Effects of Dietary Myriophyllum elatinoides Supplementation on Growth Performance, Slaughter Performance, and Immune Organ Indices in Linwu Ducks (Postprint)

Authors: Huang Ke, Li Lili, Xiao Runlin, Liangxue Sheng, Wang Shengping, Chen Qinghua, Zeng Guanjun

Date: 2017-10-23T00:00:00+00:00

Abstract

This experiment aimed to investigate the effects of dietary green foxtail algae supplementation on growth performance, slaughter performance, and immune organ indices in Linwu ducks, in order to determine the appropriate inclusion level of green foxtail algae in Linwu duck diets. A total of 480 healthy 30-day-old Linwu ducks with similar body weight were selected and randomly divided into 3 groups, with 4 replicates per group and 40 ducks per replicate. Group 1 (control group) was fed the basal diet, while groups 2 and 3 were fed experimental diets containing 10% and 20% green foxtail algae, respectively. The experimental period lasted 28 days. At 44 and 58 days of age, ducks were slaughtered to determine live body weight, carcass yield, semi-eviscerated yield, eviscerated yield, breast muscle percentage, leg muscle percentage, skin and fat percentage, and immune organ indices. The results showed that: 1) During the 30-44 day and 45-58 day periods, group 3 exhibited significantly higher average daily gain, average daily feed intake, and feed conversion ratio compared with group 2 and the control group ($P<0.05$), but no significant differences were observed between group 2 and the control group ($P>0.05$). 2) At 44 and 58 days of age, no significant differences were observed among groups in live body weight, carcass yield, semi-eviscerated yield, eviscerated yield, leg muscle percentage, or skin and fat percentage ($P>0.05$); however, the breast muscle percentages of both group 2 and group 3 were significantly higher than that of the control group ($P<0.05$). 3) At 44 days of age, no significant differences were observed among groups in thymus index, spleen index, or bursa of Fabricius index ($P>0.05$); at 58 days of age, the bursa of Fabricius index of group 3 was significantly higher than that of the control group ($P>0.05$), the spleen index of group 3 was significantly higher than those of the control group and group 2 ($P>0.05$), and

no significant differences were observed among groups in thymus index (P>0.05). These results indicate that the addition of 10% green foxtail algae to Linwu duck diets had no significant effects on growth performance, slaughter performance, or immune organ indices.

Full Text

Effects of Dietary *Myriophyllum quitense* on Growth Performance, Slaughter Performance and Immune Organ Index of Linwu Ducks

HUANG Ke[1],[2], LI Lili[1], *XIAO Runlin*[1], *SHENG Liangxue*[1], *WANG Shengping*[3], *CHENG Qinghua*[2], ZENG Guanjun[1]

[1]. Changsha Research Station for Agricultural Environmental Monitoring, Institute of Subtropical Agriculture, Chinese Academy of Sciences; Key Laboratory for Agro-Ecological Processes in Subtropical Region, Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha 410125, China
[2]. College of Animal Science and Technology, Hunan Agricultural University, Changsha 410128, China
[3]. Hunan Province Microbiology Institute, Changsha 410009, China

Abstract: This study investigated the effects of dietary *Myriophyllum quitense* on growth performance, slaughter performance, and immune organ index of Linwu ducks to determine the appropriate supplementation level. A total of 480 healthy 30-day-old Linwu ducks with similar body weight were randomly allocated into three groups, each with four replicates of 40 ducks. Group 1 (control) received a basal diet, while groups 2 and 3 received experimental diets containing 10% and 20% *M. quitense*, respectively. The 28-day trial involved slaughter at 44 and 58 days of age to measure live body weight, carcass yield, half-eviscerated yield, eviscerated yield, breast muscle percentage, leg muscle percentage, subcutaneous fat percentage, and immune organ indices. The results showed: (1) During both 30–44 days and 45–58 days, group 3 exhibited significantly different average daily gain, average daily feed intake, and feed-to-gain ratio compared to group 2 and the control (P<0.05), while no significant differences were observed between group 2 and the control (P>0.05). (2) At both 44 and 58 days of age, no significant differences were found among groups in body weight, carcass rate, half-eviscerated rate, eviscerated rate, leg muscle rate, or subcutaneous fat rate (P>0.05), but the breast muscle rate in groups 2 and 3 was significantly higher than in the control (P<0.05). (3) At 44 days, no significant differences were detected in thymus, spleen, or bursa of Fabricius indices among all groups (P>0.05). At 58 days, the bursa of Fabricius index in group 3 was significantly higher than in the control (P<0.05), and the spleen index in group 3 was significantly higher than in both the control and group 2 (P<0.05), though thymus index remained unaffected (P>0.05). In conclusion, dietary supplementation with 10% *M. quitense* has no obvious adverse effects on growth performance, slaughter performance, or immune organ indices in Linwu

ducks.

