

Analysis of Nutritional Components of Glycyrrhiza and the Effects of its Extract on Meat Quality of Tan Sheep

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Abstract: The basic nutrient components, flavor amino acids, fatty acid and minerals contained in Glycyrrhiza were analyzed and studied the effects on meat quality of Tan sheep through animal experiments. The results showed that Glycyrrhiza had a high levels of nutrients. It was a kind of roughage that can supply nutritions for the animals' demand as the basic nutrition composition. The EAA/TAA of Glycyrrhiza was 43.15% which showed high quality of protein but the content of α -linolenic acid was lower, palmitic acid and total fatty acids were similar with alfalfa which was called as the king of pasture grass.

Key words: Glycyrrhiza, nutrient component, flavor substances, Tan sheep, meat quality

INTRODUCTION

Roughage is an important nutritional source for ruminant animals and plays an important role in the performance and rumen development (Suarez *et al.*, 2007). Glycyrrhiza is a kind of legume perennial herbaceous plant. It has high contents of crude protein, crude fat and lower crude fiber in stems and leaves which contain a variety of amino acids, major elements and minor elements having high nutritional value. Natural plants act as feed or feed adding agent with small side effects, no drug resistance, high nutritional composition and advantage of biological activity has been widely applied to cattle and sheep production (Nasri *et al.*, 2011). After Glycyrrhiza was intake by cattle and sheep it can promote some physiological function or improve the body's internal environment which has the effects of fighting stress, promoting growth, enhancing immunity and performance, especially in increasing their growth, decreasing the feed consumption and improving the meat quality (Lum and Hirsch, 2003).

According to the reports, Ningxia Tan sheep with a special mutton flavor has a close relation to some natural plants. Glycyrrhiza grows naturally among Ningxia Tan sheep distribution areas as a kind of legume perennial herbaceous plant which has a function for improving the meat quality of Tan sheep. This study collected with Glycyrrhiza which growing naturally among Ningxia Tan

sheep distribution areas to assess the nutrition and nutrient value, researching the effect of Glycyrrhiza extract in stabling Tan sheep meat quality through animal experiments so as to provide a theoretical basis for further improving the mutton flavor.

MATERIALS AND METHODS

Collection of the samples: The test samples simulated sheep feeding, collected Glycyrrhiza from the growing period to the early flowering stage, collected alfalfa of local cultivars as comparison and dried them at 65°C in the laboratory madding into samples.

Selection of experimental animals: Selecting twenty healthy lambs (about 4 months days of age) of Ningxia Tan sheep which had similar age, similar weight (about 18 kg) then divided randomly into 2 groups after weighting in the morning, respectively be control group, experimental group, each group of 10 lambs. The initial weight of test sheep had no significant difference checked by t-test.

Feeding and management of experimental animals: There were 6 days for pre-test and 55 days for experiment. Checking the health of the lambs during the pre-test days, expelling parasite and strengthening the stomach (pulvis stomachicus 30 g day⁻¹). Using 1% trichlorphon solution

to spurt the nose to expel worms, inject the sheep pox (1 mL/one) and trigeminy four vaccines (1.5 mL/one) during spring against. The experimental sheep picked the feed and drove water freely. Keep the sheepfold clean, make records of daily research and the lambs healthy status.

Experimental diets: The diet made referenced to the feeding standard of the Chinese Merino sheep (in 2001). The composition of the diet was corn 68.53%, wheat bran 6.12%, sesame meal 20.09%, premix 5.0%, salt 0.27%. The nutritional level for the DE was 8.41MJ kg⁻¹, CP was 11%, Ca was 4.96% and P was 2.93%. The basal diets had concentrate/roughage ratio of 30:70. Concentrated feed made of powdered used with compound feed. During the pretesting time used experimental concentrated feed to substitute for the original concentrated feed gradually. Both of the two groups fed with the same amount of silage (0.40 kg/one) and the alfalfa hay (0.30 kg/one).

Determination of indicators and methods

Analysis of nutritional components of Glycyrrhiza: Determining the Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Ash (Ash), Calcium (Ca), Phosphorus (P), Neutral Detergent Fibre (NDF) and Acid Detergent Fiber (ADF) of Glycyrrhiza (AOAC, 1995; Van Soest *et al.*, 1991). The determination on species and content of Amino Acid (AA), fatty acids, mineral elements which included Mg, Fe and Cu.

Production of the meat and the mutton quality: After the experiment, according to the AOAC to slaughter and determine carcass weight, yield of carcass, eye muscle area, GR, the rate of water loss, pH value, moisture, the content of dry matter and crude protein.

