

# Effect of additives and ensiling periods on physical properties and proximate composition of maize cob silage

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Received 22nd December 2025; Accepted 27th January 2026

**ABSTRACT:** This study evaluated the effect of urea, yeast, molasses, and ensiling period on the silage qualities, proximate composition and fibre fractions of maize cob silages. Twelve kilograms (12 kg) of maize cobs were chopped into smaller pieces of about 1cm and sprinkled with a solution of urea, molasses and yeast at 1%, 3% and 1% respectively. The experiment was laid out in a 3×4 factorial in a randomised complete block design (RCBD) with three ensiling periods (3, 5 and 7 weeks), three additives (urea, molasses, and yeast) and a control. At the end of the ensiling periods, silages were opened and physical, proximate and fibre fractions were determined. The results revealed that silage properties (colour, aroma and pH) of maize cobs were improved in silages treated with urea and yeast, with the exception of molasses. Silage properties were further improved when the ensiling period increased from 3 to 7 week. The crude protein (CP) content increased significantly ( $p < 0.05$ ) with urea treatment (9.21%). The crude protein content was also increased after ensiling from 3-7 weeks (10.78%), while the fibre fraction (CF, ADF and NDF) decreased significantly ( $P < 0.05$ ) with urea treatment after a 7-week ensiling period. Therefore, it can be concluded that the addition of urea improved the physical, nutritional properties and preservation capacity of maize cob after a 7-week ensiling period.

**Keywords:** Maize cobs, molasses, silage quality, urea, yeast.

## INTRODUCTION

Ruminants in the tropics are raised predominantly on grasses, which are inherently poor in digestibility, nutritive value and unavailable in the off-season (Babayemi, 2009). The shortage of good-quality forage needed to sustain livestock growth, especially during the dry season, has been a perennial problem in Nigeria (Jibrin *et al.*, 2013). Maize (*Zea mays*) cob can be considered to be one of the important potential crop residues available for ruminant feeding in the country. The major residues obtained from this crop are maize husk (covering on seed), cob, shank and stover. Corn cob shanks are by-products of maize production and may be used as alternative feed resources

for ruminants, especially during the dry season (Jibrin *et al.*, 2013). However, the weakness of crop residues as feed is generally less palatable, low degradability and low in nutrient content (Jibrin *et al.*, 2013). Application of additives in silage making is one of the management practices crucial at ensiling time, storage and feed-out phase to reduce nutrient loss and improve its nutritive value. Various chemical and biological additives have been used to control undesirable microorganisms (e.g., aerobic bacteria and fungi) and improve aerobic stability in silages (Tolera and Sundstøl, 2000). The most useful additives are molasses, which is a source of fermentable

carbohydrate and urea that provide fermentable nitrogen for microorganisms in the silage (Kung and Shaver, 2002). Therefore, the study was conceived to evaluate the proximate composition and fibre fractions of maize cobs treated with different additives.

## MATERIALS AND METHODS

The study was conducted at the Department of Animal science Bayero University, Kano Teaching and Research Farm. Kano state lies on a longitude of 9°30' and 12°30' North and latitude 8°42' and 9°30' East in the semi-arid region in northern Nigeria (Olofin, 1987). The Maize cobs were obtained from the Department of Agronomy Farm, Bayero University, Kano. The bottles and reagents were purchased within the Kano metropolis. Before ensiling, 12 kg of maize cobs were chopped into smaller pieces of about 1cm. Four additives (urea, molasses, yeast and control) were used. Thirty-six bottles were purchased, and each was filled with treated maize cobs, compressed and tightly closed with a cello tape to ensure they are completely airtight. Each bottle was replicated three times and divided into three ensiling periods of 3rd, 5th and 7th weeks and stored at ambient conditions in the laboratory. Urea was used at a level of 1% dry matter of maize cobs dissolved in 3000 ml of water and mixed with chopped maize cobs as described in the procedure of Roy and Rangnekar (2006). Yeast at a level of 1% dry matter of maize cobs was dissolved in 3000 ml of water, and mixed with raw maize cobs. Molasses at a level of 3% dry matter of maize cobs was diluted in 1000 ml of water and mixed with chopped maize cobs. Maize cobs were prepared by adding 2000 ml of water and ensiling directly. The experiment was laid out in a 3x4 factorial experiment in Randomised Completely Block Design (RCBD) with four treatments (urea, molasses, yeast and control) and three ensiling periods (3, 5 and 7 weeks). After the 3rd, 5th and 7th weeks, the fermentation was terminated, and the silages were opened for silage quality assessment. The assessed quality characteristics were colour, aroma, and pH according to Babayemi and Igbekoyi (2008). The pH was determined by adding 100 ml of distilled water to a sample of 25 g from each treatment in a beaker, and a pH meter glass electrode was inserted to determine the pH. The conditions were scored for aroma and colour by three independent scorers on a subjective scale of 1-4. Samples of ensiled maize cobs were analysed for proximate composition (CP, CF, EE, DM, Nitrogen-free extract and Ash) according to (AOAC, 2000). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Van Soest *et al.* (1991). The data generated were subjected to analysis of variance (ANOVA) using the SAS package (SAS, 2016), and significant differences detected between the means were separated using Duncan Multiple Range Test (DMRT) and considered significant at a probability level of 0.05.

