Effects of Dietary Supplementation with Firmiana Seed Oil and Rosiglitazone on Production Performance, Serum Hormones, and Biochemical Parameters in Sheep (Postprint)

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Abstract

This experiment aimed to investigate the effects of dietary supplementation with an inhibitor (Firmiana seed oil) and a promoter (rosiglitazone) of stearoyl-CoA desaturase (SCD) on production performance and serum hormonal and biochemical indices related to lipid metabolism in fattening sheep. Eighteen crossbred rams (Merino × Small-tailed Han) with an average body weight of (27.71$±$2.64) kg and similar body condition were randomly allocated into 3 groups (n=6). The control group (Group C) was fed a basal diet, the Firmiana seed oil group (Group W) received the basal diet supplemented with 15 g/d Firmiana seed oil, and the rosiglitazone group (Group L) received the basal diet supplemented with 8 mg/d rosiglitazone. The experimental period lasted 50 d, comprising a 10-d adaptation period, a 5-d preliminary period, and a 35-d formal experimental period. The results showed: 1) Regarding production performance, dietary supplementation with Firmiana seed oil and rosiglitazone had no significant effects on production performance, slaughter performance, or meat production performance in sheep (P>0.05); Regarding fat deposition, backfat thickness in Group W was increased by 12.55% and 17.23% compared with Groups C and L, respectively (P<0.05). 2) Regarding serum hormone indices, compared with Group C, serum growth hormone (GH), glucagon (GC), and leptin (LEP) contents in Group W were significantly elevated (P<0.05), and serum GC content in Group L was significantly elevated (P<0.05). 3) Regarding serum biochemical indices, compared with Group C, serum high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglyceride (TG) contents in Group W were significantly elevated (P<0.05), and serum TG content in Group L was significantly higher than that in Group C (P<0.05). In conclusion, dietary supplementation

with Firmiana seed oil and rosiglitazone had no significant effects on production performance, slaughter performance, or meat production performance in sheep, but Firmiana seed oil significantly increased backfat thickness; dietary supplementation with Firmiana seed oil significantly increased serum GH, GC, and LEP contents, while rosiglitazone significantly increased serum GC content; dietary supplementation with Firmiana seed oil significantly increased serum HDL-C, LDL-C, TC, and TG contents, and rosiglitazone significantly increased serum TG content.

Full Text

Effects of Dietary Supplementation of Sycamore Seed Oil and Rosiglitazone on Production Performance, Serum Hormone and Biochemical Indexes of Sheep

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Abstract

This study investigated the effects of dietary supplementation with a stearoyl-CoA desaturase (SCD) inhibitor (sycamore seed oil) and promoter (rosiglitazone) on production performance and serum hormone and biochemical indexes related to lipid metabolism in fattening sheep. Eighteen crossbred rams (Merino × Small-tailed Han) with similar body weight [(27.71$±$2.64) kg] and body condition were randomly allocated into three groups (n=6). The control group (C) received a basal diet, the sycamore seed oil group (W) received the basal diet plus 15 g/d sycamore seed oil, and the rosiglitazone group (L) received the basal diet plus 8 mg/d rosiglitazone. The 50-day trial consisted of a 10-day transition period, a 5-day pre-trial period, and a 35-day formal trial period. The results showed: (1) Dietary supplementation with sycamore seed oil or rosiglitazone had no significant effects on production performance, slaughter performance, or meat productivity (P>0.05). However, for fat deposition, backfat thickness in group W was 12.55% and 17.23% higher than in groups C and L, respectively (P<0.05). (2) For serum hormone indexes, compared with group C, serum growth hormone (GH), glucagon (GC), and leptin (LEP) concentrations in group W were significantly elevated (P<0.05), while serum GC concentration in group L was significantly increased (P<0.05). (3) For serum biochemical indexes, compared with group C, serum high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglyceride (TG) concentrations in group W were significantly increased

(P<0.05), whereas only serum TG concentration in group L was significantly higher than in group C (P<0.05). In conclusion, dietary supplementation with sycamore seed oil or rosiglitazone did not significantly affect production performance, slaughter performance, or meat productivity in sheep, but sycamore seed oil significantly increased backfat thickness. Sycamore seed oil supplementation significantly elevated serum GH, GC, and LEP concentrations, while rosiglitazone significantly increased serum GC concentration. Sycamore seed oil also significantly increased serum HDL-C, LDL-C, TC, and TG concentrations, whereas rosiglitazone significantly elevated serum TG concentration.

