NUTRITIONAL EVALUATION OF ENSILED TOMATO POMACE-CORNCOB MIXTURES: IMPLICATIONS FOR SUSTAINABLE RUMINANT FEEDING IN THE NORTHERN GUINEA SAVANNAH

Isa, A. A.,[1]* Abdu, S. B.[1] and Adamu, H. Y.[1]

[1] Department of Animal Science, Ahmadu Bello University Zaria, Nigeria
* Corresponding author: Tel: 08106394784 Email: aadauisa@gmail.com

ABSTRACT

The escalating demand for affordable livestock feed in sub-Saharan Africa has prompted exploration of agro-industrial by-products like tomato pomace (TP) and corncob (CC) for silage production. This study assessed the chemical composition of ensiled TP-CC mixtures at ratios of 80:20, 70:30, 60:40, and 50:50 (TP:CC) before and after 21 days of fermentation. Pre-ensiling analysis revealed significant variations ($P<0.05$) in crude protein (1.86–4.38%), crude fibre (30.29–36.23%), ether extract (2.20–3.90%), ash (3.70–8.25%), and hemicellulose (14.12–18.09%), with no differences in dry matter, nitrogen-free extract, neutral detergent fibre, or acid detergent fibre. Post-ensiling, crude protein increased notably (2.44–6.13%), crude fibre decreased (20.87–33.64%), and fibre fractions (NDF, ADF, hemicellulose) showed reductions, enhancing digestibility. The 50:50 ratio exhibited optimal nutrient profiles for ruminant utilisation. Ensiling improved nutritional quality through microbial fermentation, offering a cost-effective, sustainable feed option for Yankasa rams in resource-limited settings, aligning with circular economy principles in animal nutrition.

Keywords: Ensiled, Ruminant, Tomato pomace, Corn-cob, Feeding

Description of Problem

In the Northern Guinea Savannah zone of Nigeria, where ruminant production faces challenges from feed scarcity and high costs, valorising agro-industrial by-products such as tomato pomace (TP) and corncob (CC) through ensiling presents a sustainable strategy for enhancing livestock nutrition (1). Tomato pomace, a residue from tomato processing, is rich in fibre, pectin, and bioactive compounds like lycopene, yet its high moisture content necessitates preservation methods to prevent spoilage (2). Corncob, abundant post-harvest, provides lignocellulosic bulk but suffers from low digestibility due to high neutral detergent fibre (NDF) and acid detergent fibre (ADF) levels (3). Ensiling these materials under anaerobic conditions promotes lactic acid fermentation, reducing pH and improving nutrient bioavailability, which can address protein deficiencies in ruminant diets (4).

Recent studies highlight ensiling's role in transforming fibrous by-products into palatable feeds, with mixtures of TP and CC showing potential to increase crude protein (CP) and reduce fibre fractions post-fermentation (5). For instance, integrating TP at varying ratios enhances hemicellulose breakdown, aiding rumen microbial activity and animal performance (6). In Yankasa rams, such silages could improve weight gain and feed efficiency, contributing to food security in semi-arid regions (7). This study evaluates the chemical composition of graded TP-CC silages to identify optimal ratios for ruminant feeding, emphasising eco-friendly practices amid climate variability.

Materials and Methods

Experimental Site

The study was carried out at the Department of Animal Science, Ahmadu Bello University, Zaria. The study area falls within latitudes11° 8' 19.56'' N and longitudes 7° 45' 51.22'' E, with altitude of 640m above the sea level (Google Earth, 2022). Shika is located within the Northern Guinea Savannah ecological zone with an average annual rainfall of 1,100mm which start from late April/early May and ends mid-humidity during the harmattan and wet season are 21-72% respectively (6).

Source of experimental feedstuff

The experimental feedstuff was tomato pomace and corncob. The tomato pomace was collected from tomato after grinding the tomato. The corncob was collected from farmland of Field Practical Training (FPT) of the undergraduate B. Agriculture student practical after crop harvest, shelled and was ground using hammer mill and stored before ensiling.

