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Research article

Growth performance and carcass quality of Tre chickens raised in different levels of saline water

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Abstract

This study aimed to find the effect of saline water on the growth performance and carcass characteristics of Tre chickens. A total of 150 Tre chickens was allotted in five treatments and three replicates per treatment. A completely randomized design was used for this study in which the birds from 4-14 weeks old had ad libitum access to feed and water in all treatments with five levels of salt (0, 0.2, 0.4, 0.6, and 0.8%). The results showed that the growth performance of Tre chicken was decreased when increased levels of salt in drinking water ($P<0.05$). The birds avoided drinking water from treatment with salt of 0.8% ($P<0.05$). The feed conversion ratio of birds was lowest at the treatment of 0 and 0.2%. Besides, carcass traits (carcass, breast, thigh, and gizzard weight) were decreased significantly when the level of salt in drinking water increased over 0.2% ($P<0.05$), but there were no significant differences between 0-0.2% salt in drinking water ($P>0.05$). Small intestine weight was longer at control treatment while large intestine was longer at treatment of 0.2% salt. Additionally, all examined criteria were decreased significantly with 0.4, 0.6, and 0.8% of salt in drinking water ($P<0.05$). It can be concluded that Tre chickens' growth could tolerant the salinity in drinking water up to 0.2%. With over 0.2% salt in drinking water, chicken's performance might be reduced.

Keywords: Carcass traits, Growth performance, Saline water, Tre chickens.

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INTRODUCTION

Recently, poultry, especially chicken, has played an important role in Vietnam's livestock structure. Water is an important aspect of raising chickens. Limited freshwater and climate change are the main constraints that livestock farmers face (Abdelsattar et al., 2020). In coastal areas of Vietnam, climate change has been causing sea-level rise, leading to encroaching saltwater, which has affected agriculture production (Renaud et al., 2015).

Salt dissolved in water is known as salinity. The salt concentration for cattle and poultry was different (Abbas et al., 2009). According to NRC (1994), the daily sodium required for a broiler is 150 mg per head. Feed intake, live weight, and carcass performance were significant among treatments when a suitable amount of salt was added (Iqbal Sanjrani et al., 2014). In previous research, saline drinking water had a negative effect on the growth performance and carcass characteristics of poultry, which were recorded in the studies of Abbas et al. (2009), Dai et al. (2009), Jankowski et al. (2012), Ahmed (2013), Alahgholi et al. (2014), and Khalilipour et al. (2019). When the amount of salt in the diet increased over the standard, there was no increase in body weight and no improvements in feed conversion (Jankowski et al., 2012; Lichtorowicz et al., 2012) but a decrease in small intestine weight (Jankowski et al., 2012; Zduńczyk et al., 2012). Dressing percentage was decreased when poultry consumed NaCl and KCl (Dai et al., 2009). Khalilipour et al. (2019) showed that lower live weight, carcass weight, breast, and thigh weight but better dry matter of thigh and breast were recorded. Mahmud et al. (2010) showed there was no effect of Na dietary on feed consumption (Zduńczyk et al., 2012). Besides, Aziz et al. (2019) debated that saline water, including bicarbonate, chloric, calcium, and magnesium, was less suitable for chicken performances. Additionally, Iqbal Sanjrani et al. (2014) showed that there was no difference between the heart, liver, gizzard, and intestine weights of chickens supplemented with different sodium levels.

Tre chicken is one of the common chickens in Vietnam, and it can be raised in diverse ecological zones, including coastal areas (Van et al., 2020). As a result of the recent condition, poultry farmers in Vietnam face a lot of risks of encroaching saltwater, which has caused some of them to go out of business because of the lack of fresh water. Besides, there were limited studies focusing on how saltwater affects the growth performance, carcass characteristics, and digestive system of poultry in Vietnam. Additionally, ElSaidy et al. (2015) recorded that chickens can endure and grow well under different water quality standards. The water quality changes and the growth of chickens also changes. For these reasons, we implemented this research to estimate the effect of saline water on growth performance, carcass characteristics, and some internal organs of Tre chickens.

MATERIALS AND METHODS

Location and Ethical approval

The study was conducted at an experimental farm from January to June 2021 in the School of Agriculture and Aquaculture, Tra Vinh University. Procedures for raising and slaughtering Tre chickens were approved by the Department of Veterinary and Animal Science, Tra Vinh University (No. 5887/QĐ-ĐHTV).

