Short note [Nota corta]

CHEMICAL ANALYSIS OF THE POTENTIAL CONTRIBUTION OF *Lantana camara* TO THE NUTRITION OF BROWSING LIVESTOCK[1]

[ANALISIS QUÍMICO DE LA CONTRIBUCIÓN POTENCIAL DE *Lantana camara* A LA NUTRICIÓN DE GANADO EN RAMONEO]

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SUMMARY

Contrary to what is known and reported that *Lantana camara* is poisonous to livestock, animals have been seen consuming it with no cases of poisoning reported in most communal areas in Zimbabwe. A study was conducted to determine the total phenolic compounds and nutrient composition. Pink flowered, red flowered and white flowered *L. camara* leaves were air dried and milled to facilitate chemical analysis of their crude protein (CP), dry matter (DM), neutral detergent fibre (NDF) and acid detergent fibre (ADF). The DM, CP, ADF, and NDF content of *L. camara* all the three varieties did not differ significantly among the three varieties assessed (P < 0.05). The mean total phenolic compounds of the red and white varieties was twice as high as that of the pink variety (Mean± standard error of difference (4.7 ± 1.5) g/kg DM; and was significant different (P < 0.05). The CP content ranged from 213.2 to 223.1 g/kg of among the three varieties. Phosphorus and calcium content ranged between 3.5 to 3.9g/kg DM and 17 to 24g/kg DM respectively while acid detergent insoluble nitrogen (ADIN) was very low and less than 2g/kg DM. The results from this study demonstrate all the three *L. camara* varieties exceeded the minimal levels of CP required to sustain animal production and have the potential to contribute to livestock nutrition as a protein supplement. However, more research should be done to determine feeding levels which are not detrimental to animal health.

Key words: Nutrient composition; total phenolic compounds; browse forage; browsing livestock

RESUMEN

Contrariamente a lo que se sabe y ha reportado que *Lantana camara* es venenosa para el ganado, se han visto animales consumiéndolo sin ningún caso de intoxicación reportado en la mayoría de las áreas comunales en Zimbabwe. Se realizó un estudio para determinar los compuestos fenólicos totales y la composición de nutrientes. Las hojas de *L. camara* con flor rosa, flor roja y flor blanca se secaron al aire y se molieron para facilitar el análisis químico de su proteína cruda (CP), materia seca (MS), fibra en detergente neutro (NDF) y fibra detergente ácida (ADF). El contenido de MS, CP, ADF y NDF de *L. camara* en las tres variedades no difirió significativamente entre las tres variedades evaluadas (P <0.05). El promedio de los compuestos fenólicos de las variedades roja y blanca fue dos veces mayor que el de la variedad rosada (Media ± error estándar de diferencia (4,7 ± 1,5) g / kg de MS y fue significativamente diferente (P <0,05) El contenido de fósforo y calcio osciló entre 3,5 y 3,9 g / kg de MS y de 17 a 24 g / kg de MS, respectivamente, mientras que el nitrógeno insoluble en detergente ácido (ADIN) fue muy bajo y menor que 2g / kg MS Los resultados de este estudio demuestran que las tres variedades de *L. camara* superaron los niveles mínimos de CP necesarios para mantener la producción animal y tienen el potencial de contribuir a la nutrición del ganado como suplemento proteico Sin embargo, se requiere investigación adicional para determinar niveles de alimentación que no sean perjudiciales para la salud animal.

Palabras clave: Composición de nutrientes; Compuestos fenólicos totales; forraje de ramoneo; ganado.

