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Effects of Saline Drinking Water on Carcass Characteristics and Litter Moisture Content of Japanese Quails (*Coturnix coturnix Japonica*)

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CURRENT study was performed to investigate the effects of added different levels of common salt in the water on carcass characteristics and litter moisture of Japanese quail. Six hundred one-day old Japanese quail chicks(8.61±0.21 grams) divided to six treatments and five replicates of 20 birds per experimental units, based on completely randomized design for 42 days. All treatments fed the same diets and only the amount of sodium chloride in the water was different. Control treatment consumed conventional drinking water containing 233 ppm total dissolved solids (TDS) and other treatments consumed water supplemented with 1.32, 2.80, 3.80, 5.56 and 7.12 grams of NaCl per liter which were equal to 1233, 2233, 3233, 4233 and 5233 ppm for other experimental groups, respectively. At the end of experiment, four chicks from each replicate slaughtered and then carcass traits measured. The results showed that pre-slaughter weight, carcass and breast yield as well asdry matter content of thighs, breast, and ash content of breast,were significantly affected by water salinity. Higher amounts of TDS in drinking water often resulted in lower pre-slaughter weight and carcass and breast yield; but greater dry matter content of thighs and ash content of thighs and breast observed in tested Japanese quails. Litter moisture content also significantly increased by increasing TDS levels in drinking water. Inconclusion, in order to maintain carcass characteristics and litter qualityof quailsat the safe range, amount of TDS in drinking water should not be more than 2233 ppm.

Keywords: Carcass yield, Japanese quail, Litter moisture, Total dissolved solids.

Introduction

Water is an important nutrient and its quantity and quality has a significant impact on animal health and performance. The challenge of water shortage in arid and semi-arid regions of the world such as Iran, is further complicated with increasing water salinity [1, 2, 3] Total dissolved solides (TDS) is one of the important indices in water quality, which determines the suitability of drinking water for animals[3, 4]. Electrical conductivity (EC) usually used to measure TDS as water salinity index [5].Drinking water in some areas of poultry production involved with relatively high levels of TDS [6, 7]. Animals tolerance to various levels of dissolved salts such as sodium (Na) and Chlorine (Cl) are differing depend on their species, breed, age, water requirement, physiological condition, season of the year and salt content of the diet as well as their adaptation [7, 8]. Although salin drinking water in moderate levels can be a favorable manner to providing partial requirments of sodium and chlorineas well as some other minerals, but higher TDS levels led to excessconsumption of Na and Cl which in turn, resulted in poor health and growth performanceof birds [6]. In addition to the negative effects of higher drinking water salinity in poultry health and performance, it may adversly affect litter and carcass quality [4, 6, 9]. Higher TDS level resulted in wet litter, footpad disorders and loose droppings, which in turn may exert unsuitable effects on broiler health, performance and carcass traits.

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Nowadays, salinity of drinking water in some areassuch as North Westof Iranis inevitable due to drying of the Lake Urmia, which is one of the largest hypersaline lakes in the world [2]. Since, there is no much more options for poultry producers other than desalination of the water or using available water for adapted or resisted animals in such conditions,some of poultry producers in the regions with higher salinity in water, try to solve the problem by reducing diet NaCl content and purifying saline water [4]. However, some others search for resistant and saline water tolerable birds. It seems that Japanese quail (*Coturnixcoturnix Japonica*) which is more resistant to various diseases and environmental condition compared with the different species of poultry[10, 11, 12], can be a suitable bird for this purpose; although its saline water tolerability is not illuminated. Increasing quail production industry in Iran due to its good reproductive potential, shorter production period, high yields in limited spaces, lower need to expensive investments and higher income as well as higher tolerability against unfavorable environmental conditions[13, 14, 15, 16], encorage us to investigate its drinking saline water tolerability. Despite of the importance of waterquality foranimals' health and production as well as products quality, researches on drinking water have been neglected. So that, this study was conducted to determine the effects of increasing TDS level in water by adding different levels of sodium chloride (common salt) on carcass characteristics and litter moisture of Japanese quails.

