NUTRITIONAL EVALUATION OF *Enterolobium cyclocarpum* PLANT PARTS AS DRY SEASON SUPPLEMENTARY FEED FOR RUMINANTS

Fasae O.A.*, Adebayo O.D. and Adeagbo A.O.
Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria.
* animalexp@yahoo.co.uk

Abstract
Studies were conducted to evaluate the nutritional potentials of *Enterolobium cyclocarpum* plant parts as supplementary feed in ruminant production. Chemical composition and qualitative screening of saponin, tannin, oxalate and phytate in plant parts were determined. *In-vitro* gas production was carried out for 72 hours on the plant parts. Results showed that the crude protein concentration of the plant parts varied from 12.84% to 16.74% for stem bark and seeds, respectively. The ether extract content was highest in the pod and seed (7.75% and 6.25%) while the bark and the leaf had the least value of 4.00% and 5.50%. Fibre fractions of plant parts also varied ($P < 0.05$) across plant parts. The qualitative screening revealed the presence of saponin, tannins, oxalate and phytate in plant parts but in varying ($P < 0.05$) quantities. *In vitro* Dry matter digestibility and methane (ml/200 mg DM) production differed ($P < 0.05$) across plant parts, while the gas production parameters (b, c and lag time) were affected ($P <0.01$). It was therefore concluded that Enterolobium plant parts possess nutritive value that makes them potential dry season supplementary feed for ruminants.

Introduction

Trees and shrubs play an important role in dry season ruminant feeding in many tropical and subtropical environments around the world. They are been identified as a source of feeds or feed ingredients for ruminants because of their high nutritive value and positive effects on rumen function (Fasae *et al.,* 2010; Arif *et al.,* 2016).

These trees possess many advantages such as such as abundance, adaptability, accessibility, high protein content and quality in terms of available energy, minerals and vitamins (Ramírez, 1998). However, a major constraint to the use of these trees is the presence of toxic and plant secondary metabolite constituents; which have different but adverse effects on animal performance including loss of appetite and reductions in dry matter intake and protein digestibility (Das *et al.,* 2010). *Enterolobium cyclocarpum* is a legume that is easily established and grows to maturity over a short period of time. The seeds, pods, stem bark and whole fruit if well harnessed could be suitable for use in livestock feeding programs, thereby serving as a potential supplement in ruminant feed compositions. This study therefore evaluates the chemical and phytochemical compositions, *in vitro* DM digestibility and gas production kinetics of *Enterolobium cyclocarpum* plant parts as supplementary feed in ruminant production.

Materials and methods

Collection and preparation of plant materials

Fresh undamaged matured leaves, seeds, pods and stem bark of *Enterolobium cyclocarpum* plant parts were harvested from various trees within the campus of the Federal University of Agriculture, Abeokuta. Samples of plant parts were collected, dried and ground into powder, after which they were sieved, bottled, labeled, and kept for laboratory analysis.

Chemical and phytochemical analysis

The chemical and phytochemical analysis was carried out at the laboratory of the Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta. The samples were analyzed for proximate composition according to the procedure of AOAC (2000). Crude protein was determined by Kjeldahl method, ether extract using the Soxhlet apparatus and ash contents of the milled samples were determined. The fibre fractions neutral detergent fibre, acid detergent fibre and acid detergent lignin of the milled samples were determined with the procedure of Van Soest *et al.,* (1991). Quantitative phytochemical compositions of the plant parts were determined as described by Harbone (1973).

In vitro gas production

In vitro gas production was determined following the procedure of Menke and Steingass (1988) and the post incubation parameters evaluated as described by Fievez *et.al* (2005)

Statistical analysis

Data obtained were analysed using the analysis of variance in a completely randomized design (SAS, 2000). Significantly treatment means was further separated using Duncan's Multiple Range Test in the same package.

Results and discussion

Table 1 shows variation in proximate composition and fibre fractions of different parts of *Enterolobium cyclocarpum* plant. The dry matter (DM) values ranges from 81.50% in the pod to 92.75% in the leaf. The crude protein (CP) concentration of the plant parts varied ($P<0.05$) between 12.84% to 16.74% which is towards an acceptable range of protein concentrations reported for the foliage of browse plant species and CP levels in legume fodder trees and shrubs (Topps, 1992). The seed and the leaf had the highest ($P<0.05$) content while the stem bark and the pod had least contents, respectively. Overall, the average CP content across plant parts in the present study indicates they could be considered as a potential CP source to supplement poor quality basal diets in ruminant feeding systems. They would provide adequate nitrogen requirement by rumen microorganism to maximally digest the main components of dietary fibre leading to the production of volatile fatty acid (Lamidi and Ogunkunle, 2016). The ether extract content was highest in the pod and seed (7.75% and 6.25%) while the bark and the leaf had the least value of 4.00% and 5.50%. The ash content of plant parts in the present study also varied across plant parts. Many factors can influence the concentration of mineral elements in plants, e.g. the plant species, minerals in the soil and their availability to the plant, soil type and soil pH, stage of growth, etc. (Underwood and Suttle, 1999). Variations were observed ($p<0.05$) in the fibre fraction composition and levels were of the same similarities for tropical fodder trees (Babayemi and Bamikole, 2006). The chemical composition of the seeds, pods, leaf and stem bark revealed that they have the potential to fill the gap in ruminant nutrition, especially crude protein content particularly in the dry season. These supports reports that tree and shrub plant parts possess many advantages such as supply of good quality green fodder during the dry periods, and high crude protein and mineral contents (Fasae *et al.,* 2010; Avornyo *et al.,* 2018). Supplementing these plant parts could solve the problem of feeding ruminant livestock during the dry season.