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INTRODUCTION

During periods of feed shortage, animals are sustained with native rangeland grasses and crop residues, which are too often deficient of essential nutrients (Ngongoni *et al.*, 2006; Mapiye *et al.,* 2009; Gusha *et al.*, 2015). However, during the same dry periods, weedy shrubs such as *Lantana camara* continue to flourish (Osuga *et al.,* 2004). Cattle, sheep and goats have been observed feeding on *L. camara* (Osuga, 2006). *Lantana camara* has also been noted to maintain relatively high levels of crude protein content (Mtui, 2008) throughout its growing season. It therefore not surprising that in heavily grazed communal land of Zimbabwe such as Murehwa, Magunje, Shurungwi, Mhondoro and Masvingo area, *Lantana camara* is browsed by animals (see Plate 1). Such foraging behaviour, which goes against conventional understanding that *L. camara* is toxic to livestock, warrants further research to establish whether the species could be exploited as a feed resource to offset forage scarcity in degraded rangelands under threat from climate change. Given the current droughts affecting tropical rangelands and field observations indicating voluntary utilisation of *L. camara* by ruminant livestock such as cattle, studies that examine its nutritional composition are needed to inform the species' management and boost livestock production. However, since previous work classify *L. camara* as toxic to livestock (Day *et al.* 2003), research has tended to shun away from determining its nutritional contribution to livestock.

Lantana camara is a shrub that belongs to the Verbenaceae family and its native to South America. It is a genus of about 150 species of the perennial flowering plants popularly used as stimulant, antirheumatic, antibacterial and as ornamental plant (Sousa *et al.*, 2012). A drought resistant high biomass producing plant (Reddy, 2013), *Lantana camara* is encroaching cultivated lands at a fast alarming rate and is considered noxious in the Noxious Weeds Act of Zimbabwe (chapter 19:07). Because of its broad distribution, invasive aptitude in both agricultural and natural ecosystems, *Lantana camara* plant is considered one of the invasive shrubs in tropical savanna rangelands (Chatanga, 2007: Masocha and Skidmore 2011). The plant is known to suppress the regeneration of neighbouring plants in the rangeland through its allelopathic effects (Fan *et al.,* 2010).

Contrary to what is known and reported that *Lantana camara* is toxic to livestock (Ghisalberti, 2000; Day *et al* 2003; Cooper 2007; Day 2009), farmers in Zimbabwe, Kenya (Roothaert and Franzel, 2001; Osuga, 2006), Tanzania (Obiri, 2006; Mtui, 2008), and South African (Basha *et al* 2012), frequently report that *L. camara* is one of the preferred browse forage shrub by goats. Hence, it is logical to deduce that browsing animals obtain nutritional value for the invasive shrub. If this is the case, it may warrant a shift from eradicating this invasive species based on claims that it is toxic species to using it as a possible browse resource as its survival in grazing areas could also be an indication of a supportive agronomic environment. In some areas, farmers have gone an extra mile on *Lantana camara* utilisation and started feeding their animals with it during periods of labour shortage and feed deficit by simple cutting branches of *Lantana camara* and placing them in pens for goats to feed on the leaves as observed in many communal settlements in Zimbabwe.

To date, previous research has concentrated most on the toxicity of *L. camara* to livestock (Ide and Tutt, 1998; Botha and Penrith, 2008), hence not much is known about the potential nutritional contribution of the species to livestock. To fill this knowledge void, the aim of this study is to assess the nutritional composition of L. camara as a first step towards its use by browsing livestock. Such information will be important in finding ways to utilise the biomass as a dry season livestock feed resource. If *Lantana camara* can be used as an alternative protein supplement, animal productivity might be improved in a sustainable way since the shrub is drought tolerant and invasive.

Plate 1: Brahman cattle browsing white *Lantana camara* variety in a rangeland in central Zimbabwe (Photo credit, M. Masocha).

MATERIALS AND METHODS

Study site

Lantana camara leaves were collected from the University of Zimbabwe farm which is located 13 km Northwest of Harare. The University of Zimbabwe is located at latitude 17.784º S and 31.053º E in agro-ecological region 2a characterised by an average rainfall of 825 mm and a mean annual temperatures of 19º C (Vincent and Thomas 1960). The chemical analysis of the samples was carried out at the University of Zimbabwe, Department of Animal Science and Faculty of Science.

Sampling method

Samples of *L. camara* leaves targeting young, fully expanded and undamaged leaves were collected from the University of Zimbabwe farm in Harare. Three different varieties distinguished by flower colour, namely the pink, red, and white were used in the study to represent different natural 'treatments'. Each treatment was replicated 10 times such that 10 samples were collected from ten different plants in complete randomised design within the rangelands. A total of 30 samples were harvested from the rangelands with 10 samples representing each variety. Using a measuring tape, an area approximately 1,200-m^2 was demarcated as the sample area. This target area was divided into three blocks each approximately 400-m^2 in area marked as a sampling plot. All L. camara stems were identified by variety counted and assigned unique numbers to facilitate randomisation in the collection of sample leaves. A table of random numbers was used to identify individual plants to sample. The fresh leaves were put in khaki sachets and transported to the Department of Animal Science at the University of Zimbabwe main campus for chemical analyses.

