Research and Application of Compressed Fermented Chestnut Leaf Feed in Fattening Mutton Sheep

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Abstract [**Objectives**] This study was conducted to further improve the utilization value of local chestnut leaves, improve the palatability of chestnut leaves and reduce tannin content in chestnut leaves. [**Methods**] Chestnut leaves and bran were evenly mixed according to different mass ratios, and the mixtures were sprayed and inoculated with a certain amount of prepared EM microbial liquid, and then compressed into 70 cm × 40 cm × 30 cm blocks by a fully automatic yellow-storage block compression and packaging machine. The obtained blocks were packaged and sealed with plastic film, and placed in a freely ventilated place for more than 15 d of anaerobic fermentation, so as to obtain compressed fermented chestnut leaf block feed. [**Results**] Through the detection and analysis of nutritional components in the compressed fermented chestnut leaf block feed in the laboratory, the protein content was equal to or greater than 10.2%, which was 44.68% higher than that of unfermented chestnut leaf feed; the tannin content was equal to or greater than 638 mg/kg, which was 18.41% lower than that of the original feed; and the crude fiber content was equal to or greater than 19.5%, which was 14.09% lower than that of the original feed. [**Conclusions**] This study improves the palatability of chestnut leaf feed, increases the use efficiency of feed and reduces feeding cost. It is worth popularizing.

Key words EM microbial liquid; Chestnut leaf; Compressed fermentation; Fattening of mutton sheep

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Chestnut leaves refer to leaves of *Castanea mollissima* Bl. in Fagaceae. Fagaceae, belonging to Fagalesa of Dicotyledoneae in Angiospermae, is distributed in all parts of southern Liaoning, and is cultivated except Qinghai and Xinjiang. It is often cultivated in low mountains, hills, gentle slopes and river beaches with an altitude of 100 – 2 500 m. It is the most concentrated in North China, Southwest China and the Yangtze River Basin, and the yield is the largest. Chestnut leaves can be used as a medicine, which tastes slightly sweet, and is neutral in nature and attributive to the lung meridian. Chestnut leaves have the effects of clearing lung-heat, relieving cough, removing toxicity for detumescence. They are commonly used for whooping cough, tuberculosis, swollen sore throat, pyogenic infections and dermatitis rhus[1].

In recent years, with the large-scale cultivation of chestnut nationwide, especially in Qianxi County, Zunhua City and Qian'an City in the Yanshan Mountains and surrounding Qinglong County, the area of chestnut cultivation has been increasing. Chestnut leaves fallen off in autumn contain abundant crude protein, tannins, flavonoids, trace elements, crude fiber, *etc.* Their crude protein content is equal to or greater than 7.0% (higher than the crude protein of corn stalks at 6.21% by ≥13%), and their contents of tannins, crude fiber, flavonoids, calcium and total phosphorus are 782 mg/kg, 22.7%, 0.38%, 1.9%, and 0.10%, respectively.

Chestnut leaves have been used as roughage for deer, and there are many studies on the components and antibacterial activity of chestnut leaves. Among the volatile components of chestnut leaves, alcohol compounds account for the largest proportion, 60.33% of the total, in which unsaturated alcohol compounds account for 47.38%. In addition, alkanes account for 23.09%; alkenes account for 8.67%; and aldehydes account for 6.14%. Chestnut leaves also contain a small amount of ketones, acids, esters and other compounds[2]. When feeding chestnut leaves to livestock such as cattle and sheep, the palatability is poor due to the high content of tannin compounds, making it difficult for cattle and sheep to consume. Moreover, it is not easy for herbivores such as cattle and sheep to digest and absorb chestnut leaves after eating, and chestnut leaves are likely to cause poisoning. It has been reported that adding a proper amount of PEG (polyethylene glycol) to chestnut leaves can effectively adsorb tannins contained in them, and thus greatly improve the feed intake of chestnut leaves, and this method has become a main way to improve animal economic benefits[3]. How can we effectively utilize excessive chestnut leaves with facilitated absorption and utilization by herbivores

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such as deer, cattle, sheep while reducing the feeding of concentrated feed Inoculating EM microbial liquid into chestnut leaves for sealed fermentation not only improves the nutritional value of chestnut leaves and significantly reduces the pH value, but also improves palatability, and moreover, the fermented material could be preserved for a long time without deterioration.

In this study, based on the principle of microbial fermentation, crude fiber and protein macromolecules were degraded into small molecules which are easily absorbed, such as small peptides, through anaerobic fermentation under suitable conditions. Abundant local chestnut leaf resources are fully developed and utilized, and the technique not only reduces the tannin content in chestnut leaves, but also increases the content of crude protein and other substances in feed. It improves the palatability of chestnut leaf feed, improves the use efficiency of feed, and also reduces feeding cost and saves the storage space of chestnut leaves.