Keywords: stearoyl-CoA desaturase; sycamore seed oil; rosiglitazone; production performance; serum indexes; sheep

Stearoyl-CoA desaturase (SCD) is a crucial enzyme that regulates fatty acid metabolism and secretion in ruminants. Located in the endoplasmic reticulum, SCD primarily catalyzes the Δ-9 desaturation of acyl-CoA, with palmitoyl-CoA and stearoyl-CoA as its preferred substrates, converting them to monounsaturated fatty acids palmitoleic acid and oleic acid, respectively. SCD can also convert trans-vaccenic acid (TVA) to cis-9, trans-11 conjugated linoleic acid (c9t11 CLA) [1-2]. Research indicates that CLA in dairy milk fat is mainly synthesized endogenously from TVA via SCD [3], and 86% of CLA in beef is generated from TVA through SCD desaturation [4]. CLA possesses numerous beneficial biological functions for human health, including anti-tumor, anti-atherosclerotic, diabetes prevention, immune enhancement, bone development and health promotion, body fat reduction, and obesity prevention [5]. Ruminant products represent the primary dietary source of CLA for humans. Currently, research reports on the endogenous synthesis of CLA and its mechanisms of lipid metabolism and conversion in vivo are very limited, and no studies using sheep as experimental animals have been reported. Therefore, this study used sheep as experimental animals to explore the effects of dietary supplementation with the SCD inhibitor sycamore seed oil and the SCD promoter rosiglitazone on production performance and serum hormone and biochemical indexes related to lipid metabolism in fattening sheep, aiming to provide a theoretical foundation for further research on the endogenous synthesis pathways of functional fatty acids such as CLA in sheep.

1.1 Experimental Materials

The feeding trial was conducted from November 2016 to January 2017 at the Inner Mongolia Agricultural University experimental farm in Tuzuo Banner, Inner Mongolia. The experimental diets were provided by Youmute Company. Sycamore seed oil was extracted using subcritical low-temperature extraction and purchased from Shaanxi Senfu Natural Products Co., Ltd. (batch number: SF-2016-10-13-4). Rosiglitazone was produced by Chengdu Hengrui Pharmaceutical Co., Ltd. (batch number: 160902) and purchased from Guoda Pharmacy.

1.2 Experimental Design and Diets

This experiment employed a completely randomized design. Eighteen healthy 4-month-old crossbred rams (Merino × Small-tailed Han) with similar genetic background, body condition, and average body weight of (27.71$±$2.64) kg were randomly divided into three groups: control group (C), sycamore seed oil group (W), and rosiglitazone group (L), with six sheep per group. All sheep were housed individually in pens (2.0 m × 1.2 m). The dietary treatments were as follows: (1) Group C received the basal diet; (2) Group W received the basal diet plus 15 g/d sycamore seed oil; (3) Group L received the basal diet plus 8 mg/d rosiglitazone. The composition and nutrient levels of the basal diet are presented in Table 1 . The basal diet was provided in pellet form.

1.3 Feeding Management

Prior to the experiment, the sheep barn, surrounding environment, and experimental equipment were thoroughly disinfected. All experimental sheep were dewormed and vaccinated before the trial began. Sheep were fed the fattening diet at 07:00 and 17:00 daily with free access to water. The experimental period lasted 50 days, including a 10-day transition period, a 5-day pre-trial period, and a 35-day formal trial period. For group W, sycamore seed oil was thoroughly mixed with the diet before feeding. For group L, rosiglitazone was administered orally before feeding.

1.4 Sample Collection and Processing

During the formal trial period, daily dry matter intake (DMI) was accurately measured for each sheep. All sheep were weighed before morning feeding on day 1 of the formal trial period and recorded as initial body weight. At the end of the formal trial period, blood was collected from fasted sheep in the morning for determination of lipid metabolism-related hormones and biochemical indexes in serum. On the morning following the formal trial period, all sheep were weighed and recorded as final body weight. Subsequently, sheep were slaughtered. After exsanguination, the head, hooves, and testes were removed, the skin was stripped, and internal organs were removed (except kidneys and perirenal fat) before weighing the carcass and measuring slaughter performance and meat productivity.

