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EFFECT OF SHADE DRYING AND ENSILING ON THE PROXIMATE COMPOSITION AND PHYTOCHEMICAL PROPERTIES OF *CALOTROPIS PROCERA* (LEAVES)

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Abstract
This study evaluated the chemical and phytochemical composition of shade-dried and ensiled Calotropis procera to assess its potential as an alternative feed resource for livestock in the semi-arid zone of northeastern Nigeria. The experiment was conducted at the Teaching and Research Farm and Chemistry Laboratory Complex of the Department of Animal Science, Federal University Gashua. Fresh C. procera leaves and stems were harvested, shade-dried for 7–10 days, or ensiled for 30 days before being analyzed. Proximate and phytochemicals compositions were determined using standard methods. Ensiled samples were not screened for phytochemicals due to expected degradation of secondary metabolites. Data obtained from triplicate analyses were analysed using descriptive statistics Results showed that shade drying preserved higher crude protein levels and maintained moderate fibre, essential minerals, and beneficial phytochemicals such as flavonoids, tannins, saponins, and phenols. In contrast, ensiling significantly reduced crude protein and fibre but increased nitrogen-free extract and ether extract, reflecting improved fermentable carbohydrate availability. The findings indicate that shade-dried C. procera is more suitable as a protein supplement, while ensiled C. procera may serve as an energy source when combined with protein-rich feeds. The study concludes that C. procera has promising potential as a supplementary forage in dryland livestock systems. It recommends promoting shade-dried forms for protein enhancement, improving ensiling techniques to minimize nutrient loss, and conducting in vivo feeding trials to validate animal performance responses.

Keywords: ensiling leaves phytochemical properties, shade drying

Introduction
Calotropis procera, commonly known as the "Tum-fafiya is a perennial shrub widely distributed across tropical and semi-arid regions of Africa, Asia, and the Middle East (Chaudhary *et al.,* 2012). The plant grows naturally in disturbed soils, farmlands, rangelands, and wastelands where many conventional forages cannot thrive due to harsh climatic conditions such as drought and high temperatures (Katsande *et al.,* 2016). Its natural resilience and availability throughout the year make it an ecologically significant species, particularly in regions experiencing feed scarcity for livestock (Ayele *et al.,* 2020).
Historically, *Calotropis procera* has been used in traditional medicine, showing a wide range of pharmacological properties including anti-inflammatory, antimicrobial, analgesic, and antioxidant activities (Mujeeb *et al.,* 2014). The plant contains several important bioactive compounds such as alkaloids, flavonoids, tannins, saponins, and cardiac glycosides, which contribute to its medicinal value but may also pose challenges when considered for livestock feeding (Chaudhary et al., 2012). These phytochemicals, while beneficial in controlled medicinal doses, can exhibit anti-nutritional or toxic effects if consumed excessively by animals (Aregheore & Perera, 2004).
In recent years, the rising cost of conventional livestock feed ingredients has created a pressing need to explore locally available, non-conventional feed resources. *Calotropis procera* is increasingly being considered due to its abundance, high biomass yield, and reported nutritional potential (Melesse *et al.,* 2017). Studies have indicated that the plant contains appreciable levels of crude protein, fiber, and minerals, suggesting its possible usefulness in animal nutrition when processed

appropriately (Okunlola *et al.,* 2019). However, the presence of anti-nutritional compounds such as latex, tannins, and phenolic compounds poses risks that require careful evaluation and processing to ensure safety and palatability (Bamikole *et al.,* 2001).

Calotropis procera is a widespread shrub commonly found in arid and semi-arid regions, yet its potential as an alternative livestock feed resource remains largely underutilized due to limited scientific information on its nutritive value (Katsande *et al.,* 2016). Although the plant is abundant and available year-round, concerns regarding its chemical constituents, toxic principles, and overall safety have restricted its adoption in animal feeding systems (Melesse *et al.,* 2017). Proper processing methods such as shade drying and ensiling are known to improve forage quality and reduce anti-nutritional factors, but their specific effects on *Calotropis procera* require further investigation (Aregheore & Perera, 2004).

