Effects of Dietary Folic Acid and Vitamin B12 on Growth Performance, Slaughter Performance, Fat Deposition, and Long-Chain Fatty Acid Elongase 7 Gene Expression in Wulong Geese (Postprint)

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Abstract

This experiment was conducted to investigate the effects of dietary supplementation with different levels of folic acid and vitamin B12 (VB12) on growth performance, slaughter performance, fat deposition, the expression level of the long-chain fatty acid elongase 7 (ELOVL7) gene and its differential expression in various tissues and organs, and correlation analysis in Wulong geese. A total of 420 five-week-old Wulong geese were randomly allocated to 7 groups with 6 replicates per group and 10 geese per replicate (half male and half female). Groups I-VI were experimental groups, and Group VII served as the control group. The experiment adopted a 2×3 factorial design with two factors and equal replications, with dietary folic acid supplementation levels of 0.25 and 2.00 mg/kg, and VB12 supplementation levels of 0.003, 0.009, and 0.018 mg/kg. The experimental period lasted for 4 weeks. Real-time PCR technology was employed to determine the expression level of the ELOVL7 gene in the liver of Wulong geese, and geese from the control group were selected to detect the expression distribution of the ELOVL7 gene in 11 tissues including heart, liver, kidney, abdominal fat, lung, gizzard, proventriculus, breast muscle, leg muscle, spleen, and pancreas. The results showed that: 1) The interaction between dietary different levels of folic acid and VB12 had a significant effect on final body weight of Wulong geese ($P<0.05$), with Group V having the highest body weight, but had no significant effect on average daily gain and feed-to-gain ratio ($P>0.05$). 2) The interaction between dietary different levels of folic acid and VB12 had significant effects on serum triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) contents ($P<0.05$). Dietary different levels of folic acid had significant effects on serum

TG and LDL-C contents (P<0.05); different levels of VB12 had significant effects on serum glucose (GLU) and LDL-C contents (P<0.05). 3) The interaction between dietary different levels of folic acid and VB12 had a significant effect on breast muscle percentage (P<0.05), but had no significant effects on slaughter percentage, half-eviscerated percentage, eviscerated percentage, and leg muscle percentage (P>0.05). The breast muscle percentages of Groups I and V were significantly higher than that of the control group (P<0.05). 4) The interaction between dietary different levels of folic acid and VB12 had significant effects on skin fat percentage, abdominal fat percentage, intermuscular fat band width, breast muscle intramuscular fat, and leg muscle intramuscular fat (P<0.05); the abdominal fat percentage of Group V was significantly lower than that of all other groups (P<0.05). 5) The interaction between dietary different levels of folic acid and VB12 had a significant effect on the expression level of the ELOVL7 gene in the liver (P<0.01); dietary supplementation with different levels of folic acid and VB12 both increased the expression level of the ELOVL7 gene in the liver compared with the control group, with Group V showing the highest expression level, which was significantly higher than that of the control group (P<0.05). 6) The expression level of the ELOVL7 gene in the liver was significantly negatively correlated with slaughter percentage (P<0.05), significantly negatively correlated with serum TG and LDL-C contents (P<0.05), extremely significantly negatively correlated with serum total cholesterol (TC) content (P<0.01), significantly positively correlated with intermuscular fat band width (P<0.05), and significantly negatively correlated with skin fat percentage, abdominal fat percentage, and leg muscle intramuscular fat percentage (P<0.05). 7) The expression level of the ELOVL7 gene was highest in abdominal fat, followed by lung and pancreas, and lower in breast muscle and leg muscle. Under the conditions of this experiment: 1) Dietary supplementation with appropriate levels of folic acid and VB12 had significant intervention effects on ELOVL7 gene expression, lipid metabolism biochemical indices, and body nutritional composition of Wulong geese; 2) The combination of 0.25 mg/kg folic acid and 0.009 mg/kg VB12 (Group V) was optimal.

