

Effects of Iodine on Growth Performance, Slaughter Performance, and Serum Antioxidant Indices in 1-4 Week-Old Wulong Geese (Postprint)

Authors: Li Xingchen, Li Wenli, Wang Baowei, Ge Wenhua, Zhang Ming' ai, Wang Fuxiang

Date: 2017-10-10T00:00:00+00:00

Abstract

This study aimed to investigate the effects of dietary iodine supplementation levels on growth performance, slaughter performance, and serum antioxidant indices of 1- to 4-week-old Wulong geese, and to determine the appropriate iodine supplementation level in Wulong goose diets. A total of 216 one-day-old Wulong geese were randomly allocated into 6 groups with 3 replicates per group and 12 geese per replicate. Group I (control) was fed the basal diet, while Groups II-VI were fed experimental diets supplemented with 0.2, 0.4, 0.8, 1.6, and 3.2 mg/kg iodine based on the basal diet. The experimental period lasted 4 weeks. The results showed that: 1) Compared with the control group, dietary supplementation of 0.4 mg/kg iodine significantly increased average daily gain and average daily feed intake ($P < 0.05$), and significantly decreased feed-to-gain ratio ($P < 0.05$). 2) Compared with the control group, dietary supplementation of 0.4 mg/kg iodine extremely significantly increased semi-eviscerated yield, eviscerated yield, and breast muscle percentage ($P < 0.01$), and significantly increased dressing percentage and leg muscle percentage ($P < 0.05$). 3) Compared with the control group, dietary supplementation of 0.4 mg/kg iodine extremely significantly increased serum total antioxidant capacity and total superoxide dismutase activity ($P < 0.01$), significantly increased serum catalase and glutathione peroxidase activities ($P < 0.05$), and significantly decreased serum malondialdehyde content ($P < 0.05$). In conclusion, under the conditions of this experiment, dietary supplementation of appropriate iodine levels had significant effects on growth performance, slaughter performance, and serum antioxidant indices of 1- to 4-week-old Wulong geese. The appropriate iodine supplementation level in Wulong goose diets was 0.4 mg/kg.

Full Text

Effects of Iodine on Growth Performance, Slaughter Performance, and Serum Antioxidant Indices of Wulong Geese Aged 1-4 Weeks

LI Xingchen¹, WANG Baowei², WANG Fuxiang³, GE Wenhua², ZHANG Ming' ai², LI Wenli^{1*}

¹College of Animal Science and Technology, Qingdao Agricultural University, Qingdao 266109, China

²Institute of High-Quality Waterfowl, Qingdao Agricultural University, Qingdao 266109, China

³Zhanhua County Bureau of Animal Husbandry, Shandong Province, Binzhou 256800, China

Abstract: This experiment investigated the effects of dietary iodine supplementation levels on growth performance, slaughter performance, and serum antioxidant indices of 1-4-week-old Wulong geese to determine the optimal iodine supplementation level. A total of 216 one-day-old Wulong geese were randomly allocated into six groups with three replicates per group and 12 geese per replicate. Group I (control) received a basal diet, while groups II-VI received experimental diets supplemented with 0.2, 0.4, 0.8, 1.6, and 3.2 mg/kg iodine, respectively. The 4-week trial yielded three key findings. First, compared with the control, dietary supplementation with 0.4 mg/kg iodine significantly increased average daily gain (ADG) and average daily feed intake (ADFI) ($P < 0.05$) while significantly reducing feed-to-gain ratio (F/G) ($P < 0.05$). Second, the 0.4 mg/kg iodine group showed highly significant improvements in half-eviscerated yield, eviscerated yield, and breast muscle percentage ($P < 0.01$), along with significant increases in dressing percentage and leg muscle percentage ($P < 0.05$). Third, this supplementation level significantly enhanced serum total antioxidant capacity (T-AOC) and total superoxide dismutase (T-SOD) activity ($P < 0.01$), increased catalase (CAT) and glutathione peroxidase (GSH-Px) activities ($P < 0.05$), and decreased malondialdehyde (MDA) content ($P < 0.05$). These results demonstrate that appropriate dietary iodine supplementation significantly improves growth performance, slaughter performance, and serum antioxidant capacity in 1-4-week-old Wulong geese, with 0.4 mg/kg identified as the optimal supplementation level.

