Effect of season on the chemical composition and *in vitro* digestibility of some browse and shrubs in Ghana

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SUMMARY

The seasonal variation in the chemical composition of some browse and shrubs in the coastal savanna of Ghana was ascertained. The browse studied were *Antiaris africana, Delonix regia, Milletia thonningii, Grewia carpinifolia, Ritchea reflexa,* and *Securinega virosa.* Samples collected in mid-November1992, early February 1993, and mid-June 1993 corresponding to the peak periods of the minor rains, dry season, and major rains, respectively, were used. Samples were analyzed for dry matter and crude protein (percent CP), neutral detergent fibre (percent NDF), acid detergent fibre (percent ADF), cellulose, acid detergent lignin (ADL), and *in vitro* dry matter digestibility (IVD). Significant differences were observed with season ($P<0.05$) but not with species ($P>0.05$) with dry matter where the dry season values were higher than those of the major and minor rains. Dry matter content ranged between 33 and 40 per cent. Crude protein content was lower ($P<0.05$) in the major rains compared to the minor rains and dry seasons. It showed significant species ($P<0.05$) variation and ranged between 11and 22 per cent. No significant seasonal effects ($P>0.05$) were observed in the fibre components and IVD values, but significant species differences ($P<0.05$) were observed. The range of values were NDF 27-63, ADF 13-46, cellulose 10-31, ADL 2.5-41, and IVD 40-80 per cent. Thus, browse and shrubs in Ghana have adequate protein levels that would make their contribution towards improving the dry season nutrition of ruminants very useful.

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RÉSUMÉ

SOTTIE, E. T., HENAKU AGYEI, A. A. O., AMANING-KWARTENG, K. & FLEISCHER, J. E.: *L'effet de la saison sur la constitution chimique et la digestibilité in vitro de quelques brouts et d'arbrisseaux au Ghana.* Une étude s'est déroulée pour s' assurer de la variation saisonnière dans la constitution chimique de quelques brouts et d' arbrisseaux dans la savane littorale du Ghana. Les brouts étudiés étaient *Antiaris africana, Delonix regia, Milletia thonningii, Grewia carpinifolia, Ritchea reflexa* et *Securinega virosa.* Les échantillons pris à la mi-novembre, 1992, au début du Février, 1993 et à la mi-juin, 1993, correspondant aux pleines saisons de la saison des pluies mineures, la saison séche et respectivement à la saison des pluies majeures, étaient utilises. Les échantillons étaient analysés pour la matiére sèche et la protéine brute (PB pour cent), la fibre détersive neutre (FDN pour cent), la fibre détersive acide (FDA pour cent), la cellulose, la lignine détersive acide (LDA) et la digestibilité de matiére séche in vitro (DIV) Des différences considerables étaient observée avec la saison ($P < 0.0\ 5$) mais pas avec les espèces ($P> 0.05$), avec la matiére sèche où les valeur de la saison sèche étaient plus élevées que ceux des saison des pluies majeures et mineures. Le contenu de la matière séche variait entre 33 et 40 pour cent. Le contenu de la protéine brute étaiet inférieur ($P < 0.05$) dans les saisons des pluies majeures par rapport aux saison des pluies mineures et aux saison séches. Elle montrait des variations considérables d'espéces ($P< 0.05$) et variaent entre 11.0 et 22 pour cent. Quelques effets saisonniers considérables n' étaient observés dans le constituants de fibre et les valeurs DIV mais des différences considérable d'espéces étaient observées. Les variations de valeurs étaient FDN 27-63 pour cent, FDA 13-46 pour cent, la cellulose 10-31 pour cent, LDA 2.5 - 41 pour cent et DIV 40 -80 pour cent. Ainsi les brouts et les arbrisseaux au Ghna ont des niveaux de protéine adéquates que pourraient rendre leurs contribution vers l'amélioration de nutrition des ruminants pendant la saison séche, trés utile.