Full Text

Effects of Dietary Folic Acid and Vitamin B12 on Growth Performance, Slaughter Performance, Fat Deposition and ELOVL7 Gene Expression in Wulong Geese

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Abstract

This study investigated the effects of dietary supplementation with different levels of folic acid and vitamin B12 (VB12) on growth performance, slaughter performance, fat deposition, and the expression level of very long-chain fatty acid elongase 7 (ELOVL7) in Wulong geese, along with tissue-specific expression patterns and correlation analyses. A total of 420 five-week-old Wulong geese were randomly allocated into seven groups, with six replicates per group and ten geese per replicate (half male and half female). Groups I–VI were experimental groups, while group VII served as the control. A 2×3 factorial crossover design with equal replications was employed, with dietary folic acid levels of 0.25 and 2.00 mg/kg and VB12 levels of 0.003, 0.009, and 0.018 mg/kg. The trial lasted four weeks. Real-time PCR was used to quantify ELOVL7 gene expression in the liver, and geese from the control group were selected to examine ELOVL7 expression across eleven tissues: heart, liver, kidney, abdominal fat, lung, gizzard, glandular stomach, breast muscle, leg muscle, spleen, and pancreas. The results showed: (1) The interaction between folic acid and VB12 significantly affected final body weight ($P<0.05$), with group V showing the highest weight, but had no significant effect on average daily gain or feed-to-gain ratio ($P>0.05$). (2) The interaction significantly influenced serum triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) concentrations ($P<0.05$). Dietary folic acid level alone significantly affected serum TG and LDL-C ($P<0.05$), while VB12 level significantly affected serum glucose (GLU) and LDL-C ($P<0.05$). (3) The interaction significantly impacted breast muscle percentage ($P<0.05$) but not dressing percentage, half-eviscerated yield, eviscerated yield, or leg muscle percentage ($P>0.05$). Groups I and V had significantly higher breast muscle percentages than the control ($P<0.05$). (4) The interaction significantly affected subcutaneous fat percentage, abdominal fat percentage, intermuscular fat band width, and intramuscular fat (IMF) content in both breast and leg muscles ($P<0.05$). Group V exhibited significantly lower abdominal fat percentage than all other groups ($P<0.05$). (5) The interaction significantly influenced hepatic ELOVL7 expression ($P<0.01$), with all supplemented groups showing higher expression than the control; group V had the highest expression, significantly exceeding the control ($P<0.05$). (6) Hepatic ELOVL7 expression was significantly negatively correlated with dressing percentage ($P<0.05$), serum TG and LDL-C ($P<0.05$), and serum total cholesterol (TC) ($P<0.01$), but significantly positively correlated with intermuscular fat band width ($P<0.05$) and significantly negatively correlated with subcutaneous fat percentage, abdominal fat percentage, and leg muscle IMF ($P<0.05$). (7) ELOVL7 expression was highest in abdominal fat, followed by lung and pancreas, with lower expression in breast and leg muscles. Under these experimental conditions: (1) Appropriate dietary levels of folic acid and VB12 significantly modulated ELOVL7 expression, lipid metabolism biomarkers, and body nutrient composition in Wulong geese; (2) The combination of 0.25 mg/kg folic acid and 0.009 mg/kg VB12 (group V) was optimal.