Chemical composition analysis

Dry matter content was determined by oven drying at 60 ºC over 48 hours followed by weighing. The samples were then ground through a 1 mm sieve and analyzed for nitrogen (N), acid detergent insoluble nitrogen (ADIN) and ash according to AOAC (2000). Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined using the method of Goering and Van Soest (1970). Phosphorus and calcium concentrations were determined by the spectrophotometer method (Danovaro 2009) and the EDTA method (Kaur 2007), respectively. The extraction of the phenolic compounds was done by using 70% aqueous acetone solution. Total phenolics (TEPH) were determined using the procedures of Folin Ciocalteu method as described by Makkar (2000). The concentrations of the total phenols were calculated using the regression equation of the tannic acid standard.

Data analysis

Data analysis was carried out using the General Linear Model (GML) procedure ofSAS version 9.3 (SAS 2010). Significance between the means was tested using the least significance difference (LSD). Formally, the General Linear Model used is:

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

Where:

Y_{ij} = is response variable (i.e., CP, DM, NDF, ADF, and total phenolic);

μ = overall mean;

T_i = is the treatment effect with three levels (i.e., Pink, Red and White); and

ε_{ij} = is the random residual error.

RESULTS AND DISCUSSION

The DM, CP, ADF, ADIN, P, Ca^{2+} and NDF content of L. camara all the three did not differ significantly among the three varieties assessed (P > 0.05; Table 1). The mean total phenolic of the red and white varieties was twice as high as that of the pink variety (4.7 ± 1.5 SE); and this difference was significant (P > 0.05). Data presented in Table 1 also show that the CP content ranged from 213.2 to 223.1 g/kg of among the three varieties. The means for ADF was less than 30% for all the varieties. The level of phosphorus and calcium was comparable to what is found in *Acacia angustissima* leaves (Gusha *et al.*, 2015). The values ranged between 3.5 to 3.9g/kg DM and 17 to 24g/kg DM for phosphorus and calcium respectively. Acid detergent insoluble nitrogen was very low and similar to what is found in most browse legumes as reported by Gusha et al., (2015). This a positive attribute of this Lantana camara as this indicates that its leaves could be easily digested.

Table 1: The chemical composition (g/kg DM) of Lantana camara leaves of three different varieties harvested from the University of Zimbabwe Farm

Parameter	Pink	Red	White	SE
DM	908.6^a	917.8^a	923.4^a	1.8
CP	213.2^a	217.5^a	223.1^a	8.3
ADF	213.5^a	201.9^a	286.9^a	10
ADIN	1.27^a	1.32^a	119^a	0.34
NDF	444.0^a	409.6^a	465.4^a	18.2
Ca^{2+}	21.1^a	24.2^a	17.4^a	6.3
P	3.5^a	3.7^a	3.9^a	1.2
Total Phenol	4.7^b	9.2^a	12.6^a	1.5

DM= dry matter, CP= crude protein, ADIN = Acid detergent Insoluble Nitrogen, ADF = Acid detergent fibre, NDF = Neutral detergent fibre, Ca2+ = calcium, Least squared means with different superscript ^{abc} in the same row denote significantly different at (P < 0.05)

The CP content in the current study, which was above 20%, is comparable to the CP of widely used browse species such as *Gliricidia sepium* (26.5%), *Leucaena leucocephalla* (28.2%) and *Acacia angustissima* (28%) reported previously (Osuga, 2006; Aregheore *et al.,* 2006; Baloyi *et al* 2009; Gusha *et al.,* 2015). This result suggests that the CP levels of different *L. camara* varieties, which are abundant in invaded rangelands, could form a potential feed resource chiefly as protein supplements to ruminants thus addressing the deficiencies in nitrogen common in most basal roughages particularly during the dry seasons when CP values range between 30-70 g/ kg DM (Mtui, 2008). Such low CP values are not enough for maintenance and growth for most ruminant livestock like goats since they reduce voluntary feed intake, the rate of fermentation in the rumen and microbial protein production thus lowering animal productivity (Aregheore *et al.,* 2006).