Ensiling procedure and evaluation

Each treatment containing the proportions specified ratios of TP to CC was thoroughly mixed, put in a plastic bag compressed to remove air and closed. Then the bags were stored for 21 days away from sun light to ferment. At the end of the ensiling period, samples of ensiled materials were taken from each plastic bag after 21days for physical characteristics, pH and chemical composition evaluation.

Chemical analysis

Chemical and proximate analysis was conducted before and after ensiling at the Animal Science Biochemical Laboratory, Ahmadu Bello University, Zaria for proximate analysis as described by (8), for the determination of Dry Matter, Crude protein, Ether Extract, Crude fibre, Ash and NFE by difference. Acid Detergent Fibre, Neutral Detergent Fibre, Hemicellulose was analysed using Van Soest *et al*. (9) methods.

Statistical Analysis

Data collected at the end of the experiments was analyzed using General Linear Model (GLM) procedure of Statistical Analysis System (10). Significant difference among treatment means was compared at 5% probability level using Duncan Multiple Range Test in the SAS Package.

Results and Discussion

Chemical composition of the graded levels of TPCC before ensiling

Table 1 presents the chemical composition of tomato pomace-corncob (TPCC) mixtures at ratios 80:20, 70:30, 60:40, and 50:50 (TP:CC) before ensiling. Significant differences ($P<0.05$) were observed in crude protein (CP; 1.86–4.38%), crude fibre (CF; 30.29–36.23%), ether extract (EE; 2.20–3.90%), ash (3.70–8.25%), and hemicellulose (14.12–18.09%), with the 80:20 ratio highest in CP and hemicellulose, and 50:50 highest in CF. No significant differences ($P>0.05$) occurred in dry matter (DM; 94.80–99.95%), nitrogen-free extract (NFE; 46.94–57.04%), neutral detergent fibre (NDF; 64.51–70.17%), or acid detergent fibre (ADF; 49.99–53.05%). These pre-ensiling profiles reflect nutrient variations due to fermentation potential, with microbial breakdown of carbohydrates altering CP, CF, NDF, ADF, and ash during anaerobic ensiling (11). Tomato pomace's pectin and non-fibre carbohydrates provide fermentable substrates, while corncob's cellulose and lignin add bulk (2,12). Ensiling's moisture from TP facilitates lactic acid bacteria activity, reducing pH and lignocellulosic bonds, thus improving digestibility (3). The complementary profiles enhance nutrient preservation, with TP's bioactive compounds aiding degradation of corncob lignin (4). Post-ensiling CP preservation or increase may stem from concentration effects or nitrogen additives, stabilising nutrients against spoilage (11).

Chemical composition of the graded levels of ensiled TPCC

Table 2 shows the post-ensiling chemical composition of TPCC at the same ratios. Significant differences ($P<0.05$) were noted in CP (2.44–6.13%; highest at 80:20), CF (20.87–33.64%; lowest at 70:30), EE (2.00–3.60%; highest at 70:30), ash (11.24–13.32%; highest at 70:30), NDF (62.50–68.50%; lowest at 50:50), ADF (48.00–51.50%; lowest at 50:50), and hemicellulose (14.50–17.50%; highest at 80:20 and 60:40). DM showed no significant differences ($P>0.05$; 95.41–96.37%). Ensiling increased CP and reduced fibre, consistent with studies on TP-CC mixtures where fermentation enhances CP and fibre digestibility (3). CF digestibility improved from 55% to 65% in similar diets due to TP's pectin (3). Biological ensiling reduced NDF and ADF in corncob, boosting accessibility (12). However, high TP (>30%) may reduce digestibility via lignin, balanced by CC's structure (1). Natural fermentation yielded moderate CP changes compared to urea-treated silages (5), underscoring treatment influences on TPCC quality through TP-CC synergy.