Keywords: folic acid; VB12; ELOVL7 gene; fat deposition; geese

Introduction

The liver is the primary site of fat synthesis in geese, and the processes of fat synthesis and decomposition are accomplished through a series of enzymatic reactions regulated by dietary nutrients, endocrine hormones, related enzymes, and genes. Therefore, investigating the molecular mechanisms of hepatic lipid metabolism is of great significance. Very long-chain fatty acid elongase 7 (ELOVL7) is a strong candidate gene regulating arachidic acid, which participates in fatty acid metabolism cycles and represents an important saturated fatty acid in the body. Yang et al. conducted a genome-wide association analysis using 282 Sutai pigs and identified ELOVL7 on chromosome 16 as a candidate gene affecting arachidic acid. Research indicates that excessive fat intake promotes ELOVL7 overexpression, leading to prostate cancer cell proliferation, while ELOVL7 knockout attenuates cancer cell growth. Thus, ELOVL7 may be a key factor elucidating the link between fat intake and prostate cancer. Vitamin B12 (VB12), as a cofactor in one-carbon metabolism, enhances folic acid utilization and promotes DNA synthesis. Both folic acid and VB12 are essential vitamins for nervous system development and normal physiological function, serving as necessary cofactors in homocysteine (Hcy) metabolism. Numerous studies demonstrate that folic acid and VB12 supplementation reduce Hcy levels and the risk of cerebrovascular disease. Stekol et al. investigated the roles of VB12 and folic acid in choline synthesis in rats, finding that VB12 deficiency reduced glycine utilization, while folic acid deficiency reduced serine utilization and, to a lesser extent, glycine utilization—both amino acids can form ethanolamine for choline synthesis. Previous research shows that varying dietary nutrient levels alter poultry meat fatty acid composition and content, which is regulated by the ELOVL gene family. While ELOVL1-6 genes have been frequently studied in poultry, and progress has been made on chicken ELOVL7 structure, research on ELOVL7 function and mechanism in goose fat metabolism remains blank.

Studies on combined folic acid and VB12 application are common in medical literature but virtually absent in poultry nutrition. This experiment examined the effects of different dietary folic acid and VB12 levels on hepatic ELOVL7 expression and its differential expression across Wulong goose tissues, enriching research on nutrient regulation of goose fatty acid metabolism and the ELOVL fatty acid elongase gene family, with the aim of elucidating at the molecular level how dietary folic acid and VB12 levels influence hepatic ELOVL7 expression, tissue-specific expression patterns, and fat deposition in Wulong geese.

1. Materials and Methods

1.1 Experimental Materials and Diets Folic acid (96% purity) and VB12 (1% purity) were produced by Ningxia Jinwei Pharmaceutical Co., Ltd. According to experimental design requirements, folic acid and VB12 were mixed with carriers at the specified ratios, gradually incorporated into complete diets, and blended for 6 minutes. The basal diet was formulated primarily based on NRC (1994) standards, with composition and nutrient levels shown in Table 1 . High-performance liquid chromatography determined basal diet folic acid and VB12 contents as 0.40 and 0.00 mg/kg, respectively.

1.2 Experimental Design and Management Experimental geese were provided by Gaomi Yinhe Runyan Goose Industry Co., Ltd., a breeding base of the National Waterfowl Industry Technology System. A total of 420 five-week-old Wulong geese with similar initial body weight ($P>0.05$) were randomly divided into seven groups, with six replicates per group and ten geese per replicate (half male and half female). Groups I–VI were experimental groups, and group VII was the control. A 2×3 factorial crossover design with equal replications was used, with dietary folic acid levels of 0.25 and 2.00 mg/kg and VB12 levels of 0.003, 0.009, and 0.018 mg/kg. The experimental design is detailed in Table 2 . The trial lasted four weeks.

Before the experiment, the goose house was thoroughly disinfected to prevent disease transmission. Geese were raised on net beds with ad libitum access to water and feed, provided in small quantities multiple times daily. House sanitation was maintained, keeping floors clean and dry. Geese health status was monitored, and disease prevention measures were implemented.

1.3 Sample Collection and Measurements

1.3.1 Growth Performance Measurement At the end of week 8, after 12 hours of feed withdrawal, geese were weighed individually to determine initial weight, final weight, and weight gain for calculating average daily gain (ADG) and feed-to-gain ratio (F/G).

