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Quality, Chemical Composition and Acceptability of Maize Stover Ensiled With or Without Urea or Poultry Litter Fed to West African Dwarf Goats

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Abstract: *Maize stover and some of its morphological fractions were ensiled with or without urea or dried poultry litter (DPL) to determine their quality characteristics and acceptability by West African Dwarf (WAD) goats. Nine experimental silages were prepared and tagged T_1 to T_9. T_1, T_4 and T_7 were ensiled without additive, T_2, T_5 and T_8 were ensiled with urea while T_3, T_6 and T_9 were ensiled with DPL. Each treatment group comprise whole stover, ear husk and leaf fraction respectively Quality characteristics of the silages were assessed after 30 days of ensiling. Acceptability trial was conducted using cafeteria feeding technique. The results showed that all the silages had good quality characteristics, being light brown to brown colour, pleasant to alcoholic smell and firm texture, except for the characteristic pungent smell of ammonia from the urea ensiled treatment groups. Silage pH was highest in urea ensiled treatments. The result of the acceptability/preference trial showed that four diets: T_3, T_6, T_7 and T_9 were accepted; the most preferred being DPL- ensiled leaf fraction which also had higher CP content than other silage types. It was concluded that maize stover and its fractional components ensiled with dried poultry litter are preferred by goats and may serve as dry season feedstuff for goats.*

Keywords: *Quality characteristics, Acceptability, Cafeteria feeding technique, Dry maize stover*

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I. Introduction

Seeking for alternative feed resources that are abundant and cheap to replace the conventional feedstuffs which are highly competed for by livestock and human beings is a major concern of animal nutritionists [1]. Maize stover represents a probable alternative by virtue of its abundance and cheapness, being a residue from a major staple food crop grown in most parts of the world [2]. As a crop residue, its high structural carbohydrates and low nitrogen contents demand some forms of treatments for efficient utilization by ruminant stock if the food security of the ever-increasing human population is to be guaranteed [3,4].

Silage making is one of the feasible methods of conserving forages for dry season feeding and ensilage with additives like urea or poultry litter has been reported to be beneficial [5,6]. Borquez *et al.* [7] noted that ensiling maize stover with pig excreta, poultry litter, or urea as a nitrogen source; with either bakery by-products or molasses as an energy source would produce silage with acceptable nutritional value which would not depress feed intake, rumen fermentation, digestion and nitrogen balance in ruminants.

Cafeteria feeding technique is a quick method of assessing the acceptability of feedstuffs [8] and its significance is evident from the consideration of the cost of preparing silage that may not be acceptable to the animal. The study was designed therefore to determine the effect of dried poultry litter or urea on the quality characteristics, chemical composition and acceptability of ensiled dry maize stover and its morphological fractions by West African Dwarf goats.

II. Materials And Method

Study Area

This experiment was conducted at the Livestock Unit of the Teaching and Research Farm, Faculty of Agriculture and Life Sciences, Federal University Wukari, Taraba state. Wukari is located on latitude 7.87°N and longitude 9.78°E of the equator, with an elevation of 189m above sea level [9]. The annual average temperature of Wukari is 26.8°C, with an annual rainfall of 1205mm. Wukari belongs to the Southern Guinea Savanna Vegetation [10].

Experimental Materials
The experimental materials were whole dry maize stover, dry ear husk and dry maize leaves ensiled with or without 36% (w/w) dried poultry litter or 4% urea.

Harvesting and Chopping of the Experimental Materials
The whole stover, ear husk and leaves were separately collected from harvested maize farms in the Teaching and Research Farm. They were separately chopped into smaller pieces of about 3-5cm using a sharp cutlass. Forty kilograms (40kg) of each of the separately chopped materials was ensiled with or without additives (urea or dried poultry litter) after hydrating to 35% dry matter (DM).

