Small Research on Promoting Food-saving Animal Husbandry

-- Taking Sun Village Breeding Base in Mancheng District, Baoding City, Hebei Province as an Example

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Abstract: As the main source of forage, corn stalks have obvious effects on saving food. Improving the quality of forage has a very important impact on ensuring food security and promoting the development of aquaculture. The author uses corn stalks from the plains of Hebei Province (Sun Village, Mancheng District, Baoding City) as the raw material, through the determination of the pH value, total acid, dry matter, crude ash, crude protein and other chemical components of corn stalks with different silage additives to study the effect of its singly or combined use on the fermentation quality of corn stalks, so as to form the best silage quality plan. The experimental result shows that: (1) The addition of inhibitors is beneficial to increase the total acid content, reduce the pH value of the silage, and ensure the smooth progress of the silage; (2) The simple addition of bacterial agents has no significant effect on the number of effective bacteria in the silage process, but the bacteria after compounding with enzyme preparation can significantly reduce the ratio of ammonia nitrogen/crude protein ($P<0.05$) (3) Adding cellulase can significantly reduce the content of crude fiber ($P<0.05$), increase soluble sugar, promote the reproduction of lactic acid bacteria, and improve The number of lactic acid bacteria and the crude protein. Based on the various data, it demonstrates that simply adding inhibitors can better improve the fermentation quality of corn silage, which not only reduces the cost, but also improves the quality of the silage, and thus it is an economical and practical solution.

Keywords: corn stover; silage additives; silage fermentation quality

1. Research background and research significance

1.1. The relationship between straw feed and food production

With the improvement of living standards, people's demand for meat has gradually increased, and the growth of animal husbandry has become an inevitable trend [1]. In 2010 alone, my country's feed corn consumption has exceeded 110 million tons, accounting for 64% of the domestic annual corn output [2]. However, China's national conditions with more people and less land determine that feed grain cannot continue to increase with the development of animal husbandry, and it is necessary to take a "food-saving" animal husbandry development path [1].

In 2010, the total amount of straw used for forage in the country reached 210 million tons, of which 96 million tons of straw were ammoniated in silage, and the straw forage treatment rate increased from 21% in 1992 to 46%. Converted in terms of nutritional value, it is equivalent to saving 60 million tons of feed grains. In the 20 years from 1990 to 2010, under the premise of an annual increase of 4.6% in total grain output in my country, the output of major food-saving livestock products such as beef, lamb, and milk has achieved annual increases of 8.59%, 6.81%, and 11.36%. The rate of increase, the effect of food saving is significant [2].

1.2 Resource distribution and yield of corn stalks

As a large agricultural country, my country is a country rich in straw resources. There are many varieties of crop stalks, and the output is large, with a total annual volume of about 640 million tons. Among them, 170 million tons of corn stalks accounted for about 27.39% of the total output [3]. As far as Hebei Province is concerned, corn planting areas are mainly distributed in shallow mountainous and plain areas, and the planting area is basically stable at about 33 million mu, of which the total amount of corn stalks in the plain area is 13.623 million tons, accounting for 58.3% of the province.

1.3 The significance of optimizing the quality of corn stalk silage

1.4 Silage additives

In order to obtain good silage, it is often necessary to control the silage process with the help of silage additives, so as to obtain better silage effects.

Common silage additives include fermentation promoters, fermentation inhibitors, nutritional additives and preservatives [4].

Fermentation promoters mainly include lactic acid bacteria, cellulase and carbohydrates [5]; fermentation inhibitors are the earliest additives used, initially using inorganic acids, and later organic acids and formaldehyde [6]; nutritional additives including Urea, salts, carbohydrates, etc., are mainly used to supplement the insufficient nutrients of silage [7]; commonly used preservatives are propionic acid, sorbic acid, ammonia, sodium nitrate, formic acid, etc., which can effectively inhibit secondary fermentation. Prevent feed deterioration [6, 8].

Since silage additives can not only provide the nutrients needed for microbial fermentation, but also prevent the decay and deterioration of silage, so that it can be stored for a long time, so additive silage has gradually become a dominant position and has attracted widespread attention at home and abroad.

2. Experiment on the effect of additives on the quality of corn stalk silage

2.1 Test Materials

2.1.1 Raw Materials

In this experiment, fresh corn stalks (with sticks), sampled from Suncun dairy farm of nanchun Town, Mancheng District, Baoding city, were cut into 1cm long. The reprocessed corn was common corn collected before harvest.