Materials and Methods

Six hundred one-day old unsexed Japanese quail chicks obtained from commercial hatchery in East Azerbaijan, Iran, and divided to six treatments and five replicates of 20 birds per experimental units, based on completely randomized design for 42 days. All treatments reared at littered floor, containing sawdust with five cm depth, in same conditions and fed the same diet (Table 1); formulated based on NRC [17] only with different amounts of salt in their drinking water. Control treatment (T1) was consumed conventional drinking water with 233 ppm total dissolved solids (TDS)without adding any salt, and other treatments (T2- T6) have 1.32, 2.8, 3.8, 5.56 and 7.12 grams of salt per liter which were equal to 1233, 2233, 3233, 4233 and 5233 ppm for experimental groups (T2-T6), respectively. All birds have free access to drinking water based on their treatments. Ethical and animal care considerations approved by the Animal Research Committee in Islamic Azad University, Shabestar Branch, Shabestar, Iran. Electrical conductivity (EC) of the treatments were measured by EC meter in the laboratoriy of chemistry, Islamic Azad University, Shabestar, Iran. Amounts of TDS were calculated using EC data by the equation,TDS = 640 * EC where, TDS as ppm and EC as dS/m [5]. Based on the suggestions of Salmanzadeh et al. [18], at the end of experimental period (42 day of age), four chicks of each replicate (with body weight near the average of related replicate), randomly considered to determine carcass characteristics. Selected birdswere fasted for nearly 12 h and then individually weighed and slaughteredin accordance with standard procedures.The weight of eviscerated carcass as well as carcass parts (breast and thighs) were measuredand displayed as percentage of pre-slaughter weight and eviscerated carcass weight, respectively. Then, dry matter and ash content of breast and thighs determined according to manual of AOAC [19].

At the last day of experment, about 150 grams of litter per replicate (from five point of the each pen) were collected, pooled and oven dried to calculate moisture content according to Dunlop et al. [20].

Statistical analysis

Experimental data were subjected to analysis of variance (ANOVA) as a completely randomized design (CRD) with six treatments and five replicates for each treatment, using general linear model (GLM) procedure of SAS [21] and then, means were compared with Duncan multiple range tests [22].

Results and Discussion

Effect of water salinity on carcass characteristics

Effect of water salinity on carcass characteristics of Japanese quails at 42 days of agewas showed in Tables 2 and 3. The results showed that pre-slaughter weight, carcass and breast yield as well as dry matter content of thighs, breast, and ash content of breast, significantly affected by treatments (water salinity). Higher amounts of TDS in drinking water often resulted in lower pre-slaughter weight and carcass and breast yield; however dry matter content of thighs and ash content of thighs and breast in tested Japanese quails increased by drinking saline water.

TABLE 1. Feed ingredients and nutrient contents of experimental diets of Japanese quails at whole growing period (1- 42 day of age)

Feed ingredients	(%)
Corn grain	52.89
Soy bean meal (44% CP)	38.80
Corn gluten (60% CP)	3.93
Sunflower oil	1.32
Oyster shell	1.34
Dicalcium phosphate	0.77
Common salt	0.25
Vitamins premix	0.25
Minerals premix	0.25
DL-Methionine	0.12
HCL- Lysine	0.08
Nutrients (calculated)	
Metabolisable energy (Kcal/kg)	2900
Crude protein (%)	24.00
Crude fiber (%)	3.93
Ca (%)	0.80
Available P (%)	0.29
Methionine (%)	0.50
Methionine+ Cysteine	0.93
Lysine (%)	1.30
Na (%)	0.11
Cl (%)	0.19
K (%)	0.95
DCAB (mEq/kg)*	237.2

*DCAB= Na^{+}+ K^{+}- Cl^{-} (mEq/kg)

TABLE 2. Effect of water salinity (TDS) levels on carcass traits of Japanese quails slaughtered at 42 days of age

Treatments	Pre-slaughter weight (g)	Carcass yield (%)	Breast yield (%)	Thighs yield (%)
T1	225.60^{a}	68.42^{a}	51.07^{a}	34.94
T2	223.50^{a}	68.28^{a}	51.76^{a}	35.10
T3	212.12^{c}	67.70^{a}	51.42^{a}	35.06
T4	216.90^{bc}	68.15^{a}	48.57^{b}	33.10
T5	219.50^{ab}	67.10^{ab}	50.41^{ab}	33.83
T6	211.25^{c}	65.86^{b}	50.51^{ab}	33.27
P value	0.0001	0.0200	0.0200	0.3400
SEM	1.195	0.52	0.62	0.61

Means in the same column with different letters (a, b and c) are differ (P<0.05).
T1- T6 containing 233, 1233, 2233, 3233, 4233 and 5233 ppm, TDS, respectively.
Breast and thighs calculated as percentage of carcass weight.
SEM, standard error of means

TABLE 3. Effect of water salinity levels on carcass composition and litter moisture of Japanese quails slaughtered at 42 days of age

Treatments	Breast dry matter (%)	Thighs dry matter (%)	Breast ash (%)	Thighs ash (%)	Litter moisture (%)
T1	26.99	25.51[d]	3.59[f]	3.36[c]	27.33[a]
T2	27.57	27.41[bc]	3.72[e]	3.64[ab]	29.70[b]
T3	27.33	27.99[b]	3.85[d]	3.44[bc]	36.68[c]
T4	27.95	26.51[cd]	3.94[c]	3.62[ab]	40.84[d]
T5	28.11	28.66[ab]	4.04[b]	3.65[ab]	48.61[e]
T6	28.92	29.54[a]	5.62[a]	3.72[a]	50.32[f]
P value	0.1471	0.0001	0.0001	0.0093	0.0001
SEM	0.49	0.46	0.01	0.06	1.715