1.5 Measurement Indicators and Methods

1.5.1 Production Performance Dry matter intake (DMI), total weight gain, average daily gain (ADG), and feed to gain ratio (FGR) were measured and calculated using the following formulas:

DMI = Total dry matter intake during formal trial period / 35
Total weight gain = Final body weight - Initial body weight
ADG = Total weight gain / 35
FGR = DMI / ADG

1.5.2 Slaughter Performance, Meat Productivity, and Fat Deposition Pre-slaughter live weight and carcass weight were measured to calculate dressing percentage. Backfat thickness was measured as the thickness of adipose tissue located 11 cm from the vertebral midline between the 12th and 13th ribs using a digital caliper. GR value was measured as the total tissue thickness at the same location using a digital caliper. Eye muscle area was determined as the cross-sectional area of the longissimus dorsi muscle between the 12th and 13th ribs, with the outline traced on sulfuric acid drawing paper during slaughter.

1.5.3 Serum Hormone and Biochemical Indicators Serum hormone indicators included growth hormone (GH), insulin (INS), leptin (LEP), and glucagon (GC) concentrations. Serum biochemical indicators included glucose (GLU), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglyceride (TG), and total cholesterol (TC) concentrations. GLU concentration was determined using a kit from Nanjing Jiancheng Bioengineering Institute, while other indicators were measured using enzyme-linked immunosorbent assay (ELISA) kits from Suzhou Calvin Biotechnology Co., Ltd., following the manufacturer' s protocols strictly.

1.6 Data Analysis

Experimental data were initially processed using Excel 2003 and then analyzed using one-way ANOVA in SAS 9.1 statistical software. Duncan' s multiple comparison test was used for post-hoc comparisons. $P<0.05$ was considered statistically significant.

2.1 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Production Performance of Sheep

The effects of dietary sycamore seed oil and rosiglitazone on production performance are presented in Table 2 . The results showed no significant differences among groups in initial body weight, final body weight, ADG, or DMI ($P>0.05$). However, numerically, group W had higher values for initial body weight, final body weight, ADG, and DMI compared to groups C and L. Additionally, FGR in groups W and L was higher than in group C, though the difference was not significant ($P>0.05$). Overall, dietary supplementation with sycamore seed oil or rosiglitazone had no significant effect on production performance, although groups W and L showed a trend toward reduced feed efficiency.

2.2 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Slaughter Performance, Meat Productivity, and Fat Deposition of Sheep

The effects on slaughter performance, meat productivity, and fat deposition are shown in Table 3 . For slaughter performance, dietary supplementation with sycamore seed oil or rosiglitazone had no significant effects on pre-slaughter live weight, carcass weight, or dressing percentage ($P>0.05$). For meat productivity,

no significant differences were observed in GR value or eye muscle area between the two treatment groups and group C ($P>0.05$), although GR value and eye muscle area in group L were numerically lower than in the other two groups. For fat deposition, backfat thickness in group W was significantly higher than in groups C and L by 12.55% and 17.23%, respectively ($P<0.05$). Compared with group C, backfat thickness in group L decreased, but the difference was not significant ($P>0.05$). In summary, dietary supplementation with sycamore seed oil or rosiglitazone had minimal effects on slaughter performance, but sycamore seed oil increased local fat deposition, whereas rosiglitazone tended to reduce meat productivity and fat deposition.

2.3 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Serum Hormone and Biochemical Indexes of Sheep