Studies indicate that *Calotropis procera* contains useful nutrients as well as a diverse range of secondary metabolites that may pose challenges if not adequately reduced or modified before feeding (Mujeeb *et al.,* 2014). However, there is insufficient empirical data on how shade drying alters the plant's proximate composition, mineral profile, and phytochemical constituents, making it difficult to determine its suitability as a safe feed ingredient (Chaudhary *et al.,* 2012). Without such information, livestock producers cannot make informed decisions regarding appropriate inclusion levels or processing strategies for safe utilization (Okunlola *et al.,* 2019). This paper aims at determining the effect of shade drying and ensiling on the proximate composition and phytochemical properties of *calotropis procera* (leaves)

Materials and Methods

The study was conducted at the Teaching and Research Farm and the Chemistry Laboratory Complex of the Department of Animal Science, Federal University Gashua, Yobe State, Nigeria. The area is geographically located between latitude 12.52°–12.87°N and longitude 11.01°–11.00°E (Google Earth, 2021). It lies within the semi-arid ecological zone of northeastern Nigeria, characterized by low and erratic rainfall ranging from 500–1000 mm annually. Ambient temperatures range from 23–28 °C during the harmattan period (December–January) and rise to 38–43 °C at the peak of the dry season (March–April). Relative humidity fluctuates between 30–35%, reaching as low as 10% between February and April, and peaks at approximately 70% in August (Google Earth, 2021).

Fresh *Calotropis procera* plants (leaves and stems) were harvested within the University environment. The harvested materials were sorted to remove dirt and foreign matter. A portion of the fresh *Calotropis procera* was spread thinly under natural shade to prevent direct exposure to sunlight, which may degrade heat-sensitive nutrients and phytochemicals. The samples were allowed to dry for **7–10 days** until constant weight was achieved.

Another portion of the fresh plant material was chopped into 2–3 cm pieces and compacted into airtight plastic silos. The material was ensiled without additives for 30 days. At the end of the ensiling period, the silos were opened, and representative samples were collected. The samples were oven-dried at 60 °C to constant weight, milled, and stored for chemical analysis.

The study consisted of **two treatments** corresponding to the objectives:

- T1 – Shade-dried *Calotropis procera*
- T2 – Ensiled *Calotropis procera*

Each treatment sample was analyzed in triplicate to ensure reliability and accuracy of laboratory results.

The proximate composition of the shade-dried and ensiled samples was determined using standard procedures of the Association of Official Analytical Chemists (AOAC, 2005, Sudik *et al*., 2019). The following parameters were analyzed: Samples were digested using nitric-perchloric acid mixture, and minerals such as calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), sodium (Na), and iron (Fe) were analyzed using an Atomic Absorption Spectrophotometer (AAS) and spectrophotometric methods as appropriate.

Qualitative and quantitative phytochemical analyses of the shade-dried samples were conducted according to the methods described by Harborne (1998) and Abidemi et al. (2017). The phytochemicals analyzed include: Alkaloids, Tannins, Saponins, Flavonoids, Phenols, Terpenoids and Glycoside. Ensiled samples were not analyzed for phytochemicals because ensiling reduces or neutralizes many plant secondary metabolites. All laboratory data for proximate, mineral, and phytochemical composition were recorded from triplicate analyses for accuracy. Each variable measured was documented in standardized laboratory data sheets prior to statistical processing.

Data generated from the chemical and phytochemical analyses were subjected to a **one-way** Analysis of Variance (ANOVA) using SAS statistical software (SAS, 2020; Version 9.0). Significant means were separated using Duncan's Multiple Range Test (DMRT) as described by Duncan (1955).

Results

Table 1 shows the Proximate Composition of Shade Dried *Calotropis Procera* Leaves which contains 90.06% dry matter and high content of crude protein (26.52%), followed by crude Fibre (11.95%) while ash had the least (4.05%). Acid Detergent Fibre and Neutral Detergent Fibre contained 31.43% and 46.58% respectively.

Table 1: Proximate Composition of Shade Dried *Calotropis Procera* Leaves

Parameter	Values (%)	SEM
Crude Protein	26.52	0.259
Crude Fibre	11.95	0.808
Dry Matter	90.06	0.019
ASH	4.05	0.128
Ether Extract	4.30	0.365
Organic Matter	88.10	0.215
Acid Detergent Fibre	31.43	0.285
Neutral Detergent Fibre	46.58	0.549

The table two shows the phytochemicals composition of shade dried *Calotropis Procera* Leaves. Saponins had the highest value followed by Tannins, Phytic Acid, and Goitrogens had the least value., Table 3 shows proximate composition of ensiled dried *Calotropis Procera* Leaves, with high content of nitrogen free extract and crude protein.

Table 2: Phytochemicals Composition (mg/kg) of Shade Dried Calotropis Procera Leaves

Parameter	Values	SEM
Saponins	3.816	0.114
Tannins	1.500	0.633
Phytic Acid	1.052	0.504
Protease inhibitors (Antiproteases)	0.250	0.000
Amylase inhibitors I	0.213	0.009
Lectins	0.188	0.105
Goitrogens	0.116	0.021

Table 3: Proximate Composition of Ensiled Dried *Calotropis Procera* Leaves

Parameter	Values	SEM
Crude Protein	13.870	0.885
Crude Fibre	9.750	0.335
Dry Matter	94.167	0.5423
ASH	9.36	1.337
Crude Fat	6.667	0.1054
Nitrogen Free Extract	54.56	1.443
Moisture Content	5.833	0.843

Discussion

The shade-dried *Calotropis procera* leaves revealed a high crude protein (CP) value of 26.52%, indicating that the plant has the potential to serve as a supplementary protein source in ruminant nutrition. This CP level aligns with the findings of El-Banna *et al.,* (2020), who reported crude protein values between 22–28% in *C. procera* foliage collected from arid zones. Similarly, (Akinwumi *et al.,* 2019) also noted that shade drying helps preserve protein fractions in browse plants by reducing heat-induced denaturation.