Preparation of Experimental Diets: Nine diets were as follows:
T_1 = Whole Dry Maize Stover ensiled without additives (control)
T_2 = Whole Dry Maize Stover ensiled with 4% Urea
T_3 = Whole Dry Maize Stover ensiled with 36% dried poultry litter
T_4 = Dry Ear Husk without additives (control)
T_5 = Dry Ear Husk ensiled with 4% Urea
T_6 = Dry Ear Husk ensiled with 36% dried poultry litter
T_7 = Dry Maize Leaves without additives (control)
T_8 = Dry Maize Leaves ensiled with 4% Urea
T_9 = Dry Maize Leaves ensiled with 36% dried poultry litter

Forty kilograms (40kg) each of the chopped experimental materials was hydrated to a moisture content of 65% which is recommended for ensiling [11]. A total of 57.14 litres of water was used for hydrating 40 Kg of the dry chopped maize stover at 15% moisture content, calculated using the formula; $w = \frac{yx}{z} - y$, described by [4] where
'w' = the amount of water needed for hydration in litres,
'x' = the initial dry matter content (DM) of the dry stover (85% in the current study),
'y' = the original weight of the dry stover and
'z' = the desired DM of the intended silage (35% in the current study)

The hydration was done by packing the dry chopped materials in bags and dipping them in the required amount of water in a drum till the water was sucked up. The hydrated materials were packed into bag silos overlaid with air-tight polythene sheets. Adequate compaction was done to expel air that might interfere with the fermentation process.

Treatments 1, 4 and 7, being chopped whole dry maize stover, dry ear husk and dry maize leaves, respectively were ensiled without additives. They were simply hydrated to 65% moisture content and compacted into the bag silos.

Treatments 2, 5 and 8, being chopped whole dry maize stover, dry ear husk and dry maize leaves, respectively were ensiled with 4% urea. 40 Kg of the chopped material was ensiled with 1.6 Kg of urea (4/100 x 40 Kg = 1.6 Kg). The urea was dissolved in part of the 57.14 litres of water for hydration and then poured into the remaining part to make the urea solution. The hydration, packaging and sealing procedures were as described above.

Treatments 3, 6 and 9, being chopped whole dry maize stover, dry ear husk and dry maize leaves, respectively were ensiled with 36% dried poultry litter after hydrating the materials as described previously. The 40 Kg hydrated material was ensiled with 14.4 Kg dried poultry litter (36/100 x 40 Kg = 0.36 x 40 = 14.4 Kg). The dried poultry litter was well mixed with the hydrated materials and thereafter compacted into bag silos overlaid with a polythene sheet. Each treatment was in triplicates and the ensilage lasted for thirty days.

Silage Quality Test
The quality of the silage was determined by measuring the silage temperature, pH and other subjective criteria like colour, odour and texture.

Silage Temperature Test
The silage temperature was determined by dipping a soil thermometer into each triplicate of the silage treatment and reading up the temperature after about five minutes and the average temperature per treatment determined [5].

Silage pH Test
The pH of the silages was determined by taking about 25g of the sample from each treatment, mixing it with 100ml of distilled water in a beaker and leaving it to stand for 1 hour. It was then agitated for about 2 minutes

[5] before inserting a calibrated pH meter glass electrode into the mixture for 1-2 seconds to read up the pH according to standard procedure [12].

Colour, Odour and Texture Test

Silage colour test was carried out by physical observation of the silage by a 5-man panel of assessors to avoid the bias of a single man assessor since the attributes to assess are on a nominal scale [11]. Each assessor recorded his observations and submitted them for final collation which was based on the frequency and consistency of observations.

Experimental Animals and Management

A total of 18 growing West African Dwarf goats weighing between 7.2 - 9.4 Kg were used for the acceptability trial. They were sourced from the Small Ruminant unit of the Teaching and Research Farm of the Federal University Wukari. They were treated for ectoparasites using Diazintol, dewormed with Albendazole and injected intra-muscularly with Oxytetracycline long-acting (L.A) broad-spectrum antibiotics during the 14 days of adaptation period.

Acceptability Test

The goats were subjected to a free choice feeding of the experimental diets on a cafeteria feed preference basis [8]. They were housed together in a spacious pen with adequate ventilation. The nine diets types were served in nine wooden feeders measuring about 150cm x 30cm, wide enough to allow about six (6) or more goats feed together conveniently [8]. The position of each of the feeders was changed daily to avoid the bias of an animal sticking to a particular spot (which simulates the conventional randomization procedure.).