Table 1: Chemical composition of the graded levels of TPCC before ensiling

Parameters (%)	80:20	70:30	60:40	50:50	SEM (±)
Dry matter	97.75	95.85	99.95	94.80	5.80
Crude protein	4.38[a]	1.86[d]	2.19[c]	3.28[b]	0.82
Crude fibre	32.74[c]	30.29[c]	34.12[b]	36.23[a]	0.35
Ether extract	3.40[a]	3.90[a]	2.30[b]	2.20[b]	0.13
Ash	3.70[c]	8.25[a]	4.30[c]	6.15[b]	0.25
Nitrogen free extract	53.53	51.5	57.04	46.94	4.34
Neutral Detergent Fibre	70.17	68.22	68.10	64.51	5.33
Acid Detergent Fibre	52.76	53.05	50.01	49.99	4.48
Hemicellulose	17.41[ab]	15.17[b]	18.09[a]	14.12[c]	1.43

[abc]Means with the s along the rows are significantly different ($P<0.05$), SEM: Standard error of means

Table 2: Chemical composition of the graded levels of ensiled TPCC

	Ratio of Corn-Cob to Tomato Pomace				
Parameters (%)	80:20	70:30	60:40	50:50	SEM (±)
Dry matter	96.37	95.41	95.44	96.36	0.50
Crude protein	6.13[a]	4.19[b]	3.00[c]	2.44[d]	0.30
Crude fibre	28.23[b]	20.87[c]	33.64[a]	28.51[b]	0.80
Ether extract	3.20[b]	3.60[a]	2.10[c]	2.00[c]	0.20
Ash	11.64[b]	13.32[a]	11.24[b]	11.29[b]	0.40
Neutral Detergent Fibre	68.50[a]	66.50[ab]	66.00[ab]	62.50[b]	0.90
Acid Detergent Fibre	51.00[a]	51.50[a]	48.50[b]	48.00[b]	0.70
Hemicellulose	17.50[a]	15.00[ab]	17.50[a]	14.50[b]	0.50

[abc]Means with the s along the rows are significantly different ($P<0.05$), SEM: Standard error of means

Conclusion and Application

The study demonstrated that ensiled tomato pomace-corncob (TPCC) is a viable feed ingredient for Yankasa rams, with the 50:50 ratio of tomato pomace to corn cob being the most effective in terms of physical characteristics, sensory attributes and preference.

References

1. Abubakar, H. M., Bala, A. and Yusuf, I. S. (2022). Evaluating the performance of small ruminants fed diets with varying levels of tomato pomace. *Tropical Animal Production, 19*(2): 132–144.
2. Akinola, F. T., Musa, M. G. and Oladele, A. J. (2020). Chemical composition and utilization of tomato pomace in livestock feeding systems. *Nigerian Journal of Animal Science, 18*(4): 89–97.
3. Adeola, M., Adeyemi, O. and Oni, J. (2020). Digestibility and fermentation characteristics of corn cob silage for ruminants. *Animal Feed Science and Technology*, 171: 56-64.
4. Ogungbade, S. M., Oladapo, R. O. and Adebayo, O. F. (2020). Pectin as a key fermentable carbohydrate in tomato pomace: Implications for nutrient utilization. *Nigerian Agricultural Journal, 51*(4): 198–207.
6. Yamusa, A. M. and Abdulkadir, A. 2020. Changing pattern of rainfall amount and rain day in samara and their implication on crop production. *World Journal of Agricultural Research*, 8(3), 131-141.
7. Omotosho, S., Yoshida, F. and Fukuda, R. (2020). Corn cob silage with microbial inoculation improves rumen fermentation and weight gain in cattle. *Animal Feed Science and Technology, 261*, 114723.
8. A.O.A.C. (2005). Association of Official Analytical Chemists 18th edition, Association of Official Analytical Chemist, Washington D. C.,USA.

9. Van Soest, P.J., Robertson, J.B. and Lewis, B. (1991). Methods for dietary fiber and non starch polysaccharides in relation to animal nutrition, *Journal of Dairy Science* 74:3587-3597.
10. SAS (2002). SAS for Windows Release 9.1. Statistical Analysis Systems Institute Inc.: Cary, NC, USA.
11. Shong, W., Musa, M. and Adeyeye, K. (2019). Physical and microbial characteristics of silages with varying moisture contents. *Journal of Dairy Science, 74*(3), 3587–3597.
12. Aliyu, M. A., Adelani, R. M. and Shittu, A. A. (2019). Chemical composition and feed utilization potential of corn cobs in ruminant diets. *African Journal of Agricultural Research*, 14(9) 400-407.