2.1.2 Additives

Four kinds of additives were used in this experiment, including two compound bacterial agents, one enzyme preparation and one inhibitor. Compound microbial agent 1 is the original one taken from the laboratory of New Hope Tianxiang Dairy Company, including 3 strains of lactic acid bacteria, 1 strain of Bacillus and 1 strain of yeast; compound microbial agent 2 is produced by Shandong Baoli Baolai Bioengineering Co., Ltd. The enzyme preparation is cellulase provided by Shaanxi Enzyme Engineering Research Institute, and the inhibitor is propionic acid. The above mentioned ones and their combination were determined by consulting the literature.

2.1.3 Medium [16,27,28]

(1) MRS medium: contains 10 g peptone, 5 g yeast extract, 10 g beef extract, 20 g glucose, 5 g sodium acetate, 2 g diammonium citrate, 1.0 ml Tween 80, 0.58 g magnesium sulfate, 0.05 g manganese sulfate, 2 g potassium hydrogen phosphate, 20 g agar, 1 000 ml distilled water. Keep at 121 ℃15 minutes in a solution of pH 6.2 ~ 6.4 .

(2) Yeast medium (YM medium): contains yeast extract 3 G, malt extract 3 G, peptone 5 g, glucose 10 g, agar 20 g, distilled water 1 000 ml.

2.2 Experimental Design

There were 8 groups in the experiment, 7 of which were added with different additives or additive combinations respectively, and the corn straw natural silage without any additives was set as the control group (CK). The specific arrangement is shown in Table 1.

Table1 Arrangement of different additives added in corn silage

Processingnumber Treatment	CK	1	2	3	4	5	6	7
Types of additives Additives Style	nothing	Bactericide1	Bactericide2	Enzyme preparation	inhibitor	Bactericide 1+ Enzyme preparation	Bactericide 2+ Enzyme preparation	Enzyme preparation + inhibitor

2.3 Test Method

2.3.1 Silage Preparation

(1) Activating the self owned bacteria prepared the fermentation broth by in the laboratory.

(2) Propionic acid (0.6%), enzyme preparation (0.05%), bacteria preparation (0.001%) were dissolved in 160ml chlorine free water (chlorine can kill lactic acid bacteria and other bacteria), and then evenly sprayed on the surface of straw, After mixing thoughlly, the author put 400g of each bag into polyethylene silage bag, extracted air and sealed it, stored it at room temperature, and took samples at 0, 5, 10, 20, 30, 40, 50, 60, 75 and 90 days for determination, accounting for 10 times in total.

2.3.2 Evaluation on Quality Evaluation of Silage

2.3.2.1 Determination of Effective Bacteria in Silage

The number of effective bacteria in the fermentation process of silage was tested and determined. The silage materials in each silage stage were separated, and the number of lactic acid bacteria and yeast in each gram of silage material was detected. MRS medium was used to isolate lactic acid bacteria and YM medium was used to isolate yeast. Using the dilution plate separation method, lactic acid bacteria were cultured at 37 ℃ for 1-2 days; yeast were cultured at 28 ℃ for 3-4 days.

2.3.2.2 Determination of Fermentation Quality in Silage

The fermentation quality and chemical composition of silage were analyzed quantitatively. Determined The pH value, dry matter (DM), total acid (TA), ammonia nitrogen (NH4 + - n) and the contents of crude ash (ash), crude protein (CP), soluble carbohydrate (WSC) and crude fiber (CF) of each stage.

2.4 Data Processing

Data used Excel to process the test, and DPS software for significance analysis.

3. Results and Analysis

3.1 Change of pH Value During Fermentation of Corn Straw Silage

The change of pH during silage fermentation can directly reflect the production capacity of lactic acid bacteria. The results of pH value determination of silage corn in each stage are shown in Figure 1.