3 Kg of each diet was served daily in separate feeding troughs for the seven (7) days acceptability trial. Individual daily silage intake was measured by subtracting the amount of leftover feed from the amount offered. The acceptability of each diet was determined using the coefficient of preference (CoP) formula, given as the ratio of individual silage intake to the average intake of all the silages [8]. This was calculated both on the daily basis and for the entire trial period. A feed is acceptable if its CoP is greater than unity (1) or rejected if it is < 1 [8].

Analysis of Proximate Composition and Cell Wall Fraction

Sequel to the determination of the coefficient of preference of the experimental silages by the goats, only the four (4) preferred silages were chemically analyzed for proximate composition and cell wall fractions according to standard procedures of [12] and [13] respectively. The rationale for the choice of samples for chemical analysis was the rejection of the other silages by the goats and the economic irrationality of further chemical analysis of rejected feed. More so, intake is a precondition for an animal to derive nutritional benefit from a feedstuff**.**

Statistical Analysis

All ordinal data collected were subjected to Analysis of Variance (ANOVA) using the general linear model (GLM) of [14]. Where differences existed in treatment means, they were separated using the Duncan's Multiple Range Test (DMRT) (Duncan, [15].

III. Results

Quality Characteristics of Dry Maize Stover Ensiled with or without Dried Poultry Litter or Urea

The result of the quality characteristics of dry maize stover ensiled with or without dried poultry litter or urea is shown in Table 1. Silage colour ranged from light brown to light yellow colour. Silage odour varied from pleasant to alcoholic and choking smell. The choking smell was particularly pronounced in urea-treated silages. All the silages were of firm texture.

The pH of the various silages is shown in Figure 1. The whole dry maize stover silage had a pH of 4.97, 8.70 and 5.50 for the control (T_1), urea-treated (T_2) and dried poultry litter-treated silage (T_3), respectively. The ear husk silages had pH of 4.27, 6.53 and 4.80 for the control (T_4), urea-treated (T_5) and poultry litter-treated silage (T_6), respectively while the maize leaf silages had pH of 5.23, 8.42 and 5.50 for the control (T_7), urea-treated (T_8) and dried poultry litter-treated silage (T_9), respectively. Conversely, Control silages had a pH range of 4.27 in T_4 to 5.23 in T_7. Urea-treated silages had a pH range of 6.53 in T_5 to 8.70 in T_2 while dried poultry litter-treated silages had a pH range of 4.80 in T_6 to 5.50 in both T_3 and T_9.

Figure 2 represents the silage temperature of the silages. The silage temperature ranged from 27.33ºC in T_1 to 28.00ºC in T_5.

Table 1: Physical Characteristics of Maize Stover and its Morphological Fractions Ensiled with or without Dried Poultry Litter or Urea

Treatments	Quality Indicators		
	Colour	**Odour**	**Texture**
T_1	Brown	Pleasant	Firm
T_2	Brown	Choking	Firm
T_3	Light-brown	Pleasant	Firm
T_4	Brown	Pleasant	Firm
T_5	Light-yellow	Fairly choking	Firm
T_6	Light-yellow	Pleasant	Firm
T_7	Light-brown	Alcohol	Firm
T_8	Brown	Choking	Firm
T_9	Light-yellow	Pleasant	Firm

T_1 = Whole Dry Maize stover ensiled without additive
T_2 = Whole Dry Maize stover ensiled with urea
T_3 = Whole Dry Maize stover ensiled with dried poultry litter
T_4 = Dry Ear Husk ensiled without additive
T_5 = Dry Ear Husk ensiled with urea
T_6 = Dry Ear Husk ensiled with dried poultry litter
T_7 = Dry Maize Leaves without additive
T_8 = Dry maize Leaves ensiled with urea
T_9 = Dry Maize Leaves ensiled with dried poultry litter

