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Research Article

Effect of Sodium Chloride Supplementation Provided through Drinking Water and/or Feed on Performance of Japanese Quails (*Coturnix coturnix Japonica*)

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Abstract: The experiment reported herein aimed to investigate whether sodium chloride (NaCl) provided through feed and/or drinking water, compared to NaCl provided in feed, affected the live weight (LW), live weight gain (LWG), feed (FI) and water intake (WI), feed conversion ratio (FCR), carcass weight (CW) and dressing percentage (DP) of Japanese quails (*Coturnix coturnix Japonica*). In a randomised block experimental design, a total of 252 one-week-old Japanese quails were allocated randomly into 4 treatment groups. Each treatment group consisted of three replicates and 21 quails within each replication. The quail chickens were reared in ground cages (75 cm by 75 cm) over a 35-day experimental period. They were offered *ad libitum* a basal ration the composition of which was 23.97% crude protein and 3083 kcal ME/kg. Treatments were i) 2.5 g NaCl/kg supplemented in feed (control group; C), ii) 2.5 g NaCl/l supplemented in drinking water (tap water; W), iii) 1.25 g NaCl/l supplemented in feed and 1.25 g NaCl/l supplemented in drinking water (F/W) and iv) 1.25 g NaCl/l supplemented in drinking water ($^1/_2$ W). At the end of the experimental period, differences among the groups in terms of FLW (183 ± 5, 192 ± 6, 179 ± 3 and 187 ± 2 g), LWG (156 ± 5, 165 ± 6, 152 ± 3 and 160 ± 2 g), FI (833 ± 17, 829 ± 17, 824 ± 9 and 846 ± 17 g), WI (1425 ± 9, 1525 ± 48, 1423 ± 69 and 1480 ± 9 l), FCR (5.34 ± 0.01, 5.02 ± 0.01, 5.44 ± 0.18 and 5.27 ± 0.14) CW (130 ± 1, 128 ± 5, 126 ± 1 and 131 ± 3 g) and DP (71.11 ± 2.33, 66.90 ± 3.22, 70.58 ± 1.53 and 69.73 ± 2.15%) were not statistically significant (P > 0.05). The mortality rate of quails in group W (7.97%) was higher than that of quails in groups C (3.17%), F/W (1.59%) and $^1/_2$ W (3.17%). These results indicate that the performance of quails was not adversely affected by NaCl supplementation of the drinking water but it increased the mortality rate.

Key Words: Sodium chloride, drinking water, feed and water intake, quail, growing performance

İçme Suyu ile Verilen Sodyum Kloridin Japon Bıldırcınların (*Coturnix coturnix Japonica*) Performansı Üzerine Etkisi

Özet: Bu çalışmanın amacı, içme suyu ile sağlanan sodyum kloridin Japon bıldırcınlarının (*Coturnix coturnix Japonica*) canlı ağırlık (CA), canlı ağırlık artışı (CAA), yem (YT) ve su (ST) tüketimi, yemden yararlanma oranları (YYO), karkas ağırlığı (KA) ve karkas randımanı (KR) üzerine etkisini belirlemektir. Bu amaçla, 252 adet bir haftalık yaştaki yerde yetiştirilmiş bıldırcınlar kullanılmıştır. Hayvanlar her birinde 63 bıldırcın bulunan (her tekerrür için 21 hayvan) 4 gruba ayrılmıştır. Denemede, % 23.97 ham protein ve 3083 kcal ME/kg içeren bazal karma serbest olarak sunulmuştur. Muameleler, i) 2.5 g NaCl/kg yemde (K), ii) 2.5 g NaCl/l suda (musluk suyu; S), iii) 1.25 g NaCl/kg yem ve 1.25 g NaCl/l suda (Y/S) ve iv) 1.25 g NaCl/l suda ($^1/_2$ S) verilerek oluşturulmuştur. Otuzbeş günlük deneme sonunda CA (183 ± 5, 192 ± 6, 179 ± 3 ve 187 ± 2 g), CAA (156 ± 5, 165 ± 6, 152 ± 3 ve 160 ± 2 g), YT (833 ± 17, 829 ± 17, 824 ± 9 ve 846 ± 17 g), ST (1425 ± 9, 1525 ± 48, 1423 ± 69 ve 1480 ± 9 l), YYO (5.34 ± 0.01, 5.02 ± 0.01, 5.44 ± 0.18 ve 5.27 ± 0.14), KA (130 ± 1, 128 ± 5, 126 ± 1 ve 131 ± 3 g) ve KR (%71.11 ± 2.33, 66.90 ± 3.22, 70.58 ± 1.53 ve 69.73 ± 2.15) bakımından gruplar arasında istatistiki farklılık bulunmamıştır (P > 0.05). S grubunun (%7.94) ölüm oranı, K (%3.17), Y/S (%1.59) ve $^1/_2$ S (%3.17) gruplarınınkinden daha yüksek bulunmuştur. Sonuçlar, içme suyuna NaCl ilavesinin bıldırcınların performansı üzerine olumsuz etkisinin olmadığını, fakat ölüm oranını arttırdığını göstermiştir.