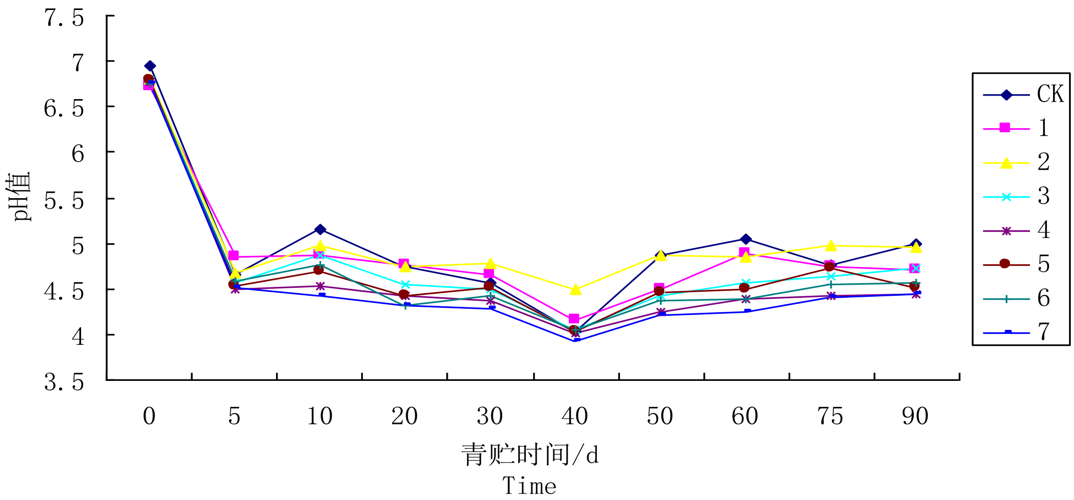


Figure.1 Changes of pH in Corn Silage Processing

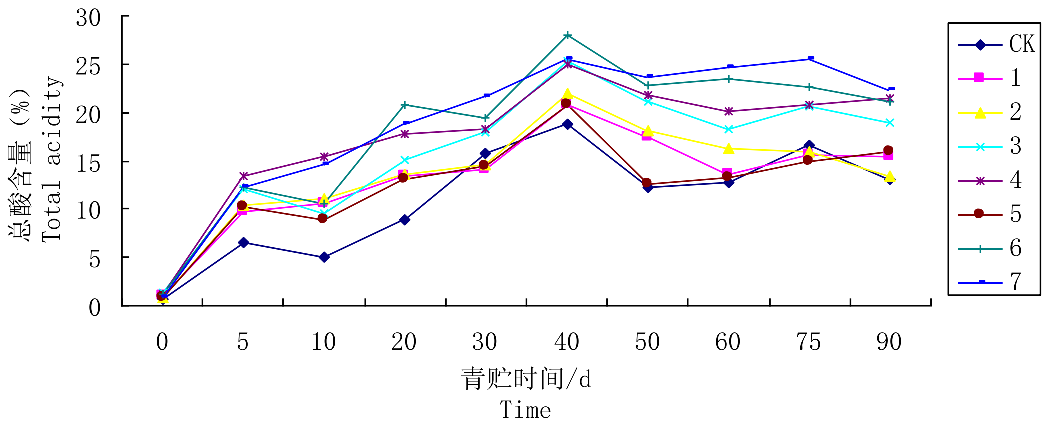
It can be seen from Figure 1 that during the first 40 days of silage, the pH values of all processing showed a downward trend with the extension of silage time. In the first 5 days of fermentation, the pH value dropped rapidly by about 2.5 units, then the rate of decline slowed down significantly, and reached the lowest on the 40th day. Then the pH value rose slowly and stabilized in the later stage. This may be because in the early stage of fermentation, due to the sufficient nutrients of silage raw materials, suitable conditions were provided with the fermentation of lactic acid bacteria, which made them rapidly produce a lot of lactic acid, resulting in a sharp decrease in pH value. Then, with the complete fermentation of lactic acid, the activity of lactic acid bacteria was inhibited, so the pH value stopped decreasing. After the 40th day, the moisture content of silage corn was mostly higher than 82%, ammonia nitrogen increased, protein decomposition intensified, resulting in the increase of pH value, and finally the interaction with lactic acid bacteria reached stability.

The results showed that the pH values of all treatments containing additives at the end of silage were lower than those of CK treatment, and the pH values of treatments 4 and 7 with inhibitors were the lowest, because the added inhibitor was propionic acid, which could reduce the pH value. In other treatments, the pH values of treatments 5 and 6 with bacteria and enzyme compound addition were lower than those of CK treatment, while the pH values of treatments with bacteria 1 were lower than those of bacteria 2 . Therefore, the acid reducing ability of adding inhibitors is the strongest, followed by the combination of bacterial agents and enzyme preparations, and the effect of only adding bacterial agents or enzyme preparations are the worst. The acid reducing ability of microbial agent 1 was better than that of microbial agent 2, which was more conducive to the preservation of silage corn.

