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FEASIBILITY OF DIFFERENT MAIZE VARIETIES AS SILAGE IN CHINA

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Abstract

In the present study, waxy maize varieties Jingkenuo 2000, Wannuo 2000, Shancainuo 1911, Jingkunuo 569 and silage maize variety Yayuqingzhu 26 were used as test materials to explore the feasibility as silage. The biomass yield per unit area, dry matter mass, and water content were analyzed to determine the optimum harvest period of silage. During the optimum harvest period, dry matter mass, crude protein, crude fat, neutral detergent fiber (NDF), and acid detergent fiber (ADF) of silage were determined. The comprehensive quality of ensilage was evaluated by using roughage quality grading index (GI). The optimum harvest period of silage was 45 days after pollination. The GI index of Wannuo 2000 was higher than Yayuqingzhu 26, which was grade 2. The content of crude fat was the highest (78.35 g/kg). NDF and ADF were relatively lower, reaching 331.32 and 148.36 g/kg. In conclusion, Wannuo 2000 can be used to make silage.

Corn-straw silage technology preserves the corn straw that has not been aged by special treatment. This plant is eaten by domestic animals in autumn and winter (Li *et al.* 2020). In the silage process, the moisture should be controlled at about 70% strictly, and a certain amount of soluble sugar is required (Ma 2021). Waxy corn straw is fresh, juicy, and rich in water-soluble polysaccharide. Water and soluble sugar need not be added during silage, saving costs and workload (Li *et al.* 2024). Studies have shown that the digestibility of waxy corn starch can reach 85%, which is 16% higher than that of ordinary corn (Lv *et al.* 2021). In the present study, several waxy maize varieties with large planting areas in China served as research objects. Special silage maize variety was used as the control. Differences in biological yield and feeding quality of the whole plant were analyzed. Experiments were conducted to explore the feasibility of whole waxy corn plant silage.

The experimental materials were planted in the Northwest A&F University farm (latitude, 34.2636; longitude, 108.0634; altitude, 400 m, Yangling, Shannxi, China) on 31 May 2023. The planting density was 52500 plants/hm^2. Pure nitrogen (225 kg/hm^2), P_2O_5 (90 kg/hm^2), and K_2O (90 kg/hm^2) were applied once as base fertilizers at sowing time. A single-factor randomized block design was used in the experiment. Each treatment was repeated three times. A total of 15 plots each covered 24 m^2 (5 m × 4.8 m). Waxy maize varieties Jingkenuo 2000, Wannuo 2000, Shancainuo 1911 and Jingkunuo 569 all with high stem, big ear, and the control variety Yayuqingzhu 26 of the national silage maize regional trial were selected.

The biomass of the whole plant was measured according to the standards of the national silage corn regional trial. From 10th days after loose powder, five plants with basically the same growth were selected for sampling every 7 days. Sampling was conducted for a total of six times, and the sampling method was according to He and Chen (2013). After sampling, the fresh weight and dry weight of the sample was determine according to Wang *et al* (2019). After harvest, silage was

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Table 1. Content of dry matter and water in the whole plant after pollination.

Varieties	Days after pollination											
	10		17		24		31		38		45	
	Dry matter (t/hm^2)	Water content (g/kg)	Dry matter (t/hm^2)	Water content (g/kg)	Dry matter (t/hm^2)	Water content (g/kg)	Dry matter (t/hm^2)	Water content (g/kg)	Dry matter (t/hm^2)	Water content (g/kg)	Dry matter (t/hm^2)	Water content (g/kg)
Jingkenuo 2000	7	879.3	9.8	838.3	14.6	821.2	17.2	795.3	18.2	745.2	19.5	690.2
Wannuo 2000	6.5	882.5	9.5	844.2	12.6	811.3	16.3	790.3	17.2	744.3	19.7	682.7
Shancainuo 1911	6.3	867.2	8.6	826.2	11.5	808.3	16.7	782.5	17.0	740.4	18.1	685.3
Jingkunuo 569	5.6	886.3	7.3	855.2	10.5	832.3	15.6	806.8	16.3	750.3	16.9	675.8
Yayuqingzhu 26 (CK)	7.3	873.5	10.1	853.2	14.1	840.3	17.3	773.2	20.1	754.9	21.1	700.3

Table 2. Content of dry matter, crude protein and crude fat in different types of maize silage.