The phytochemical composition (%) of different plant parts of *Enterolobium cyclocarpum* are presented in Table 2. The qualitative screening revealed the presence of saponin, tannin, oxalate and phytate in plant parts investigated but in varying quantities. The values obtained for these metabolites followed a similar trend with the stem bark having the highest contents while the seed had the lowest content of these metabolites with exception of saponin. Variation in the concentration of various phytochemical contents in plant parts has also been reported (Çirak *et al.*, 2007), where among different tissues, full opened flowers were found to be superior to stems, leaves and the other reproductive parts.

The use of trees and shrubs of legumes or other species as a supplement for ruminant diets has very important characteristic content of some of these secondary metabolites, which make them very valuable (Kamra *et al.*, 2006).

Table 3 shows the gas production kinetics and some post-incubation parameters of *Enterolobium cyclocarpum* plant parts. *In vitro* Dry matter digestibility and methane (ml/200 mg DM) production differed ($P < 0.05$) across plant parts. Differences may be due, not only to the chemical composition but also to the structure of stem, leaf and seed ratios. The trend for methane production across plant plants in this study is similar to earlier reports for *Azadiractha indica* (Fasae *et al.*, 2018) with leaves and stem bark having the highest and lowest methane production, respectively. All the plant parts significantly affected ($P <0.01$) the gas production parameters (b, c and lag time). According to Getachew *et al.* (2004), based on the fact that the gases produced reflect the degradation of the sample tested, the rate and the maximum potential of gas production are probably the main parameters for evaluating the quality of forages tested by the gas production technique. Thus, the most fermentable or digestible forages would be those, which present the greatest values of maximum potential associated with high gas production rate, resulting in more fermentation of the material in a shorter period of incubation.

Table 1: Chemical composition of *Enterolobium cyclocarpum* plant parts

Parameters	Plant parts				
	Seed	Leaf	Pod	Stem bark	SEM
Dry matter	83.75^b	92.75^a	81.50^b	92.00^a	1.34
Crude protein	16.74^a	15.14^b	14.48^c	12.84^d	0.37
Ether extract	6.25^b	5.50^b	7.75^a	4.00^c	0.41
Ash	10.24^b	10.00^b	11.75^a	11.97^a	0.24
Neutral detergent fibre	58.00^a	53.50^b	54.07^b	60.50^a	0.89
Acid detergent fibre	30.50^b	30.07^b	31.00^{ab}	36.13^a	0.72
Acid detergent lignin	7.01^b	7.23^b	9.01^a	9.41^a	0.45

[abcd] *Means in the same row with different superscripts are significantly different (P<0.05)*

Table 2: Phytochemical composition (%) of *Enterolobium cyclocarpum.* plant parts

Parameters	Plant parts				
	Seed	Leaf	Pod	Stem bark	SEM
Oxalate	0.09^d	0.05^c	0.17^b	0.31^a	0.02
Tannin	0.99^c	0.60^c	2.13^b	3.44^a	0.28
Saponin	0.53^c	1.90^a	1.05^b	0.60^c	0.14
Phytate	0.51^c	0.34^c	1.00^b	1.30^a	0.09

[abcd] *Means in the same row with different superscripts are significantly different (P<0.05)*

Table 3: *In vitro* Dry matter digestibility and gas production kinetics and estimated parameters of *Enterolobium cyclocarpum* plant parts.

Treatments	CH_4	DMD (%)	SCFA (µmol)	ME MJ kg^{-1}	b (ml/200mgDM)	C (ml/hr)	Lag time (hr)
Leaf	19.50^{a}	56.40^{a}	0.65	8.37^{a}	45.69^{a}	0.03	1.54
Pod	11.50^{bc}	53.04^{b}	0.58	8.45^{a}	42.37^{a}	0.07	1.42
Seed	13.50^{b}	53.30^{b}	0.59	7.72^{ab}	30.87^{b}	0.04	1.41
Bark	9.50^{c}	46.97^{c}	0.44	6.26^{b}	25.64^{b}	0.07	1.36
SEM	1.08	1.70	0.04	0.32	2.59	0.01	0.09

$^{a, b, c}$ *Means along the same column with different superscripts are significant ($p<0.05$).*
SCFA= Short chain fatty acid, ME= Metabolizable energy, b= Volume of gas produced in time (t)
c= Fractional rate of gas production, CH_4= Methane; DMD= Dry-matter digestibility

Conclusion

Based on the results, Enterolobium plant parts can be used as supplements in ruminant feed especially during dry season when there is not enough grasses and legumes to cater for animal's nutrient requirement. Supplementing this plant parts could alleviate the problem of feeding ruminant livestock during this season. Furthermore, since *Enterolobium cyclocarpum* is a drought resistant plant, the availability of its leaves at the peak of the dry season is an advantage and can be used as supplement for ruminant feeding all year round.

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