Keywords: *Myriophyllum quitense*; Linwu ducks; growth performance; slaughter performance; immune organ index

Introduction

With the rapid development of animal husbandry in China, feed resource shortages are becoming a major obstacle to sustainable industry growth. Scientific utilization of unconventional feed resources based on their nutritional characteristics and animal physiological requirements is therefore essential. *Myriophyllum quitense*, a species in the family Haloragidaceae, originates from South America and has been cultivated in China as an ornamental plant for over 200 years. It exhibits strong adaptability, rapid biomass accumulation, and high pollution tolerance, making it widely applicable for ecological restoration of eutrophic water bodies. The Institute of Subtropical Agriculture, Chinese Academy of Sciences has developed a core purification technology using *M. quitense* wetland systems to address agricultural and rural environmental pollution in China, achieving notable results in water ecological management and resource optimization. *M. quitense* grows rapidly in nitrogen- and phosphorus-rich water, with nitrogen absorption capacity reaching 1–2 t/hm^2 annually (equivalent to the annual excretion of approximately 280–560 pigs) and phosphorus absorption of 0.18–0.30 t/hm^2 per year. However, research on its utilization as a feed resource remains in its infancy, with limited relevant literature available. This study aims to evaluate the effects of graded levels of dietary *M. quitense* on growth performance, slaughter performance, and immune organ indices in Linwu ducks, providing a theoretical basis for developing this novel feed resource and its scientific application in meat duck diets.

1.1 Experimental Material

Myriophyllum quitense was provided by the Kaihui Base of Changsha Agricultural Environmental Observation Station, Institute of Subtropical Agriculture, Chinese Academy of Sciences. Its major nutrient composition is presented in Table 1 .

1.2 Experimental Design

Four hundred eighty 30-day-old healthy Linwu ducks with similar body weight (half male, half female) were randomly divided into three groups with four replicates each containing 40 ducks. Initial body weights among groups were not significantly different (P>0.05). Group 1 (control) received a corn-soybean meal basal diet, while groups 2 and 3 received experimental diets containing 10% and 20% *M. quitense*, respectively. Diets were formulated as pelletized

complete feeds according to NRC (1994) nutrient requirements. Diet composition and nutrient levels are shown in Table 2 . The 28-day trial employed pen housing with *ad libitum* access to feed and water.

1.3 Management

The experiment was conducted at the Jinjing Base of Changsha Agricultural Environmental Observation Station, Institute of Subtropical Agriculture, Chinese Academy of Sciences. Ducks were raised in free-range conditions with pellet feeding, *ad libitum* water and feed (provided at 08:00 and 16:00 daily), and received routine vaccination and conventional management throughout the trial period.

1.4 Measurements

1.4.1 Growth Performance Body weights were recorded at 30, 44, and 58 days of age to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed-to-gain ratio (F/G). Mortality was recorded daily. Calculations were as follows: - ADG (g/d) = (final body weight –initial body weight) / trial days - ADFI (g/d) = total feed intake / trial days - F/G = ADFI / ADG

1.4.2 Slaughter Performance At 44 and 58 days of age, two ducks per replicate with similar body weight were selected, deprived of feed for 12 hours (with water), weighed, and slaughtered. Following Yang' s method, live body weight was measured to calculate carcass rate, half-eviscerated yield, eviscerated yield, breast muscle rate, leg muscle rate, and subcutaneous fat rate: - Carcass rate (%) = (carcass weight / live weight) × 100 - Half-eviscerated rate (%) = (half-eviscerated weight / live weight) × 100 - Eviscerated rate (%) = (eviscerated weight / live weight) × 100 - Breast muscle rate (%) = (breast muscle weight / eviscerated weight) × 100 - Leg muscle rate (%) = (leg muscle weight / eviscerated weight) × 100 - Subcutaneous fat rate (%) = (subcutaneous fat weight / eviscerated weight) × 100

1.4.3 Immune Organ Index After slaughter, thymus, spleen, and bursa of Fabricius were weighed to calculate immune organ indices: - Immune organ index = organ fresh weight / live body weight

1.5 Statistical Analysis

Experimental data were preliminarily processed using Excel 2013 and analyzed by covariance using SPSS 20.0 software. Results are expressed as means with significance set at $P<0.05$.