Statistics and analysis: Using the ANOVA Method with the Software of SAS (8.2) to analysis the experimental data after dealing with Excel. The average value multiple comparisons used the Duncan Method.

RESULTS AND DISCUSSION

Analysis of conventional nutrition composition: Glycyrrhiza significantly higher than alfalfa in dry matter content, crude fat, crude ash ADF, NDF and Ca.

Glycyrrhiza has less crude protein than alfalfa. When there are high content of crude protein and low content of NDF and ADF in the grass, it will has a high nutritional value. Conversely, it has a low nutritional value (De Ruig, 1986; Fang *et al.*, 2011; Wang *et al.*, 2011; Zweifel-Schielly *et al.*, 2012). Comprehensive Glycyrrhiza nutrients, researchers can see it has a high level of nutrients. As roughage, it can satisfy the conventional nutrition composition of the ruminant demand. It is a good forage plant (Table 1).

Amino acids: Many kinds of amino acid content of Glycyrrhiza as shown in Table 2. Although, the Total Amino Acid (TAA), crude protein in Glycyrrhiza is significantly lower than alfalfa but there is no significant difference ($p>0.05$) in restrictive Amino Acid/Total Amino Acid (LAA/TAA) and Amino Acid flavor/Total Amino Acid (Flavour AA/TAA) between two kinds of grass. In the grass, the composition and proportion of the amino acid influence the utilization rate of the nitrogen compounds, protein conversion, the composition and the quantity of the ruminal microbes of ruminant animals directly (Brooks *et al.*, 2011; Felisberto *et al.*, 2011; Vanhatalo *et al.*, 2009). According to composition and proportion of the amino acid in feed, judgment the quality of the protein feed accurately. For the same protein feed, the higher total amino acids, the better its quality. The small difference between the content of total amino acid and protein, the better its quality. In the case of the same total amino acids, the higher content of essential amino acid the better its quality. Additionally, the important factor of affect protein balance is the content of the essential amino acids and proportion in fodder. recommends from the food agriculture organization of The United Nations and the world health organization (FAO/WHO, 1973). The EAA/TAA of better quality protein is around 40%. The EAA/TAA of Glycyrrhiza is 43.15% in this measurement results. Explain the protein quality is good.

Fatty acids: The fatty acids in diets can be gastrointestinal absorption directly and deposition in the body of livestock and poultry (Wood and Enser, 1997). Studies have reported, the content of the alpha linolenic acid in pig fat tissue is highly relevant with it in the food. According to the fatty acid composition of pig diet can

Table 1: Conventional nutrition composition of Glycyrrhiza (%)

Composition	DM	EE/DM	CP/DM	ASH/DM	Ca/DM	P/DM	NDF/DM	ADF/DM
Glycyrrhiza	33.88±0.57 ^A	6.19±0.01 ^A	18.81±0.08 ^B	23.40±0.33 ^A	1.26±0.03 ^B	0.23±0.00 ^B	34.10±0.87 ^A	31.71±0.30 ^A
Alfalfa	20.38±0.10 ^B	2.77±0.04 ^B	35.24±0.19 ^A	11.24±0.09 ^B	1.47±0.02 ^A	0.39±0.07 ^A	18.65±0.39 ^B	14.64±0.35 ^B

The same column with the same shoulder lowercase shows no significant difference ($p>0.05$). The same column shoulder marked with different capital letters said highly significant difference ($p<0.01$)

Table 2: All kinds of amino acid content of Glycyrrhiza (DM foundation,%)