## RESULTS

The result of the effect of additives on the silage characteristics of Maize cobs is presented in Table 1. In terms of colour and aroma, the light brown colour and pleasant aroma were obtained in the control (untreated maize cob). While silage treated with urea, molasses and yeast resulted in a pale yellow colour and sweet aroma. The highest pH value was obtained in the control (4.57) compared to other treatments.

The pH values, colour and aroma of maize cob silage made at different ensiling periods are presented in Table 2. The pH values of silages were significantly affected ( $p < 0.05$ ) by the ensiling period. The pH values varied from 3.32 at 7<sup>th</sup> weeks, 3.83 at 5<sup>th</sup> weeks and 4.38 at 3<sup>rd</sup> weeks. In terms of colour and aroma, all silage made at different periods were light brown and pleasant aroma at 3<sup>rd</sup> weeks, pale yellow colour and sweet aroma at 5<sup>th</sup> and 7<sup>th</sup> weeks respectively.

The effect of additives and ensiling period is presented in Figure 1. The silage colour and aroma for all the additives, irrespective of the ensiling period, resulted in pale yellow and sweet aroma, with the exception of control, which resulted in light brown and pleasant aroma.

The effect of additives and ensiling period on maize cobs silage pH characteristics is presented in Table 2. The results revealed that silage made without additives (control) at the 3<sup>rd</sup> and 5<sup>th</sup> ensiling period produced the highest pH values (4.76 and 4.44) while silage made with additives at different ensiling periods produced the least pH values.

The result of the effect of additives on the chemical composition of ensiled maize cob silage is presented in Table 3. The proximate composition is significantly ( $p > 0.05$ ) different among the treatments. Control had the highest DM content (91.26%) while yeast-treated maize cobs recorded the lowest DM content (88.36%). Molasses and yeast-treated maize cobs had the highest ash content (5.68% and 5.55%) compared to urea-treated cobs and the control. Urea-treated maize cobs had the highest CP (9.21%) while the control recorded the lowest CP value (3.79%). Control had the highest CF content (48.92%), while the least value was obtained in yeast-treated maize cobs (33.01%). The highest ether extract (EE) value was recorded in maize cobs treated with molasses (2.09%), while the least value was recorded in urea-treated maize cobs (1.38%). Control recorded the highest nitrogen-free extract (NFE) value (54.66%) while maize cobs treated with yeast recorded the least value (37.64%).

The result of the effects of the ensiling period on the chemical composition of maize cob silage is shown in Table 4. The mean value of all parameters evaluated varied significantly ( $p < 0.05$ ). The DM percentage was highest at the 3-week ensiling period (90.44%) compared to the 5th and 7th weeks, respectively. Ash was highest at 7th weeks (5.49%) and lowest at 5th weeks (4.89%). Crude protein CP content was highest at the 7th week (10.78%),