3.2 Changes of Total Acid Content in Corn Straw Silage During Fermentation

Total acid is also one of the indicators reflecting the acid production capacity of lactic acid bacteria during silage. The determination of total acid content in each stage of silage is shown in Figure 2.

Figure.2 Change of Total Acid In Corn Silage Process



The total acid content increased continuously in the first 40 days and reached the highest on the 40th day, then decreased and tended to be stable in the later stage. The group that added the inhibitor at the end whose total acid content was the highest, while the total acid content of group 2 and CK was the lowest. In terms of acid production capacity, the combination of inhibitor and enzyme preparation had the best effect, and the group with enzyme preparation was better than that with bacterial preparation separately.

3.3 Changes of Effective Flora During Fermentation on Silage Corn

3.3.1 Changes of Lactic Acid Bacteria in Different Silage Stages

Lactic acid bacteria are the dominant bacteria in silage corn fermentation, and the dominant growth of lactic acid bacteria ensures the smooth silage process [6], which lays the foundation for the production of qualified silage.

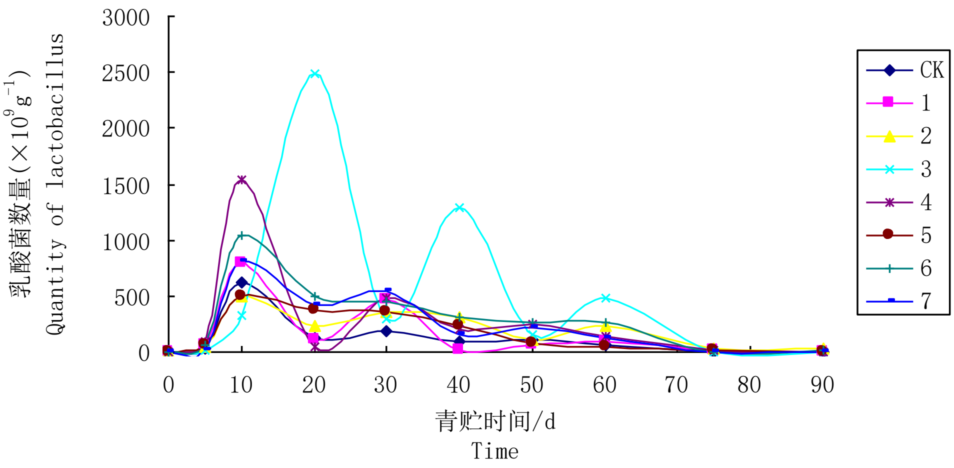


Figure.3 Quantity Change of Lactobacillus In Corn Silage Process

The changes of lactic acid bacteria in different periods are shown in Figure 3. Except treatment 3, the number of lactic acid bacteria in all treatments reached the maximum on the 10th day, then fluctuated, decreased, and finally stabilized 70 days later. The highest point of group 3 was delayed and the largest number of lactic acid bacteria appeared on the 20th day of silage, and the decline fluctuated greatly. This may be due to the dropped temperature during the silage process, which reduces the activity of …and has a direct impact on the lower speed of reproduction. When the temperature rises, the activity of the lactic acid bacteria recovers and the reproduction speed also increases. When the temperature rose, the activity of lactic acid bacteria recovered and the propagation rate increased. For the ability to increase the number of lactic acid bacteria, the order of each treatment was: enzyme preparation > inhibitor > bacterial preparation 2 + enzyme preparation > inhibitor + enzyme preparation > bacterial preparation 1 > CK > bacterial preparation 1 + enzyme preparation > bacterial preparation 2. The effect of enzyme alone is better than that of enzyme combined with bacteria or inhibitor. The effect of adding bacteria is not ideal as expected.

3.3.2 Changes of Yeast Quantity In Different Silage Stages

Yeast, as a component of natural silage flora and additive bacteria, can increase cell protein and make up for protein loss in silage, which is conducive to obtaining high-quality silage [20,21]. According to the literature collecting and analyzing, there are very few yeasts in the treatment with inhibitor or enzyme only, so these three treatments were not determined. The number of yeasts in different periods of corn straw is shown in Figure 4.