1.3.2 Serum Lipid Metabolism Indices Measurement At the end of week 8, two geese per replicate (one male and one female) were randomly selected. After 12 hours of feed withdrawal, blood was collected from the jugular vein and centrifuged at 3,000 r/min for 15 minutes. Serum was separated and stored in 1.5 mL tubes at -20°C until analysis. Serum glucose (GLU), total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) concentrations were measured using assay kits purchased from Nanjing Jiancheng Bioengineering Institute.

1.3.3 Slaughter Performance Measurement At the end of week 8, two geese per replicate (one male and one female) were randomly selected. After

12 hours of feed withdrawal, geese were slaughtered by jugular vein bleeding. Slaughter performance indices including carcass weight, half-eviscerated weight, eviscerated weight, breast muscle weight, and leg muscle weight were measured according to *Poultry Production Performance Terminology and Measurement Methods* [8], and dressing percentage, half-eviscerated yield, eviscerated yield, breast muscle percentage, and leg muscle percentage were calculated.

1.3.4 Fat Deposition Measurement At the end of week 8, two geese per replicate (one male and one female) were randomly selected. After 12 hours of feed withdrawal and slaughter by jugular vein bleeding, geese were wet-plucked, drained, and weighed. Abdominal fat weight, subcutaneous fat weight, subcutaneous fat thickness, and intermuscular fat band width were measured according to *Poultry Production Performance Terminology and Measurement Methods* [8] to calculate abdominal fat percentage, subcutaneous fat percentage, breast muscle IMF percentage, and leg muscle IMF percentage.

1.3.5 Gene Expression Measurement At the end of week 8, two geese per replicate (one male and one female) were selected. After slaughter by jugular vein bleeding, the abdominal cavity was opened and tissue samples (heart, liver, kidney, abdominal fat, lung, gizzard, glandular stomach, breast muscle, leg muscle, spleen, and pancreas) were aseptically collected, rapidly placed in cryovials in liquid nitrogen, and transferred to -80°C until analysis.

For liver samples, 50 mg of tissue was homogenized with 1 mL TRNzol reagent (Roche) to extract RNA. Concentration and purity were measured using a Bio-Photometer nucleic acid/protein analyzer. Qualified RNA was reverse-transcribed into cDNA using a reverse transcription kit. The real-time fluorescence quantitative PCR reaction system (20 L) consisted of: SybrGreen qPCR Master Mix 10 L, forward and reverse primers (10 mol/L) each 0.4 L, DNA template 2.0 L, and ddH2O 7.2 L. The PCR program was: 94°C predenaturation for 5 min, 35 cycles of 94°C denaturation for 30 s, 55°C annealing for 30 s, 72°C extension for 60 s, and final extension at 72°C for 7 min. RNA from heart, kidney, abdominal fat, lung, gizzard, glandular stomach, breast muscle, leg muscle, spleen, and pancreas tissues was similarly reverse-transcribed to cDNA for tissue expression difference analysis.

Based on the NCBI goose ELOVL7 gene accession number (NW_013185694.1), primers were designed using Primer 5.0 software, with glyceraldehyde-3-phosphate dehydrogenase (GAPDH) as the reference gene. Primers were synthesized by Sangon Biotech (Shanghai) Co., Ltd. Gene primer sequences are shown in Table 3 . Each sample was run in triplicate, and the 2^(-ΔΔCT) method was used to calculate ELOVL7 gene expression relative to GAPDH.

1.4 Statistical Analysis Data were analyzed using the GLM model in SPSS 17.0 software to examine main effects and interactions. ANOVA and LSD tests

were used for significance analysis. $P<0.05$ was considered statistically significant.

2. Results

2.1 Effects of Dietary Folic Acid and VB12 on Growth Performance of 5-8 Week-Old Wulong Geese As shown in Table 4 , the interaction between dietary folic acid and VB12 significantly affected final body weight ($P<0.05$), with group V showing the highest weight, but had no significant effect on average daily gain or feed-to-gain ratio ($P>0.05$). The final weight of group V was significantly higher than groups I, VI, and VII ($P<0.05$). Compared with the control (group VII), dietary folic acid and VB12 tended to increase average daily gain, though not significantly ($P>0.05$). These results indicate that dietary folic acid and VB12 affected growth performance in 5-8 week-old Wulong geese, with the combination of 0.25 mg/kg folic acid and 0.009 mg/kg VB12 (group V) having the most significant effect.