**Table 1.** Effect of additives on silage characteristics of maize cobs.

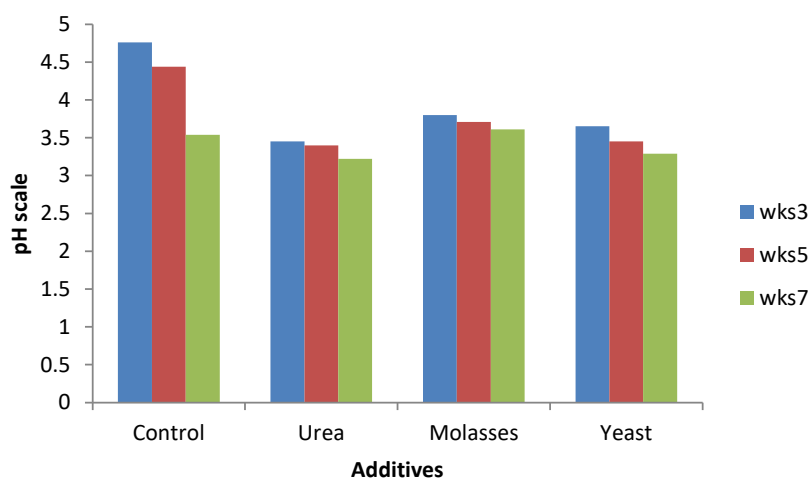
Treatments	Parameters		
	pH	Colour	Aroma
Control	4.57 <sup>a</sup>	Light brown	Pleasant
Urea	3.40 <sup>b</sup>	Pale yellow	Sweet
Molasses	3.80 <sup>b</sup>	Pale Yellow	Sweet
Yeast	3.63 <sup>b</sup>	Pale yellow	Sweet
SEM	0.11		

<sup>a,b,c</sup>means in the same row with different superscripts differ significantly ( $p < 0.05$ ), SEM = standard error mean, 2 = light brown and pleasant, 3 = pale yellow colour and sweet aroma.

**Table 2.** Effects of ensiling period on maize cob silage characteristics.

Periods	Parameters		
	pH	Colour	Aroma
Week 3	4.38 <sup>a</sup>	Light brown	Pleasant
Week 5	3.83 <sup>b</sup>	Pale yellow	Sweet
Week 7	3.32 <sup>c</sup>	Pale yellow	Sweet
SEM	0.11		

<sup>a,b,c</sup>means in the same row with different superscripts differ significantly ( $p < 0.05$ ), SEM = standard error mean, 2 = light brown and pleasant, 3 = pale yellow colour and sweet aroma.

**Figure 1.** pH values of treated and untreated maize cob silage.**Table 3.** Effect of additives on the chemical composition of ensiled maize cob.

Treatments	Parameters (%)							
	DM	ASH	CP	CF	EE	NFE	ADF	NDF
Control	91.26 <sup>a</sup>	4.44 <sup>c</sup>	3.79 <sup>c</sup>	48.92 <sup>a</sup>	1.71 <sup>c</sup>	54.66 <sup>a</sup>	65.79 <sup>a</sup>	79.94 <sup>a</sup>
Urea	90.74 <sup>b</sup>	4.38 <sup>b</sup>	9.21 <sup>a</sup>	37.51 <sup>c</sup>	1.38 <sup>d</sup>	50.42 <sup>b</sup>	48.72 <sup>c</sup>	69.67 <sup>c</sup>
Molasses	90.55 <sup>b</sup>	5.68 <sup>a</sup>	5.85 <sup>b</sup>	40.93 <sup>b</sup>	2.09 <sup>a</sup>	47.51 <sup>b</sup>	54.58 <sup>b</sup>	72.89 <sup>b</sup>
Yeast	88.36 <sup>c</sup>	5.55 <sup>a</sup>	9.04 <sup>ab</sup>	33.01 <sup>d</sup>	1.84 <sup>b</sup>	37.64 <sup>d</sup>	44.24 <sup>d</sup>	67.73 <sup>d</sup>
SEM	0.22	0.02	0.47	1.03	0.12	0.96	1.05	1.08

<sup>a,b,c</sup>means in the same row with different superscripts differ significantly ( $p < 0.05$ ), DM = Dry Matter; CP = Crude Protein; CF = Crude Fibre; EE = Ether Extract; ADF = Acid Detergent Fibre; NDF = Neutral Detergent Fibre; SEM = Standard Error of Mean.