Amino acids	Glycyrrhiza	Alfalfa
Aspartic acid (Asp)	1.00±0.01 ^B	4.47±0.06 ^A
Threonine (Thr)	0.62±0.01 ^b	1.34±0.01 ^a
Serine (Ser)	0.68±0.02 ^b	1.24±0.01 ^a
Glutamic acid (Glu)	1.49±0.06 ^B	2.77±0.04 ^A
Glycine (Gly)	0.48±0.01 ^B	1.38±0.01 ^A
Alanine (Ala)	0.75±0.01 ^B	1.95±0.04 ^A
Valine (Val)	0.63±0.04 ^b	1.53±0.02 ^a
Methionine (Met)	0.24±0.01 ^b	0.31±0.00 ^b
Isoleucine (Ile)	0.31±0.00 ^b	0.92±0.01 ^a
Leucine (Leu)	0.69±0.04 ^B	1.86±0.02 ^A
Tyrosine (Tyr)	0.39±0.01 ^a	0.86±0.02 ^a
Phenylalanine (Phe)	0.55±0.01 ^B	1.37±0.01 ^A
Lysine (Lys)	0.73±0.02 ^B	1.73±0.02 ^A
Histidine (His)	0.28±0.00 ^B	0.70±0.01 ^A
Arginine (Arg)	0.29±0.01 ^B	1.53±0.02 ^A
Proline (Pro)	0.50±0.05 ^B	2.03±0.03 ^A
Tryptophan (Trp)	0.03±0.01 ^B	0.32±0.07 ^A
Total Amino Acids (TAA)	9.58±0.16 ^B	25.94±0.35 ^A
Crude Protein (CP)	18.81±0.08 ^B	35.24±0.19 ^A
Total Amino Acids/ Crude Protein (TAA/CP)	50.92±0.85 ^B	73.61±1.00 ^A
Essential Amino Acids (EAA)	4.14±0.02 ^B	9.90±0.13 ^A
Essential Amino Acids/ Total Amino Acids (EAA/TAA)	43.15±0.48 ^a	38.14±0.03 ^b
Restrictive Amino Acids (LAA)	0.92±0.02 ^b	2.17±0.02 ^b
Restrictive Amino Acids/ Total Amino Acids (LAA/TAA)	9.57±0.08 ^a	8.35±0.02 ^a
Flavor Amino Acids (Flavour AA)	5.16±0.06 ^B	13.29±0.18 ^A
Flavor Amino Acids/ Total Amino Acids (Flavour AA/TAA)	53.89±0.34 ^a	51.23±0.01 ^a

The same column with the same shoulder lowercase shows no significant difference ($p>0.05$). The same column shoulder marked with different capital letters said highly significant difference ($p<0.01$). Dry matter basis with fresh weight

predict the fatty acid composition of pig fat tissue (Nguyen *et al.*, 2003). Palm acid is of saturated fat. Moderate consumption is avail to fat metabolism. Palm acid excessive edible is the main reason for fat deposition in animal body.

The Saturated Fat (SFA), Saturated Fatty Acid/Total Fatty Acids (SFA/TFA) in Glycyrrhiza is significant higher than alfalfa. The Unsaturated Fatty Acid (USFA) of Glycyrrhiza was significantly higher than alfalfa. The Unsaturated Fatty Acid/Total Fatty Acids (USFA/TFA), Essential Fatty Acids (EFA) and Essential Fatty Acid/Total Fatty Acids (EFA/TFA) significantly lower than the alfalfa (Table 3). The content of alpha Glycyrrhiz acid in Glycyrrhiza was significantly lower than in the alfalfa. The content of palm acid, total fatty acids have no significant difference with the king of forage for alfalfa (Table 3). Explains, add appropriate Glycyrrhiza in sheep and goat diets can prevented the body from fat deposits.

Mineral substance: The mineral element which needed with animals played an important role in the normal physiological biochemistry process including the cuprum, the iron, the magnesium, the chromium and the selenium. They reached the purpose of improving meat quality by

Table 3: All kinds of fatty acids in licorice (DM foundation %)

Fatty acids	Glycyrrhiza	Alfalfa
Monolaurate (C12:0)	0.00 ^a	0.00 ^a
Nutmeg acid (C14:0)	0.07±0.08 ^a	0.00 ^a
Palmitic acid (C16:0)	0.50±0.01 ^a	0.45±0.03 ^a
Palm oleic acid (C16:1n7)	0.01±0.00 ^B	0.03±0.01 ^A
Hard acetate acid (C18:0)	0.11±0.01 ^a	0.08±0.00 ^a
Oleic acid (C18:1n9c)	0.08±0.01 ^a	0.05±0.01 ^a
Linoleic acid (C18:2n6c)	0.28±0.01 ^b	0.39±0.01 ^a
Alpha linolenic acid (C18:3n3)	0.70±0.01 ^B	1.21±0.05 ^A
Arachidic acid (C20:0)	0.04±0.00 ^a	0.03±0.01 ^a
The 21 carbonic acid (C21:0)	0.28±0.03 ^A	0.00 ^B
Shun-11-20 a carbon with acid (C20:1)	0.00 ^a	0.00 ^a
Behenic acid (C22:0)	0.18±0.04 ^A	0.03±0.02 ^B
The 13,16 twenty-two carbon two ene-acid (C22:2n6)	0.01±0.00 ^B	0.05±0.01 ^a
Wood tar acid (C24:0)	0.11±0.01 ^a	0.03±0.01 ^b
Total Fatty Acids (TFA)	2.36±0.19 ^a	2.36±0.10 ^a
Saturated Fatty Acids (SFA)	1.29±0.16 ^A	0.60±0.03 ^B
Saturated Fatty Acid/ Total Fatty Acids (SFA/TFA)	54.44±2.47	25.42±0.08 ^B
The Unsaturated Fatty Acid (USFA)	1.07±0.03 ^B	1.76±0.07 ^a
The Unsaturated Fatty Acid/ Total Fatty Acids (USFA/TFA)	45.56±2.47 ^B	74.5±0.09 ^A
Essential Fatty Acids (EFA)	0.98±0.02 ^B	1.60±0.06 ^A
Essential Fatty Acid/ Total Fatty Acids (EFA/TFA)	41.57±2.60 ^B	67.64±0.06 ^A

