



**PHYTOCHEMICALS AND PROXIMATE COMPOSITION OF WATER-TREATED
SICKLE POD (*Cassia tora*) LEAF FROM DIFFERENT AGRICULTURAL ZONES OF
BAUCHI SOUTH**

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ABSTRACT

The study evaluates the proximate composition, phytochemical content, and anti-nutritional factors of *C. tora* leaves sourced from four locations in Bauchi South—Bauchi metropolis (Sp1), Alkalari (Sp2), Toro (Sp3) and Dass (Sp4). *Cassia tora*, commonly known as "Sickle senna" or "tora" is a medicinal plant that is widely used in ethno-veterinary medicine across several cultures. The leaves of this plant are particularly valued for their health benefits and are used in various medicinal preparations. In this experiment, samples of *Cassia tora* leaves were collected from different agricultural zones {Bauchi metropolis (Sp1), Alkalari (Sp2), Toro (Sp3) and Dass (Sp4)} of Bauchi south respectively. The leaves were grinded, packaged and labeled as Sp1, Sp2, Sp3 and Sp4 respectively. Proximate compositions of the leaves encompassing the levels of moisture, ash, crude protein, lipid (EE), crude fiber and metabolizable energy (ME) content were determined. Significance difference ($p < 0.05$) was shown across the sample points with regard to crude protein, Nitrogen free extract (NFE) and ME. *Cassia tora* of Alkalari (Sp2) was highest (28.91%) in terms of % crude protein values followed by Sp4 (24.47%), Sp1 (24.09%) and Sp3 (24.04%) respectively. Other parameters (CF, Moisture, EE, DM and ash) observed to be statistically non-significant ($P > 0.05$) across the groups (Sp1, Sp2, Sp3, and Sp4). Phytochemical analysis revealed the presence of bioactive compounds such as: flavonoids, glycosides, steroids, tannins, and saponins across all the groups with the exception of alkaloids and anthraquinones in Sp1, Sp2 and Sp3 correspondingly. The experiment also examined some anti-nutritional factors among the phytochemicals present in *Cassia tora* leaves. Phytic acid as well as oxalates were found to be significantly higher ($P < 0.05$) in Sp1, Sp2 and SP4 across the groups examined. Tannin was significantly ($P > 0.05$) higher in Sp3 (1.53g/100g) followed by Sp2 (1.26mg/100g) across the specimen groups analyzed. It can be concluded that *Cassia tora* leaves of Bauchi metropolis have great potentialities as protein source as well as phyto-additives for improving animal health and productivity. Further research should be carried out to determine the effects of *Cassia tora* leaves on digestibility and growth performance by animals.

Keywords: Agricultural, Anti-nutritional, Factors, Phytochemicals and Proximate

INTRODUCTION

In livestock feeding systems, the nutritional value of *Cassia tora* is inhibited by the presence of anti-nutritional factors (ANFs) including phytic acid, oxalates, and tannins, which can interfere with protein digestibility and mineral bioavailability (Adeyeye & Ayejuyo, 2014). Processing techniques such as soaking, boiling, or fermentation have been shown to improve palatability, lower ANF concentrations, and enhance the safety of plant-based feed ingredients, although they may also influence the retention of beneficial phytochemicals (Oluwole *et al.*,

2023). Importantly, the proximate composition and bioactive profile of *C. tora* are highly variable, depending on agro-climatic conditions such as soil fertility, rainfall, and temperature (Alamgir, 2017). This variability suggests that nutritional evaluations must be site-specific to optimize its integration into animal diets.

With the increasing ban on in-feed antibiotics and the demand for safe, cost-effective alternatives to support livestock productivity (Bonos *et al.*, 2017), *Cassia tora* offers considerable promise. Its rich reservoir of bioactive compounds (Shaik & Syed, 2015) can act as natural growth promoters, gut health modulators, and immune-stimulants, contributing to sustainable animal production. Moreover, its availability as a low-cost, underutilized plant resource aligns with efforts to reduce feed costs while promoting climate-smart and health-oriented livestock farming. The study evaluates the proximate composition, phytochemical content, and anti-nutritional factors of *C. tora* leaves sourced from four locations in Bauchi South—Bauchi metropolis (Sp1), Alkalari (Sp2), Toro (Sp3), and Dass (Sp4). The findings are expected to provide insights into its nutritional suitability and potential as a natural feed additive for enhancing animal health and performance.

MATERIALS AND METHODS

Collection and Identification of *Cassia tora* Leaves

Cassia tora leaves were sampled from four Bauchi South zones—Bauchi metropolis (Sp1), Alkalari (Sp2), Toro (Sp3), and Dass (Sp4)—located within the Sudan/Guinea savanna (9°30'–11°30'N; 8°45'–10°30'E). The area (49,119 km²; 5.3% of Nigeria) experiences 1,000–1,300 mm annual rainfall and temperatures of 18–37°C. Identification was confirmed with Voucher Specimen 1370 at ATBU herbarium.