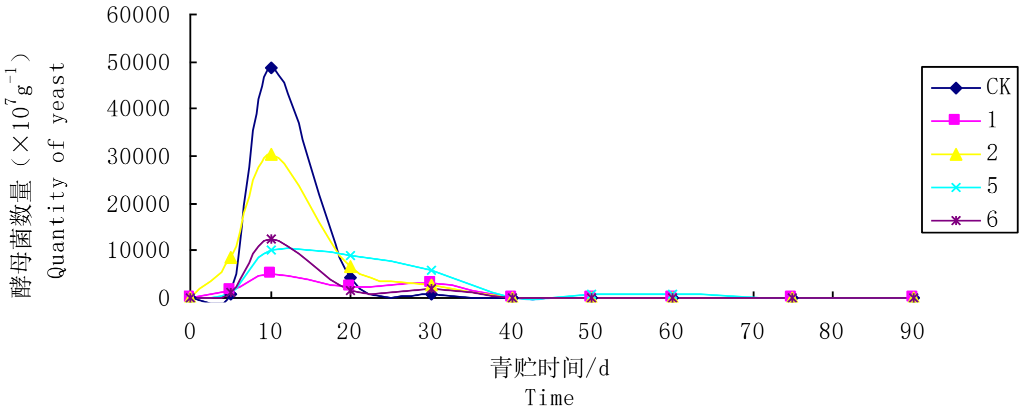


Figure.4 Quantity Change of Yeast In Corn Silage Process

Figure. 4 shows that yeast mainly acts in the early stage of silage. The number of yeasts in each additive treatment was lower than that in CK treatment. The number of yeasts in all treatments increased rapidly to its highest level from the 5th day to the 10th day of silage, then decreased sharply in the next ten days. Then the speed became slower down to 10-3 in the later stage of silage. On the 10th day, the yeast content of each treatment was above 1010, and the yeast number of CK reached 10^{-3}. This is due to the sufficient nutrients in the early stage of silage and the vigorous reproduction of yeast. After the 10th day, the number of lactic acid bacteria increased sharply, which inhibited the growth of yeast.

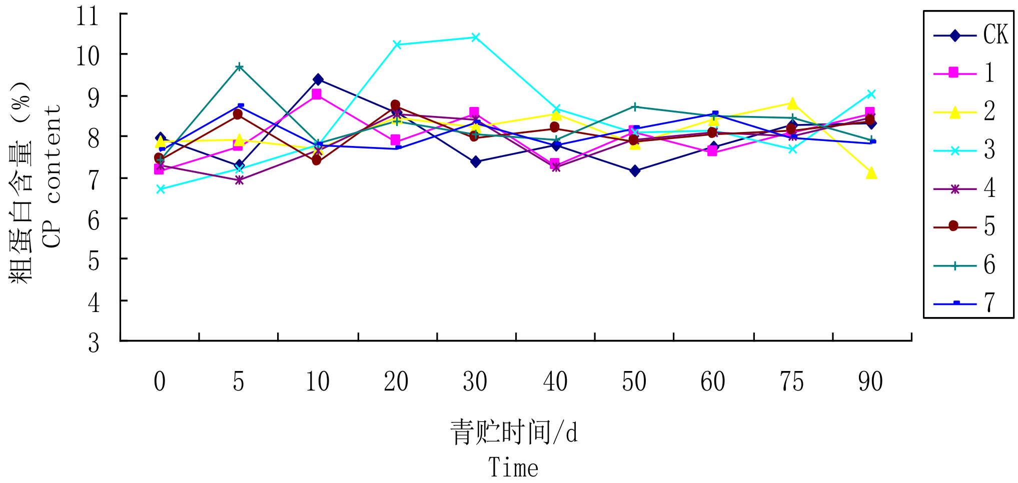
3.4 Changes of Chemical Components In Silage Corn During Fermentation

3.4.1 Changes of Crude Protein and Ammonia Nitrogen During Silage

Crude protein and ammonia nitrogen are important indexes to determine the quality of silage. The higher the content of ammonia nitrogen obtained, the worse the quality of silage produced[19]. The higher the crude protein content was, the lower the ammonia nitrogen content was, indicating that the less amino acids and protein were decomposed, the better the silage quality was. The changes of crude protein and ammonia nitrogen during corn silage are shown in Figure. 5 and Figure. 6.

Figure. 5 and Figure. 6 showed that the crude protein content of each treatment did not fluctuate during the silage process and remained stable basically, but it increased slightly at the end of silage compared with the initial state. This is due to the decomposition of amino acids and protein by spoilage bacteria in the fermentation process, resulting in the decrease of crude protein content. However, with the growth of microorganisms, yeast increased the bacterial protein of silage, and the increase was slightly higher than the consumption.