The same column with the same shoulder lowercase shows no significant difference ($p>0.05$). The same column shoulder marked with different capital letters said highly significant difference ($p<0.01$). Content is 0.00, says not detect or content is extremely low

the unique way (Jegade *et al.*, 2011; Salakova *et al.*, 2011; Arvizu *et al.*, 2011; Memisi *et al.*, 2008). But the ingestion of the mineral element was different from the sugar, the protein, the fat and. It could not transform *in vivo* of animal but the only way of the feed or water (Garmyn *et al.*, 2011).

The content of the cuprum, the iron and the selenium were significantly higher than alfalfa. The content of the magnesium and the chromium were significantly lower than alfalfa. According to the above, the plenty of Cu, Fe and Se in Glycyrrhiza increased the corresponding minerals *in vivo* of sheep and improved the flavor and quality of the mutton (Table 4).

Effects of Glycyrrhiza extract on the carcass trait of Tan sheep:

The live weight before butchering, carcass weight, yield of carcass and eye muscle area had no significant difference in Tan sheep between two groups ($p>0.05$). But the experimental group were higher than the control group. It showed that Glycyrrhiza extract had effects on the carcass properties of Tan sheep (Table 5).

Effects of physicochemical properties of Glycyrrhiza extract on Tan sheep meat:

Glycyrrhiza extract had a tendency of improving the rate of cooked meat and decreasing the rate of loss water in Tan sheep (Table 6). But there were no significant difference between two groups ($p>0.05$).

Table 4: The mineral content of Glycyrrhiza (DM basis, mg kg⁻¹)

Pasture grass	Cuprum	Iron	Magnesium	Chromium	Selenium
Glycyrrhiza	20.88±0.01 ^A	2735.20±2.00 ^A	1863±1.51 ^B	0.647±0.02 ^B	7.642±0.01 ^A
Alfalfa	10.16±0.05 ^B	324.65±0.11 ^B	3442±6.05 ^A	1.801±0.02 ^A	1.235±0.01 ^B

Means with same small letter superscripts in the same row differ insignificantly (p>0.05); means with different small letter differ significantly (0.01<p<0.05); means with different capital letter superscripts differ significantly (p<0.01)

Table 5: Effects of Glycyrrhiza extract on carcass trait of Tan sheep

Groups	Live weight/kg	Carcass weight/kg	Yield of carcass/%	Eye muscle area/cm ²
Experimental	23.33±0.76 ^a	12.13±0.05 ^a	0.53±0.01 ^a	12.71±4.40 ^a
Control	22.83±2.31 ^a	11.25±0.75 ^a	0.49±0.02 ^a	14.59±3.74 ^a

Table 6: Effects of Glycyrrhiza extract on meat physicochemical properties of Tan sheep

Groups	Rate of cooked meat/%	Rate of loss water/%	pH value
Experimental group	53.91±0.02 ^a	20.66±0.04 ^a	6.82±0.11 ^a
Control group	47.44±0.10 ^a	20.82±0.12 ^a	6.57±0.12 ^a

Table 7: Effects of Glycyrrhiza extract on meat quality of Tan sheep

Groups	Dry matter/%	Crude protein/%	Intramuscular fat/%	GR value/cm
Experimental	7.15±0.01 ^a	78.07±3.34 ^a	4.99±0.02 ^a	0.6047±0.0947 ^a
Control	6.93±0.02 ^a	71.05±6.25 ^a	4.47±0.02 ^a	0.5967±0.1771

Means with same letter superscripts in the same row differ insignificantly (p>0.05)

Effects of Glycyrrhiza extract on the meat quality of Tan sheep meat: The content of dry matter, crude protein, intramuscular fat, GR value had no significant difference between two groups (p>0.05) in Tan sheep (Table 7) but the 4 targets in experimental group were higher than the control group.