Materials and Methods

Experimental materials

Chestnut leaves that naturally fell off after first frost were collected from Li Chunwei Farm in Baitazhai, Saheqiao, Qianxi County, Hebei Province and Longsheng Farm, Longwan Village, Santun Town, Qianxi County, Hebei Province. EM original strain powder (living bacteria count $\geqslant 20 \times 10^{11}$ CFU/g, mositure $\leqslant$ 12%) was purchased from Taobao (purchased from Shandong Jida Biotechnology Co., Ltd. with the brand Yuehean). Wheat bran and sealed cans were commercially available. The EM original strain powder was a kind of mixed microorganisms, including Bacillus subtilis, lactic acid bacteria, yeast, photosynthetic bacteria, nitrifying bacteria, Bifidobacterium and other beneficial bacteria.

Experimental methods

Preparation of EM liquid Saccharides and boiled water were mixed according to a mass ratio of 30 ∶ 2. The mixture was cooled to a temperature lower than 40 ℃ to obtain a cooled mixed solution of sugar water. The EM original strain was inoculated to the cooled mixed solution of sugar water, and EM microbial liquid was obtained after 2 – 5 d of sealed fermentation.

Experimental methods The collected chestnut leaves and bran were mixed according to the mass ratios of 10 ∶ 0, 9 ∶ 1, 8 ∶ 2 and 7 ∶ 3 respectively. Next, the prepared EM liquid was inoculated respectively after uniform stirring. The EM liquid was sprayed to raw materials at a mass ratio of 1 ∶ 100, and after stirring, the mixture was compacted into sealed tanks, which were then sealed for 15 d of anaerobic fermentation, with the humidity maintained at 30% – 35% and the temperature at 20 – 30 ℃, to obtain yellow compressed fermented chestnut leaf feed.

Laboratory detection of its effective components After decompression of sealed compressed fermented chestnut leaf feed, the aroma of cider and vinegar could be smelt. The changes of crude protein content, tannin content, crude fiber content, calcium content, total phosphorus and pH value in each group were detected after natural drying (to the degree that the feed could be pulverized for detection).

Crude protein was determined according to the first method of GB 5009 5-2016. The method for tannins (calculated by gallic acid) referred to NY/T 1600-2008. Crude fiber was determined according to GB/T 5009 10-2003. The content of calcium was determined according to GB/T6436-2018/3 potassium permanganate method. The determination of total phosphorus adopted GB/T 6437-2018. Aflatoxin B1 was determined according to NY/T 2071-2011.

Results and Analysis

Effects of fermentation of different mass ratios of raw materials on effective components of chestnut leaves

Unfermented chestnut leaves served as group 1, and the mass ratios of 10 ∶ 0, 9 ∶ 1, 8 ∶ 2 and 7 ∶ 3 were corresponding to groups 2 – 5, respectively. The test results of various components are shown in Table 1.

Table 1 Effects of fermentation of different mass ratios of raw materials on effective components of chestnut leaves

Group	Crude protein content//%	Tannin content//mg/kg	Crude fiber content//%	Calcium content//%	Total phosphorus//%	pH
Group 1	7.05	782	22.7	1.90	0.10	5.76
Group 2	8.11	626	21.8	1.54	0.10	5.56
Group 3	9.94	673	20.2	1.79	0.08	4.62
Group 4	10.20	638	19.5	1.79	0.10	5.05
Group 5	9.95	646	19.8	1.84	0.10	4.85

Chestnut leaves and bran (bran was the energy carrier used in fermentation by EM microorganisms) were mixed according to different mass ratios, and the crude protein content of fermented feed increased with the increase of bran addition. Tannin content also changed, and with the increase of bran addition, tannin content also increased, while the content of crude fiber decreased. The content of crude protein was highest at 10.2% in group 4 with a ratio of 8 ∶ 2, which showed a tannin content of 638 mg/kg, a crude fiber content of 19.5%, a calcium content of 1.79%, and a total phosphorus content of 0.10%. Group 2 exhibited the lowest tannin content at 626 mg/kg, and its crude fiber content, calcium content, total phosphorus content and pH were 21.8%, 1.54%, 0.10% and 5.56, respectively. Compared with unfermented chestnut leaves, the protein content increased by 44.68% and the tannin content decreased by 18.41%, so the nutritional value of fermented feed was greatly improved. The ratio of raw materials of 8 ∶ 2 was preferred among various ratios. During the above compression fermentation, detection was performed on aflatoxin B1

and the result was "not detected".

Feeding experiment

Experimental object With local small-tailed Han sheep as the experimental object, fattening lambs with similar body condition and average weight of about 15 kg were selected, and 40 lambs were divided into an experimental group and a control group, with 20 lambs in each group. The feeding cycle was 120 d, and the total weight of sheep flock was measured at the beginning and end of the experiment.

