Effect of drying methods on the anti-nutritional content of selected browse plants in rain forest zone of Nigeria

[1]Akinyemi, B. T., [1]Dele, P. A.,[1]Mozea, K. O., Okukenu, O.A.,[1]Babatunde, M. O., Jolaosho, A. O. and [1]Arigbede,O. M.,
Department of Pasture and Range Management,
Federal University of Agriculture, Abeokuta, OgunState.
Corresponding author: akinyemibt@funaab.edu.ng

Abstract

During the dry season, there is always scarcity of plants and grasses for ruminants to consume. However, the few available plants during this season have higher anti-nutritional factors . The high level of anti-nutritional above the recommended values could have an adverse effect on the health status and metabolic process of the animal feeding on such plants. The experiment was conducted to determine the effect of drying methods on the anti-nutritional levels of some browse plants in the leaves and leaves + twigs from (Albizia lebbeck, Albizia saman, Daniella oliveri, Enterolobium cyclocarpum, Gliricidia sepium, Leucaena leucocephala, Milletia griffoniana and Pterocarpus santalinoides). The browse plants were collected and identified, while anti-nutritional profiles were analyzed using Boham and Russel procedures. Flavonoids and phytates were recorded. There were significant (P>0.05) differences in the drying methods and anti-nutritional factors in the plant parts. The flavonoid content of the browse plants ranged from 2.67% to 7.33% while the phytate content ranged from 0.30 to 0.69 (mg/kg) respectively. Albizia lebbeck was highest (P<0.05) for flavonoid while Enterolobium cyclocarpum had the highest for phytate content. It is concluded that drying methods had effect on the forages considered. However, the leaves and twigs of these browse plants contained flavonoid and phytate contents which were within the recommended limits and thus safe for ruminant consumption.

Keywords: Browse plants, Dry methods, flavonoid, browse plants, anti-nutritional factors

Effet des méthodes de séchage sur la teneur anti-nutritionnelle des plantes de navigation sélectionnées dans la zone de forêt tropicale du Nigéria

Résumé

Pendant la saison sèche, il y a toujours une pénurie de plantes et d'herbes pour consommer des ruminants. Cependant, les quelques plantes disponibles au cours de cette saison ont des facteurs anti-nutritionnelles plus élevés. Le niveau élevé d'anti-nutritionnelle au-dessus des valeurs recommandées pourrait avoir un effet défavorable sur l'état de santé et le processus métabolique de l'alimentation des animaux sur de telles plantes. L'expérience a été menée pour déterminer l'effet des méthodes de séchage sur les niveaux anti-nutritionnelles de certaines plantes de navigation dans les feuilles et des feuilles + brindilles de (Albizia lebbeck, Albizia saman, Daniella oliveri, Enterolobium cyclocarpum, GliricidiaSepium, Leucaena leucocephala, Milletia griffoniana et Pterocarpus santalinois). Les plantes de navigation ont été collectées et identifiées, tandis que des profils anti-nutritionnelles ont été analysés à l'aide de procédures Boham et Russel. Les flavonoïdes et les phytates ont été enregistrés. Il y avait des différences significatives (p> 0,05) dans les méthodes de séchage et les facteurs anti-nutritionnelles dans les parties de la plante. La teneur en flavonoïde des usines de navigation varie de 2,67% à 7,33% tandis que la teneur en phyté allait respectivement de 0,30 à 0,69 (mg / kg). AlbiziaLebbeck était la plus élevée (p <0,05) pour *flavonoïde tandis que le cyclocarpum d'Enterolobium avait le plus élevé pour la teneur en phyté. Il est conclu que les méthodes de séchage avaient une incidence sur les fourrages considérés. Cependant, les feuilles et les brindilles de ces plantes de navigation contenaient du contenu flavonoïde et de phyté dans les limites recommandées et donc sans danger pour la consommation de ruminants.*

Mots-clés: Parcourir les plantes, les méthodes à sec, le flavonoïde, les plantes de navigation, les facteurs anti-nutritionnelles