The effects on serum hormone and biochemical indexes are presented in Table 4 . For serum hormone indexes, compared with group C, serum GH, GC, and LEP concentrations in group W were significantly increased ($P<0.05$), while serum INS concentration showed no significant change ($P>0.05$) but tended to decrease numerically. In group L, serum GH and LEP concentrations increased and serum INS concentration decreased, but none of these differences reached significance ($P>0.05$), whereas serum GC concentration was significantly elevated ($P<0.05$). For serum biochemical indexes, compared with group C, serum GLU concentrations in groups W and L decreased by 12.29% and 10.08%, respectively, but these differences were not significant ($P>0.05$). Serum HDL-C, LDL-C, TC, and TG concentrations in group W were significantly higher than those in groups C and L ($P<0.01$). In group L, serum HDL-C, LDL-C, TC, and TG concentrations were higher than in group C, with TG concentration being significantly higher ($P<0.05$), while other indicators showed no significant differences ($P>0.05$). In conclusion, dietary sycamore seed oil increased serum GH, GC, and LEP concentrations without significantly affecting INS, whereas rosiglitazone significantly increased GC concentration without significantly affecting other hormones. Regarding serum biochemical indexes, sycamore seed oil increased HDL-C, LDL-C, TC, and TG concentrations without significantly affecting GLU, while rosiglitazone increased TG concentration without significantly affecting other indicators.

3.1 Determination of Supplement Levels for Sycamore Seed Oil and Rosiglitazone in Sheep Diets

Conjugated linoleic acid (CLA) is present in meat products, dairy products, seafood, and plant-based foods, but its content and biological activity vary considerably. CLA with high biological activity mainly originates from ruminant products, with over 75% being c9t11 CLA [6]. Due to its numerous physiological functions, including anti-cancer, anti-atherosclerotic, immune enhancement, mitigation of immune side effects, obesity prevention, meat quality improvement, and metabolic regulation, research on CLA synthesis, sources, and methods to

increase CLA content in animal products has attracted considerable attention. The important substrate for endogenous CLA synthesis in ruminant tissues is TVA. Studies have shown that when ruminants consume feed rich in linolenic acid, the linolenic acid enters the rumen and undergoes biohydrogenation to produce the intermediate TVA, which is then desaturated by SCD in mammary and other tissues to form CLA. Research results indicate that 78% of CLA is synthesized from TVA via SCD desaturation [7]. Therefore, this experiment added flaxseed at 8% of concentrate content to the basal diet of sheep to increase the precursor TVA for endogenous CLA synthesis.

This experiment selected sycamore seed oil as an SCD activity inhibitor. Research has shown that sycamore seed oil contains large amounts of unsaturated fatty acids, primarily including 22.23% oleic acid, 30.16% linoleic acid, and 23.22% sterculic acid [8]. Studies have reported that SCD1 activity and gene expression are affected by dietary fatty acid composition and saturation, with dietary saturated fatty acids increasing SCD1 activity in tissues, while polyunsaturated fatty acids (PUFA) have the opposite effect, inhibiting its activity [7]. Kay et al. [9] used sterculia oil rich in sterculic acid as an SCD activity inhibitor in dairy cow feeding trials and achieved good inhibitory effects. Griinari et al. [3] infused 10 g/d of sterculia oil into the abomasum of lactating dairy cows approximately 200 days postpartum and found that CLA in milk fat was mainly synthesized endogenously from TVA via SCD. Since the sterculic acid content in sterculia oil is similar to that in sycamore seed oil, this experiment used sycamore seed oil as a substitute. Based on sheep body weight, the abomasal infusion dose should have been 1.5 g/d of sycamore seed oil. However, since this experiment used direct oral feeding, and considering that PUFA hydrogenation in the rumen can reach approximately 90%, this experiment added 15 g/d of sycamore seed oil rich in sterculic acid to the sheep diet.

This experiment selected rosiglitazone as an SCD activity promoter. As a thiazolidinedione insulin sensitizer, rosiglitazone can significantly enhance target tissue sensitivity to insulin and has anti-insulin resistance effects. Insulin is a highly efficient promoter of SCD gene transcription, and its effect on SCD has been confirmed in in vivo and in vitro trials in mice, cattle, chickens, and humans [10]. Reports have indicated that administering 8 mg/d rosiglitazone to patients with type II diabetes can increase SCD activity and gene expression [11]. To avoid affecting the health status of sheep, this experiment added 8 mg/d rosiglitazone to the sheep diet.