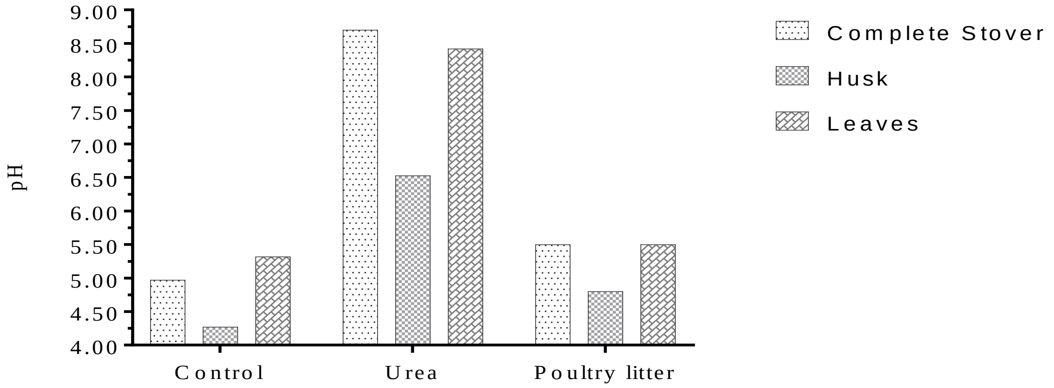

Figure 1: pH of Dry Maize Stovers ensiled with urea and Poultry Litter

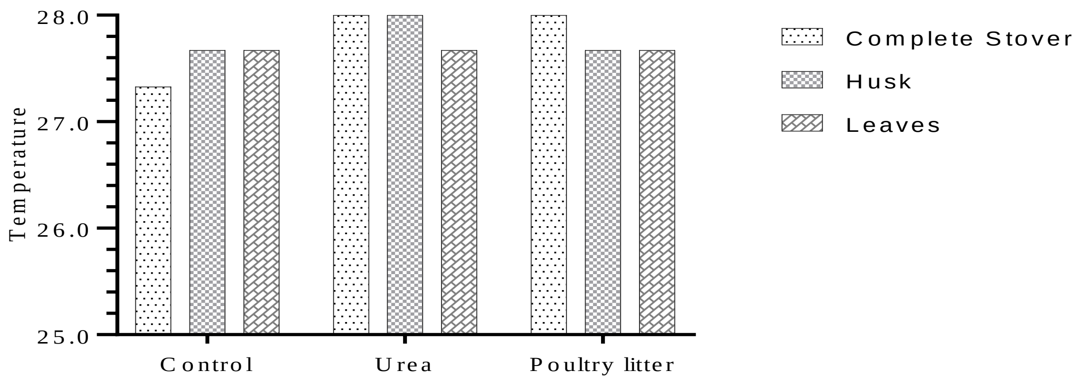

Figure 2: Temperature of Dry Maize Stovers ensiled with urea and Poultry Litter

Coefficient of Preference (CoP) of Dry Maize Stover ensiled with or without Urea or Poultry Litter fed to West African Dwarf Goats.

The coefficient of preference (CoP) of the dry maize stover ensiled with or without urea or poultry litter fed to West African Dwarf Goats is presented in Table 2. The CoP ranged from 0.72 in T_1 to 1.44 in T_9. T_3,

T_6, T_7 and T_9 had CoP above unity while the other treatments had CoP below unity, implying the latter were refused, whereas the former group of silages was accepted.

Table 2: Coefficient of Preference (CoP) of Maize Stover Ensiled with or without Dried Poultry Litter or Urea fed to West African Dwarf Goats

Treatments (T)	Silage Intake (Kg)	Coefficient of preference (CoP) per period	Coefficient of preference (CoP) per day
T_1	10.00	0.72	0.71^{d}
T_2	10.50	0.76	0.75^{d}
T_3	15.40	1.11	1.23^{bc}
T_4	11.80	0.85	0.84^{d}
T_5	11.70	0.85	0.83^{d}
T_6	16.20	1.17	1.15^{c}
T_7	19.36	1.40	1.38^{ab}
T_8	9.70	0.70	0.69^{d}
T_9	19.94	1.44	1.42^{a}

a, b, c, d Means with different superscript are significantly different ($P < 0.05$)

