24. Chehraghi, M., A. Zakeri and M. Taghinejad-Roudbaneh, 2013. Effects of different feed forms on performance in broiler chickens. Eur. J. Exp. Biol., 3: 66-70.
25. Jafarnejad S., M. Farkhoy, M. Sadegh and A.R. Bahonar, 2010. Effect of crumble-pellet and mash diets with different levels of dietary protein and energy on the performance of broilers at the end of the third week. Vet. Med. Int. 10.4061/2010/328123
26. Lv, M., L. Yan, Z. Wang, S. An, M. Wu and Z. Lv, 2015. Effects of feed form and feed particle size on growth performance, carcass characteristics and digestive tract development of broilers. Anim. Nutr., 1: 252-256.
27. Rierson, R.D., 2011. Broiler preference for light color and feed form and the effect of light on growth and performance of broiler chicks. M.Sc. Thesis, Kansas State University, Manhattan, Kansas, USA.
28. Omosebi, D.J., O.A. Adeyemi, M.O. Sogunle, O.M.O. Idowu and C.P. Njoku, 2014. Effects of duration and level of feed restriction on performance and meat quality of broiler chickens. Archivos de Zootecnia, 63: 611-621.

29. Nassef, E.D., S. Mustaf and K. Tarek, 2015. Effect of feed restriction on growth performance, sudden death syndrome and some blood parameters in broiler chickens. Assiut. Vet. Med. J., 61: 204-209.
30. Adeyemi, O.A., C.P. Njoku, O.M. Odunbaku, O.M. Sogunle and L.T. Egbeyale, 2015. Response of broiler chickens to quantitative feed restriction with or without ascorbic acid supplementation. Iran. J. Applied Anim. Sci., 5: 393-401.
31. Saber, N.S., N. Maheri-Sis, A. Shaddel-Telli, K. Hatefinezhad, A. Gorbani and J. Yousefi, 2011. Effect of feed restriction on growth performance of broiler chickens. Ann. Biol. Res., 2: 247-252.
32. Rahimi, S., A. Seidavi, M. Sahraei, F.P. Blanco, A. Schiavone and A.L.M. Marin, 2015. Effects of feed restriction and diet nutrient density during re-alimentation on growth performance, carcass traits, organ weight, blood parameters and the immune response of broilers. Italian J. Anim. Sci., 14: 318-324.
33. Nada, S.M., K.A. Rashid and A.H.K. Al-Hillali, 2007. Effect of magnetic water on some productive characteristics of broiler chickens. Iraq J. Poult. Sci., 2: 181-187.
34. Gholizadeh, M., H. Arabshahi, M.R. Saeidi and B. Mahdavi, 2008. The effect of magnetic water on growth and quality improvement of poultry. Middle-East J. Sci. Res., 3: 140-144.
35. Maertens, L., S. Leleu and E. Delezie, 2015. Effect of feed form and change of feed form on the performances, mortality and footpad dermatitis of fast growing broilers. Proceedings of the 3rd Symposium One World, One Health: Linked to Intestinal Health and Poultry Production, October 15-16, 2015, Gent, Belgium.
36. Amer, F.M., 2015. Effect of diet forms and litter types on the productive and physiological traits of broiler (Sasso). Ph.D. Thesis, Faculty of Agriculture, Alexandria University, Egypt.
37. Jalal, M.A.R. and H.A. Zakaria, 2012. The effect of quantitative feed restriction during the starter period on compensatory growth and carcass characteristics of broiler chickens. Pak. J. Nutr., 11: 817-822.
38. McMahon, C., 2009. Investigation of the quality of water treated by magnetic fields. Undergraduate Thesis, Faculty of Engineering and Surveying, University of Southern Queensland.
39. Lal, P.K. and N.S.B.M. Atapattu, 2007. Effects of dietary physical form on performance and water intake of broiler. Proceedings of the 4th Academic Sessions, (AS'07), Matara, Sri Lanka, pp: 206-210.