Introduction

Leguminous forages and fodder trees are common in the tropical areas and are major source of feed for animals (Aganga *et al.,* 2000), yet the inability of farmers in countries of West Africa to make proper use of the available browse trees in their environment, in feeding their ruminants puts the livelihood of these animals at risk. The presence of secondary plant compounds is the major limitation to the quality of feeds which have the ability to suppress feed intake and utilization by animals (Thi Mui *et al.,* 2002). Anti-nutritional factors (ANF) are substances that when found in feed, reduce the availability of essential nutrients, thereby limiting the nutritional status of the animal and some have immune suppressive characteristics. Secondary metabolites have different mode of action, it could be by depressing metabolic utilisation of protein or digestion. Some of these ANFS aid in decreasing or increasing the requirement of certain vitamins and can also interfere with the optimum maximisation of mineral elements. Flavonoids have been linked with antioxidant activity in biological systems, chiefly due to their redox potential, which can play an essential role in neutralising free radicals, absorbing, quenching singlet and triplet oxygen, or decomposing peroxides (Manojlović, 2012). Flavonoids have evoked multiple biological functions through their free-radical scavenging activity, which include anti-bactericidal, immune stimulatory, anti-inflammatory and anti-viral functions (Kandaswami and Middleton, 1998), they are ubiquitous in higher plants (Sathiamoorthy *et al.,* 2007) and could significantly inhibit microbes which are resistant to conventional antibiotics (Iinuma *et al.,* 1994). Drying is an alternative form of storage used in Nigeria (Alector and Abiodun, 2013). Dehydrated fodders are easy to use and have a long shelf life than fresh fodder (Chauhan and Sharma, 1993). It is the cheapest and quite simplest method of conservation used in the reduction of excess moisture in the fresh material and forage crops through sum of hot and dry natural air (Mandhyan *et al*. 1988). Preservation of these fodders prevents wastage and makes them readily available during the dry season (Lakshmi and Vimala, 2000). Hence, the aim of this study is to evaluate the effect of drying methods on the anti-nutritional levels of some browse plants.

Materials and methods

The experiment was carried out at the Department of Pasture and Range Management, College of Animal Science and Livestock Production (COLANIM), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The experiment was 8 x 3 x 2 factorial design which was replicated three times. It comprises of eight browse plants (*Albizia lebbeck, Albizia saman, Daniella oliveri, Enterolobium cyclocarpum, Gliricidia sepium, Leucaena leucocephala, Milletia griffoniana* and *Pterocarpus santalinoides),* three drying methods (air, sun and oven dry) and two plant parts (leaves, leaves+twigs). The leaves, leaves and twigs of the browse plants were collected during the early dry season (October - December) in which the leaves, leaves and twigs of *Albizia lebbeck, Albizia saman, Daniella oliveri, Enterolobium cyclocarpum, Gliricidia sepium, Leucaena leucocephala, Milletia griffoniana* and *Pterocarpus santalinoides*

Sample preparation

The browse species were harvested, sorted into leaves, leaves and twigs. The samples were subjected to three drying methods of drying; Air drying at room temperature, Sun drying and oven drying at $65^{0}C$ until a constant weight was attained. Thereafter, the samples were hammer milled, labeled, packaged and stored in a dry place for further laboratory analysis. Phytate was determined using the method described by Russel, (1980) and flavonoid was done using the method of Boham and Kocipai-Abyazan (1974). All data obtained was subjected to one-way Analysis of variance (ANOVA) and the treatment means were separated using Duncan Multiple Range test.

Results

Table 1 shows the anti-nutritional content of browse plants, drying methods and plant parts. A significant (P<0.05) difference was observed in the flavonoid and phytate content of the browse plants. Flavonoid content ranged from 7.33% in *Albizia lebbeck* to 2.67% in *Pterocarpus santalinoides.* The phytate contentwas significant (P<0.05) with values ranging from 0.69 (mg/kg) in *Enterolobium cyclocarpum* to 0.31 (mg/kg) in *Gliricidia sepium.* Drying methods and plant parts were not significant (P>0.05) on the anti-nutritional content of the browse plants. Table 2 shows the interaction effect of drying methods of browse plants on anti-nutritional factors. A significant (P<0.05) difference was reported in the drying methods of browse plants on flavonoid and phytate content. The flavonoid content of oven dried browse plants ranged from 6.50 % in *Gliricidia sepium* to 1.33% in *Pterocarpus santalinoides*. The sun dried browse plants from 7.50% in *Albizia lebbeck* to 3.00% in *Pterocarpus santalinoides* while air dried browse plants ranged from 8.16% in *Albizia lebbeck* to 3.66% in *Pterocarpus santalinoides* respectively. The phytate content of oven dried browse plants were significant (P<0.05) with values ranging from 0.68 (mg/kg) in *Albizia lebbeck* to 0.32 (mg/kg) in *Daniella oliveri*. The sun dried browse plants had values that ranged from 0.89 (mg/kg) in *Leucaena leucocephala*to 0.30 (mg/kg) in *Daniella oliveri* while air dried browse plants has 0.66 (mg/kg) in *Enterolobium cyclocarpum*to 0.29 (mg/kg) in *Daniella oliveri* respectively.