Previous research has demonstrated that that animal feeds with less than 6% crude protein content are unlikely to provide the minimum ammonia levels required for maximum microbial growth in the rumen Norton (2000) reported. Hence, the high CP content of raw *L. camara* leaves obtained in this study, which was nearly four times higher than the minimum 6% CP level, indicates that *L. camara* varieties considered support minimum ruminant production and may potentially be used as protein supplement. Considering that maximum microbial production could supply 95% of the maintenance protein requirement under low levels of production (Wickersham *et al.,* 2008), the CP levels of *L. camara* varieties obtained in this study are well above the acceptable range of 78 – 110 g/kg dry matter recommended to meet lactation requirements in goats (National Research Council 2007).

However, optimal use of *L. camara* as a crude protein supplement requires careful consideration of the levels of soluble phenolic compounds hence feeding *L. camara* biomass, to ruminants *ad lib* especially that from red and white varieties with 0.09 and 1.26% total phenolic compounds, respectively may not be the best option (Mangan 1988). Rather restrictive feeding is ideal and to this end, further experimental research is warranted to establish threshold feeding levels beyond which *L. camara* poisoning may occur.

Another interesting aspect of results of the nutritive composition of *L. camara* varieties is that the measured NDF content was low to moderate, ranging from 409.6 to 465g/kg DM. Such high NDF values indicate that the varieties had high cell contents, which correlates positively with high digestibility (Mangan 1988) given that ADF, which contains lignin and cellulose constituted a small fraction (<30%) of DM. Thus, the digestibility of the fibre may not be a problem for ruminant livestock. It is also important to note that the results of cell wall examination presented as ADF and NDF in this study, were both relatively low and thus provide empirical evidence to support the idea that the fibre content of *L. camara* varieties are not a deterrent in the utilisation of the species as a feed for ruminants that are capable of tolerating higher levels of NDF and ADF.

With regard to anti-nutritional factors, the results of this study demonstrate that the pink flowered *L. camara* variety had lower quantities of the total phenolic compounds compared to the red and white flowered varieties. The value observed in pink flowered L. camara agrees with the previous studies which were carried out at the University of Queensland. Specifically, Morton (1994) reported that most plants of the pink flowered variety are not toxic to livestock. While the red flowered and white flowered varieties had twice as much total phenolic compounds as the pink one, the concentration of total phenolic compounds in these varieties was still not high enough to potentially affect the production of ruminants. This finding corroborates the work of Goel and Makkar (2012) as well as Waghorn (2008) which documented a number of benefits associated with feeding livestock forages with phenolic compounds. For instance, phenolic compounds lower methane production thus reducing global warming and some like tannins they reduce rumen protein degradation thus increase post ruminal digestion of protein (Jayanegara *et al.,* 2009). Key phenolic compounds in the diet such as tannin and saponins have also been shown to play an important role in control of internal parasites (Goel and Makkar 2012) hence the levels of less than 2% total phenolics measured in three L. camara could be beneficial rather than detrimental to ruminants.

What makes this study different is in characterising the nutritional composition of L. camara as a potential protein supplement and this is in contrast to most previous studies considering L. camara as a poisonous invasive species not to be fed or consumed by livestock. Ironically, this conventional wisdom is inconsistent with field observations indicating that livestock in particular goats and cattle consume *L. camara* in Zimbabwean rangelands.

CONCLUSION

Overall, the results of this study demonstrate that the nutritional composition of the red, white and pink flowered *Lantana camara* varities are potential source of feed for ruminant livestock with the pink flowered variety being the most suitable source due to its low total phenolic compounds and high CP. Although this study showed that *Lantana camara* has high crude protein content it is recommended that further field studies should be done to determine the variety most preferred by animals if allowed to voluntarily feed. Together with the current information, such studies could help in deciding whether or not *L. camara* could be used exploited to mitigate food shortages for livestock in invaded rangelands with reduced resilience to climate change.

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