Preparation of Saline Water

Salt (Visaco company, Vietnam) used for this study was bought from a local store. At the beginning of the experiment, the river water in Ben Tre province was investigated, and 0.4% salt (equivalent to 4,000 ppm) was recorded. Therefore, this 0.4% salt was set up as a standard for formulating salinity levels for this study (T4 with 0.4% salt). The salinity was measured by a salinity refractometer (Atago, Master-S/MillM Alpha, Japan) with an accuracy of ±2‰. Five treatments were designed according to the salt percentage, including T0 (0%), T2 (0.2%), T4 (0.4%), T4 (0.6%) and T8 (0.8%). The drinking water was used to dilute the percentage of salinity using a digital scale.

Animal and Experimental Design

The animals were fed ad libitum and had free access to water during the experiment. All ingredients and chemical compositions are presented in Table 1. The water for each treatment was prepared every day according to levels of salt.

Table 1 Chemical composition of ingredients used in the experiment

Ingredients	DM	OM	CP	EE	CF	Ash	ME
Corn	87.20	98.20	7.05	1.80	1.24	1.80	3,692
Broken rice	86.20	99.40	7.88	0.91	0.10	0.60	3,480
Rice bran	88.70	92.60	12.8	10.30	7.60	7.44	2,724
Soybean meal	87.20	94.20	44.80	1.73	3.70	5.76	2,65
Fish meal	91.60	85.80	62.30	10.00	0.40	14.20	3,223
DCP	100	14.80	-	-	-	85.20	-
Limestone	100	-	-	-	-	-	-
Mineral premix	100	-	-	-	-	-	-

DM = Dry matter (%), CP = Crude protein (%), EE = Ether extract (%), CF = Crude fiber (%), ME = Metabolizable energy (kcal/kg DM), DCP = Dicalcium phosphate (%).

The feed for the experimental chickens was divided into two phases, including (1) the starter phase from 4 to 8 weeks old and (2) the finisher phase from 9 to 14 weeks old (Table 2). Diets were formulated to meet the nutrient requirements of chickens (NRC, 1994).

Table 2 Nutrition composition in diet of Tre chickens according to phase

Criteria	Starter phase	Finisher phase
Ingredients (%)		
Corn	17.00	17.00
Broken rice	18.00	18.00
Rice bran	39.00	44.80
Soybean meal	17.80	13.00
Fish meal	7.00	6.00
DCP	0.50	0.50
Limestone	0.40	0.40
Vitamin – Mineral premix*	0.30	0.30
Total	100	100
Analyzed composition in the diet		
DM	88.10	88.10
OM	93.30	93.30
CP	20.00	18.00
ME (Kcal/kg, DM)	3,006	3,005

*: Vitamin – mineral premix was calculated following the requirement of poultry at starter phase and finisher phase

A completely randomized design was established to collect data from the first to the fourteenth week of the experiment. A total of 150 chicks (Tre chickens) at 4 weeks old were randomly allocated in five treatments with three replications per treatment. In each replication, there were 10 chicks, including (5 males and 5 females). The surface of the pen was 5 m^2, which was made from net, wood, and iron. The floor was covered by husk rice and Balasa bio-yeast and changed frequently to keep it clean and avoid diseases. Feeders and automatic drinking nipples were provided for all cages.

All birds were vaccinated from the first week to the third week against diseases, including New Newcastle, Marek, Gumboro, Respiratory and Avian Influenza.

Data collection

Feed and water intake were noted daily. Before each feeding, the amount of feed left over was recorded. The animal was weighed individually using a digital scale at 4 - 8, 9-14-week-old. Body weight gain was calculated as the difference between the final and initial body weights. Feed intake was calculated using the initial amount of feed given to the birds minus leftovers. Feed intake, mortality, and body weight were recorded in order to calculate the feed conversion ratio.

At 14-week-old, two chickens were randomly slaughtered to evaluate carcass characteristics, including the weight of carcass, breast, and thigh, as well as internal organs such as gizzard, liver, heart, small intestine, and large intestine. The carcass traits of chickens were recorded based on their commercial parts, including warm carcasses, breasts and thighs, and edible organs. Birds with body weights closest to the pen's average body weight were fasted for 6 hours prior to slaughter.