Means in the same column with different letters (a, b, c and e) are differ ($P<0.05$).
T1- T6 containing 233, 1233, 2233, 3233, 4233 and 5233 ppm, TDS, respectively.
SEM, standard error of mean

Effects of high salt diet and/or drinking water on carcass traits of various types of poultry previously investigated by various researchers and reported variable results. Our findings are in agreement with findings of Dai et al [9], which stated that carcass quality significantly affected by water containing salt solutions. Based on their results, there is a significant difference in carcass yield between control and salt solutions treatment groups. Birds consuming NaCl containing water had lower carcass yield than that of control group. In addition, breast meat was affected in birds consuming salt solution containing 0.2% NaCl. In contrast to the current results, Erener et al. [23] andMushtaq et al. [24]reported that different level of salt consumption could not affects carcass traits of the birds. Erener et al. [23] also showed that different NaCl content in water and diet could not affect dressing percentage and even edible organs percentage of Japanese quails.Moreover, Borges et al. [25] declared that different levels of electrolytes in drinking water could not affect carcass characteristics of broilers. In addition, Alahgholiet al [7]mentioned that carcass characteristics, abdominal fat and liver weights not affected by water TDS levels; but heart weight markedly increased by increasing TDS levels in drinkingwater.Surprisingly, El-Deek[26] mentioned that carcass and breast percentages increased by enhancing NaCllevel in their experiment.This is perhaps may be due to providing actual Na and Cl and/or other minerals requirements of birds from saline drinking water. Moreover, Mushtaq et al. [27] reported that in spite of reducing dressing percentage,thigh and breast meat percentage increased by increasing sodium level in the diet of broilers.Khalafalla et al. [28] suggested that, birds utilize Na in the drinking water more efficiently than that in the diet.

Variable results in various studies can be due todifferent intensity of drinking water salinity, animal species, breed, age, water requirement, physiological condition, ambient temperature and salt contents of the diets as well as adaptation of animals [7, 8, 28].

Effect of water salinity on litter moisture

Effect of water salinity on litter moisture of Japanese quails has shown in Tables 3. It is markedly observed that, litter moisture content significantly increased by the increasing TDS levels in drinking water of birds ($p<0.000$).In agreement with our findings, previously, Pourreza et al. [29] indicated that there is significantly positive and direct correlation between TDS level and litter wetness. Watkins et al. [6] reported that moisture content of poultry excreta directly affected by the level of salt in the diet and drinking water. Additionally, Alahgholi et al [7] proposed that higher sodium consumption leads to decreasing renin secretion, which in turn resulted in angiotensin II production. Secretion of this hormone is causes higher excretion of water and sodium and increase the litter moisture.

Honarbakhsh et al. [4]also observed the increased litter moisture using increasing levels of water TDS.Tykałowski[30] reported that, in spite of the fact that electrolytes in particular sodium cause rapid growth of meat type poultry, however higher sodium consumption conduce to increasing water intake and higher moisture content of excreta and litter of the birds.

Afifi et al. [31] informed that broiler chickens can tolerate up to 2000 ppm sodium chloride in the drinking water. Ahmed [32] declared that TDS level of drinking water above 2610 ppm led to negative effects on performance and health of the chickens. In other hand, Alahgholi et al. [7] supported that drinking water consumption with TDS of more than 3000 ppm negatively affects the performance and litter characteristics of broiler chickens. Our suggestion (TDS should not be more than 2233 ppm in Japanese quails), is almost in agreement with the studies that mentioned above.

Moisture content of litter is an important index in bird's health and performance. Higher wetness of litter resulted in higher incidence of leg diseases (e.g. footpad dermatitis), viral survival and coccidiosis and lower growth rate and carcass yield and quality as well as quail feathers in birds. Moreover, adverse effect of litter moisture on welfare and environmental condition of thepoultry house such as ammonia production and fly development should not be neglected [7, 26, 31, 33, 34].In order to solving litter wetness problems, it can be suggested food and water related issues as well as altering rearing system. Razee et al. [35] resulted that, littered floor reared quails had lower performance and health indices than qualis reared in cage system. They suggested the cage system as an alternative troubleshooting way for wet litter problems in Japanese quails.

Conclusion

Based on the results of current study, it can be concluding that; in order to maintain carcass quality indices and litter quality at the safe and acceptable range, amount of TDS in drinking water of Japanese quails should not be more than 2233 ppm.

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Conflict of interest

The authors declare that there is no conflict of interest.

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