	Jingkenuo 2000	Wannuo 2000	Shancainuo 1911	Jingkenuo 569	Yayuqingzhu 26 (CK)
Dry matter (g/kg)	(305.72±8.74) Aa	(285.64±9.47) Bc	(270.69±14.55) Cd	(250.36±17.77) De	(299.6±9.61) Ab
Crude protein (g/kg)	(86.35±3.82) Cc	(91.86±0.74) Bb	(91.74±3.52) Bb	(92.36±4.77) Aa	(86.6±6.61) Cc
Crude fat (g /kg)	(77.01±4.11) Bc	(78.35±5.32) Aa	(77.61±6.21) Bb	(65.33±5.98) De	(75.62±6.54) Cd
NDF (g /kg)	(326.32±20.69) Ee	(331.32±35.65) Dd	(362.51±19.89) Bb	(345.62±20.96) Cc	(411.35±18.62) Aa
ADF (g/kg)	(152.32±18.69) Dd	(148.36±14.98) Ee	(169.98±13.65) Bb	(162.69±16.65) Cc	(213.65±19.65) Aa
RFV (%)	(207.43±18.98) Cc	(220.54±22.67) Aa	(184.45±16.34) Ee	(200.56±26.43) Dd	(217.56±17.34) Bb
RFV grade	Special grade	Special grade	Special grade	Special grade	Special grade
GI/MJ	(22.95±3.11) Bb	(24.11±2.65) Aa	(16.65±2.01) Dd	(17.93±1.65) Cc	(23.81±2.65) Aa
GI grade	3	2	3	3	2

In a row, having similar letter means they are statistically similar, having different lowercase letters means they differ significantly at P 0.05 according to LSD test, and having different uppercase letters means they differ significantly at P 0.01 according to LSD test.

prepared according to the method of Wu *et al* (2020). The dry matter mass, crude protein, crude fat, neutral detergent fiber (NDF), and acid detergent fiber (ADF) of silage were determined according to Yang (1993). By measuring and comparing the RFV of roughage, the quality and nutritional value were determined. The roughage quality grading index (GI) relates energy and crude protein (Meng *et al*. 2023).

All statistical analyses were performed with SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). ANOVA was conducted, and significant differences for all statistical tests were calculated at a least significant difference of 0.05.

Table 3. Correlation analysis of different traits.

	Water content	Dry matter	Biomass	Crude protein	Crude fat	NDF	ADF	Dry matter after fermentation
Water content	1.00							
Dry matter	0.88*	1.00						
Biomass	0.95**	0.98**	1.00					
Crude protein	-0.85*	-0.72	-0.75	1.00				
Crude fat	0.53	0.66	0.65	-0.33	1.00			
NDF	0.68	0.45	0.60	-0.34	-0.01	1.00		
ADF	0.73	0.49	0.63	-0.45	-0.02	0.99**	1.00	
Dry matter after fermentation	0.81*	0.89*	0.85*	-0.86*	0.72	0.14	0.21	1.00

NS= non-significant, *,** indicate significance at 5 and 1%, respectively.

At first, the biomass of different varieties increased with the days after pollination. When the peak was reached, the biomass began to decline. When the biomass of the whole plant reached the highest, the dry matter content of the varieties differed (Table 1). As growth proceeded, the water content of the whole corn plant decreased gradually (Table 1). When the whole-plant biomass was the highest, the yield of dry matter was low, the water content was high, and it easily deteriorated when making silage. Meanwhile. 45 days after pollination, the water contents of the whole plant were 690.2 g/kg (Jingkenuo 2000), 682.7 g/kg (Wanuo 2000), 685.3 g/kg (Shaancainuo 1911), 675.8 g/kg (Jingkenuo 569), and 700.3 g/kg (Yayuqingzhu 26). The water content of the whole plant in each variety was lower than 700 g/kg, which met the requirements of silage production. The biomass, dry matter, and water content of the whole plant comprehensively, 45 days after pollination was the optimum harvest time of the different maize varieties.

The dry matter content of the whole-corn varieties after silage fermentation are shown in Table 2. Compared with the control, the dry matter content of Jingkenuo 2000 increased by 2.04%, whereas that of Wanuo 2000, Caitianuo 1911, and Jingkenuo 569 decreased by 4.66, 9.65 and 16.44%, respectively. The crude protein content of Jingkenuo 569 was significantly higher than that of the other varieties (P<0.01), which was 6.65% higher than the control, while Jingkenuo 2000 was the lowest, which was 0.29% lower than that of the control. Significant differences existed in crude fat content among all varieties (P<0.05) (Table 2). The crude fat content of Wannuo 2000 was the highest, increasing by 3.61% compared with the control. The crude fat content of Jingkenuo 569 was the lowest, which was 13.61% lower than that of the control. Significant differences (P<0.01) existed in NDF among different varieties (Table 2). The content of ADF in Wannuo 2000 was 30.56% lower than that of the control, indicating that it had higher feeding value. According to the grading standard of roughage quality index, RFV and GI in different varieties were graded and compared, and the results are shown in Table 2. According to the grading standard, all the test materials were super grade. The GI index of Wannuo 2000 was higher than that of CK, which was grade 2. Wannuo 2000 had the best comprehensive quality.

Relevant analysis indicated that water content, dry matter mass, biomass per unit area, and crude protein content after fermentation were significantly correlated with dry matter ($P<0.05$) (Table 3). A significant negative correlation existed between crude protein content and plant water content ($P<0.05$). A significant positive correlation was found between ADF and NDF ($P<0.01$).

Through this experiment, it may be conducted that Wannuo 2000 can be used to make the whole plant silage, where the feeding quality was better than ordinary silage corn varieties.

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