2.2 Effects of Dietary Folic Acid and VB12 on Serum Lipid Metabolism Indices As shown in Table 5 , the interaction between dietary folic acid and VB12 significantly affected serum TG, HDL-C, and LDL-C concentrations ($P<0.05$). Dietary folic acid level alone significantly influenced serum TG and LDL-C ($P<0.05$), while VB12 level significantly affected serum GLU and LDL-C ($P<0.05$). Compared with the control, dietary folic acid and VB12 tended to reduce serum lipid metabolism indices. These findings demonstrate that dietary folic acid and VB12 can improve serum lipid metabolism indices in Wulong geese.

2.3 Effects of Dietary Folic Acid and VB12 on Slaughter Performance As shown in Table 6 , the interaction between dietary folic acid and VB12 significantly affected breast muscle percentage ($P<0.05$) but not dressing percentage, half-eviscerated yield, eviscerated yield, or leg muscle percentage ($P>0.05$). Groups I and V had significantly higher breast muscle percentages than the control ($P<0.05$). These results indicate that dietary folic acid and VB12 can increase breast muscle percentage and reduce abdominal fat percentage, altering carcass composition in Wulong geese.

2.4 Effects of Dietary Folic Acid and VB12 on Fat Deposition As shown in Table 7 , the interaction between dietary folic acid and VB12 significantly affected subcutaneous fat percentage, abdominal fat percentage, intermuscular fat band width, breast muscle IMF, and leg muscle IMF ($P<0.05$). Group V showed significantly lower abdominal fat percentage than all other groups ($P<0.05$). Dietary folic acid and VB12 levels had no significant effect on subcutaneous fat thickness ($P>0.05$). These findings demonstrate that dietary folic acid and VB12 can reduce fat deposition in Wulong geese.

2.5 Effects of Dietary Folic Acid and VB12 on Hepatic ELOVL7 Gene Expression As shown in Table 8 , the interaction between dietary folic acid and VB12 significantly affected hepatic ELOVL7 gene expression ($P<0.01$). All supplemented groups showed higher ELOVL7 expression than the control, with group V exhibiting the highest expression, significantly greater than the control ($P<0.05$).

2.6 Correlation Between Hepatic ELOVL7 Expression and Serum Lipid Metabolism As shown in Table 9 , hepatic ELOVL7 expression was significantly negatively correlated with serum TG and LDL-C ($P<0.05$) and extremely significantly negatively correlated with serum TC ($P<0.01$). Negative correlations with serum GLU and HDL-C were observed but were not significant ($P>0.05$). These results indicate that hepatic ELOVL7 expression regulates serum lipid metabolism through a synchronous reverse regulation mechanism.

2.7 Correlation Between Hepatic ELOVL7 Expression and Slaughter Performance As shown in Table 10 , hepatic ELOVL7 expression was significantly positively correlated with dressing percentage ($P<0.05$). Negative correlations with half-eviscerated yield, eviscerated yield, and leg muscle percentage were observed but were not significant ($P>0.05$), while a positive correlation with breast muscle percentage was also not significant ($P>0.05$). These findings suggest that hepatic ELOVL7 expression influences the slaughter performance of Wulong geese.

2.8 Correlation Between Hepatic ELOVL7 Expression and Fat Deposition As shown in Table 11 , hepatic ELOVL7 expression was significantly positively correlated with intermuscular fat band width ($P<0.05$) and significantly negatively correlated with subcutaneous fat percentage, abdominal fat percentage, and leg muscle IMF ($P<0.05$). A positive correlation with subcutaneous fat thickness was observed but was not significant ($P>0.05$). These results demonstrate that hepatic ELOVL7 expression is closely related to fat deposition in geese, and dietary folic acid and VB12 can improve body fat distribution by regulating hepatic ELOVL7 expression.