40. Huang, K.H., C. Kemp and C. Fisher, 2011. Effects of nutrition on water intake and litter moisture on broiler chickens. Proceedings of the Australian Poultry Science Symposium, February 14-16, 2011, University of Sydney, Australia.
41. Mench, J.A., 2002. Broiler breeders: Feed restriction and welfare. Worlds Poult. Sci. J., 58: 23-29.
42. D'Eath, R.B., B.J. Tolkamp, I. Kyriazakis and A.B. Lawrence, 2009. Freedom from hunger' and preventing obesity: The animal welfare implications of reducing food quantity or quality. Anim. Behav., 77: 275-288.
43. Morrissey, K.L., T. Widowski, S. Leeson, V. Sandilands, A. Arnone and S. Torrey, 2014. The effect of dietary alterations during rearing on growth, productivity and behavior in broiler breeder females. Poult. Sci., 93: 285-295.
44. Rezaeipour, V. and S. Gazani, 2014. Effects of feed form and feed particle size with dietary L-threonine supplementation on performance, carcass characteristics and blood biochemical parameters of broiler chickens. J. Anim. Sci. Technol., Vol. 56. 10.1186/2055-0391-56-20
45. Amer, F.M., F.N. Soliman, M.B. El-Deen and A. El-Sebai, 2015. Effect of diet forms and litter types on the productive traits of broiler (Sasso). Egypt. Poult. Sci. J., 35: 719-734.
46. Shabani, S., A. Seidavi, L. Asadpour and M. Corazzin, 2015. Effects of physical form of diet and intensity and duration of feed restriction on the growth performance, blood variables, microbial flora, immunity and carcass and organ characteristics of broiler chickens. Livestock Sci., 180: 150-157.
47. Zohair, G.A.M., G.A. Al-Maktari and M.M. Amer, 2012. A comparative effect of mash and pellet feed on broiler performance and ascites at high altitude (field study). Global Veterinaria, 9: 154-159.
48. Mehmood, S., A.W. Sahota, M. Akram, K. Javed and J. Hussain *et al*., 2013. Influence of feed restriction regimes on growth performance of broilers with different initial weight categories. J. Anim. Plant Sci., 26: 1522-1526.
49. Tabler, G.T., I.L. Berry and A.M. Mendenhall, 2004. Mortality patterns associated with commercial broiler production. Avian Advice Vol. 6, No. 1.
50. Heier, B.T., H.R. Hogasen and J. Jarp, 2002. Factors associated with mortality in Norwegian broiler flocks. Prev. Vet. Med., 53: 147-158.
51. Attia, Y.A., W.S. El-Tahawy, E.E. Abd El-Hamid, A. Nizza, F. Bovera, M.A. Al- Harthi and M.I. El-Kelway, 2014. Effect of feed form, pellet diameter and enzymes supplementation on growth performance and nutrient digestibility of broiler during days 21-37 of age. Archiv. Tierzucht, 34: 1-11.

52. El-Hammady, H.Y., M. El-Sagheer, H.H.M. Hassanien and H.A. Hassan, 2014. Impact of light source and feed form on growth performance and carcass traits of broiler chicks. Proceedings of the 7th International Poultry Conference, November 3-6, 2014, Ain Suknna-Red Sea, Egypt.
53. Arce-Menocal, J., E. Avila-Gonzalez, C. Lopez-Coello, L. Garibay-Torres and L.A. Martinez-Lemus, 2009. Body weight, feed-particle size and ascites incidence revisited. J. Applied Poult. Res., 18: 465-471.
54. Huchzermeyer, F.W., 2012. Broiler ascites: A review of the ascites work done at the poultry section of the Onderstepoort Veterinary Institute 1981-1990. World's Poult. Sci. J., 68: 41-50.
55. Tsiouris, V., I. Georgopoulou, C. Batzios, N. Pappaioannou, R. Ducatelle and P. Fortomaris, 2014. Temporary feed restriction partially protects broilers from necrotic enteritis. Avian Pathol., 43: 139-145.