Introduction

Ruminant-fed resources from natural grasslands include grass, shrubs, and browse. The latter two are, however, grossly under-utilized in many tropical countries owing to a general lack of knowledge and understanding of their potential contribution to the nutrition of the ruminant. Browse and shrubs can supply protein, lipid, minerals, and vitamins which may be lacking in grass, especially during the dry season (Le Houerou, 1980; Norton, 1994; Topps, 1992). For instance, Rose Innes & Mabey (1964) reported that the protein content of some browse and shrubs on the Accra Plains of southern Ghana varied from 11 to 17 per cent. In contrast, the protein content of grass during the dry season was only 3 to 4 per cent (Lansbury, Rose Innes & Mabey, 1965).

The objective was, therefore, to study the seasonal variation in the chemical composition of some browse and shrubs in the coastal savanna of Ghana to investigate if these could support livestock in the dry season.

Materials and methods

The study was done at the University of Ghana's Department of Animal Science located in the Accra Plains of southern Ghana. The pattern of annual rainfall in this area is bimodal and total rainfall ranges between 550 and 1000 mm with an average of about 730 mm. The major rainy season spans between April and July, and the minor season spans between September and November. The dry seasons are in August and the period between December and March. Average annual maximum and minimum temperatures are about 29 and 23.5 °C, respectively.

The browse and shrubs used in the study were *Antiaris africana, Delonix regia, Milletia thonningii* (Schùm and Thonn), *Khaya senegalensis* (Desr.) A Jurs., *Griffonia simplicifolia* (Vahl ex DC) Biall, *Grewia carpinifolia, Ritchea reflexa,* and *Securinega virosa.* Samples were collected from the University campus and the surrounding areas in mid-November 1992, early February 1993, and mid-June 1993. These periods corresponded to the peak periods of the minor rains, dry season and major rains respec-tively. The design was a 3 × 8 factorial with season (3) as well as browse and shrubs (8) as the factors.

Fresh samples of leaves and immature stems weighing between 330 and 575 g per plant, depending on the species, were collected. Samples were collected from three different plants for each species. The samples were weighed and dried at 65 °C for 48 h to obtain the dry matter. After drying, samples were bulked for each species to obtain a composite sample which was then ground to pass through 1-mm sieve and analyzed for crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) cellulose, and acid detergent lignin (ADL) according to procedures outlined by AOAC (1990). *In vitro* dry matter digestibility (IVD) was determined by the method described by Minson & McLeod (1972).

The data were analyzed by the two-way ANOVA technique as outlined by Snedecor & Cochran (1976).

Results

Table 1 shows the dry matter contents of the browse and shrubs as influenced by season and species. Dry season values were significantly higher ($P<0.05$) than those of the rainy season. However, the values for both the major and minor rainy seasons were similar ($P>0.05$). No significant differences ($P>0.05$) were observed among species. The dry matter contents ranged from an average of 33 per cent in *Securinega* to 40 per cent in *Ritchea.*

Table 2 shows the crude protein contents of the browse and shrubs. The average crude protein values for all species during the major rains were significantly lower ($P<0.05$) than those for the dry and minor rainy seasons. However, the crude protein content of the species during the minor rains were similar to those of the dry season. Significant differences ($P<0.05$) were observed among species. *Khaya* and *Milletia* had the lowest and highest values, respectively.

TABLE 1

Dry Matter Content of Some Browse and Shrubs in Ghana as Influenced by Season and Species

	Season			
Species	*Dry*	*Major rains*	*Minor rains*	*X ± SE*[1]
A. africana	44.3	34.9	31.2	36.8 ± 6.75[3]
D. regia	38.5	34.4	34.3	35.7 ± 2.40
M. thonningii	36.7	34.4	31.5	35.0 ± 3.06
K. senegalensis	40.6	32.7	34.9	36.1 ± 4.08
G. simplicifolia	40.6	34.0	31.9	35.5 ± 4.54
G. carpinifolia	50.3	30.0	37.7	39.3 ± 10.75
R. reflexa	44.9	35.7	40.6	40.4 ± 4.60
S. virosa	43.3	25.2	29.2	32.6 ± 9.51
X ± SE[1]	42.4 ± 4.26a[4]	33.0 ± 3.76a	33.9 ± 3.77a	

LSD[2] Season = 4.31 Species = 9.40

1. Mean ± standard error
2. LSD = Least significant difference
3. Mean values in the same column with different letters are significant ($P<0.05$)
4. Mean values in the same row with different letters are significant ($P<0.05$)