Figure.5 Change of CP in Corn Silage Process



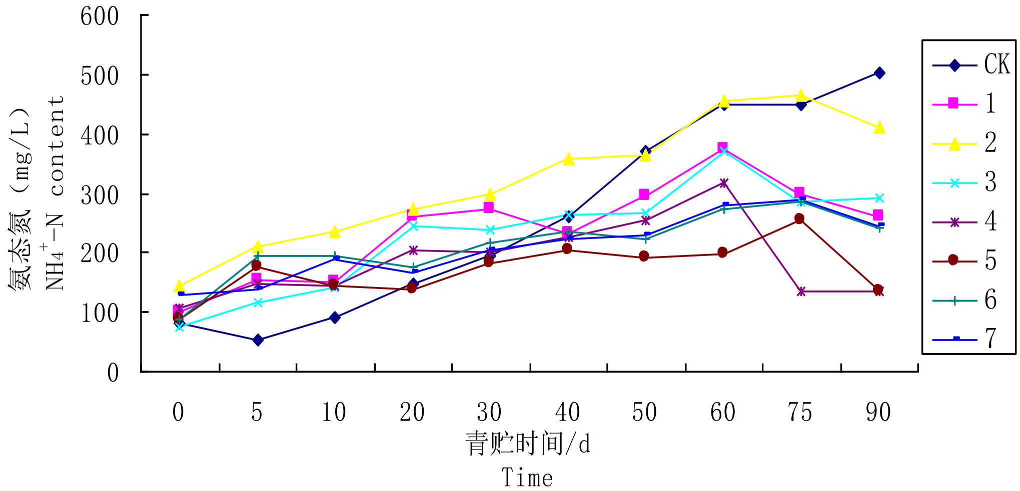


Figure.6 Change of NH4+-N in Corn Silage Process

However, except CK and treatment 2, the other treatments showed a certain downward trend in the later stage. Due to the role of spoilage bacteria, ammonia nitrogen is increasing, and microbial biological fixation uses ammonia nitrogen produced by partial decomposition as an available nitrogen source, so that the growth of ammonia nitrogen is slow, or even slightly decreased.

3.4.2 Changes of Soluble Sugar Content In Corn Silage

Soluble sugar is the main substrate of silage fermentation. For corn straw, the main soluble sugar is sucrose, glucose and fructose. Generally speaking, a large amount of soluble sugar will be used by microorganisms during silage fermentation, so the remaining soluble sugar will be greatly reduced after silage.

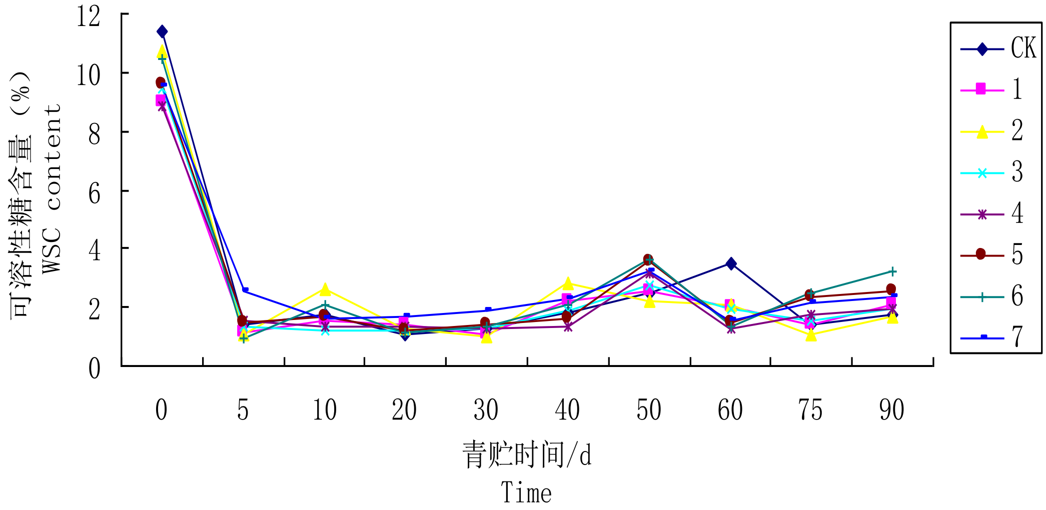


Figure.7 Change of WSC in Corn Silage Process

It can be seen from Figure 7 that the change trend of each treatment is roughly the same. Soluble sugar decreased rapidly in the first 5 days of silage, remained unchanged from the 5th day to the 40th day, followed by a large fluctuation, first increased, then decreased, and finally increased slowly between the 40th and 90th days. Because lactic acid bacteria can only use monosaccharide, in the early stage of fermentation, lactic acid bacteria began to reproduce, consumed a lot of soluble sugar, and the soluble sugar content decreased sharply. At the same time, yeasts also use monosaccharide, which aggravates the consumption of soluble sugar. With the inhibition of yeast, soluble sugar increased slightly due to the decomposition of crude fiber, and then fluctuated due to the fluctuation of the number of lactic acid bacteria.