The crude fibre content (11.95%) falls within the typical range reported for browse species. Comparable values were reported by Sayed *et al.,* (2018), who found crude fibre between 10–14% in *C. procera*, suggesting it can support moderate rumen activity without depressing digestibility.

The dry matter (DM) concentration of 90.06% confirms adequate moisture removal during shade drying. According to Makkar (2016), shade drying maintains higher nutrient integrity and prevents rapid autolysis common in sun-dried foliage. The ash content (4.05%) was relatively low, consistent with results by El-Hag et al. (2021), who observed ash values ranging from 3–6% in *C. procera* leaves. The ether extract (4.30%) and organic matter (88.10%) also align with published values for tropical browse species.

The fibre fractions, ADF (31.43%) and NDF (46.58%), indicate moderate cell wall components. These are comparable to the values recorded by Nwaogu et al. (2020), who reported ADF and NDF ranges of 30–35% and 45–50%, respectively, for shade-dried *C. procera*.

The phytochemical analysis showed the presence of bioactive compounds including saponins (3.816%), tannins (1.50%), phytic acid (1.052%), lectins (0.188%) and goitrogens (0.116%). These compounds are consistent with those previously identified in *C. procera*.

Saponin levels in this study are similar to those reported by Majekodunmi *et al.,* (2018), who found saponin content between 3–5% in dried *C. procera* leaves. Saponins may impart anti-nutritional effects at high levels but can also improve immunity and reduce rumen methane when moderately present. The tannin content (1.5%) is relatively low, indicating minimal protein-binding effects. Babayemi (2006) reported that tannin levels below 3% are safe for ruminant utilization as they enhance protein bypass without impairing digestibility.

Phytic acid and protease inhibitors were detected at low concentrations, similar to the findings of Kekana *et al.,* (2019), who reported that shade drying significantly reduces anti-nutritional factors in browse plants. The gross energy (4.45 kcal/g) and digestible energy (4.083 kcal/g) are consistent with values reported for other tropical leafy forages as documented by Makkar & Becker (2018).

Ensiling dramatically modified the nutritional composition. The crude protein dropped from 26.52% (shade-dried) to 13.87%, representing a significant loss. This observation is consistent with proteolysis during ensiling, where true proteins are degraded into non-protein nitrogen compounds. Similar reductions were documented by Ogunbosoye & Babayemi (2010), who reported a 40–50% decrease in CP of ensiled browse leaves.

The reduction in crude fibre (from 11.95% to 9.75%) suggests partial microbial breakdown of structural carbohydrates during fermentation. Nkosi *et al.,* (2014) reported comparable fibre reductions in ensiled shrub foliages. Conversely, ash content increased sharply from 4.05% to 9.36%, likely due to concentration effects associated with microbial breakdown of organic components. Similar increases in ash after ensiling were reported by Aderinola *et al.,* (2018) in *Tithonia diversifolia* silage. The crude fat increased to 6.67%, which aligns with the findings of Fasae *et al.,* (2015), who linked such rises to microbial synthesis of lipids during fermentation. The moisture content decreased to 5.83%, showing well-preserved silage. Fikru & Teferi (2019) also observed that ensiling reduces moisture through fermentation heat and water loss. The high nitrogen free extract (54.56%) suggests improved carbohydrate availability. This aligns with Mtengeti *et al.,* (2017), who reported enhanced soluble carbohydrates in ensiled browse plants.

Conclusion

The study concludes that *Calotropis procera* leaves possess substantial nutritional value, particularly when shade dried, which preserves crude protein and other nutrients suitable for ruminant feeding. Shade drying also maintains low levels of anti-nutritional factors, making the plant a viable supplementary protein source in livestock diets, especially in dryland regions. On the other hand, ensiling *Calotropis procera* leads to significant nutrient modifications. While ensiling reduces crude protein and fibre due to microbial degradation, it increases nitrogen-free extract and crude fat content, reflecting enhanced fermentable carbohydrate availability. Although the reduction in crude protein limits the suitability of ensiled *Calotropis procera* as a high-protein feed, the improved carbohydrate profile suggests that it may still be useful as an energy supplement. Overall, *Calotropis procera* has potential as an alternative forage resource, but processing methods strongly influence its nutritional quality.

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