Dry matter (DM), crude protein (CP), organic matter (OM), and total mineral (Ash) were evaluated according to AOAC (1990), and ME contents of the feeds were determined following previous methods (NHONHO analysis center, Can Tho, Vietnam).

Statistical analysis

The effect of saline water on performance was accessed using ANOVA one-way by Minitab 16. A pairwise comparison between means was made using the Tukey test.

RESULTS

Effect of saline water on growth performance of Tre chickens

Table 3 Effect of saline water on growth performance of Tre chickens

Criteria	Treatments (n=30)					SEM	*P*
	T0	T2	T4	T6	T8		
Initial weight (g)	199.80	211.00	200.80	201.30	198.60	4.494	0.359
Final weight (g)	1026.07^{a}	1054.67^{a}	903.67^{b}	895.00^{b}	824.33^{c}	14.621	0.001
Starter phase							
FI (g/bird)	54.42^{a}	53.01^{ab}	50.78^{b}	52.40^{ab}	53.17^{ab}	0.745	0.060
BWG (g/bird/day)	14.10^{a}	13.80^{ab}	10.32^{bc}	10.32^{bc}	9.91^{c}	0.780	0.001
FCR (kg feed/kg BW)	3.88^{ab}	3.85^{b}	4.98^{ab}	5.21^{ab}	5.38^{a}	0.324	0.001
Finisher phase							
FI (g/bird)	68.63^{a}	68.15^{a}	66.60^{ab}	66.06^{b}	65.39^{b}	0.445	0.001
BWG (g/bird/day)	9.25^{bc}	11.51^{a}	10.21^{ab}	10.03^{ab}	8.58^{c}	0.321	0.001
FCR (kg feed/kg BW)	5.75	5.97	6.64	6.78	6.72	0.554	0.580
Starter and finisher phases							
Water intake, ml/head	80.33^{a}	76.96^{b}	68.17^{c}	65.74^{d}	65.65^{d}	0.392	0.001
FI (g/bird)	40.20^{a}	40.21^{a}	39.02^{bc}	38.86^{c}	39.35^{bc}	0.322	0.030
BWG (g/bird/day)	10.69^{a}	11.01^{a}	9.34^{b}	9.25^{b}	8.48^{c}	0.161	0.001
FCR (kg feed/kg BW)	3.48^{c}	3.38^{c}	3.86^{b}	3.88^{b}	4.29^{a}	0.058	0.001

^{a,b,c,d}: Means within a column with different superscripts differ significantly ($P \leq 0.05$). FI: feed intake, BWG: body weight gain, FCR: Feed conversion ratio

Table 3 showed that the growth performance of Tre chickens was affected positively when decreased levels of saltwater in drinking water from 0.4% to 0% salt ($P<0.05$) and affected negatively when increased levels of saltwater from 0.4 to 0.8% ($P<0.05$). At initial weights, there were no differences between treatments ($P>0.05$); the differences were shown at the end of the experiment ($P<0.05$). During the experiment, the chicken avoided drinking water from the high concentration of saltwater ($P<0.05$). In T2 and T0, Tre chickens drank water normally. Feed intake, daily weight gain, and feed conversion ratio showed a significant difference ($P<0.05$) when increased levels of saltwater compared to T0 during 1-14 weeks of age. Particularly, in the starter phase, feed intake and body weight gain were better at T0, and FCR was better at T2 ($P<0.05$). At the finisher phase, it was better at T2 for both feed intake and body weight gain ($P<0.05$). However, there were no significant differences in the FCR of the finisher phase ($P>0.05$).

Effect of saltwater on carcass traits of Tre chickens

Tre chicken carcass characteristics are shown in Table 4. Carcass weight, thigh weight, and breast weight were decreased significantly when increasing levels of salt in drinking water ($P<0.05$). However, carcass percentage, breast percentage, and thigh percentage were not different between treatments ($P>0.05$). Carcass, breast, and thigh weights were highest at T0 ($P<0.05$) while there was no difference between T0 and T2 ($P>0.05$).