Anahtar Sözcükler: Sodyum klorid, içme suyu, yem ve su tüketimi, bıldırcın, büyüme performansı

Introduction

Waste from the food industry (cotton-seed, sunflower seed, soybean meals) and feedstuffs of animal origin (bone meal, fish meal) contain high Na concentrations, but these usually do not supply a bird's requirements. The deficiency is usually countered by adding common salt (NaCl) to the diet. Even though the fears of a number of authors concerning the possible toxic effect of salt on birds seem to be exaggerated, there is no doubt that excess salt must be avoided; both salt in excess and salt deficiency strongly impair the productivity of birds (1).

In addition, if sodium chloride (NaCl) is not homogeneously mixed with the diet, the expected performance of poultry cannot be obtained. Another way of providing minerals and vitamins which avoids the homogeneity problem (2-4) is supplementation of these nutrients in drinking water. While the effects of various concentrations of NaCl have been examined extensively (5,6), detailed information on the responses of growing birds to sodium chloride supplementation provided through drinking water in comparison to dietary supply is limited. Previous studies were carried out to study the effect of water sodium on the chick requirement for dietary sodium (7) and the effect of water salinity on the performance of poultry (8-12) or to investigate the maximum water salinity that can be tolerated by poultry (13).

The experiment reported herein aimed to investigate whether sodium chloride provided through feed and/or drinking water, compared to NaCl provided in feed, affected live weight, live weight gain, feed and water intake, feed conversion ratio, carcass weight and dressing percentage of Japanese quails (*Coturnix coturnix Japonica*).

Table 1. Basal diet composition.

Ingredients	%
Yellow corn	40.87
Soybean meal (48% CP)	22.67
Full fat soybean	12.00
Wheat	10.00
Sunflower meal	6.00
Meat and bone meal	3.00
Fish meal	2.00
Vegetable oil	2.00
Dicalcium phosphate (DCP)	0.55
Vitamin premix**	0.20
Trace mineral premix**	0.10
Limestone	0.25
DL-Methionine	0.11
Total	100.00
Calculated analysis	
Crude protein, %	23.97
ME, kcal/kg	3083
Lysine, %	1.83
Methionine, %	0.51
Calcium, %	0.75
Available phosphorus, %	0.48

* Salt supplementation to the basal diet; C: 2.5 g NaCl/kg supplemented in feed; W: 2.5 g NaCl/l supplemented in drinking water (tap water), F/W: 1.25 g NaCl/l supplemented in feed and 1.25 g NaCl/l supplemented in drinking water and $^1/_2$ W: 1.25 g NaCl/l supplemented in drinking water .

** Vitamin premix provided the followings per kg of diet: A 1 200,000 IU, D_3 160,000 IU, E 1600 mg, K_3 400 mg, B_1 200 mg, B_2 600 mg, B_6 400 mg, B_{12} 8 mg, C 4000 mg, Calcium D-Pantotenat 800 mg, Niacin 2000 mg, Folic acid 60 mg, Biotin 4 mg, Colin chloride 80000 mg, and trace mineral premix provided the followings per kg of diet: Mn 8000 mg, Fe 3000 mg, Zn 6000 mg, Cu 500 mg, Co 50 mg, I 200 mg, Se 20 mg.