T_1 = Whole Dry Maize stover ensiled without additive
T_2 = Whole Dry Maize stover ensiled with urea
T_3 = Whole Dry Maize stover ensiled with dried poultry litter
T_4 = Dry Ear Husk ensiled without additive
T_5 = Dry Ear Husk ensiled with urea
T_6 = Dry Ear Husk ensiled with dried poultry litter
T_7 = Dry Maize Leaves without additive
T_8 = Dry maize Leaves ensiled with urea
T_9 = Dry Maize Leaves ensiled with dried poultry litter

Chemical Composition of accepted silages

The chemical composition of the four accepted silages (T_3, T_6, T_7 and T_9 but re-named as T_1, T_2, T_3 and T_4, respectively) is presented in Table 3. Dry matter content ranged from 81.90% in T_3 to 95.03% in T_1. Crude protein content ranged from 6.19% in T_1 – 9.23% in T_4, while crude fibre content ranged from 20.88% - 24.14% in T_3 and T_2, respectively. Ash content was highest (10.35%) in T_1 and lowest (3.79%) in T_2. Ether extract content was also highest (2.40%) in T_1 and lowest (1.96%) in T_3. A similar trend was observed in nitrogen-free extract content with T_3, being 47.60% and T_1, being 57.67%. Organic matter content ranged from 75.52% in T_2 to 84.68% in T_1. The total digestible nutrient content (TDN %) ranged from 61.60% in T_1 to 67.50% in T_4. The metabolizable energy was also lowest (7.19 MJ/Kg DM) in T_1 and highest (9.79 MJ/Kg DM) in T_4.

Table 3: Chemical Compositions of Accepted Silages

	Treatments			
Parameters (%)	T_1	T_2	T_3	T_4
Dry Matter (DM)	95.03	89.31	81.90	86.34
Crude Protein (CP)	6.19	6.23	7.63	9.23
Crude Fibre (CF)	23.37	24.18	20.88	21.21
Ether Extract (EE)	2.40	2.14	1.96	2.04
Ash	10.35	3.79	4.10	4.32
Nitrogen Free Extract (NFE)	57.69	52.79	47.60	49.54
Organic Matter	84.68	75.52	77.80	82.02
Cell wall fractions				
Acid Detergent Fibre (ADF)	37.48	30.20	29.11	29.06
Neutral Detergent Fibre (NDF)	47.55	59.36	58.28	59.07
Acid Detergent Lignin	8.79	7.44	11.87	10.36
Calculated values				
*TDN (%)	61.60	66.70	67.46	67.50
**Metabolizable energy (MJ/Kg DM)	7.19	9.27	9.59	9.79

*Schroeder [16] TDN = 87.84 – (0.70 x ADF %)
**MAFF [17] ME = 13.5 – 0.15*ADF % + 0.14*CP % - 0.15*Ash %

T_1 = Dry Whole maize stover ensiled with 36% (w/w) dried poultry litter
T_2 = Dry Ear husk ensiled with 36% (w/w) dried poultry litter
T_3 = Maize leaves ensiled without additives
T_4 = Maize leaves ensiled with 36% (w/w) dried poultry litter

IV. Discussion

Silage Quality Characteristics

The Light-brown to light yellow colour observed in the silages denotes that they were of good quality as their colours were similar to those of the parent materials from which the silages were produced. This is consistent with the report of [18]. The light brown colour is also similar to that reported by [4] for dry Maize stover ensiled with ground dried cassava peels. The pleasant to alcoholic smell observed in this study is indicative of well-preserved silages. This agrees with the reports of [19] and [4]. The choking/pungent smell observed in T_2, T_5 and T_8 is characteristic of urea-treated feedstuffs [20]. This smell often repels animals from feeding on urea-treated feedstuff except it is exposed for a while for the ammonia to escape into the air. The observed firm texture in all the silages also denotes they were of good quality as earlier reported by [19].