Glycyrrhiza contains many tannins: The content of tannins was up to 8.4%, slightly bitter. At the same time, its palatability is poorer for the sticky tired of honey or honey dew on stem appearance. Only the camels feed themselves, the sheep feed a little, other livestock don't like. But this study showed that Glycyrrhiza has higher levels of nutrients. The protein quality is good. Glycyrrhiza has low alpha Glycyrrhiza acid. The content of palm acid, total fatty acids is similar to alfalfa, the king of forage. As rough feed can satisfy the conventional demand of ruminant nutrition composition. It is a good forage plants.

The influence of the Glycyrrhiza extract on the carcass traits of Tan sheep: In the experiment, the live weight, carcass weight, slaughter rate and eye muscle area of treatment group Tan sheep are higher than those in the control group. And the higher eye muscle area the heavier carcass weight. This shows that eye muscle area and meat yield is highly relevant.

The influence of the Glycyrrhiza extract on physical and chemical characteristics of Tan sheep: The water loss rate of the meat will not only affect the food quality of meat from taste, aroma, juicy sex, nutrition, tender degrees, the color and so on directly, also has the important economic significance. If the water binding capacity is poor, muscle moisture loss great (even if only 1%) will bring a great of loss to the producers, slaughterhouses, storage, transportation and sales companies. This study showed that Glycyrrhiza extract has the trend to reduce the water loss rate and improve cooked rate of Tan sheep. pH value is an important index in the evaluation of the meat. PH value discretion can affect incardine, meat shrinkage, cooking loss and tender degrees (Muchenje *et al.*, 2009; Gardner *et al.*, 2005; Bressan *et al.*, 2011). In normal physiological state, the muscle pH can remain stable value as 7.35-7.45. But after the slaughter, the muscle pH value begin to fall (Li *et al.*, 2006). A reduction of pH to 6.2-6.4 in an hour. After 1 h of the slaughter, the main show from the speed of muscle glycogen and strength to ferment. The meat storage losses small with high value pH and help to improve the hydraulic department. This study showed that the pH value for two groups Tan sheep are in the normal range. The pH value in treatment group a little higher than that in control group. This shows that add Glycyrrhiza extract to Tan sheep group feed can reduce the speed of the muscle glycogen ferment after the slaughter. To improve the meat quality of Tan sheep.

The influence of the Glycyrrhiza extract on the meat quality of Tan sheep: Intramuscular fat has obvious improvement action in texture, tight sex and the water retention performance (Bressan *et al.*, 2011; Lanza *et al.*, 2006; Babiker *et al.*, 1990; Brewer *et al.*, 2001). Smith and Young (1991) studied found intramuscular fat can significantly improve the quality of the mutton. And intramuscular fat can improve the water retaining capacity of the meat. This study, the content of crude protein and intramuscular fat in treatment group are higher than those in the control group. Demonstrated that Glycyrrhiza extract can improve the water retaining capacity of the meat. GR value reflects the carcass fat content. GR determination value has the very big relations to the varieties and body condition of sheep. The lamb grading standards in New Zealand stipulated, it has a higher

content of carcass fat when weight carcass in 16.0-25.5 kg, GR value in 12-15 mm trunks. This test, the GR value of the two Tan sheep groups is in 6.0 mm or so. Below this range may relate to the varieties, body condition, feeding and management of the Tan sheep. This shows added Glycyrrhiza extract to feed can improve the meat quality of Tan sheep.

CONCLUSION

It was demonstrated that proper addition of Glycyrrhiza in sheep and goats diets could prevent the body fat deposition. Glycyrrhiza was rich in Cu, Fe and Se which had positive effects on improving mutton quality and flavor. Adding Glycyrrhiza extract into stabling Tan sheep feeding diets had the trend of increasing Tan sheep live heavy, carcass weight, slaughter rate and improved the meat quality.

IMPLICATIONS

This study demonstrates that Glycyrrhiza has higher levels of nutrients. As rough feed can satisfy the conventional demand of ruminant nutrition composition. The EAA/TAA of Glycyrrhiza is 43.15%. Explicates the protein quality is good. Glycyrrhiza has low alpha Glycyrrhiza acid. The content of palm acid, total fatty acids is similar to alfalfa, the king of forage. Explicates, add appropriate Glycyrrhiza to sheep and goats diets can effectively prevent body fat deposits; Glycyrrhiza has rich content of Cu, Fe and Se. Has a positive effect in improving the quality and flavor of the mutton.

Adding Glycyrrhiza extract to Tan sheep diets has the trend of increasing the live weight, carcass weight and slaughter rate of the Tan sheep. Improved the mutton pH value, can reduce the speed of the muscle glycogen ferment after the slaughter effectively, slow mutton rancidity process. Also has the trend to reduce the water loss rate and improve cooked rate of Tan sheep can improve the meat quality of Tan sheep.

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