Keywords: iodine; growth performance; slaughter performance; antioxidant indices

Introduction

Iodine is an essential trace element for animal growth and development, playing critical physiological roles. Research by Wang Yingmin [1] revealed that

iodine is primarily absorbed in the small intestine of monogastric animals, with secondary absorption occurring in the stomach, whereas ruminants absorb iodine within the rumen. Both iodine deficiency and excess can disrupt thyroid hormone synthesis and secretion, causing endocrine disorders that either impair or excessively stimulate growth, thereby affecting animal performance. Wang Zongyuan [2] reported that iodine deficiency in young animals leads to physiological dysfunction, growth retardation, and in severe cases, incomplete central nervous system development resulting in cretinism. Zhou Ming [3] found that long-term consumption of iodine-deficient diets reduces iodine content in animal products. Conversely, Boumaud et al. [4] demonstrated that excessive iodine intake adversely affects thyroid function and growth, potentially causing tumor development.

Current Chinese feeding standards show substantial variation in iodine requirements across poultry species. The *Feeding Standard of Chickens* (NY/T 33-2004) specifies 0.35 mg/kg for growing layers and 0.70 mg/kg for broilers and broiler breeders. The *Feeding Standard of Meat Ducks* (NY/T 2122-2012) recommends 0.4 mg/kg for commercial Pekin ducks, 0.4 mg/kg for Pekin duck breeders aged 1-3 weeks (decreasing to 0.3 mg/kg at 4-22 weeks), and 0.4 mg/kg for dual-purpose ducks aged 1-3 weeks (decreasing to 0.3 mg/kg at 4-8 weeks). These disparities highlight the need for species-specific research.

Despite iodine's established importance, research on iodine requirements for geese remains scarce, particularly for Wulong geese. No definitive standards currently exist for iodine supplementation in goose diets, creating a critical knowledge gap. This study systematically investigated the effects of dietary iodine levels on growth performance, slaughter performance, and serum antioxidant indices in 1-4-week-old Wulong geese to establish optimal supplementation guidelines and contribute to a comprehensive nutritional standard system for this breed.

1.1 Experimental Materials

Iodine was supplemented as potassium iodide (KI, 99% purity) purchased from Qingdao Puxing Biotechnology Co., Ltd.

1.2 Experimental Animals and Design

Two hundred sixteen healthy one-day-old Wulong geese were randomly divided into six groups with three replicates each, containing 12 geese per replicate (equal sex ratio). The 4-week feeding trial consisted of a control group (Group I) fed a basal diet and five treatment groups (Groups II-VI) receiving the basal diet supplemented with 0.2, 0.4, 0.8, 1.6, and 3.2 mg/kg iodine, respectively. The basal diet was formulated according to NRC (1994) goose feeding standards and Chinese Feed Composition Tables, using corn and soybean meal as primary

ingredients with corn straw as the fiber source. Dietary composition and nutrient levels are presented in Table 1 .

Table 1 Basal diet composition and nutrient levels (air-dry basis), %

Ingredients: Corn, soybean meal, fish meal, wheat middling, corn straw, dicalcium phosphate, limestone, choline chloride, salt, trace elements, multivitamin.

Nutrient levels: Metabolizable energy (ME) MJ/kg, crude protein (CP), crude fiber (CF), calcium (Ca), available phosphorus (AP), lysine (Lys), methionine + cysteine (Met+Cys).

Note: Trace elements and multivitamin provided per kilogram of diet: VA 1,500 IU, VD₃ 200 IU, VE 12.5 mg, VK₃ 1.5 mg, VB₁ 2.2 mg, VB₂ 5.0 mg, nicotinic acid 65 mg, pantothenate 15 mg, VB₆ 2 mg, biotin 0.2 mg, folic acid 0.5 mg, choline 1,000 mg, Fe 90 mg, Cu 6 mg, Mn 85 mg, Zn 85 mg, Co 2.5 mg.

1.3 Management Practices

Geese were raised on net floors with ad libitum access to water and feed. Feed was provided in small, frequent meals. Ambient temperature and humidity were recorded three times daily at 08:00, 14:00, and 20:00. Brooding temperatures were maintained at 28-30°C in week 1, 26-27°C in week 2, and 24-25°C in week 3, after which temperature was gradually reduced to ambient. Average relative humidity was 65%. Lighting schedules were 23 h in weeks 1-2, 18 h in week 3, and natural light in week 4.