TABLE 2

Crude Protein Content of Some Browse and Shrubs in Ghana as Influenced by Season and Species

	Season			
Species	*Dry season*	*Major rains*	*Minor rains*	*X ± SE*[1]
A. africana	14.7	14.77	19.1	16.2 ± 2.56ab[3]
D. regia	19.9	16.99	18.8	18.5 ± 1.52b
M. thonningii	21.9	17.11	19.1	19.4 ± 2.41b
K. senegalensis	12.9	11.8	11.0	11.9 ± 0.96a
G. simplicifolia	18.22	16.12	16.9	17.0 ± 1.00ab
G. carpinifolia	18.22	16.12	17.1	17.1 ± 0.99ab
R. reflexa	19.77	17.11	17.3	18.0 ± 1.5ab
S. virosa	18.8	13.56	21.6	17.9 ± 4.08ab
X ± SE[1]	18.02 ± 2.91a[4]	15.42 ± 1.92b	17.61 ± 3.08a	

LSD[2] Season = 2.11 Species = 6.49

1. Mean ± standard error
2. LSD = Least significant difference
3. Mean values in the same column with different letters are significantly different ($P<0.05$)
4. Mean values in the same row with different letters are significantly different ($P<0.05$)

Table 3 shows the neutral detergent fibre contents of the browse and shrubs. No significant differences ($P>0.05$) were observed among seasons. On the contrary, significant differences ($P<0.05$) were observed among species. *Securinega* and *Milletia* had the lowest and highest NDF values, respectively.

Table 4 shows the acid detergent fibre contents of browse and shrubs. No significant differences ($P>0.05$) were observed among seasons. Significant differences ($P<0.05$) were, however, observed among species. *Delonix* and *Milletia* had the lowest and highest values, respectively.

Table 5 shows the cellulose contents of the browse and shrubs. No significant differences ($P>0.05$) were observed between seasons. Significant differences ($P<0.05$) were, however, found among species. *Delonix* and *Milletia* had the lowest and highest values, respectively.

Table 6 shows the acid detergent lignin contents of the browse. *Securinega* and *Curifflmia* had the lowest and highest values, respectively.

Table 7 shows the *in vitro* dry matter digestibility contents of browse and shrubs as influenced by season and species. No significant differences ($P>0.05$) were found among the average seasonal values. On the other hand, significant differences ($P<0.05$) were observed among species. Except for *Milletia* whose IVD value was very low (41 per cent), most browse and shrubs had IVD values that varied from moderate (52 per cent) to high (78 per cent).

Discussion

The higher dry matter values obtained for the browse and shrubs during the dry season may be partly due to the increased evapotranspiration rate as well as to the reduced soil moisture availability

TABLE 3

Neutral Detergent Fibre Content of Some Browse and Shrubs in Ghana as Influenced by Season and Species

	Season			
Species	*Dry*	*Major rains*	*Minor rains*	*X ± SE*[1]
A. africana	42.1	48.0	43.9	44.7 ± 3.02bc[3]
D. regia	57.6	53.8	56.5	56.0 ± 1.96d
M. thonningii	61.8	63.7	63.3	62.9 ± 1.00e
K. senegalensis	47.9	48.6	55.4	50.6 ± 4.14ed
G. simplicifolia	53.0	50.3	55.0	52.8 ± 2.36ed
G. carpinifolia	62.3	55.8	45.1	54.4 ± 8.69d
R. reflexa	47.4	35.7	44.9	42.7 ± 6.16b
S. virosa	31.7	30.5	26.5	29.6 ± 2.72a
X ± SE[1]	50.5 ± 10.45a[4]	48.3 ± 10.71a	48.8 ± 11.35a	

LSD[2] Season = 8.54 Species = 6.65

1. Mean ± standard error
2. LSD = Least significant difference
3. Mean values in the same column with different letters are significantly different ($P<0.05$)
4. Mean values in the same row with different letters are significantly different ($P<0.05$)

TABLE 4

Acid Detergent Fibre Content of Some Browse and Shrubs in Ghana as Influenced by Season and Species