Preparation of Extracts

Leaves were washed, shade-dried, soaked for three days, re-dried, and milled into powder for proximate and phytochemical analysis (Sharma *et al.*, 2021).

Experimental Design and Analysis

A CRD with four treatments (locations) and four replicates was used. Data were subjected to Analysis of variance ANOVA (SPSS v.23), and means separated with least significance difference LSD at $p < 0.05$.

RESULTS AND DISCUSSIONS

Proximate composition of *Cassia tora* Leaves from Different Locations of Bauchi south

The result in Table 1 reveals that the proximate composition of *Cassia tora* leaves collected from Bauchi South (SP1–SP4) showed significant variation ($p < 0.05$) across most nutritional parameters, except ether extract ($p > 0.05$). Such differences are likely influenced by ecological and edaphic factors, including soil fertility, rainfall, and microclimatic conditions, as earlier noted by Onyeka *et al.* (2023). Moisture content was uniformly low (12.50–12.85%), while dry matter values were high (87.15–87.50%). This high dry matter content is advantageous for feed storage and preservation, reducing microbial spoilage and prolonging shelf life, which is critical in smallholder systems where storage infrastructure is limited (Uchenna & Eze, 2021). Crude protein exhibited significant differences ($p < 0.05$), with SP2 recording the highest value (28.90%). This protein concentration is far above the minimum crude protein requirement (7–12%) for ruminant maintenance (NRC, 2016), suggesting that *C. tora* leaves could effectively supplement protein-deficient basal diets such as crop residues. High-protein browse species improve rumen microbial activity, enhance feed intake, and support growth, reproduction, and milk yield (Xue *et al.*, 2022).

Crude fiber also varied significantly ($p < 0.05$), ranging from 11.40–12.10%. These moderate fiber levels are beneficial, as they support rumen function and digestive motility without excessively reducing nutrient digestibility. High fiber is associated with gut fill and reduced voluntary intake, but the moderate levels observed here are suitable for balanced forage–concentrate feeding systems (Yusuf *et al.*, 2022). Ether extract values (3.75–3.90%) did not differ significantly ($p > 0.05$) among sites, aligning with reports that tropical legumes generally contain low lipid concentrations (Adegbeye *et al.*, 2021). Although modest, this lipid fraction contributes essential fatty acids and enhances the energy density of the diet. Ash content showed significant variation (14.65–17.20%; $p < 0.05$), with SP2 recording the highest value (17.20%). This indicates strong mineral presence, which is vital for bone formation, enzyme activation, and general metabolic functions in livestock (Okoro *et al.*, 2022). Variations in ash likely reflect underlying soil mineral composition across the study locations.

Nitrogen-free extract (NFE) and metabolizable energy (ME) both differed significantly ($p < 0.05$). NFE ranged from 25.10–33.63%, with SP4 highest, indicating a rich reserve of soluble carbohydrates that provide readily available energy to ruminants. Similarly, ME values ranged between 2350.35–2630.30 kcal/kg, with SP3 and SP4 recording the highest. Such high energy density is crucial for growth, lactation, and reproduction, especially when forages are used to balance low-energy crop residues. These findings reinforce the species' value not only as a medicinal plant but also as a functional livestock feed component that can improve animal nutrition, performance, and health in resource-limited farming systems.

Table 1: Proximate composition of *Cassia tora* leaves from different locations of Bauchi south

PARAMETERS	SP1	SP2	SP3	SP4	SEM
Moisture	12.50	12.85	12.60	12.50	12.61 ± 0.26
Dry matter	87.50	87.15	87.40	87.50	87.38 ± 1.80
Crude protein	24.09 ^b	28.90 ^a	24.09 ^b	24.47 ^b	25.39 ± 1.17
Crude fiber	12.10 ^a	12.10 ^a	11.80 ^b	11.40 ^b	11.85 ± 2.95
Lipid (EE)	3.75	3.85	3.90	3.00	3.62 ± 0.21
Ash	16.55 ^a	17.20 ^a	14.65 ^b	15.00 ^b	15.85 ± 0.61
NFE	31.01 ^a	25.10 ^c	32.96 ^a	33.63 ^a	30.67 ± 2.29
M.E (kcal/ME)	2350.35 ^c	2500.65 ^b	2630.30 ^a	2627.92 ^a	253.17 ± 6.65

KEYS: SP1: Bauchi metropolis, SP2: Alkaleri, SP3: Toro, SP4: Dass, SP= Sample point, SEM: Standard Error Mean, ^{abcd}Means with different superscript within row differs significantly ($P < 0.05$)

Anti-nutritional Factors of *Cassia tora* From Different Locations of Bauchi South