Diet formula Roughage: Yellow compressed fermented chestnut leaf block feed and compressed corn stalk block feed were from Tangshan Youchao Agricultural Development Co., Ltd. (Yangjiayu Village, Hanerzhuang Township, Qianxi County).

Roughage for the experimental group: Yellow compressed fermented block chestnut leaf feed fermented for more than 20 d was decompressed, and lambs were allowed to eat freely. The cost of yellow compressed fermented chestnut leaf package was 0.77 yuan/kg.

Roughage for the control group: Crushed corn stalk (with a particle size of 20 – 30 mm) was mixed with bran according to the mass ratio of 8 ∶ 2, and then lambs were allowed to eat freely. The feeding cost of compressed corn stalk was 0.75 yuan/kg.

Concentrated feed was prepared from raw materials purchased in the market according to nutritional components (corn flour 63%, bran 13%, soybean meal 22%, salt 1% and mixture of vitamins and trace elements 1%). The fattening lambs in the experimental group and the control group were supplemented with the same concentrate. The composition and nutritional level of concentrate are shown in Table 2 below.

According to the price of concentrate components, the cost of concentrate was 3 090 yuan/t.

Fattening lamb diet: 10% concentrate +90% roughage.

Experimental methods

According to fattening techniques of lambs, we tried to kill parasites *in vivo* and *in vitro* before experiment, and then, parasites were dispelled once a month. Sheep pox vaccine, sheep tetravaccine, foot-and-mouth disease vaccine, peste des petits ruminants vaccine and other vaccines were inoculated on time. The sheephouse should be kept dry and tidy, properly ventilated and disinfected regularly. Concentrate and roughage should be well matched. The lambs were fed less but for more times first, and then could eat and drink freely. Feed should be added three times a day. Every morning or evening, remaining feed in the trough should be cleaned, collected and weighed, and the daily intake should be recorded. Fasting weight was measured before and after experiment.

Table 2 Nutritional composition and level of concentrate

Raw material	Proportion//%	Nutritional component	Content
Corn flour	63	ME (MJ/kg)	13.63
Bran	13	CP (%)	16.40
Bran	22	Ca (%)	0.098
Additive	2	P (%)	0.255

Results of feed experiment

After 120 d of feeding and management, the recorded results of body weight and total feed consumption are shown in Table 3 and Table 4. The estimated economic benefits are shown in Table 5.

As can be seen from Table 3 – Table 5, under the same environment, the composition of roughage affected the fattening of lambs. Compared with the control group, the average daily gain of lambs in the experimental group fed with the fermented feed increased by 58.96 g/sheep, with a growth rate of 20.71%. In addition, the total feed consumption of lambs increased by 61.42 kg, and the use efficiency of roughage also increased by 2.11%. According to the average market price of mutton sheep as 24 yuan / kg, the final profit of mutton sheep increased by 150.66 yuan/sheep, with a profit growth rate of 22.61%, showing remarkable economic benefits.

Table 3 Results of fattening lambs with different roughage in Chunwei Farm

Group	Number	Initial weight//kg	Final weight//kg	Total weight gain//kg	Total feed consumption//kg	Average daily weight gain//g/sheep
Experimental	20	302.28	1 126.44	824.16	3 298.03	343.40
Control	20	301.50	987.36	685.86	2 896.8	285.78
Difference	–	0.78	139.08	138.30	401.23	57.62

Table 4 Results of fattening lambs with different roughage in Longshenf Farm

Group	Number	Initial weight//kg	Final weight//kg	Total weight gain//kg	Total feed consumption//kg	Average daily weight gain//g/sheep
Experimental	20	308.5	1 154.74	846.24	3 309.4	352.60
Control	20	310.0	1 011.52	701.52	2 921.6	292.30
Difference	–	–1.5	143.22	144.72	388.6	60.30

Table 5 Analysis on the average production of each sheep with different roughage during the experimental period

Group	Weight gain//kg	Unit price//yuan/kg	Sales proceeds//yuan	Feed price//yuan/kg	Feed cost//kg	Profit//yuan
Experimental	41.76	24	1 002.24	1.002	185.51	816.97
Control	34.68	24	829.44	0.984	163.13	666.31
Difference	7.98	–	173.04	0.018	22.38	150.66

Conclusions and Discussion

From the above feed experiment preparation, feed composition analysis and feeding experiment, we could get the yellow compressed

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fermented chestnut leaf feed, which was rich in nutritional value, and not only provided palatability, but also improved the protein use efficiency of coarse feed and the use efficiency of the feed. After feeding animals, the use efficiency of the fermented chestnut leaf feed increased by a rate equal to greater than 2.11% and the economic profit increased by 22.51%. The animals showed good growth indexes and obvious weight gain, and the economic benefit was greatly improved. The yellow compressed fermented chestnut leaf feed is suitable for wide application and popularization.

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