	Season			
Species	*Dry*	*Major rains*	*Minor rains*	*X ± SE*[1]
A. africana	29.6	30.6	26.7	29.0 ± 2.03b[3]
D. regia	34.6	35.7	17.0	29.1 ± 10.49b
M. thonningii	38.0	40.1	43.8	40.6 ± 2.94d
K. senegalensis	34.4	36.5	38.8	36.6 ± 2.20bcd
G. simplicifolia	37.4	31.4	32.6	33.8 ± 3.17bcd
G. carpinifolia	45.5	41.2	26.1	37.6 ± 10.19cd
R. reflexa	32.1	27.1	32.2	30.5 ± 2.92bc
S. virosa	14.2	13.5	12.8	13.5 ± 0.70a
X ± SE[1]	33.2 ± 9.03a[4]	32.0 ± 8.89a	28.8 ± 10.41a	

LSD[2] Season = 7.44 Species = 8.39

1. Mean ± standard error
2. LSD = Least significant difference
3. Mean values in the same column with different letters are significantly different ($P<0.05$)
4. Mean values in the same row with different letters are significantly different ($P<0.05$)

characteristic of the dry season. On the other hand, the non-significant difference in dry matter content among species was perhaps due to the predominance of matured leaves among those present at sampling. The more matured the leaf, the higher the dry matter content. At any time of the plant's development, the available leaves consist of individual leaves in different physiological state (Langer, 1973), and this influences the material harvested at any time.

The lack of significant differences between seasons in NDF, ADF, ADL, and IVD suggest that materials for feeding livestock could be obtained at any season provided they are properly preserved. On the other hand, the observed differences among species have also been noted by other workers with other species (Norton, 1994; Addo-Kwafo, 1996), and may be due to a combination of factors among which may include the plant parts and age of the materials sampled (Norton, 1994). For example, the stem generally had higher fibre components and lower digestibility compared to leaves, and these may be in different physiological maturity state even if by appearance they look similar.

The seasonal variations in crude protein observed in this study may be partly due to the variation in the phenology of the plants with the changing season. For example, *Khaya* sheds most of its leaves and grows new ones in the dry season. *Milletia*, on the other hand, sheds most of its leaves in the dry season but begins to grow new ones, most of which are carried over to the rainy season. Thus, at the peak of the rainy

TABLE 5

Cellulose Content of Some Browse and Shrubs in Ghana as Influenced by Season and Species

Species	Season			$X \pm SE^{1)}$
	Dry	*Major rains*	*Minor rains*	
A. africana	16.1	19.3	17.3	17.6 ± 1.62b[3)]
D. regia	12.1	11.0	6.5	9.9 ± 2.97a
M. thonningii	25.6	22.1	25.2	24.3 ± 1.92c
K. senegalensis	20.5	20.2	22.4	21.0 ± 1.19bc
G. simplicifolia	18.2	14.9	18.1	17.1 ± 1.88b
G. carpinifolia	31.0	17.4	15.0	21.1 ± 8.63bc
R. reflexa	22.8	17.6	23.9	21.4 ± 3.37bc
S. virosa	10.2	9.7	10.4	10.1 ± 0.36ba
$X \pm SE^{1)}$	19.6 ± 6.93a[4)]	16.5 ± 4.37a	17.4 ± 6.57a	

LSD[2)] Season = 4.77 Species = 5.46

1. Mean ± standard error
2. Least significant difference
3. Mean values in the same row with different letters are significantly different ($P<0.05$)
4. Mean values in the same column with different letters are significantly different ($P<0.05$)

TABLE 6

Acid Detergent Lignin Content of Some Browse and Shrubs in Ghana as Influenced by Season and Species

Species	Season			$X \pm SE^{1)}$
	Dry	*Major rains*	*Minor rains*	
A. africana	7.9	7.7	6.3	7.3 ± 0.87b[3)]
D. regia	11.3	9.0	9.6	10.0 ± 1.19cd
M. thonningii	10.5	15.6	17.1	14.4 ± 3.46f
K. senegalensis	13.4	14.0	14.1	13.8 ± 0.38ef
G. simplicifolia	17.5	15.1	14.4	15.7 ± 1.63f
G. carpinifolia	12.8	11.2	10.4	11.5 ± 1.22de
R. reflexa	8.9	9.3	8.4	8.9 ± 0.45bc
S. virosa	3.1	3.5	2.5	3.0 ± 0.50a
$X \pm SE^{1)}$	10.7 ± 4.26a[4)]	10.7 ± 4.14a	10.4 ± 4.76a	

LSD[2)] Season = 3.46 Species = 2.30

1. Mean and standard error
2. Least significant difference
3. Mean values in the same column with different letters are significanty different ($P<0.05$)
4. Mean values in the same row with different letters are significantly different ($P<0.05$).

season it would be carrying new but mostly matured leaves.