1.4 Performance Measurements

1.4.1 Growth Performance Daily feed provision and residual amounts were recorded to monitor health status and calculate feed intake. At 4 weeks, body weight was measured to calculate ADG, ADFI, and F/G for the 1-4-week period.

1.4.2 Slaughter Performance At the end of week 4, two geese per replicate (one male and one female, totaling 36 birds) were randomly selected, fasted for 12 hours, weighed, and blood-sampled via wing vein before slaughter. Measurements included carcass weight, half-eviscerated weight, eviscerated weight, abdominal fat weight, breast muscle weight, and leg muscle weight, from which dressing percentage, eviscerated yield, half-eviscerated yield, abdominal fat percentage, leg muscle percentage, and breast muscle percentage were calculated according to *Poultry Performance Terminology and Measurement Methods* (NY/T 823-2004).

1.4.3 Serum Antioxidant Indices At 4 weeks, six geese per group (two per replicate, one of each sex) were blood-sampled via wing vein (10 mL), centrifuged at 3,000 rpm to obtain serum, which was stored at -40°C for antioxidant analysis. Assay kits were purchased from Nanjing Jiancheng Bioengineering Institute. Serum MDA content was determined by thiobarbituric acid (TBA)

method, CAT activity by visible light spectrophotometry, T-AOC by colorimetry, T-SOD activity by hydroxylamine method, and GSH-Px activity by GSH-Px colorimetric assay.

1.5 Statistical Analysis

Data were analyzed using one-way ANOVA with LSD post-hoc test in SPSS 17.0. Results are expressed as mean \pm standard deviation. Significance was declared at $P < 0.05$ and highly significant at $P < 0.01$.

2.1 Effects of Iodine on Growth Performance of Wulong Geese

As shown in Table 2, ADG increased initially then decreased with rising iodine levels, peaking in Group III (0.4 mg/kg), which was 7.50 g/d higher than the control ($P < 0.05$). Other groups did not differ significantly ($P > 0.05$). ADFI followed a similar pattern, with Group III showing the highest intake, 9.02 g/d greater than the control ($P < 0.05$). F/G decreased then increased, reaching its minimum in Group III, which was 0.16 lower than the control ($P < 0.05$).

Table 2 Effects of iodine on growth performance of Wulong geese

Note: In the same column, values with the same or no letter superscripts indicate no significant difference ($P > 0.05$), adjacent lowercase letters indicate significant difference ($P < 0.05$), and alternate lowercase letters indicate highly significant difference ($P < 0.01$). This applies to all tables.

2.2 Effects of Iodine on Slaughter Performance of Wulong Geese

Table 3 shows that dressing percentage, half-eviscerated yield, eviscerated yield, breast muscle percentage, and leg muscle percentage all increased initially then decreased, with Group III achieving the highest values. Compared with the control, Group III increased dressing percentage by 6.32% ($P < 0.05$), half-eviscerated yield by 7.02% ($P < 0.01$), eviscerated yield by 7.13% ($P < 0.01$), breast muscle percentage by 0.58% ($P < 0.01$), and leg muscle percentage by 3.05% ($P < 0.05$). Abdominal fat percentage decreased then increased, but differences among groups were not significant ($P > 0.05$).

Table 3 Effects of iodine on slaughter performance of Wulong geese, %

2.3 Effects of Iodine on Serum Antioxidant Indices of Wulong Geese

As presented in Table 4, serum MDA content decreased then increased with iodine supplementation, reaching its lowest level in Group III, which was 0.016 U/mL lower than the control ($P < 0.05$). Serum T-AOC and activities of CAT, T-SOD, and GSH-Px increased then decreased, with Group III showing the highest values—2.51 U/mL ($P < 0.01$), 1.23 U/mL ($P < 0.05$), 46.24 U/mL ($P < 0.01$), and 95.68 U/mL ($P < 0.05$) higher than the control, respectively.