The range of silage temperature observed in this study falls within the range of 26^{o}- $28^{o}C$ reported by [21] for good silage and within the $25.7^{o}C$ - $28.7^{o}C$ reported by [4] for fresh and dry maize stover silage. It is also similar to the range of $26.0^{o}C$ – $27.5^{o}C$ for Guinea grass silage reported by [5]. The lower than 45-$60^{o}C$ reported to be capable of causing a colour change in silage due to Maillard reaction could be attributed to the good colour of silages observed in this study [22].

The pH range of this study is higher than the 4.2 – 5.0 reported as good or average for silage [23]. The pH of T_1, T_4 and T_6 are similar to those reported as being good or average while the other treatments had pH above 5 which is regarded as bad quality [23]. However, the 6.53 – 8.70 pH range for the urea-treated silages (T_2, T_5 and T_8) may not necessarily imply they are bad. The higher than normal pH range is characteristic of urea-treated feedstuffs due to the release of ammonia that could have counteracted the effect of lactic acid and other organic acids produced during fermentation [20]. The pH range is also higher than the 6.0 pH reported by [20] and may be due to the higher (4%) amount of urea used for the ensilage. To ensure adequate silage preservation by fermentation acids, an addition of soluble carbohydrates had been suggested when ensiling feedstuffs with urea above 1% [20].

Coefficient of preference of experimental diets by West African Dwarf goats

The CoP of T_3, T_6, T_7 and T_9 being above unity (1) implies that they were accepted by the goats while those with CoP less than one (T_1, T_2, T_4, T_6 and T_8) were rejected. In other words, all the treatments with dried poultry litter were accepted alongside maize leaves ensiled without additives. The preference of the dried poultry litter-ensiled materials is consistent with the findings of [24] and similar to that reported by [4] for green and dry maize stover silage fed to Red Sokoto goats. The highest (1.44) CoP observed in T_9 could be due to the higher crude protein (CP) content of the silage in comparison to the other silages. The CoP and CP content in the current study exhibited a direct relationship, which is consistent with the findings of [25]. The CoP also seemed to have an inverse relationship with the acid detergent fibre (ADF) content of the silages.

Chemical composition of the accepted diets

The lower than the 7% minimum CP requirement for ruminants observed in T_1 and T_2 suggests that they may need to be supplemented with concentrate before they can serve as ruminant feed. This is consistent with the findings of [4]. T_3 and T_4 however meet the minimum CP requirement (7%) for ruminant feed [26]. The higher (10.35%) ash content in T_1 than the other treatments may be due to additional minerals from the poultry litter used in ensiling the material or from soil contamination from the litter [27]. The probable effect of higher ash content in T_1 is its lower metabolizable energy (ME) content compared to other silages. High ash content from soil contamination has been reported to reduce the energy content of the feed [27]. T_3 and T_4 meet the minimum TDN requirement (67%) for ruminant growth while T_1 and T_2 require supplementation to satisfy growth demand [28].

All the silages had ADF contents that were higher than the maximum of 24% (DM basis) prescribed by [29] to encourage adequate intake by growing goats. The ADF values for T_2, T_3 and T_4 fall within the range of 23.3 – 35.0% reported by [30] for maize stover silage while T_1 was higher. High ADF content had been reported to induce maximum gut fill that reduces intake [29]. The inverse trend of CoP and ADF content connotes that both are inversely related and the observation agrees with the report of [31] and [16]. The range of 47.55 – 59.36% NDF observed in this study falls within the range of 40.722 – 59.43% NDF reported by [4] for fresh and dry maize stover silage and similar to the range of 37.5 – 54.7% reported by [30] for maize stover silage. The ADL content of the silages are lower than the 16.80% reported by [19] for maize stover silage but fall within the range of 8.11 – 17.02% reported by [4] for fresh and dry maize stover silage. The observed variation may be due to differences in the variety and maturity of the parent material [30].

V. Conclusion

It was concluded from the result of this study that whole dry maize stover and ear husk ensiled with dried poultry litter and dry maize leaves ensiled with or without dried poultry litter are acceptable to goats and may serve as dry season feed for goats.

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