The crude protein values obtained for the various species in this study agree with those published by the other workers (Rose Innes & Mabey, 1964; Le Houerou, 1980; Norton, 1994; Topps, 1992). For instance, Rose Innes & Mabey (1964) reported that the crude protein content of *Griffonia, Milletia, Khaya* and *Grewia* were 18.0, 19.0, 15.0, and 18.0 per cent, respectively. Norton (1994) had also reported that the crude protein content of most browse and shrubs ranged between 13 and 30 per cent of the dry matter. In this study, the values obtained (12-20 per cent) were higher than those of the natural grasses (2.4 per cent) during the dry season (Lansbury, Rose Innes & Mabey, 1965). Thus, barring any deleterious compounds, these browse and shrubs can be used to improve the nitrogen nutrition of ruminant live-stock during the dry season.

Tropical Africa lacks information on the digestibility of browse and shrubs. That notwithstanding, the values obtained in the study (52-78 per cent) compare favourably with the range of values published for other browse and shrubs (32-69 per cent) (Mabey & Rose Innes, 1964a,b; Mabey & Rose Innes, 1966c; Norton, 1994; Topps, 1992). The IVD value of *Milletia* obtained in the study was, however, lower than that reported by Addo-Kwafo (1996). The latter obtained a value of 53 per cent for the foliage of an 8-month-old

TABLE 7

In Vitro *Digestibility of Some Browse and Shrubs in Ghana as Influenced by Season and Species*

	Season			
Species	*Dry*	*Major rains*	*Minor rains*	$X \pm SE^{1)}$
A. africana	70	72.02	71.6	71.33 ± 0.87e[3)]
D. regia	52.9	57.0	58.4	56.07 ± 2.87bc
M. thonningii	40.7	41.1	40.4	40.74 ± 0.36a
K. senegalensis	50.9	53.7	51.4	52.04 ± 1.49b
G. simplicifolia	53.1	54.6	53.2	53.62 ± 0.85bc
G. carpinifolia	58.4	59.1	58.4	58.61 ± 0.40cd
R. reflexa	60.1	64.0	61.3	61.92 ± 2.00d
S. virosa	75.0	80.0	78.0	77.68 ± 2.51f
$X \pm SE^{1)}$	57.69 ± 10.0a[4)]	60.19 ± 11.9a	59.0 ± 11.74a	

LSD[2)] Season = 10.33 Species = 5.11

1. Mean and standard error
2. Least significant difference
3. Figures in the same column with different letters are significant ($P<0.05$)
4. Figures in the same row with different letters are significant ($P<0.05$)

plant in the dry season. It is possible that the latter samples were physiologically less mature than the former. The IVD values obtained for *Antiaris, Griffonia* and *Grewia* were lower than those of the *in vitro* digestibility, i.e. DMD, reported as 69.5 per cent for *Griffonia, Antiaris* and *Grewia,* respectively.

As pointed out by Norton (1994), the IVD does not always predict the dry matter digestibility (DMD) accurately, especially when dealing with browse. The digestibilities of these browse and shrubs, nevertheless, were similar or better than that of the natural grasses (53 per cent) at the end of the major rains (Lansbury, Rose Innes & Mabey, 1965). Thus, their inclusion in the diet may improve the digestibility of the basal diet during the dry season.

In conclusion, the browse and shrubs available in Ghana were found to have protein and digestibility levels that suggest that they have the potential of augmenting the quality of available feed resources for ruminant livestock in the dry season. The lack of significant seasonal differences in the chemical composition, except for the crude protein content, suggest that the material gathered in any season is as good as any other if preserved well.

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