Table 4 Effects of iodine on serum antioxidant indicators of Wulong geese, U/mL

Discussion

3.1 Effects of Iodine on Growth Performance

Previous studies have reported varied effects of iodine supplementation across species. Bedi et al. [5] observed improved growth rates in goats receiving 0.08 mg/kg iodine daily. Pattanaik et al. [6] found that iodine-supplemented mustard cake increased body weight in goats, with the high-iodine group significantly heavier at trial completion, though ADG differences were not significant. Liu et al. [7] reported significant effects of iodine level on ADG in meat rabbits, with optimal iodine (0.5 mg/kg) significantly improving ADG and reducing F/G compared to controls and lower supplementation levels. These findings align with our results. However, Meyer et al. [8] found no significant effects of iodine on daily gain or slaughter performance in growing-finishing cattle, and Wichtel et al. [9] reported no impact on growth rate in Angora goats. These discrepancies may reflect species differences, as our study focused on poultry rather than mammals. Yang et al. [10] found that 0.8 mg/kg iodine significantly increased ADG and body length in meat rabbits, consistent with our observations. The NRC (1994) recommendation of 0.35 mg/kg iodine for 1-4-week-old geese is lower than our optimal level, likely because it was extrapolated from chicken requirements. Our results demonstrate that 0.4 mg/kg iodine maximized ADG and ADFI while significantly improving F/G in Wulong geese. This improvement may occur because adequate iodine intake ensures sufficient thyroid hormone synthesis, which subsequently acts on growth hormone to promote tissue differentiation, development, and maturation.

3.2 Effects of Iodine on Slaughter Performance

Iodine deficiency or excess disrupts thyroid hormone synthesis and secretion, impairing organ development and reducing slaughter performance. Han et al. [11] reported that selenium-iodine supplementation in dairy cows significantly increased serum protein-bound iodine and reduced white muscle disease incidence from 17.9% to 0%, likely by enhancing thyroid hormone bioavailability and stimulating organ development. While limited data exist on iodine's effects on slaughter performance, our study provides compelling evidence that 0.4 mg/kg iodine significantly improved dressing percentage, half-eviscerated yield, eviscerated yield, breast muscle percentage, and leg muscle percentage in Wulong geese. Based on these comprehensive improvements, we recommend 0.4 mg/kg as the optimal iodine supplementation level for maximizing slaughter performance in 1-4-week-old Wulong geese.

3.3 Effects of Iodine on Serum Antioxidant Indices

Many diseases originate from excessive free radical production, which triggers lipid peroxidation of biological membranes, releases the highly toxic MDA, damages membrane integrity, and induces autoimmune diseases and cancer [12]. This process also affects membrane fluidity and permeability [13]. Serum MDA content indirectly reflects the degree of tissue damage [14]. In our trial, MDA content decreased, suggesting iodine supplementation influenced oxidative status without causing overt tissue damage. Studies on rats have shown that both iodine deficiency and excess alter serum SOD activity and MDA content, though results vary [15–19]. Xie et al. [20] and Du et al. [21] reported that potassium iodide and potassium iodate affect antioxidant enzyme activities differently. Ye et al. [22–23] observed that varying potassium iodide doses initially decreased then increased SOD activity in rats, possibly indicating compensatory mechanisms. These divergent results may stem from differences in species, diet composition, and rearing environment. In our study, increasing iodine levels decreased serum MDA content and increased T-AOC and CAT, T-SOD, and GSH-Px activities up to 0.4 mg/kg, beyond which trends reversed. This optimal level significantly reduced MDA while enhancing antioxidant enzyme activities. Collectively, our findings support 0.4 mg/kg as the appropriate iodine supplementation level for 1–4-week-old Wulong geese.

Conclusion

Under the conditions of this experiment, the optimal dietary iodine supplementation level for 1–4-week-old Wulong geese is 0.4 mg/kg.

References

- [1] Wang Yingmin. *Prevention of Trace Element Metabolic Disorders in Livestock* [M]. Beijing: China Agriculture Press, 1988: 60.
- [2] Wang Zongyuan. *Animal Nutritional and Metabolic Diseases and Toxicology* [M]. Beijing: China Agriculture Press, 1997.
- [3] Zhou Ming. Effects of trace elements on animal reproductive function [J]. *Foreign Animal Husbandry: Feed*, 1990(6): 12–15.
- [4] Boumaud C, Orgiazzi J J. Iodine excess and thyroid autoimmunity [J]. *Journal of Endocrinological Investigation*, 2003, 26(2): 49–56.
- [5] Bedi S P S, Pattanaik A K, Khan S A, et al. Effect of graded levels of iodine supplementation on the performance of barbaric goats [J]. *Indian Journal of Animal Sciences*, 2000, 70(7): 736–739.
- [6] Pattanaik A K, Khan S A, Varshney V P, et al. Effect of iodine level in mustard (*Brassica juncea*) cake-based concentrate supplement on nutrient utilisation and serum thyroid hormones of goats [J]. *Small Ruminant Research*, 2001, 41(1): 51–59.
- [7] Liu Hanzhong, Ma Mingwen, Li Xin, et al. Effects of dietary iodine sup-