Table 3 shows the interaction effect of plant parts of browse plants on anti-nutritional factors. There were significant (P<0.05) difference recorded in the leaves and leaves with twigs. The flavonoid content of leaves of the browse plants were significant (P<0.05) with values ranging from 8.00% in *Albizia lebbeck* to 1.44% *Pterocarpus santalinoides* while leaves with twigs ranged from 6.67% in *Albizia lebbeck* to 3.33% in *Daniella oliveri*. The phytate content in the leavesof the browse plants ranged from 0.69 (mg/kg) in *Enterolobium cyclocarpum* to 0.30 (mg/kg) in *Daniella oliveri* while the phytate content in the leaves with twigs ranged from 0.68 (mg/kg) in *Enterolobium cyclocarpum* to 0.30 (mg/kg) in *Daniella oliveri* respectively. Table 4 shows the interaction effect of drying methods and plant parts of browse plants on anti-nutritional content. There were significant (P<0.05) difference for the leaves and leaves with twigs of browse plants and the drying methods on anti nutritional content. The flavonoid contents of sun dried browse leaves had values ranging from 5.08% to 4.46% in air dried

Table 1: Effects of drying methods and plant parts of browse plants on the anti-nutritional content of selected browse plants

Browse plants	Flavonoid (%)	Phytate (mg/kg)
Albizia lebbeck	7.33^{a}	0.38^{bc}
Albizia saman	4.50^{a}	0.64^{a}
Gliricidia sepium	6.78^{b}	0.31^{bc}
Enterolobium cyclocarpum	4.89^{b}	0.69^{a}
Pterocarpus santalinoides	2.67^{c}	0.40^{bc}
Millettia griffoniana	3.56^{bc}	0.41^{b}
Daniella oliveri	3.56^{bc}	0.30^{c}
Leucaena leucocephala	4.72^{bc}	0.67^{a}
SEM	0.51	0.03
Drying method		
Oven Dry	4.33	0.50
Sun Dry	4.71	0.47
Air Dry	5.21	0.46
SEM	0.22	0.03
Plant part		
Leaves	4.72	0.47
Leaves with twigs	4.78	0.48
SEM	0.33	0.18

^{a,b,c}Means on the same column with different superscripts are significantly different (P<0.05)

Table 2: Interaction effect of drying methods of browse plants on anti-nutritional content of selected browse plants

Browse plant	Drying method	Flavonoid (%)	Phytate (mg/kg)
Albizia lebbeck	Oven dry	6.33^{abcdef}	0.38^{ef}
	Sun dry	7.50^{ab}	0.40^{ef}
	Air dry	8.16^{a}	0.36^{f}
Albizia saman	Oven dry	4.33^{bcdefgh}	0.68^{bc}
	Sun dry	4.50^{bcdefgh}	0.63^{bcd}
	Air dry	4.66^{bcdefg}	0.61^{bcd}
Gliricidia sepium	Oven dry	6.50^{abcde}	0.35^{f}
	Sun dry	7.16^{abc}	0.31^{f}
	Air dry	6.66^{abcd}	0.30^{f}
Enterolobium cyclocarpum	Oven dry	3.83^{defgh}	0.64^{bcd}
	Sun dry	5.83^{abcdefg}	0.77^{ab}
	Air dry	5.00^{bcdefg}	0.66^{bc}
Pterocarpus santalinoides	Oven dry	1.33^{h}	0.41^{ef}
	Sun dry	3.00^{gh}	0.31^{f}
	Air dry	3.66^{defgh}	0.47^{def}
Millettia griffoniana	Oven dry	3.16^{fgh}	0.42^{ef}
	Sun dry	3.16^{fgh}	0.42^{ef}
	Air dry	4.33^{bcdefgh}	0.39^{ef}
Daniella oliveri	Oven dry	3.33^{efgh}	0.32^{f}
	Sun dry	3.16^{fgh}	0.30^{f}
	Air dry	4.16^{cdefgh}	0.29^{f}
Leucaena leucocephala	Oven dry	5.83^{abcdefg}	0.55^{cde}
	Sun dry	3.33^{efgh}	0.89^{a}
	Air dry	5.00^{bcdefg}	0.56^{cde}
SEM		0.22	0.04

$^{a, b, c, d, e, f, g, h}$Means on the same column with different superscripts are significantly different (P<0.05) leaves. While the flavonoid content of the leaves with twigs of air dried browse plants ranged from 5.96% to 4.04%in oven dried leaves with twigs. The phytate content of the leaves of the browse plants however had the oven dried leaves ranging from 0.52 (mg/kg) to 0.42 (mg/kg) in air dried leaves, while phytate content of leaves with twigs ranged from 0.53 (mg/kg) in sun dried browse plants to 0.42 (mg/kg) in oven dried plants, respectively.