Results and Discussion

Nutritional analysis indicates that *M. quitense* possesses relatively high nutritional value with balanced amino acid composition. Its crude protein content falls between energy and protein feed types, though crude fiber content is relatively high. Linwu ducks, a geographical indication product from Linwu County, Hunan Province and one of China' s eight famous duck breeds, exhibit relatively slow early growth rates. Ducks have distinct digestive physiological characteristics, including large gastrointestinal volume and well-developed gizzard and ceca, enabling high utilization of dietary fiber. High-fiber diets also reduce fat deposition. Shi et al. reported that Sichuan white geese fed diets containing 10% alfalfa meal showed favorable growth performance. He et al. demonstrated that appropriate stocking density for 21–63 day-old Linwu ducks in net-floor systems is 3–5 birds/m^2. Compared with that study, the current trial achieved higher ADG and ADFI, attributable to superior dietary nutrient levels. Xia et al. found that adding alfalfa meal and cellulase to layer diets improved feed utilization efficiency. *M. quitense* grows rapidly in nitrogen- and phosphorus-rich water with strong environmental nitrogen absorption capacity, producing 45–90 t/hm^2 of dry hay annually under suitable wetland conditions. The present results show that dietary *M. quitense* increased ADFI with increasing supplementation level while decreasing ADG, though the 10% group showed no significant difference from the control. Given its rapid growth, high yield, and low cost, 10% dietary *M. quitense* supplementation can improve growth performance and reduce feed costs in meat ducks.

As a local Hunan breed traditionally raised in free-range mountain systems, Linwu ducks are highly active with well-developed leg muscles. Li et al. found that 4% aquatic plant supplementation minimally affected meat duck slaughter performance, while Liang et al. reported that 4% grass meal supplementation had little effect on Cherry Valley duck slaughter performance, though higher grass meal levels decreased half-eviscerated and eviscerated yields, likely due to dietary crude fiber effects. Zhan et al. demonstrated that appropriate ryegrass supplementation improved slaughter performance in Yangzhou geese. The current slaughter trial revealed that at 44 days, 10% *M. quitense* supplementation increased carcass rate and significantly elevated breast muscle rate compared to the control. At 58 days, while most parameters showed no significant differences, the control group exhibited higher carcass, half-eviscerated, and eviscerated rates than the 10% and 20% *M. quitense* groups, whereas breast muscle rate was significantly higher in both supplemented groups. Compared with Chen et al., carcass rates were similar, but eviscerated yield, half-eviscerated yield, leg muscle rate, and breast muscle rate increased while subcutaneous fat rate decreased. Therefore, 10% supplementation appears optimal for practical meat duck production.

Immune organ-to-body weight ratios serve as preliminary indicators of immune function, with thymus and spleen being primary immune organs. Rivas et al. suggested that thymus, spleen, and bursa of Fabricius indices can evaluate

chick immune status, where greater absolute and relative organ weights indicate stronger cellular and humoral immunity. Ma et al. also associated increased immune organ weight with enhanced immune function through cell growth and proliferation, while weight reduction indicates compromised immunity. Wei et al. demonstrated that inulin improved broiler growth performance and immune organ indices, and Tang et al. showed that 5% pine needle powder increased thymus and bursa indices in broilers, promoting immune cell proliferation and differentiation. In meat duck production, artificially selected large breeds often show inferior stress resistance compared to local breeds. Li reported that Jianchang ducks exhibited higher immune organ indices and stronger disease resistance than large commercial meat ducks, with all indices in the current study surpassing those of large meat duck breeds. The present findings indicate that immune organ indices increased with *M. quitense* supplementation level, suggesting that *M. quitense* may promote immune organ development, though the underlying mechanism requires further investigation.

In conclusion, dietary supplementation with 10% *M. quitense* has no obvious adverse effects on growth performance, slaughter performance, or immune organ indices in Linwu ducks while reducing feed costs.