- plementation level on growth performance and serum biochemical indices of weaned to 2-month-old meat rabbits [J]. *Chinese Journal of Animal Nutrition*, 2010, 22(4): 1076-1080.
- [8] Meyer U, Weigel K, Schöne F, et al. Effect of dietary iodine on growth and iodine status of growing fattening bulls [J]. *Livestock Science*, 2008, 115(2/3): 219-225.
- [9] Wichtel J J, Thompson K G, Craigie A L, et al. Effects of selenium and iodine supplementation on the growth rate, mohair production, and thyroid status of Angora goat kids [J]. *New Zealand Journal of Agricultural Research*, 1996, 39(1): 111-115.
- [10] Yang Guozhong, Sun Quanwen, Wu Zhanfu, et al. Effects of dietary iodine level on production performance of meat rabbits [J]. *Progress in Veterinary Medicine*, 2007, 28(11): 50-53.
- [11] Han Bo, Liang Jian, Zhang Yixian, et al. Effects of dietary selenium, iodine, and copper on production and reproductive performance of dairy cows in Ningxia region [J]. *Journal of Nanjing Agricultural University*, 2000, 23(3): 76-80.
- [12] Dean R T, Fu S L, Stocker R, et al. Biochemistry and pathology of radical-mediated protein oxidation [J]. *Biochemical Journal*, 1997, 324(1): 1-18.
- [13] Yan Yuqin, Fang Hui, Xiang Jianmei, et al. Effects of iodine deficiency and excess on thyroid cell membrane lipid fluidity in rats [J]. *Chinese Journal of Preventive Medicine*, 2000, 34(5): 266-268.
- [14] Fang Hui, Yan Yuqin, Chen Zupei. Experimental study on antioxidant capacity of thyroid in iodine-deficient and iodine-excess rats [J]. *Chinese Journal of Endemiology*, 2001, 20(1): 11-13.
- [15] Karbownik M, Lewinski A. The role of oxidative stress in physiological and pathological processes in thyroid gland; possible involvement in pineal-thyroid interactions [J]. *Neuro Endocrinology Letters*, 2003, 24(5): 293-303.
- [16] Ye Zhenkun, Luo Yuyu, Xiang Jianmei, et al. Quantitative morphological observation of iodine supplementation effects with potassium iodate and potassium iodide on iodine-deficient goiter rats [J]. *Chinese Journal of Endemiology*, 2005, 24(4): 365-367.
- [17] Ye Zhenkun, Luo Yuyu, Xiang Jianmei, et al. Effects of supplementing different doses of potassium iodate and potassium iodide on antioxidant capacity of thyroid and blood in iodine-deficient rats [J]. *Chinese Journal of Endemic Disease Control*, 2003, 18(5): 260-263.
- [18] Li Ying, Wang Danna, Chen Xiujie. Effects of iodine deficiency and excess on thyroid morphology and antioxidant capacity in rats [J]. *Chinese Journal of Endemiology*, 2002, 21(2): 91-93.
- [19] Liu Yingying, Chen Zupei, Xiang Jianmei. Experimental observation of low iodine on animal cell antioxidant capacity [J]. *Chinese Journal of Endemiology*, 1997, 16(4): 221-224.
- [20] Xie Wenqin, Liu Shoujun, Yu Jun, et al. Comparative study on effects of potassium iodate and potassium iodide on antioxidant capacity in mice [J]. *Chinese Journal of Endemiology*, 2005, 24(6): 631-633.
- [21] Du Linlin, Liu Shoujun, Gao Jinxia, et al. Dynamic comparative study on

effects of different iodine agents at field doses on blood antioxidant capacity in mice [J]. *Chinese Journal of Endemic Disease Control*, 2008, 23(2): 90-92.

[22] Ye Zhenkun, Lin Laixiang, Sun Yina, et al. Effects of different doses of potassium iodate on blood antioxidant capacity in rats [J]. *Journal of Environment and Health*, 2007, 24(4): 195-197.

[23] Ye Zhenkun, Lin Laixiang, Nie Xiuling, et al. Effects of different doses of potassium iodide on blood antioxidant capacity in rats [J]. *Chinese Journal of Public Health*, 2007, 23(1): 81-82.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv –Machine translation. Verify with original.