Materials and Methods

In a randomised block experimental design, a total of 252 one-week-old Japanese quails were allocated randomly into four treatment groups. Each treatment group consisted of three replicates and 21 quails within each replication. The quail chickens were reared in ground cages (75 cm by 75 cm) over a 35-day experimental period. They were offered *ad libitum* a basal ration, the composition of which is given in Table 1. Treatments were i) 2.5 g NaCl/kg supplemented in feed (control group; C), ii) 2.5 g NaCl/l supplemented in drinking water (tap water; W), iii) 1.25 g NaCl/l supplemented in feed and 1.25 g NaCl/l supplemented in drinking water (F/W) and iv) 1.25 g NaCl/l supplemented in drinking water ($^1/_2$ W). The total salt, Na and Cl contents of the tap water were 0.20%, 43 and 38 ppm, respectively, before adding sodium chloride. The total salt content of tap water was calculated using its electrical conductivity value while Na and Cl contents were determined by flamephotometry and titrimetry, respectively (14). Water supplemented with NaCl where necessary for treatment groups was prepared weekly at the appropriate concentrations.

The quails were weighed in groups at weekly intervals. Feed consumption was recorded weekly and water intake and mortality were recorded daily. The feed conversion ratio (g feed/g gain) and water intake per feed consumption (l water/g feed) were calculated. At the end of the experimental period, two quails (one male and one female) from each replicate group (a total of six quails from each treatment) were slaughtered, and then carcass weight and edible inner organs (heart, liver and gizzard) were weighed. Dressing percentage was calculated as g carcass weight/100 g live weight. Data were statistically analysed by ANOVA (SPSS for Windows, Release 9.0). The experimental design was a randomised block with treatments and blocks being the main effects.

Results

The performance of Japanese quails at 42 days of age offered sodium chloride provided through drinking water and/or feed are presented in Table 2. There were no significant differences between the treatment groups in terms of initial body weight, final body weight, live weight gain, feed consumption, feed conversion ratio, water consumption or water/feed consumption ratio ($P > 0.05$). Carcass weight, dressing percentage and edible inner organs were not significantly affected by sodium chloride supplementation in the drinking water or feed (Table 3; $P > 0.05$).

The mortality of quails in group W was higher than that of quails in the other groups (Table 4).

Table 2. The effect of sodium chloride provided through drinking water and/or feed on the live weight, live weight gain, feed and water intake, feed conversion and water/feed ratio of quails.

Traits	C $\bar{X} \pm S\bar{x}$	W $\bar{X} \pm S\bar{x}$	F/W $\bar{X} \pm S\bar{x}$	$\frac{1}{2}$ W $\bar{X} \pm S\bar{x}$
Initial body weight (g)	27 ± 0.1	27 ± 0.1	27 ± 0.1	27 ± 0.1
Final body weight (g)	183 ± 5	192 ± 6	179 ± 3	187 ± 2
Live weight gain (g)	156 ± 5	165 ± 6	152 ± 3	160 ± 2
Feed consumption (g)	833 ± 17	829 ± 17	824 ± 9	846 ± 17
Feed conversion ratio (g feed/g gain)	5.34 ± 0.01	5.02 ± 0.01	5.44 ± 0.18	5.27 ± 0.14
Water consumption (g)	1425 ± 9	1525 ± 48	1423 ± 69	1480 ± 9
Water/feed consumption ratio (l water/g feed)	1.72 ± 0.14	1.84 ± 0.01	1.73 ± 0.01	1.76 ± 0.01

Table 3. Carcass weight, dressing percentage and edible inner organs of quail receiving sodium chloride in the drinking water and/or feed.

Traits	C $\bar{X} \pm S\bar{x}$	W $\bar{X} \pm S\bar{x}$	F/W $\bar{X} \pm S\bar{x}$	$\frac{1}{2}$ W $\bar{X} \pm S\bar{x}$
Carcass weight (g)	130 ± 1	128 ± 5	126 ± 1	131 ± 3
Dressing percentage (%)	71.11 ± 2.33	66.90 ± 3.22	70.58 ± 1.53	69.73 ± 2.15
Edible inner organs (g)	11 ± 0.3	11 ± 1.2	9 ± 0.2	9 ± 0.2
Percentage edible inner organs (g/100 g body weight)	5.61 ± 0.20	5.63 ± 0.53	5.18 ± 0.13	4.83 ± 0.01

Table 4. The effect of sodium chloride in the drinking water and/or feed on mortality.