3.2 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Production Performance of Sheep

This study demonstrated that dietary supplementation with sycamore seed oil or rosiglitazone had no significant effects on production performance indicators including initial body weight, final body weight, ADG, and DMI in sheep. The results for the sycamore seed oil group were consistent with previous research. Studies have shown that adding soybean oil or sunflower oil to goat diets had

no significant effect on DMI, possibly because the dietary metabolizable energy levels were similar across treatment groups [12]. Zhao Tianzhang [13] added 2.4% fish oil, sunflower oil, or a mixture of both to the diet of Bamei mutton sheep and found no significant effects on production performance indicators. Ferreira et al. [14] reported that adding fish oil or a blend of fish oil and soybean oil to the diet of fattening sheep had no significant effects on DMI, ADG, or final body weight. Although dietary supplementation with sycamore seed oil in this experiment had minimal effects on production performance indicators, numerically, group W showed improvements compared to group C, possibly due to enhanced feed palatability and increased feed intake. Rosiglitazone, as an insulin sensitizer, had no significant effect on production performance indicators when added to sheep diets but reduced feed efficiency, possibly because rosiglitazone decreased serum GLU concentration, leading to increased GC secretion and consequently promoting fat decomposition. Currently, no relevant reports on adding rosiglitazone to sheep diets have been published.

3.3 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Slaughter Performance, Meat Productivity, and Fat Deposition of Sheep

This study showed that sycamore seed oil and rosiglitazone had minimal effects on slaughter performance and meat productivity in sheep. Research has indicated that adding 2.4% oil to the diet of Bamei mutton sheep had little effect on slaughter performance but significantly improved carcass meat productivity and local fat deposition, primarily manifested as increased abdominal fat deposition and backfat thickness [13]. Awawdeh et al. [15] reported that adding 3.2% soybean oil or butter extracted from food residues to the diet of fattening sheep significantly increased carcass weight, GR value, and backfat thickness. In this experiment, sycamore seed oil supplementation had no significant effect on slaughter performance or meat productivity, but backfat thickness in group W was significantly higher than in the other groups. Additionally, dietary rosiglitazone supplementation showed no significant changes in slaughter performance, meat productivity, or fat deposition compared to group C, but exhibited a decreasing trend, possibly due to rosiglitazone increasing tissue sensitivity to insulin.

3.4.1 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Serum Hormone Indexes of Sheep

The amount of fat deposition in animals represents a balance between fat anabolism and catabolism, which is indirectly regulated by hormones. Growth hormone (GH) is a protein hormone secreted by the anterior pituitary gland and is an important endocrine factor regulating animal growth and controlling the metabolism and storage of the three major nutrients: carbohydrates, proteins, and fats. Insulin (INS) is an important energy metabolism hormone secreted by pancreatic β-cells that promotes the synthesis of fats, proteins, and glycogen. Glucagon (GC) is an energy metabolism hormone secreted by pan-

creatic α-cells that has opposite effects to insulin, promoting catabolism. GC stimulates hepatic glycogenolysis and gluconeogenesis and can activate lipase to promote fat decomposition. Leptin (LEP) is a protein hormone encoded by the obesity gene and is primarily secreted by white adipose tissue. Its physiological function involves regulating energy metabolism and reducing body fat deposition by binding to receptors widely distributed on the surface of cells in the hypothalamus, nerves, heart, adipose tissue, and pancreas [16].

The results of this experiment showed that dietary sycamore seed oil significantly increased serum GH, GC, and LEP concentrations in sheep, possibly because long-term consumption of sycamore seed oil high in unsaturated fatty acids elevated blood lipids in group W, thereby stimulating the secretion of GH, GC, and LEP and promoting fat decomposition. Dietary sycamore seed oil had no significant effect on serum INS concentration but showed a decreasing trend, possibly due to the antagonistic relationship between INS and GC/GH. When the body is in a fasting state, INS secretion decreases while GH and GC secretion increase. Elevated serum GH reduces glucose utilization and increases fat utilization. When fasting is accompanied by decreased serum GLU concentration, GC secretion increases, and the liver releases large amounts of GLU into the blood, thereby preventing hypoglycemia. In this experiment, dietary rosiglitazone had no significant effects on serum GH, INS, or LEP concentrations, but significantly increased serum GC concentration. These results suggest that rosiglitazone increased tissue sensitivity to insulin in sheep, thereby stimulating GC secretion to maintain serum GLU balance.