3.4.3 Changes of Crude Fiber Content During Corn Silage

The determination of crude fiber content selected four periods in the silage process, which were 0, 10, 40 and 90 days respectively. The measured values are shown in Figure 8

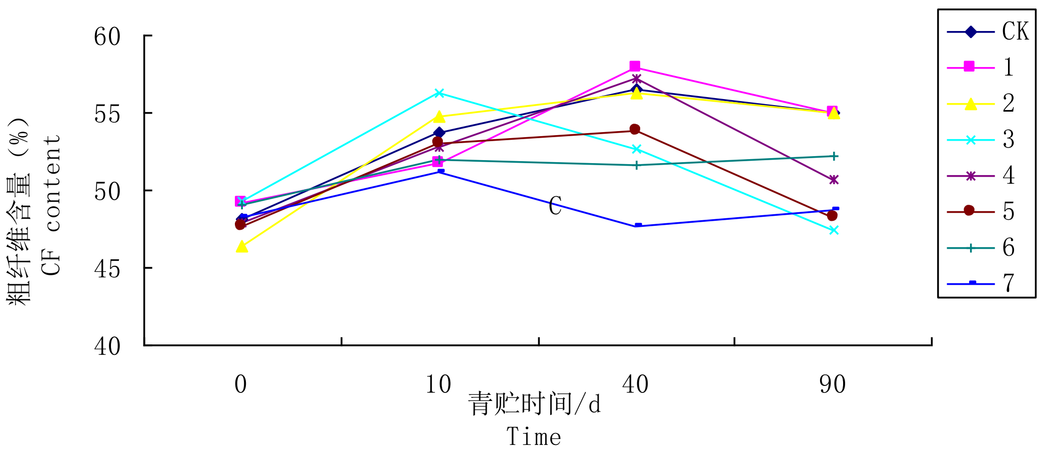


Figure.8 Change of CF in Corn Silage Process

It can be seen from figure 8 that the crude fiber content of each treatment showed an upward trend from the 0 to 10 days of silage, which was due to the large consumption of soluble sugar and ammonia nitrogen at this stage, resulting in the decrease of dry matter content and the increase of crude fiber content. Subsequently, due to the different decomposing ability of cellulase, the cellulose content of different treatments increased or decreased.

3.4.4 Changes of Main Nutrient Contents In Fermented Feed at the End of Corn Silage

After 90 days of silage fermentation, the contents of DM, ash, CP, NH4 + - N, NH4 + - N / CP, CF and WSC were determined. The results are shown in Table 2.

Table 2 Content of main nutrients in corn silage

测定指标 Index	鲜玉米 Fresh corn	处理 Treatment							
		CK	1	2	3	4	5	6	7
DM(%)	19.17	17.69	18.04	16.80	17.71	17.84	17.43	17.20	17.13
Ash(%)	8.92	10.56	10.16	10.33	10.90	10.41	10.94	11.21	11.08
CP(%)	7.97	8.34	8.55	7.12	9.03	8.44	8.35	7.94	7.84
NH4+-N(mg/L)	82.42	501.54	261.38	411.27	292.68	135.24	136.46	241.24	245.21
NH4+-N/ CP(%)	0.10	0.60	0.31	0.58	0.32	0.16	0.16	0.30	0.31
CF(%)	48.17	55.04	55.03	54.98	47.47	50.66	48.20	52.26	48.77
WSC(%)	11.39	1.74	2.05	1.67	1.98	1.95	2.55	3.19	2.34

It can be seen from table 4 that compared with before silage, DM of all treatments decreased, and treatment 2 decreased the most by 12.36%, and the dry matter content of each treatment was significantly different from that of treatment 2 ($P < 0.05$). As the dry matter content is less than 25%, the moisture content in silage is too high, which easily leads to Clostridium fermentation and affects the quality of silage. The difference of crude ash content before and after silage was obvious, and the crude ash content of each treatment increased compared with that before silage.