Groups	Initial number	Age (weeks)					Total mortality	Mortality %
		2	3	4	5	6		
C	63	1	0	0	1	0	2	3.17
W	63	1	1	0	2	1	5	7.94
F/W	63	0	1	0	0	0	1	1.59
$\frac{1}{2}$ W	63	0	0	1	0	1	2	3.17

Discussion

The results of the present experiment show that providing NaCl in water and/or feed does not reduce the performance of Japanese quails. Therefore, providing NaCl in water is reliable in terms of avoiding the homogeneity problem in mixing poultry diet. However, it should be kept in mind that providing NaCl in water requires additional labour. Ross (7) compared the responses of broiler chickens to NaCl in the diet and drinking water and reported that, when allowance was made for differences in food and water intakes, sodium in the drinking water was used more effectively than sodium in the diet. If the homogeneity were a problem in the present study, then one would expect NaCl in water to improve the performances of Japanese quails. The results presented here do not allow us to explain whether NaCl provided in feed in the group C were homogeneously mixed since providing NaCl in water did not improve the performance of Japanese quails in the present study, contrary to the findings of Ross (7).

Shanawany et al. (8) examined the effect of NaCl in drinking water on Japanese quails. The authors used concentrations of 0, 500, 1000 or 1500 mg NaCl/l in the drinking water and noted that water intake increases and feed consumption decreases as salt concentration increases. Damron (9) added up to 800 ppm NaCl to the drinking water of White Leghorn hens and detected that daily feed and water intake and body weight change over the experimental period were not influenced by any level of waterborne NaCl. In our study, the final body weight and body weight gain of quails receiving 2.5 g NaCl/l in the drinking water were numerically higher than that of quails in other treatments. Balnave (10) observed improvements in growth when three-to-six-week-old broilers were provided with up to 2.4 g NaCl/l of drinking water. Balnave (5) and Khalafalla et al. (6) reported that the toxicity of sodium chloride given in the drinking water was approximately the same as an equivalent intake from the diet. These authors also noted that a supplement of 3 g NaCl/l to the drinking water was not toxic to two-day-old chicks. Therefore, relatively low concentrations of sodium chloride in drinking water may improve liveweight gain in broilers, perhaps through a greater retention of water (6).

Drinking water itself contains NaCl at various concentrations. Therefore, when water is used in poultry feeding, the NaCl content of the water should be measured to ensure that an appropriate amount of NaCl is provided. Balnave (5) and Khalafalla et al. (6) have reviewed the responses of newly hatched poultry (layer-type and broiler chickens, turkey poults and ducklings) to mineral supplements in drinking water. These authors noted that salt levels in drinking water ranged from 2.6 to 10.6 g/l and showed that high concentrations of salt in drinking water were associated with reduced growth and increased mortality in newly hatched poultry. In the present study, the mortality rate in group W was higher than that of the other groups. This can be attributed to an increase in mortality rate with an increase in sodium chloride level in the water. Afifi et al. (13) noted that the main cause of high mortality is the toxic effect of NaCl when used at high levels in feeds or water. The authors noted also that broiler chicks could tolerate up to 2 g NaCl /100 ml in the drinking water, and live weight gains are decreased, water consumption and water to feed ratio are increased, and feed conversion ratio (g feed/g gain) is adversely affected beyond the 0.2% level.

The animal material used may also be a reason for differences between these and other reports on the effects of water salinity on the performance of poultry, since Damron (9) identified strain sensitivity differences to both deficiency and excess of NaCl in feed or water.

These results indicate that the performance of quails was not adversely affected, but the mortality rate was increased by NaCl supplementation of the drinking water. Therefore, providing NaCl in water may not be appropriate since additional labour is also required for the preparation of salt solutions.

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