Table 3: Interaction effects of plants parts of browse plants on anti-nutritional content of selected browse plants

Browse plant	Plant parts	Flavonoid (%)	Phytate (mg/kg)
Albizia lebbeck	Leaves	8.00[a]	0.37[b]
	Leaves with twigs	6.67[abc]	0.38[b]
Albizia saman	Leaves	5.44[bcde]	0.64[a]
	Leaves with twigs	3.56[efg]	0.64[a]
Gliricidia sepium	Leaves	7.44[ab]	0.31[b]
	Leaves with twigs	6.11[abcd]	0.32[b]
Enterolobium cyclocarpum	Leaves	3.67[efg]	0.69[a]
	Leaves with twigs	6.11[abcd]	0.68[a]
Pterocarpus santalinoides	Leaves	1.44[g]	0.38[b]
	Leaves with twigs	3.89[def]	0.41[b]
Millettia griffoniana	Leaves	3.00[fg]	0.41[b]
	Leaves with twigs	4.11[def]	0.40[b]
Daniella oliveri	Leaves	3.78[def]	0.30[b]
	Leaves with twigs	3.33[efg]	0.30[b]
Leucaena leucocephala	Leaves	5.00cdef	0.65[a]
	Leaves with twigs	4.44[cdef]	0.67[a]
SEM		0.22	0.05

[a, b, c, d, e, f, g, h] Means on the same column with different superscripts are significantly different ($P<0.05$)

Table 4: Interaction effect of drying methods and plant parts on anti-nutritional content of selected browse plants

Drying method	Plant part	Flavonoid (%)	Phytate (mg/kg)
Oven dry	Leaves	4.63[ab]	0.52[a]
	Leaves with twigs	4.04[b]	0.42[b]
Sun dry	Leaves	5.08[ab]	0.48[ab]
	Leaves with twigs	4.33[ab]	0.53[a]
Air dry	Leaves	4.46[ab]	0.42[b]
	Leaves with twigs	5.96[a]	0.49[ab]
SEM		0.24	0.43

[a,b,c]Meansonthesamecolumnwithdifferentsuperscriptsaresignificantlydifferent($P<0.05$)

Discussion

Flavonoids showed variations in different browse species at duration of heat exposure and processing condition as reported by Motlhanka (2012). The results obtained from the interaction of the browse plants, plant parts and drying conditions had significant influence on the flavonoid content. The difference in drying conditions had effect on the quantity of flavonoid which is similar to Motlhanka (2012), who noted that a decrease in the quantity of flavonoid was as a result of certain factors such as thermal interaction, surface area and leaf matrix. The range of value obtained for the interaction between sun drying and browse plant parts is contrary to the value obtained for *Pseudolachnostylis maprouneifolia* reported by Motlhanka (2012) and this may be due to the differences in plant type, leaf size, intensity of sunlight during drying, other environmental and genetic factors of individual plants. The anti-nutritional factor of *P. santalinoides* without the drying effect was determined by Nwokoreie *et al.*(2015) with results higher than the phytate and Flavonoid content of the leaves of *Pterocarpus santalinoides* obtained in the present study. Phytate have the ability to bind minerals like Calcium, Magnesium, Iron, Zinc, and Molybdenum thereby reducing their bioavailability in the intestine tract. Phytate contents of browse leaves which are analysed may come as a result of Phosphorus stored by the plants as reported by Lola and Markakis (1975). The range of the phytate content of browse plants was higher than *Telfeira occidentalis* reported by Adegunwa *et al.*(2011). This could be as a result of difference in soil composition and plant type. The phytic acid content of oven dried *Gliricidia sepium* leaves was similar to that of Onwuka (1994) for browse plants. However there was rapid increase and then a reduction in the phytate content of sun dried and over dried browse plants. This depends on the browse species and the plant parts. This variation disagrees with Oboh *et al.* (2005) who stated that processing decreases phytate content of plant food.

Conclusion

From this study, it can be concluded that the anti-nutritional factors of the browse plants analysed were within the recommended limits acceptable for ruminants which will not be deleterious t.

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