The result in Table 2 shows significant variation ($p < 0.05$) in the anti-nutritional profile of *Cassia tora* leaves across Bauchi South sites. Phytic acid was most abundant (175.99–206.35 mg/100 g), highest in SP2, with potential effects on mineral bioavailability but also antioxidant benefits (Kumar *et al.*, 2021). Tannins were low (1.18–1.53 mg/100 g), a nutritionally favorable range that may enhance antioxidant activity (Bhat *et al.*, 2021). Oxalates varied widely, highest in SP1 and SP2 (65.00 mg/100 g) and lowest in SP3 and SP4 (17.50 mg/100 g), with implications for calcium utilization (Noonan and Savage, 2019). Overall, moderate phytic acid, low tannins, and variable oxalates indicate *C. tora* leaves as a promising nutritional and ethno-veterinary resource (Oluwole *et al.*, 2023).

Table 2: Some Anti-nutrients factors of *Cassia tora* leaves harvested from different locations of Bauchi south

Parameters	SP1	SP2	SP3	SP4	SEM
Phytic Acid (mg/100g)	190.14 ^b	206.35 ^a	175.99 ^c	204.75 ^a	194.30 ± 7.11
Tannin (mg/100g)	1.18 ^c	1.26 ^b	1.53 ^a	1.19 ^c	1.29 ± 0.81
Oxalate (mg/100g)	65.00 ^a	65.00 ^a	17.50 ^b	17.50 ^b	41.25 ± 13.71

KEYS: SP1: Bauchi metropolis, SP2: Alkaleri, SP3: Toro, SP4: Dass, SP= Sample point, SEM: Standard Error Mean; ^{abcd}Means with different superscript within row differs significantly (P<0.05)

Phytochemical Analysis of *Cassia tora* Leaves Harvested from Various Locations of Bauchi South

Phytochemical screening of *Cassia tora* leaves from Bauchi South revealed both uniform and site-specific patterns of secondary metabolite expression. Tannins, saponins, glycosides, and steroids were consistently present across all sites ($p < 0.05$), indicating their stability as core phytochemicals of the species. This uniformity underscores the reliability of *C. tora* as a consistent source of bioactive compounds relevant to livestock nutrition and health (Oluwole *et al.*, 2023). In contrast, alkaloids, flavonoids, and anthraquinones varied significantly ($p < 0.05$), occurring only in SP3 and SP4. These site-specific differences reflect agro-ecological influence, where soil fertility, rainfall, and microclimatic conditions shape secondary metabolite synthesis. Such ecological modulation is consistent with reports on tropical browse plants, where environmental gradients directly influence phytochemical yield and diversity (Sasidharan *et al.*, 2022).

From a functional perspective, the variable metabolites—alkaloids, flavonoids, and anthraquinones—are noteworthy for their antimicrobial, antioxidant, and anti-inflammatory activities, which enhance animal resilience against pathogens and oxidative stress. The consistent compounds also contribute important nutraceutical roles: tannins improve protein utilization at moderate levels, saponins suppress enteric methane production, and glycosides and steroids regulate metabolic functions and feed efficiency (Kholif, 2023). Overall, the phytochemical diversity of *C. tora* reflects both species-specific stability and ecological adaptability, offering dual benefits for ruminant feeding systems: a reliable baseline of core metabolites and an added layer of site-specific compounds with therapeutic value. This reinforces its relevance in integrated, climate-smart livestock nutrition strategies.

Table 3: Phytochemical components in *Cassia tora* leaves harvested from different location of Bauchi south

Parameters	SP1	SP2	SP3	SP4
Tannins	+	+	+	+
Saponins	+	+	+	+
Glycosides	+	+	+	+
Steroids	+	+	+	+
Alkaloids	-	-	+	+
Flavonoids	+	+	+	+
Anthraquinones	+	+	-	+

KEYS: SP1: Bauchi metropolis, SP2: Alkaleri, SP3: Toro, SP4: Dass, SP= Sample point, SEM: Standard Error Mean, Presence (+), absence (-)

CONCLUSION AND RECOMMENDATIONS

Cassia tora leaves from Bauchi South showed significant variation across sample points ($p < 0.05$). SP2 had the highest crude protein (28.90%) and ash (17.20%), while SP4 recorded the



highest NFE (33.63%) and comparable ME with SP3 (>2600 kcal/kg). SP1 and SP2 had higher oxalates (65.00 mg/100 g), whereas tannins remained low across all sites.

Phytochemicals such as tannins, saponins, glycosides, and steroids were present in all samples, while alkaloids (SP3, SP4), flavonoids, and anthraquinones (SP4 only) showed location-specific distribution. It can be concluded that, *Cassia tora* leaves of Bauchi south especially Alkali (Sp2) and Dass (Sp4) have great potentialities as protein source as well as phyto-additives for improving animal health, production and productivity. Further in vivo experiment should be conducted to determine its effects of growth performance and haemato-biochemical indices on farm animals.

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