2.9 Tissue Expression Differences of ELOVL7 Gene As shown in Figure 1 [Figure 1: see original paper], ELOVL7 gene was expressed in all examined tissues: heart, liver, kidney, abdominal fat, lung, gizzard, glandular stomach, breast muscle, leg muscle, spleen, and pancreas. Expression levels from highest to lowest were: abdominal fat > lung > pancreas > kidney > glandular stomach > heart > gizzard > spleen > liver > leg muscle > breast muscle. ELOVL7 expression was highest in abdominal fat, with no significant differences among heart, liver, gizzard, spleen, breast muscle, and leg muscle ($P>0.05$).

3. Discussion

3.1 Effects of Dietary Folic Acid and VB12 on Growth and Slaughter Performance Folic acid and VB12 are essential cofactors for DNA and RNA synthesis and are crucial for early growth and development. Their deficiency is a major cause of megaloblastic anemia, and maternal folic acid deficiency during pregnancy can lead to fetal neural tube defects. Dietary folic acid supplementation affects broiler performance, with improved feed conversion efficiency and daily gain at higher levels, suggesting that folic acid, as an essential substance for purine and pyrimidine synthesis and an effective methyl donor in fast-growing modern broilers, promotes growth. Research indicates that rapidly growing animals have increased folic acid requirements, and appropriate supplementation can enhance growth rates. This study showed that appropriate dietary folic acid and VB12 levels significantly affected breast muscle percentage and abdominal fat percentage in Wulong geese, increasing breast muscle percentage and reducing abdominal fat percentage compared with the control. This suggests that hepatic ELOVL7 expression regulates slaughter performance, and appropriate dietary folic acid and VB12 can alter goose meat nutrient composition.

3.2 Effects of Dietary Folic Acid and VB12 on Hepatic ELOVL7 Gene Expression Stabler et al. demonstrated that both folic acid and VB12 deficiencies cause pernicious anemia. While folic acid supplementation can alleviate anemia caused by VB12 deficiency, it may cause neurological damage. Methylmalonic acid and total Hcy concentrations are specific and sensitive indicators for diagnosing VB12 deficiency and distinguishing it from folic acid deficiency. VB12 is primarily absorbed and transported via intrinsic factor and cobalamin transport proteins and is closely related to nucleic acid and protein synthesis. VB12-dependent methionine synthase catalyzes methyl group transfer from methyltetrahydrofolate to Hcy, forming methionine and ultimately S-adenosylmethionine (SAM). VB12 deficiency reduces SAM availability for DNA methylation, thereby affecting gene expression. VB12 influences folic acid metabolic efficiency, participates in purine and nucleotide synthesis, and maintains DNA synthesis and repair, ensuring chromosome stability. This study demonstrated that dietary folic acid and VB12 significantly affected hepatic ELOVL7 expression, with group V showing the highest expression and body weight, providing a valuable reference for poultry diet formulation. This experiment aimed to investigate the combined effects of folic acid and VB12 on hepatic ELOVL7 expression in poultry, clarify the gene' s role in tissue nutrient redistribution, and provide a theoretical basis for poultry meat quality research. The mechanism of ELOVL7 in fatty acid metabolism requires further investigation.