Except for treatment 2, treatment 6 and treatment 7, the crude protein content increased to a certain extent. The ammonia nitrogen content of all treatments was significantly higher than that before silage ($P < 0.05$), and the ammonia nitrogen content of CK at the end of silage was higher than that of other treatments. This is because the spoilage bacteria in silage are mainly Escherichia coli, which mainly decompose the protein and amino acids in silage, resulting in the increase of ammonia nitrogen content in feed [18]. The ratio of ammonia nitrogen to crude protein could reflect the quality of silage. At the end of silage, the ratio of ammonia nitrogen / crude protein of all additives treatments was lower than that of CK, and the difference was significant ($P < 0.05$). The ratio of treatment 4 and 5 was the smallest, which was 73.33% lower than that of CK.

Except for treatment 3, the crude fiber increased. However, because all kinds of additives promoted the decomposition of crude fiber, all additives treatments were lower than CK at the end of silage, and treatment 3 had the largest reduction, which was 13.75%. Compared with before silage, the soluble sugar of all treatments decreased significantly. At the end of silage, the soluble sugar of all treatments except treatment 2 was higher than that of CK, and the difference of treatment 6 was significant ($P < 0.05$).

4. Conclusion and Discussion

4.1 Conclusion

(1) The addition of inhibitors is beneficial to increase the total acid content, reduce the pH value of the silage, inhibit the growth of spoilage bacteria and other miscellaneous bacteria, reduce the content of ammonia nitrogen, avoid the rot of silage corn, and ensure the smooth progress of the silage.

(2) The separate addition of bacterial agents has no significant effect on the number of effective bacteria in the silage process, but the combination of bacterial agents and enzyme preparations can significantly reduce the ratio of ammonia nitrogen/crude protein and improve the quality of silage.

(3) Adding cellulase can significantly reduce the crude fiber content, increase soluble sugar, promote the reproduction of lactic acid bacteria, increase the number of lactic acid bacteria, and increase the crude protein content.

(4) It can be seen from the comprehensive data that separately adding inhibitors can better improve the fermentation quality of corn silage, which not only reduces the cost, but also improves the quality of the silage, and thus it is an economical and practical solution.

4.2 Discussion

(1) In this experiment, the addition of bacteria preparations, enzyme preparations, bacterial enzyme complexes, and inhibitors and enzyme preparation complexes did not achieve the desired effect, and the addition of inhibitors alone better improved the quality of silage. This shows that the wild strains in the raw materials of corn silage in the plains of Hebei Province are sufficient to make the silage fermentation proceed smoothly and obtain good-quality silage, and the inhibitor acts as a preservative and inhibits secondary fermentation. Therefore, the main purpose of the selection of additives for corn silage is anti-corrosion, inhibition of bacteria and secondary fermentation.

(2) Although the addition of microbial agents has little effect on the number of effective bacteria, the addition of microbial agents has a certain effect on reducing the production of ammonia nitrogen and making up for the loss of crude protein. Among them, the effect of microbial agent 1 is better than that of bacteria. In this study, the combined use of inoculants and additives has been preliminarily explored, and more combined use needs to be further studied.

4.3 Application and promotion of research results

The experiment aims to select the most suitable and economical one among the many additives for silage straw in the North China Plain, with experimental data to illustrate it

(1) The improvement of the quality of silage corn can improve the virtuous cycle of agricultural ecology. The use of herbivorous animals to return to the field can produce a large amount of organic fertilizer, which can not only reduce the use of chemical fertilizers and avoid soil compaction, but also increase the content of soil organic matter and improve the soil fertility.

(2) The improvement of the quality of silage corn is beneficial to increase farmers' enthusiasm for planting silage corn and effectively adjust the structure of agricultural industry.

(3) The planting and promotion of silage corn can also prevent the waste of resources caused by straw burning and destruction of air pollution.

(4) As a large agricultural country in the world, China is also a country lacking energy. If the efficiency of corn silage can be extended to energy utilization, the silage market will be even broader.

(5) This result can be promoted in three ways. First, publish this experiment so that farmers can see the data. Second, social organizations such as breeding associations and cattle breeding associations have been established in various places in Hebei Province. These organizations can recommend my results to farmers. Third, I plan to write the experimental data as livelihood recommendations to the government's animal husbandry department. The government can make this achievement a promotion project, invest this additive in a concentrated way, and then distribute it to farmers for free through non-profit organizations and farmers shouldn’t be enforced through government administrative orders.

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