**Table 4.** Effect of ensiling periods on the chemical composition of maize cob.

Periods	Parameters							
	DM	ASH	CP	CF	EE	NFE	ADF	NDF
Week 3	90.44 <sup>a</sup>	4.89 <sup>b</sup>	4.89 <sup>c</sup>	44.34 <sup>a</sup>	1.68 <sup>b</sup>	50.69 <sup>a</sup>	55.76 <sup>a</sup>	74.58 <sup>a</sup>
Week 5	90.23 <sup>ab</sup>	5.00 <sup>b</sup>	10.24 <sup>b</sup>	42.52 <sup>b</sup>	1.80 <sup>a</sup>	45.78 <sup>b</sup>	52.46 <sup>b</sup>	73.84 <sup>a</sup>
Week 7	90.04 <sup>b</sup>	5.49 <sup>a</sup>	10.78 <sup>a</sup>	37.02 <sup>c</sup>	1.79 <sup>a</sup>	46.21 <sup>b</sup>	51.78 <sup>b</sup>	68.95 <sup>b</sup>
SEM	0.29	0.16	0.49	1.38	0.13	1.39	1.72	1.27

a,b,c,: means in the same row with different superscripts differ significantly ( $p < 0.05$ ), DM = Dry Matter; CP = Crude Protein; CF = Crude Fibre; EE = Ether Extract; ADF = Acid Detergent Fibre; NDF = Neutral Detergent Fibre; SEM = Standard Error of Mean.

while the least CP content was obtained at the 3rd week (4.89%). CF content was highest at the 3rd week (44.34%) and lowest at the 7th weeks ensiling period (37.02%). Ether extract was highest at the 5<sup>th</sup> week (1.80%) and lowest at the 3rd week (1.68%). Acid detergent fibre (ADF) was highest at the 3rd week of the ensiling period (55.76%) compared to the 5th and 7th weeks. The highest neutral detergent fibre (NDF) was recorded at the 3rd week (74.58%), while the least value was obtained at the 7<sup>th</sup> week of the ensiling period (68.95%).

## DISCUSSION

The colour, aroma and pH characteristics of maize cob silages treated with different urea, yeast and molasses at different ensiling period indicates that all silages were adequately fermented with a light brown, pale yellow colour, pleasant and sweet aroma. Kung and Shaver (2002), in their interpretation of silage analysis, stated that a pleasant or sweet aroma is accepted for a good or well-made silage. This also agrees with Oduguwa *et al.* (2007), who reported that pale yellow colour and sweet aroma are indications of good quality silage. pH value is one of the simplest ways of evaluating silage. Silage that has been properly fermented will have a much lower pH (moderately acidic to slightly acidic). The pH values obtained in this study were similar to those of Babayemi (2009) of 3.38-4.61, when by-products of orange were ensiled with additives. The higher DM percentage observed in the control (91.26%) agreed with report of previous studies by Kamarloiy and Teimouri (2008). The present study indicates that there was not much variation in the DM content due to ensiling time in the presence or absence of additives. DM may decrease or increase, which may depend on different factors such as biochemical or microbial reaction during the ensiling period. The higher ash content observed in molasses and yeast may be attributed to their effects in the silage. The CP content in the current study ranged from (3.79%) in the control and (9.21%) in urea. The higher CP content at the 7th weeks ensiling period was also supported by Snijders *et al.* (2004). The higher NFE in the control compared to the additives may be due to the addition of water for proper compactness during ensiling. Furthermore, the lower fibre contents (CF, NDF and ADF) observed in urea, molasses

and yeast treated cobs is an indication that treatment of agricultural by-products with urea, yeast or molasses releases ammonia, which reacts with the lignocellulose materials and improves their feeding values (Tolera and Sundstøl, 2000). The ADF and NDF contents of maize cobs decrease as the ensiling period increases; this decrease was mainly due to a decrease in hemicellulose, as corroborated by Van Soest *et al.* (1991). The decrease in NDF agreed with the report of Suksombat (2004), who found that NDF decreased with urea treatment for different ensiling periods. The CF values observed in all additives at different ensiling periods in this study meet the minimum requirement for ruminants (Tolera and Sundstøl, 2000). The fibre components (ADF and NDF) were within the range values reported in previous studies (Tadesse *et al.*, 2014). The decrease of ADF in urea at different ensiling periods observed in this study is an indication that urea treatment enhances nitrogen content of lignocellulosic materials, and the increase was further improved with the ensiling period, which helps in disrupting the cell wall components and causes a decline in these components (Tadesse *et al.*, 2014).

## Conclusion

Based on the results of the study, it is concluded that the addition of urea, yeast and molasses improved the physical and proximate composition of ensiled maize. The ensiling period further enhanced the silage qualities and proximate composition, with the best values obtained in the 7th week of the ensiling period. It can be recommended that the nutritive value of agricultural wastes (maize cobs) can be improved by the addition of yeast, urea and molasses during ensiling.

## CONFLICT OF INTEREST

The authors declare no competing interests.

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