3.3 Correlation Between Hepatic ELOVL7 Expression and Serum Lipid Metabolism Fatty acids are fundamental cellular components that play crucial roles in energy storage, signal transduction, and metabolic regulation. Composed of long linear hydrocarbon chains (hydrophobic tails) and terminal carboxyl groups (hydrophilic heads), fatty acids are classified as saturated

or unsaturated based on double bond presence. High levels of monounsaturated and polyunsaturated fatty acids, such as essential -3 series, benefit cardiovascular health, whereas high saturated fatty acid levels increase heart disease risk. Thus, fatty acids are vital for maintaining homeostasis. Studies show that ELOVL7 primarily participates in saturated fatty acid synthesis, working with ELOVL1 and ELOVL3 to complete C18:0, C20:0, C22:0, and C24:0 synthesis. This study found that hepatic ELOVL7 expression was significantly negatively correlated with serum TG and LDL-C ($P<0.05$) and extremely significantly negatively correlated with serum TC ($P<0.01$), with non-significant negative correlations with GLU and HDL-C. These results indicate that hepatic ELOVL7 exerts inhibitory regulation on serum lipid metabolism, suggesting that dietary folic acid and VB12 can improve fat metabolism by increasing hepatic ELOVL7 expression.

3.4 Correlation Between Hepatic ELOVL7 Expression and Fat Deposition Arachidic acid participates in fatty acid metabolism cycles and is an important saturated fatty acid in the body. ELOVL7 is currently recognized as a strong candidate gene regulating arachidic acid. Research on ELOVL7 in lipid metabolism has focused on pigs, mice, and aquatic animals, with virtually no studies in geese, and its mechanism remains unclear. This study' s correlation analysis revealed that hepatic ELOVL7 expression was significantly positively correlated with intermuscular fat band width and significantly negatively correlated with subcutaneous fat percentage, abdominal fat percentage, and leg muscle IMF. This suggests that dietary folic acid and VB12 directly affect hepatic ELOVL7 expression, thereby influencing fat distribution in geese and preliminarily establishing the relationship between genetic and nutritional factors (folic acid and VB12 combination).

3.5 Tissue Expression Specificity of ELOVL7 Gene The ELOVLs are a family of very long-chain fatty acid elongase genes originally derived from yeast ELO. Seven ELOVL proteins (ELOVL1–7) have been identified in organisms, with ELOVL1, ELOVL3, ELOVL6, and ELOVL7 primarily involved in saturated and monounsaturated fatty acid synthesis, while ELOVL2, ELOVL4, and ELOVL5 mainly participate in polyunsaturated fatty acid synthesis. Studies indicate that the ELOVL family catalyzes key steps in very long-chain fatty acid elongation and plays important regulatory roles in animals. Yang et al. analyzed ELOVL gene expression in Chinese mitten crabs, finding expression in all tissues with highest levels in hepatopancreas and intestine and lowest in heart. Knockout of ELOVL7 in cancer cells effectively reduced C20, C22, and C24 fatty acid content and directly affected cancer cell growth. This study found that ELOVL7 expression was highest in abdominal fat and lowest in glandular stomach, heart, spleen, breast muscle, and leg muscle, with no significant differences among these tissues. These results demonstrate tissue-specific ELOVL7 expression in geese, enriching research on the ELOVL fatty acid elongase gene family in poultry and laying a foundation for further investigation of ELOVL

family expression characteristics.

4. Conclusion

1. Dietary folic acid and VB12 at different levels intervened in hepatic ELOVL7 expression in Wulong geese, with the combination of 0.25 mg/kg folic acid and 0.009 mg/kg VB12 (group V) producing the highest expression. Appropriate folic acid and VB12 combinations increased breast muscle percentage, reduced abdominal fat percentage, and altered carcass composition.
2. Hepatic ELOVL7 expression regulated serum lipid metabolism in Wulong geese through a synchronous reverse regulation mechanism.
3. Hepatic ELOVL7 expression was significantly positively correlated with dressing percentage, negatively correlated with half-eviscerated yield, eviscerated yield, and leg muscle percentage, and positively correlated with breast muscle percentage, indicating its influence on slaughter performance. Hepatic ELOVL7 expression was significantly positively correlated with intermuscular fat band width and significantly negatively correlated with subcutaneous fat percentage, abdominal fat percentage, and leg muscle IMF. ELOVL7 expression was highest in abdominal fat, followed by lung and pancreas, and lowest in breast and leg muscles.

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