3.4.2 Effects of Dietary Sycamore Seed Oil and Rosiglitazone on Serum Biochemical Indexes of Sheep

Serum biochemical indexes are closely related to animal nutritional status and can reflect physiological metabolic states. Changes in these indexes can elucidate the mechanisms of nutrient metabolism in the body. Serum GLU concentration is an important indicator of energy balance in animals. Under liver regulation, serum GLU concentration remains relatively constant, and either excessively high or low levels can adversely affect the body. Related studies have shown that serum GLU concentration in animals should not exceed 6.1 mmol/L, and within the normal range, higher production performance corresponds to higher GLU concentration [17]. For ruminants, serum GLU concentration 2-3 times higher than normal often indicates diseases such as rumen acidosis, whereas levels as low as half the normal value often suggest starvation, nutritional deficiency, or ketosis [18]. In this experiment, GLU concentrations in all groups were within the normal range. Dietary sycamore seed oil had no significant effect on serum GLU concentration, consistent with reports by Zhang Yuhong [19] and Abdullah et al. [20]. Rosiglitazone supplementation also had no significant effect on serum GLU concentration, indicating that the rosiglitazone dosage did not adversely affect normal metabolism in sheep.

Triglycerides are important energy-supplying substances and the main form of

energy storage in the body [21]. Studies have shown that dietary supplementation with oilseed can significantly increase serum TG concentration in sheep [19], which is consistent with our results. This experiment found that dietary sycamore seed oil significantly increased serum TG concentration, possibly due to its high unsaturated fatty acid content. Some studies have reported that administering rosiglitazone to patients with type II diabetes significantly reduced serum TG concentration [22]. However, this experiment showed that dietary rosiglitazone supplementation significantly increased serum TG concentration in sheep, possibly because rosiglitazone affected the production of factors related to lipid metabolism. Therefore, the relationship between TG concentration in blood and rosiglitazone requires further investigation.

High-density lipoprotein cholesterol is an important plasma lipoprotein in the human body that participates in reverse cholesterol transport and represents the primary form of cholesterol transport from extrahepatic tissues back to the liver. HDL-C is mainly composed of a phospholipid bilayer containing apolipoproteins and free cholesterol. It is the main source of biliary lipoprotein cholesterol, which is the most important pathway for cholesterol disposal in the body, further highlighting the significance of HDL-C for cholesterol homeostasis [23]. Low-density lipoprotein cholesterol is the primary form for transporting cholesterol synthesized in the liver to tissues throughout the body. Total cholesterol refers to the sum of cholesterol in all lipoproteins in the blood, including free cholesterol and cholesterol esters, and is mainly synthesized and stored in the liver. Cholesterol is an important raw material for synthesizing physiologically active substances such as adrenocortical hormones, sex hormones, bile acids, and vitamin D, and is also a major component of cell membranes. Serum TC concentration can serve as an indicator of lipid metabolism. This study found that dietary sycamore seed oil significantly increased serum TC, HDL-C, and LDL-C concentrations compared to group C, consistent with reports by Liu Licheng [24] and Bu Dengpan [25]. This may be because the linoleic acid in sycamore seed oil increased serum TG and TC concentrations (i.e., elevated blood lipids), thereby stimulating corresponding increases in serum HDL-C and LDL-C. The results also showed that dietary rosiglitazone tended to increase serum HDL-C, LDL-C, and TC concentrations, but the differences were not significant.

In summary, dietary supplementation with sycamore seed oil and rosiglitazone affected serum hormone and biochemical indexes without influencing production performance. Based on these findings, future research should investigate their effects on CLA content to corroborate the reasons for different CLA levels in tissues and provide guidance for understanding endogenous CLA synthesis pathways.

Conclusion

1. Dietary sycamore seed oil supplementation had no significant effects on production performance, slaughter performance, or meat productivity in sheep but increased backfat thickness. Rosiglitazone had no significant

effects on any production performance indicators.

2. Dietary sycamore seed oil supplementation significantly increased serum GH, GC, and LEP concentrations in sheep. Rosiglitazone significantly increased serum GC concentration.

3. Dietary sycamore seed oil supplementation significantly increased serum HDL-C, LDL-C, TC, and TG concentrations in sheep. Rosiglitazone significantly increased serum TG concentration.

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