Table 4 Effect of saltwater on carcass characteristics of Tre chickens

Criteria	Treatments					SEM	*P*
	T0	T2	T4	T6	T8		
Live weight, g/head	993.33^a	965.50^a	872.00^b	854.67^b	780.00^c	12.790	0.001
Carcass weight, g	687.33^a	659.17^a	590.00^b	580.00^b	519.00^c	5.107	0.001
Carcass percentage, %	69.21	68.35	67.69	67.87	67.59	0.929	0.423
Breast weight, g	173.67^a	163.33^a	145.00^b	142.67^b	125.00^c	2.852	0.001
Breast percentage, %	25.26	24.79	24.58	24.61	24.10	0.527	0.651
Thigh weight, g	110.50^a	105.00^a	90.67^b	88.67^b	79.00^c	1.412	0.001
Thigh percentage, %	16.08	15.93	15.37	15.29	15.23	0.267	0.139

^{a,b,c}: Means within a column with different superscripts differ significantly ($P\leq0.05$)

The effect of saltwater on edible organs and intestine length

The effect of saltwater on gizzard, heart, liver, and intestine length is presented in Table 5. Gizzard weight was significantly different between treatments and higher at the treatment of T0 and T2 ($P<0.05$). Gizzard weight was highest at the T0. Gizzard weight increased when saltwater decreased. Small intestine length was longer at T0 but large intestine length was longer at T2 ($P<0.05$).

Table 5 Effect of saltwater on edible organs and intestine lengths of Tre chickens

Criteria	Treatments					SEM	*P*
	T0	T2	T4	T6	T8		
Liver weight, g	16.43	15.93	15.00	15.17	15.10	0.352	0.063
Gizzard weight, g	38.93^a	38.07^a	36.00^{ab}	32.00^b	31.33^b	1.193	0.003
Heart weight, g	5.00	5.00	4.97	5.00	4.97	0.365	1.001
Small intestine length, cm	123.50^a	104.33^b	102.83^b	95.00^{bc}	81.67^c	3.825	0.001
Large intestine length, cm	11.10^c	19.57^a	9.93^c	10.50^c	17.30^b	0.401	0.001

^{a,b,c}: Means within a column with different superscripts differ significantly ($P\leq0.05$)

DISCUSSION

The study indicated the negative effect of saltwater on Tre chicken's growth performance, carcass traits, edible organs, and the length of small and large intestines. The results of our study were similar to the studies of Abbas et al. (2009), Lichtorowicz et al. (2012), Ahmed (2013), Alahgholi et al. (2014), Aziz et al. (2019), Khalilipour et al. (2019). The initial weights were not different between treatments,