References

[1] JIA Yifei, YUAN Tao, MA Yingdong. Purification effect of *Myriophyllum* on polluted water in garden landscapes[J]. *Journal of Northwest Forestry University*, 2015, 30(6): 250–254.

[2] ZHANG Shunan, XIAO Runlin, LIU Feng, et al. Interception effect of ecological ditches on nitrogen and phosphorus pollutants[J]. *Environmental Science*, 2015, 36(12): 4516–4522.

[3] WU Fei, YAO Kang, LIU Feng. Application value of *Myriophyllum quitense* as feed material[C]//China Engineering Science Forum—Animal Nutrition and Breeding Environment Control Forum. Changsha, 2015: 151–156.

[4] YANG Ning. *Poultry Production Science*[M]. Beijing: China Agriculture Press, 2002: 289–292.

[5] MING Daoxu. *Biostatistics and Experimental Design*[M]. Beijing: China Agriculture Press, 2001: 112–114.

[6] CHEN Yuanfa. Linwu duck[J]. *Hunan Agriculture*, 2002(3): 21.

[7] SCHUBERT R, RICHTER G, GRUHU K. Comparative investigation of the digestive performance of Cairina and Pekin ducks and laying hens[J]. *Archiv für Tierernahrung*, 1982, 32: 531–537.

[8] MOHAMED K, LARBIER M, LECLERCQ B. A comparative study of the digestibility of soyabean and cottonseed meal amino acids in domestic chicks

and muscovy ducklings[J]. *Annales de Zootech*, 1986, 35(1): 79-86.

[9] SHI Yinghua, WANG Chengzhang, YAO Huixia, et al. Effects of different types of crude fiber feed on production performance of Sichuan white geese[J]. *Chinese Journal of Animal Nutrition*, 2010, 22(6): 1752-1756.

[10] HE Ping, LIU Zengzai, DAI Qiuzhong, et al. Effect of net-floor stocking density on growth performance of Linwu ducks aged 21-63 days[J]. *Journal of Domestic Animal Ecology*, 2016, 37(4): 51-53, 58.

[11] XIA Suyin, WANG Chengzhang, ZHAN Fabo, et al. Effects of alfalfa meal and cellulase on lipid metabolism, antioxidant capacity and intestinal microflora in laying hens[J]. *Chinese Journal of Animal Nutrition*, 2011, 23(11): 1991-1999.

[12] LI Jiao, YANG Xiaohong, FAN Chunhe, et al. Effect of dietary aquatic plant supplementation on slaughter performance of meat ducks[J]. *Inner Mongolia Agricultural Science and Technology*, 2008(2): 62-64.

[13] LIANG Tianyi, WURENTUONALE, LI Jiao, et al. Effect of dietary grass meal supplementation on slaughter performance of Cherry Valley ducks[J]. *Chinese Agricultural Science Bulletin*, 2010, 26(10): 21-24.

[14] ZHAN Jinshun, XIA Chen, ZHAO Guoqi, et al. Effects of ryegrass pellet diets on growth performance, slaughter performance and serum biochemical indices of Yangzhou geese[J]. *Chinese Journal of Animal Nutrition*, 2014, 26(5): 1333-1339.

[15] CHEN Dengke, LI Lili, XU Bo, et al. Study on production performance and meat quality characteristics of Linwu ducks[J]. *Journal of Domestic Animal Ecology*, 2008, 29(4): 25-28.

[16] RIVAS A, FABRICANT J. Indications of immunodepression in chickens infected with various strains of Marek' s disease virus[J]. *Avian Diseases*, 1985, 32: 1-8.

[17] MA Deying, SHAN Anshan, LI Qundao. Effects of Chinese herbal medicine additives on growth performance and immune function of layer chicks[J]. *Chinese Journal of Animal Nutrition*, 2004, 16(2): 36-40.

[18] WEI Yinan, HUANG Qianqian, LÜ Yajun, et al. Effects of inulin on growth performance, immune organ index and antioxidant indices of broilers[J]. *Journal of Northwest A&F University: Natural Science Edition*, 2013, 41(11): 13-18.

[19] TANG Shengqiu, DONG Xiaoying. Effect of pine needle powder on immune organ index of Tiejiao partridge chickens[J]. *China Feed*, 2009(6): 42-44.

[20] LI Le. Study on developmental characteristics of immune organs in Jianchang ducks and large meat ducks[D]. PhD Dissertation. Ya' an: Sichuan Agricultural University, 2013.

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