proving the significant findings at the end of the trial were from the effect of saline water. At the end of the treatment, the final weights were different statistically.
Water intake was decreased in the experiment showing that Tre chickens try to avoid saline water probably due to their behavior in avoiding drinking saline water. Umar et al. (2014) showed that animals are disgusted with high levels of chlorine and other minerals such as Ca and K in the water. The high amount of these factors in drinking water might affect the taste, odor, and watercolor leading to an effect on water intake. The study recorded fewer effects of saline water on Tre chickens in the finisher phase, especially for FCR. In similar results to Khalilipour et al. (2019), young birds are more sensitive to salt than older chickens. Aziz et al. (2019) recorded the same results: with 0.2% salt in drinking water, chickens become more resistant to saltwater, or there are not many effects of saltwater on chicken's performance. The results showed that there were no differences between treatment with 0.2% salt, and without salt and 0.2% salt improved the body weight gain of Tre chickens. This is because the amount of salt in the diets and drinking water might still be within the tolerance of Tre chickens. Besides, 0.2% salinity levels in drinking water might provide enough for Tre chicken's requirements, which was lacking in the diet. It was in line with the study of Honarbakhsh et al. (2007) who found chickens providing drinking water with salinities of 375, 1,375, and 2,375 ppm had better body weight, daily feed intake, and FCR. Korleski et al. (2011) showed that when the amount of sodium and chloride was increased from 2.11 to 2.95 g during the starter phase, it had a good effect on body weight growth and feed conversion ratio. Salt consumption in feed and water, notably sodium, potassium, and chloride, is linked to performance issues (El-Badry et al., 2015). However, the amount and type of salt in water have an impact on water intake (Mamabolo et al., 2009). This could be related to appetite loss produced by lesions in the appetite center as well as inflammation, which caused a drop in all evaluated parameters. With sodium chloride-dominated drinking water and the high salt content of fishmeal in feed, poultry productivity will probably suffer negative effects. Salinity levels in drinking water exceeding 2610 ppm, according to Ahmed (2013), have a deleterious impact on chicken performance and health. As the same results, Alahgholi et al. (2014) found that drinking water with a salt of more than 3000 ppm has a negative impact on performance. Alahgholi et al. (2014) also recorded that daily weight gain decreased, feed conversion ratio increased in 4500 ppm of saltwater over the growing, finishing, and entire phase of chicken production. Water is essential for both nutrient absorption and waste excretion, solute content has a significant impact on water flow across the epithelium (Collet, 2012). The bad performance of Tre chickens might be due to saltwater relating to the imbalance of anion-cation, and this imbalance disturbed the absorption of amino acids, thus leading to the decrease in growth performance. It was also explained in the study of Alahgholi et al. (2014). Kettunen et al. (2001) found that drinking water with a higher salinity can have a negative impact on avian performance due to changes in osmotic pressure and intracellular metabolism. Animals' ability to endure saline water or the tolerance and sensitivity of chickens to saline water is determined by the animal's species, age, water requirement weather, salinity level, and the amount of salt in the water (Abdelsattar et al., 2020). Some researchers found that when the salinity levels were low, the animals' performance improved, but when the salinity levels were increased, the animals' performance dropped (Abdelsattar et al., 2020).
Water salinity had a strong effect on carcass weight, breast weight and thigh weight significantly. It was similar to the results of Khalilipour et al. (2019); high amounts of salt in drinking water often caused a low in carcass, breast and even pre-slaughter weight. The study of Dai et al. (2009) also recorded that carcass quality had been affected by salt in drinking water. Carcass yield was lower in the drinking water group containing NaCl than in the control group. In addition, chickens fed a salt solution containing 0.2 percent of NaCl caused a decrease in breast meat. It was in line with the results of carcass, breast, and thigh weight in this study.

However, there were no effects of saltwater on carcass percentage of Tre chickens. This result was also similar to the findings of Erener et al. (2002), who also found that the amount of NaCl in the water and the diet had no effect on the carcass percentage of Japanese quails such as dressed percentage and edible part percentage. According to Borges et al. (2003), varying quantities of electrolytes in drinking water have little effect on broiler carcass properties. Regardless of the source, when the trace mineral requirements are met, mineral supplementation may not result in substantial variations in performance, production, or meat quality (Ribeiro et al., 2020). Muhammad et al. (2014) found that increasing Na from 0.20 to 0.30 percent reduced breast and thigh meat. This discrepancy could be attributable to the heat stress circumstances, as additional nutrients ingested to maintain acid-base balance might not be converted to meat. Increasing Na under normal physiological conditions had no effect on basal metabolism, and energy was mostly used for meat synthesis rather than being wasted as belly fat in the current study by Khalilipour et al. (2019). That is the reason why there were no effects of saltwater on carcass percentages.

In the current study, saltwater affected the weight of the gizzard and intestine length. It was due to chickens trying to digest nutrients to compensate for growing loss and lesions of some organs. Bird’s enhancement in digestive or metabolic capability is reflected in the increased weight of their gizzard. The ability of the digestive system to absorb nutrients is reflected in intestinal weight, which indicates poultry’s health status (Khalilipour et al., 2019). As the explanation by Cura Castro et al. (2009), the bird's ability to adjust body growth following water limitation, including salinity levels, may have been aided by the bird's preference for organ expansion, which increased the efficiency of digestive processes, especially for gizzard weight.

CONCLUSIONS

For optimal growth performance of Tre chickens in coastal areas, the maximum level of salinity should be equal to 0.2% salt added to their drinking water. The study recommended that saltwater with less than 0.2% or 2,000 ppm should be ideal for raising Tre chicken in coastal areas.

AUTHOR CONTRIBUTIONS

Nguyen Thuy Linh, Nguyen Hoang Qui, Nguyen Thi Truc Linh, Nguyen Van Vui, Truong Thanh Trung, and Nguyen Thi Kim Dong: Conceptualize and design the experiment, investigate, supervise, edit, perform formal analysis, and prepare the manuscript.

CONFLICT OF INTEREST

We have no conflict of interest.

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